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Students as Co-Creators of a Classroom in an Immersive Web Environment

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Abstract. This paper reports on an intervention with thirty-seven students from two seventh-grade classes. The students, divided into eleven working groups, were involved in a design for the learning process. By imagining a classroom in an Immersive Web Environment (IWE), they had to think about how IWE could be developed to learn English vocabulary. To do this, they used scenery paper, markers and coloured pencils and voted on the room they wanted to be built. After this vote, they thought about how they could include their colleagues' ideas and they redesigned the room to be built, using Artificial Intelligence tools and paper and pencil. The results presented in this article refer to the data obtained by analysing the students' logbooks, used in the ideation (phase one) and construction/customisation (phase two) phases of IWE. In phase one, the students incorporated playful and interactive elements into their designs and that the IWE made references to games and films, and in phase two they showed enthusiasm, but also many difficulties in modelling the IWE. Before starting the intervention, a questionnaire survey was administered with the aim of characterising the students' experience of video games, 3D modelling and IWE. The results showed that most of the students play video games, although they don't programme them. Most are familiar with 3D modelling of objects, although their experience is limited to a few classroom activities. They are not familiar with IWE platforms and their knowledge of Virtual Reality (VR) is associated with gaming experiences.

Keywords: Immersive Web Environments, Personalization, Co-Creation.

1 Introduction

The digital technologies offer new possibilities for creating innovative and interactive learning environments, including Immersive Web Environments. IWE combines elements of virtual reality, 3D objects and online interactivity [1]. These environments allow personalized educational experiences to be developed and students to explore content collaboratively [1,2]. They also allow students to actively participate in construction and personalization, moving from passive elements and receivers of information to active participants and committed to their own learning process [3]. Immersive Web Environments use technology that allows access via web browsers, ensuring compatibility with various devices such as mobile devices, computers and Virtual and Augmented Reality glasses [4,5].

This study explores the implementation of an innovative pedagogical project in which 7th grade students are involved in co-creating a virtual classroom in an IWE to promote vocabulary learning in English. The main objective is to understand how students conceptualise and design IWE, promoting creativity and collaboration between them. Analysing the students' logbooks makes it possible to identify the challenges and opportunities the students faced during the process of ideating and building IWE, encouraging them to reflect on their strategies and decisions for designing IWE. In this way, it is possible to identify the difficulties and limitations faced by the students in modelling the IWE and the metacognitive processes, through the way the students planned and evaluated their own ideas and progress during the ideation and construction phases of the IWE.

A Participatory Design (PD) methodological approach was adopted [6, 7] in which students were co-creators and co-designers [6, 7] allowing them to influence the design process according to their realities and needs [7] and from the lens of student perspectives [7, 8]. Co-creators are usually involved in the whole process, from start

to finish, and co-designers share ideas and thoughts [7]. This approach has been combined with Design Thinking (DT), ensuring iterative development and student involvement, having provided the appropriate tools for them to express their opinions and knowledge [7]. The fundamentals of DT processes are inspiration, ideation and implementation [9, 10]. The integration of PD and DT in the development of this project gave importance to experimentation, the ideas generated were accompanied by experimentation and testing in practice to improve their applicability [10].

The study was developed in three main phases: design, construction and use of the IWE, allowing all students to contribute to the design of the environment and for their ideas to be incorporated into the final project. In this way, the students applied their knowledge of English throughout the project while developing technical and collaborative skills that are essential for the 21st century. It also reports on the collaboration between students and students and teachers in the design, development and construction of these environments.

The article also addresses the difficulties they faced and their perception of these challenges, as well as the strategies used and solutions adopted to overcome these difficulties. The study also aims to explore how students learn to learn and develop metacognitive skills along the way.

2 Methodology

The students, divided into eleven groups (with 3 and 4 members), were challenged to rethink the 'classroom' space and create an IWE to learn vocabulary related curriculum content in the subject of English. There was no specific criterion for the formation of the groups; it was the students who chose their working groups. Thirty-seven students took part in the study, from two seventh grade classes in a school where the students are not English native speakers. The average age was 12.5 years (standard deviation 0.83 and median 12), ranging from 11 to 16 years.

In this article, we present the qualitative results of analysing the logbooks through a content analysis [11, 12]. Content analysis enables an effective approach to qualitative data [13, 14]. Thematic categories that emerged from the data were identified. These logbooks were drawn up by the eleven working groups during the lessons in which the students designed (phase one) and personalised (phase two) the IWE. The quantitative results were obtained by applying the questionnaire survey to the students. The aim of this questionnaire is to obtain information on the students' familiarity with issues related to the use of video games, experience in 3D modelling and knowledge and use of IWE.

The students participated voluntarily and were informed that they could withdraw at any time without any penalty. All ethical and data protection procedures were considered, and the confidentiality and anonymity of the participants was guaranteed [15, 16]. The data was collected and analyzed anonymously to protect the privacy of the participants. Informed consent was obtained from the students, their parents/guardians and the school management, who were informed about the research and authorized the students' participation. The students were also informed about the use of their work.

The study was drawn up by the researchers and the planning sent to the teacher responsible for its implementation, who validated the feasibility of the work plan. The intervention was divided into three phases: 1) imagining IWE, 2) building IWE and 3) using IWE as an English classroom. Phase one aims to stimulate students' creativity in designing an IWE, challenging them to imagine what a classroom would be like in a virtual environment for learning English vocabulary. This stage involved the students in the process of co-authoring the entire IWE. By having to think and imagine IWE and what they should include in the space to help them learn English vocabulary, students are starting to reflect on the learning process (leading students to learn how to learn). Phase two, in addition to enabling students to realize the ideas they developed in phase one, promotes the development of technical skills in 3D modelling. Phase three allows the students to use the IWE they have created as a real learning environment, enabling them to take part in activities they have created to learn in English in an interactive way. Only in phase three did they have the rule to speak exclusively in English during inter-actions, while in phases one and two there was no such requirement.

The article focuses exclusively on phases one and two, in which logbooks were the main data collection tool. Although phase three is relevant to a broader understanding of the study, it has not been included in this analysis as it did not involve the use of this instrument.

In phase one, imagining IWE, the task was to design a classroom for learning vocabulary in English. The students drew the classroom and filled in a logbook, which was structured to help them with this activity. They were asked to think about questions such as:

- What do I need to research about the subject I'm going to build the IWE about?
- What do I know about building and customizing an IWE?
- What do I need to research about how to customize/build the IWE?

─ What 3D models will I need? (Will I research and download them? Will I model these objects?)
─ How will I combine the ideas I have with the content of the subject to build the space?

They were asked to give a brief description of the classroom they had imagined and at the end, the students attached the scenario they had drawn. To draw the IWE, the students used scenery paper, markers and colored pencils.

These works were displayed in an IWE created by the researchers, the link to which was sent to the teacher, who shared it with her students. After visiting the space using their laptops, mobile devices and even virtual reality glasses Meta Quest [17], each student voted for the space they thought should be built, so all the students took part in choosing the IWE design. The voting process was as follows: the teacher sent the students a link to an online form created for this purpose. Thus, each student had the opportunity to select the option they wanted, after accessing the form and registering their individual and anonymous vote. The answers were automatically stored and counted, and the result was shown to the students at the end of the vote.

After this vote, the students were asked to reflect on how to integrate their colleagues' ideas. The aim was for the students to critically reflect on their colleagues' ideas and to develop negotiation and argumentation skills, ensuring that everyone felt an integral part of the decision-making process. The students had to evaluate the different proposals and find compromises, thus ensuring that the final IWE integrated the different perspectives and that all were represented in the result.

To redefine the room to be built, they used AI tools such as the Blockade Labs platform [18], which makes it possible to create immersive 360º scenarios more quickly and efficiently, as well as enabling students to visualise and explore different ideas in real time. However, as the prompts were very simple, the results they obtained were not at all interesting, so they opted to go back to using scenery paper and pencils. They were asked to fill in the Logbook with reflections on:

─ What do I know about the subject I'm going to build the IWE on?
─ What do I need to research about the subject I'm going to build the IWE on?
─ What do I know about customizing and building IWE?
─ What do I need to research about how to customize/build the IWE?
─ What 3D models will I need? (Will I research and download or will I model these objects?
─ How will I combine the ideas I have with the content to build the space?
─ How will we combine everyone's ideas?

They attached images of the immersive room to be built and gave a brief description of it.

In phase two, the students used the Spoke platform [19] to build the IWE, which can be viewed and "inhabited" on the Mozilla Hubs platform [20]. To model the 3D objects that allow the IWE to be customized, the students used the Tinkercad platform [21]. All the platforms were indicated by the researchers. It is important to mention that the Mozilla Hubs and Spoke platforms were discontinued by Mozilla on 31 May 2024. They were asked to give a brief description of the activities carried out and to reflect on them:

─ What difficulties experienced.
─ What they did to overcome them.
─ Attitudes and behavior towards the difficulties experienced.
─ Additional notes.

The questions set out in the students' logbook are intended to guide the whole process and were considered by the researchers to be essential for stimulating reflection on the creation of IWE. These questions are intended to guide the students to promote learning that is based on stimulating critical thinking and self-regulation of intentional learning, which goes beyond the simple assimilation of content. In line with the principles of metacognition, the questions encourage students to reflect on how they learn, promoting the competence of learning how to learn. They aim to help students think about, understand and adjust their learning strategies and processes. The questions were developed based on studies on metacognition and are based on the results of a pilot study previously conducted, as well as analyses carried out during teacher training.

3 Results and Discussion

The data was collected at different times. A questionnaire survey was conducted to thirty-seven students before the intervention began. During the ideation and construction/personalisation phases, the students, divided into groups, filled in logbooks. The questionnaire consisted of closed and open questions, while the logbook only consisted of open questions. A thematic coding method was used to analyse the content of the open questions. The answers were read and grouped into categories that emerged from the data. The process involved an initial reading of all the answers, followed by the identification of recurring patterns in the students' responses. An interpretation of the students' perceptions was also carried out.

3.1 Logbooks

The presentation and analysis of the results of the intervention is based on the data collected from the logbooks filled in by the various working groups. Content analysis was used, with the categories emerging from the data itself. In addition, a brief interpretation of the results was made, accompanied by recommendations for overcoming the difficulties encountered.

In the first phase, the students were challenged to imagine the classroom and were asked to answer several questions to help them "think" about the different aspects. The first was to give a brief description of how they imagined the classroom (Table 1).

Table 1. Brief description of how you imagine your classroom.

Category	Sub-category	Example	Description/Interpretation
Traditional	N/A	"a large, traditional classroom with desks and computers"	Students still identify with traditional classrooms
Thematic	Games/Movie	"Our room will be Minecraft-themed"	Thematic
	Popular figures	"Two teachers, Messi and Ronaldo"	Inclusion of popular figures that students admire
	Future/Fiction	"Futuristic room"	Futuristic and fictional spaces
Interactive Elements	Technology	"With YouTube videos."	Use of digital technologies and platforms
	Interactive Environments	"Amusement park with vocabulary spread in the amusements." "Magic pools that help train vocabulary."	Environments that combine fun
Creative and Immersive Space	Nature	"Room under the sea and surrounded by fish." "Jungle" "We see mountains through glass"	Creation of immersive environments with elements of nature.
	Interactive	"When we click on Duolingo, we enter the site."	Integration of interactive elements that allow active and personalized learning.

Students imagine interactive and playful learning environments (amusement parks and/or water parks), based on popular themes, such as games or movies in which the presence of technology is constant. Note that there are references to futuristic spaces, but also to traditional classrooms.

Regarding the question "What do I know about the subject on which I am going to build my Immersive Web Environment (IWE) classroom?". Table 2 shows the results.

Table 2. What do I know about the subject I'm going to build my IWE classroom?

Category	Sub-category	Example	Description/Interpretation
Knowledge of the Subject	Basic Content Knowledge	"I know the subject of English, but I don't know how to build IWE." "It's to learn vocabulary in English."	They have a clear understanding of the English content, which is not the case with IWE.
	Digital Tools	"Duolingo, games, quizzes."	Digital tools they already use, which can be integrated into IWE.
Knowledge about IWE	Lack of Technical Knowledge	"We don't know yet how to build the room yet." "I still don't know how to build IWE, only that I can create according to our imagination."	They reveal a lack of knowledge about the construction of the IWE.

The students show knowledge of the English content they want to integrate and use in IWE. They mention some digital tools, which suggest experience in using them. However, they lack technical knowledge when it comes to building IWE. To achieve this, it will be necessary to provide the students with technical support both in the planning phase and in the construction phase of the environment. This support was already planned in the intervention schedule, and the research team prepared tutorials to provide to the students and teacher. In addition, the teacher attended the training given by the researchers.

The students were asked to indicate “What do I need to research about the subject on which I am going to build the IWE?” The results are shown in Table 3.

Table 3. What do I need to research about the subject I'm going to build IWE on?

Category	Sub-category	Example	Description/Interpretation
Focus on Content	Specific Resources	"Researching 3D models (Big Ben, Duolingo)". "It is necessary to do online research and see what exists."	Recognize the need to integrate resources related to English content.
	Playful elements	"Water Park." "Amusement ideas and vocabulary in English" "Search games in English”	Interest in incorporating playful elements
Technical Knowledge	Online General Search	“Research on how to build IWE" "Search for tutorials on Youtube" "I need to do online searches"	They recognize the need for online research to build the IWE.

The students show that they want to integrate specific and fun elements related to the content in English. They mention the need to research 3D models and digital tools, particularly games. They continue to show concern about the construction of IWE. They recognize the need to learn and indicate that they will search for tutorials on YouTube. In addition to the tutorials, they will make available, the researchers have prepared a list of resources and research topics to help them.

Table 4 shows the results to the question “What do I know about building and customizing an IWE?”

Table 4. What I know about building and customizing an IWE.

Category	Sub-category	Example	Description/Interpretation
Basic Knowledge	General Notions	"I know we can build." "It's in 3D."	They know that it is possible to build an IWE
Customization	Possibility of Customization	"I know that it is possible to build the set to our measure and customize it to our liking." "I know that it is possible to build and customize.”	They know that it is possible to customize IWE.
Collaborative Construction	Social Interaction	“It may have resources for us to use together" "We can find friends."	They are aware that it is a collaborative and social space.
Lack of Knowledge	Interest in learning	I don't know anything yet, but I want to learn."	Students show lack of knowledge but reveal interest in learning.

Students indicate that they can build and customize IWE and show interest in learning how to do so, despite their lack of specific knowledge about the process of building and customizing AWI. They see these environments as spaces for collaboration and a place where they can “meet their friends”. The intervention planning included moments in which students were encouraged to explore the various customization possibilities.

Table 5 shows the results obtained when the students were asked “What do I need to research about how to customize/build the IWE”.

Table 5. What I need to research on how to customize/build the IWE.

Category	Sub-category	Example	Description/Interpretation
Focus on Customization Construction	Technical Research	"Search for a tutorial on YouTube." "Go to Google and search."	To build IWE they intend to use online research.
	Specific Features for Customization	"What can we put in our IWE."	Interest in the various customization options available in IWE.
Related Topics	Personal Interest	“Ideas for amusements" "Ideas for vocabulary”	Explore themes that explore the contents in a playful way
Lack of Technical Knowledge	Lack of Knowledge	"We don't know anything about IWE yet."	They express a lack of knowledge.

The students mention specific themes to be explored in the IWE. To make up for the lack of knowledge on how to customize and build the IWE, they intend to search for tutorials and information online, especially on YouTube and Google, which reveals a self-taught approach to overcome the lack of technical knowledge.

Regarding the 3D models they will need and whether they are thinking of researching and downloading or modeling these objects, the answers can be seen in table 6.

Table 6. 3D objects needed.

Category	Sub-category	Example	Description/Interpretation
Common Items 3D Models	Furniture and Equipment	"Tables, chairs, doors, paintings, poufs."	Indicate common items
Themed 3D Models	Specific Topics	"London Models" " Duolingo Model" "Slide from a pool" "Amusement parks."	Plan to incorporate specific topics
Functional Elements	Interactive Objects	"Social Media Symbols, WIFI, Duolingo"	They mention interactive and functional elements.

Although the students want to create themed environments, they are looking for an environment that is familiar and functional, with familiar items (such as tables and chairs...). The integration of elements linked to social networks, Wi-Fi and applications such as Duolingo suggest that they want a space that is interactive and accessible. The researchers will provide a library of 3D models, but they also want to encourage students to model 3D objects. These objects should be educationally relevant.

Finally, they were asked “How am I going to combine the ideas I have with the subject content to build the space?”. Table 7 shows the Content Analysis of the answers obtained.

Table 7. How am I going to combine the ideas I have with the contents of the subject to build the space?

Category	Sub-category	Example	Description/Interpretation
Direct Application of Content	Simple/Undefined Answers	"The room we designed has English content." "Our scenario will be to learn English."	They do not show how ideas and content will be integrated.
Use of Tools and Resources	Use of Interactive Digital Resources	"YouTube videos on the subject we are giving in English" "We are going to build a scenario where it is possible to learn grammar or vocabulary in an interactive way"	Plan to use digital resources
	Playful Elements	“Games, so I can have fun and learn 7th grade English" "Play duolingo."	Interest in incorporating playful elements
Interactive and Creative Themes	Theme Scenarios	"The room we built is going to be in London and it's going to have some teleportation."	Integrate scenarios and themes that are interactive by integrating with the contents

Students want to align their design ideas with the creation of thematic and interactive scenarios, integrating them with English content. However, some answers are not very detailed. The inclusion of resources such as YouTube videos and games like Duolingo indicate that the students want to continue using digital and playful tools, such as games.

After voting to choose the scenario they were going to build, the students filled in a new logbook with the same questions as before, but including a new question “How are we going to combine everyone's ideas?” The answers are reflected in Table 8.

Table 8. Content analysis after voting.

Category	Sub-category	Example	Description/Interpretation
Understanding AWI	Format and Functionality	"It's going to be online and 3D and we can visit using VR glasses."	Three-dimensional virtual environment, accessible online through virtual reality glasses.

3D Models to Include	Functional and Everyday Objects	"3D models: paintings, notebooks, pencils, windows, chairs, rugs and everyday objects."	Simulation of a traditional classroom.
2nd-level heading	Specific and Creative Objects	"Slide, cat mat, sofa, computer, ball pool, trampoline."	List a variety of unconventional objects to include in IWE
Planning and Development	3D Model Planning	"3D models to include: English monuments, Duolingo statue." "Portals."	3D models focusing on educational and decorative elements.
Themes and Environments	Specific Scenarios	“House with several rooms, cinema room and greenhouse.”	Exploring specific themes to customize or environment.

The students understand IWE as a 3D virtual environment, accessible online and with virtual reality (VR) glasses. They reached a consensus on the specific theme of the IWE and carefully selected the 3D models by identifying specific items that will be important to the design of the IWE. The models ranged from functional and common objects, such as furniture and school supplies, to creative and unconventional elements, such as trampolines and cat mats.

The students also recorded the activities they carried out during the IWE construction phase in a logbook. Table 9 shows the content analysis.

Table 9. Logbook: construction phase.

Category	Sub-category	Example	Description/Interpretation
Platforms Used	Spoke Exploration	"Spoke platform exploitation."	Familiarization with the Spoke platform, to build IWE
	Creating Scenarios in the Spoke	"Creating scenarios in Spoke."	Building immersive environments using the Spoke platform.
	3D Object Modeling in Tinkercad	"3D object modeling on the Tinkercad platform."	Modeling of 3D objects that will be inserted into the environment.
Technical and Operational Challenges	Difficulties with the Spoke Platform	"I found it difficult to model in Spoke."	They mention difficulties when using the platform.
Collaboration and Group Work	Collaborative Work	"I asked my colleagues. I asked the teacher.”	Students show adaptability in seeking help and collaborating with each other
	Adaptation	"I had to join a group."	Forming or joining the groups work to continue the work.
Emotional Reactions to Hardship	Frustration	"I was sad because I would want to create on my computer."	Feelings sadness when faced with technical and access problems.
	Satisfaction	“Satisfied with the result”	Feelings of satisfaction with the result obtained

The students explored the Spoke and Tinkercad platforms, which allowed them to build the IWE and create the 3D objects to integrate into space. However, they faced technical difficulties, with access problems, especially when using the Spoke platform. To overcome these difficulties, they worked in groups and asked for help from both the teacher and their classmates. Some students reported feeling sad and frustrated due to the difficulties in accessing the Spoke platform, while others, who managed to use it, were satisfied with the result and found modeling easy.

The results show the high potential of IWEs as collaborative and interactive learning environments. The incorporation of playful elements and references to games and characters by the students demonstrates an understanding of their interests and favours active involvement in the learning process. The metacognitive approach used in the logbooks, by encouraging students to reflect on their learning processes, contributed to a more meaningful and student-centred experience, integrating emerging technologies and active methodologies. However, the analysis of the logbooks indicated that although the students recorded their perceptions of the IWE creation process, their reflections are very superficial. Future studies should therefore include guiding questions throughout the process and follow-up interviews.

Despite the guidance provided by the researchers, there was a need for more specific guidelines. Thus, in addition to practical recommendations and strategies for integrating digital platforms, it is essential to train teachers in the use of these technologies, as well as developing approaches that encourage student reflection throughout the process. It was noted that even with the additional technical support provided by guided tutorials, students faced technical challenges, particularly with platforms such as Spoke. In addition, the discontinuation of the Mozilla Hubs and Spoke platforms raises concerns about the longevity and accessibility of the tools used in the project. It is therefore recommended that alternative platforms be adopted which offer similar functionalities and more intuitive interfaces.

To maximize the educational potential of digital tools in the development of immersive environments, it is essential to offer adequate technical support and encourage collaboration between students.

3.2 Questionnaire Survey

The questionnaire survey was completed by all the students (thirty-seven who took part in the study). The questions, all of which had to be answered, were organised into three main sections: one dealing with the students' involvement with video games, another focusing on the students' experience of modelling 3D objects and another exploring their knowledge and use of IWE. This questionnaire, applied before the intervention, allows us to evaluate the students' level of familiarity with games, 3D modelling and immersive environments, in order to understand how the students' previous experiences influence the IWE creation process.

At the beginning, the students were asked to indicate their age and the devices they owned. This information allows us to characterise the students, providing an overview of their familiarity with technology.

The answers obtained to the first single-answer question relating to the age of the students showed that most of the students, 22 (59.5 per cent), are 12 years old, while 12 (32.4 per cent) are 13 years old. Only 1 (2.7%) student said they were 11, another (2.7%) said they were 14, and another student (2.7%) said they were 16.

The next multiple-choice question allowed students to select the devices they owned from a pre-defined list (Table 10). This list included the following options: Mobile phone, Tablet, Laptop computer, Stationary computer, Virtual reality glasses and 'Other'. The 'Other' option allowed students to add other equipment that was not included in the list provided. Students could also choose one or more options from the list previously provided.

Table 10. What equipment do you have? (You can select several options).

Questions/options	Number of answers	%
Mobile phone	31	83,8%
Laptop computer	31	83,8%
Fixed computer	11	29,7%
Tablet	11	29,7%
Virtual reality glasses	2	5,4%
PS4	2	5,4%
Nintendo	1	2,7%
Playstation	2	5,4%
Playstation 3	1	2,7%
Two Consoles	1	2,7%
One Console	1	2,7%

The results show that the most common devices among students are mobile phones and laptops, followed by desktop computers and tablets. Less common were virtual reality glasses and the PS4. The students also mentioned other devices such as Nintendo, Playstation, and Playstation 3, but few indicated these options.

The students were then asked if they played video games. 34 (91.9%) of the students answered 'Yes', while only 3 (8.1%) indicated that they 'Don't' play.

On how often they play and the number of hours they spend playing. Regarding frequency (table 11), a group of students said they play every day, 9 (24.3%) said they play a few days a week and 6 (16.2%) play only at weekends. 2 (5.4%) said they play a few days a month, while 3 (8.1%) said they don't play. 2 (5.4%) students used the option 'Other' to mention that they play infrequently. In terms of time spent playing, 16 (43.2%) of the students play between 2 and 4 hours a day, while 9 (24.3%) play between 2 and 4 hours a week. Others indicated that they only play between 2 and 4 hours a month. 3 (8.1%) indicated that they don't play at all and 6 (16.2%)

used the option ‘Other’ to indicate variations in the time spent playing: between 30 minutes and 1 hour a day, 7 to 9 hours a day, or not being able to count the hours because they rarely play.

Regarding the games they usually play, the students answered ‘Minecraft’, ‘Roblox’, ‘Fortnite’, ‘Call of Duty’, ‘Free Fire’, ‘Pokemon’, ‘Dragon Ball’, ‘The Sims 4’ and ‘Fifa’. Again, 3 (8.1%) of the students said that they don't play games.

About creating or programming games, 33 (89.2%) students said they never answered ‘No’, while 4 (10.8%) said ‘Yes’. Among those who had programmed, the platforms used were: Roblox (10.8%) Minecraft (8.1%) and Scratch (2.7%).

As for the types of graphics, many of the students, 22 (59.5%), showed a preference for 3D graphics, while 13 (35.1%) preferred a mixture of 2D and 3D graphics and 2 (5.4%) opted for 2D graphics.

The group of questions related to gaming habits and the students' relationship with game creation, the analysis of the data obtained indicates that although the majority of students play games frequently and spend a significant amount of time playing, few have experience in game programming. There is a clear preference for 3D graphics, which creates good expectations for IWE development

When asked if they had ever modelled a 3D object, the majority 22 (59.5%) answered ‘Yes’, while 15 (40.5%) answered ‘No’.

Only 3 (8.1%) of the students said they modelled 3D objects a few days a week, the same number of students who said they did it a few days a month. A larger number, 10 (27%), indicated that they modelled 3D objects only a few days a year. However, 15 (40.5%) said they had never modelled. In addition, 6 (16.2%) said that their experience was limited to very specific occasions ‘I modelled once in a class’, ‘Once or twice in classes’, ‘Only in some classes, but not very often’

As for the number of hours spent modelling 3D objects, the data shows that many students spent little time. Only 1 student (2.7%) mentioned spending between 2 and 4 hours a day, while 3 (8.1%) spent between 2 and 4 hours a week, 1 (2.7%) said between 2 and 4 hours a month and 10 (27%) spent between 2 and 4 hours a year. 15 students (40.5%) indicated that they had never modelled. In addition, 7 (18.9%) gave varied or non-specific answers, mentioning, for example, that they modelled for 1 hour and 30 minutes, another said 2 hours and 5 students said they couldn't quantify the time they spent modelling 3D objects.

Regarding the platforms used to model 3D objects, 21 (56.8%) of the students who had already had these experiences said they had used Tinkercad. Only 1 (2.7%) mentioned Fusion 360, and the rest said they had never modelled. The students were also asked to indicate which 3D objects they had already modelled. They indicated simple objects such as houses, Christmas trees and presents.

The results of the group of questions, which aimed to investigate whether the students already experience with modelling 3D objects had, indicate that although most of the students have some familiarity with modelling 3D objects, this experience is fairly sporadic and the time spent is generally low. The tools used are Tinkercad, and the creation of objects tends to be simple. The results suggest that the students' experience is limited and only realised in specific classroom activities.

To the question ‘Have you ever heard of Virtual Reality or Immersive Web Environments (Metaverse)? (Please select only one of the following options: Yes/No), 24 (64.9%) answered ‘yes’, while 13 (35.1%) answered ‘no’. Students who answered ‘yes’ to this question were asked to indicate what they understood by Immersive Web Environments. The answers revealed that the students had a limited understanding, associating it with the use of virtual reality glasses and simulation and gaming environments.

When asked which IWEs they knew, only 7 (18.9%) said VR Chat, 2 (5.4%) Frame VR, Decentraland and Roblox, while the majority chose ‘None’ and only 1 (2.7%) student said they knew of games that could be played with VR glasses. No students indicated that they were familiar with the Mozilla Hubs, Spoke or Spatial platforms.

Regarding the devices used to access these environments, 14 (37.8%) mentioned mobile phones, 11 (29.7%) said they used computers, while 7 (18.9%) said they used virtual reality glasses and 1 (2.7%) said tablets. A significant number of students indicated that they do not access these environments.

About the reason why they access these environments, 18 (48.6%) indicated that they do so mainly to play games, while 10 (27%) said they chat with friends. Only 3 (8.1%) use these environments to create or build spaces and 1 (2.7%) to visit places I don't know, 1 (2.7%) says they use them to create or develop games. The rest do not access the environments.

The students were also asked where they access it and the majority of those who do access it, 13 (35.1%), indicated that they do so at home. Only 3 (8.1%) accessed it at school and 1 (2.7%) mentioned using it both at home and at school. The rest don't access it

When asked if it is possible to learn in these environments, 25 (67.6%) said “yes”, and mentioned that with “Minecraft we can learn to build houses”; “In Roblox and some games it is possible to simulate real-life jobs”. 3 (8.1%) said “No” and 9 (24.3%) said “I don't know”.

Finally, when asked how they imagined a classroom or school in an immersive environment, 12 (32.4%) students said they couldn't imagine it (they answered, I don't know). others described natural environments, such as a forest or a jungle. Other students refer to highly technological classrooms, with the use of VR glasses, LED panels and adaptable virtual spaces ‘very fun, you can do more things that you can't do in real life’.

This group of questions aimed to assess the students' level of familiarity with Immersive Web Environments (IWE) and Virtual Reality (VR).

The results reveal that although most students have some knowledge of VR and IWE, this knowledge is limited to experiences with games. Familiarity with specific IWE platforms is low, and the use of these environments for educational activities is not yet widely explored, however, students recognise the potential of these spaces for learning. The students' responses show that they want virtual reality and nature to be integrated and that they imagine an environment that is more playful, technological and flexible than traditional classrooms.

4 Conclusion

This study analyzed student participation in the co-creation of Immersive Web Environments for learning English vocabulary. The students were involved in all stages of the IWE design and construction process. Through content analysis of the activities carried out by the students, recorded in a logbook, it was observed that they envisioned interactive and playful learning environments, such as amusement parks and/or water parks, in addition to traditional classrooms, in which the presence of technology is constant. However, the students encountered technical challenges, such as internet connection difficulties, which were sometimes unavailable or extremely slow, preventing access to the platforms. In addition, the lack of specific knowledge in 3D modeling and IWE construction was a recurring concern mentioned in the logbook. The students tried to overcome these difficulties by collaborating with each other, readjusting their working groups, turning to the teacher and researching online tutorials, but there was a clear need for guidance from the teacher and support from researchers with digital resources such as tutorials or research material.

The results indicate that collaborative work was important in overcoming the difficulties they encountered. These results highlight the importance of integrating pedagogical practices that encourage active student participation, promoting not only the development of technical skills, but also the ability to work as a team and solve problems and make group decisions. This study contributes by demonstrating how the co-creation of learning environments, mediated by emerging technologies, enables students to develop essential 21st century skills [22]. Students considered these environments to be collaborative and social spaces, showing the importance of continuing research to understand the impact of these environments as social learning spaces [23] as well as exploring new ways of integrating technology and pedagogy. Technology, Pedagogy, Content & Space [24] and/or Pedagogy-Space-Technology [25].

Limitations include the dependence on digital technologies, which may have influenced the participation of students less familiar with these tools, as well as limited internet access. The results showed that the students seemed to have an adequate level of knowledge and understanding of digital tools. However, the data obtained after the intervention showed that they did not have sufficient technical knowledge to effectively and efficiently use some of the digital tools proposed by the researchers.

As future work, we intend to continue studying student collaboration and participation in the IWE design and construction process, as well as integration with other innovative pedagogical methodologies, such as gamification, and integration of emerging technologies, such as augmented reality (AR) and artificial intelligence (AI). Another relevant aspect for future research would be to diversify the scenarios and themes, exploring other disciplines and cultural contexts. It is important to investigate how IWE can be designed to meet the needs of all students.

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