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Metaverse as a Higher Education Tool: Notes From Musical Curricula at Early Childhood Education and Primary School Education Bachelor´s Degrees

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Abstract

The use of the metaverse as an educational tool provides an immersive learning experience that gives students the chance to enter a virtual space that is perceived as a real-life environment. This study aims to examine how the metaverse can be a learning resource for engaging in music learning. Previous studies have set the metaverse as a potential means for higher education. Due to this, a concert hall with a symphonic orchestra in a performative set has been developed at a private university for the musical curricula included within the Early Childhood and Primary School Education Bachelor´s Degrees. Twenty recorded audio pieces in which the main instruments from the orchestra can be identified are also included. This investigation followed experimental, descriptive models, and 170 participants were involved. Results are similar to the evidence provided in the revised literature confirming the metaverse's value as an educational tool. It has been proven that being able to interact with the objects within the metaverse helps getting familiar with their characteristics. The surveyed students have confirmed that the metaverse is a useful learning resource as well as a suitable option for their future professional environment.

Keywords: metaverse; virtual reality; higher education; musical education; educational resources

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INTRODUCTION

This research shows the results obtained after the implementation of an innovation project designed for the following subjects: Musical education teaching and learning, from Early Childhood Bachelor´s Degree and Musical expression teaching and learning, from Primary School Education Bachelor´s Degree including both face-to-face and blended learning. The drafted contents in these couple of subjects entail the first point of contact with musical instruments included in the units related to the introduction of musical teaching methodologies. The Orff approach highlights how important learning instruments are in musical education, and the concept of "school orchestra" within the classroom is introduced (Esquivel, 2009).

In order to discover the origins of the school orchestra, what it tries to simulate, and how it is organised and distributed, students first have to learn what a sympho-

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nic orchestra is. The central project of this investigation was designed due to the difficulties faced each year to access, manipulate and examine a great number of professional instruments (individually and collectively within an orchestra). Thanks to virtual reality (VR) and virtual learning environments, the idea of immersion in a big concert hall where students could find a symphonic orchestra in a performative set was proposed.

Students could move freely through the metaverse to investigate and explore every element which arouses their curiosity. At the same time, this lets them discover the magical halo created during musical performances inside a big concert hall.

According to Jerónimo et al. (2011), "there is a new learning paradigm introduced by a new generation of students who play videogames, serious games, interacts with social networks, and different virtual environments on a daily basis" (p. 36), raising the question of the way learning process is being developed at all levels. For our particular case, we focused in Higher Education.

From the students' view, the traditional learning approach at university could be defined as a passive path in which professors are to be listened to in their master classes, and students are to memorise those contents later at home, with the support of writing materials in either format, paper or digital. It is well known that students do not consider this a valid nor an enriching experience they feel involved in, since this approach does not foster a full commitment within professor's experience. Thus, a more flexible methodology is needed, with different perspectives to address the learning process and going a step further, aiming the students' full involvement in the teaching and learning process. Our outlook is that an immersive experience meets such requirements. Valdés and Ángel (2023) says that "immersion is a way of being, in the sense of 'belonging to', and not only making reference to 'being in'. Not only to stay on the surface; but being merged and part of it" (p. 3).

Technology is one of the tools we introduced aiming to achieve the intended flexible methodology and immersive experience, used in an effective way which allows content comprehension and assimilation. The use of this technology in the abovementioned subjects (including face-to-face and blended learning modalities) is based on VR. Since the professional future of the undergraduates enrolled in these two Bachelor´s Degrees is oriented to education, being school teaching the most usual choice. It is essential to offer an inspiring and stimulating academic model which covers the main topics relevant to be explained in the classroom. One of these main topics, linked to musical subjects, is school orchestra (Esquivel, 2009). This project is designed to go beyond learning instruments via documents, Figures, videos and recorded sounds, or by ad hoc assistance to concerts (usually constricted to several standards which may end up in a non-appealing event). With the object of consolidating a free and up-close experience, the students would be able to manipulate musical instruments freely, as a free-risk game (Valdés y Ángel, 2023, p. 4), giving them the opportunity to move on-site wherever they want. This investigation pursues the constant improvement of teaching and learning materials.

With VR, "environments are recreated for the person to interact with them and have an on-site experience as close as possible to 'being' in a real place" (Pérez-Salas, 2008, p. 253). In this case, the virtual world replaces the real one, and people can live an immersive experience with a sense of authenticity. On the other hand, augmented reality (AR) merges virtual and real environments and creates a mixed space with both atmospheres (Rigueros Bello, 2017, p. 259). This does not mean virtual world replaces the real world, but connect with it in real time and mutually enrich each other (p. 260).

Amongst several researches which reinforce this proposal, the result obtained by Juca-Maldonado et al. (2020) reflected that 64% of the participants confirmed that

"if virtual reality was used as a supportive tool in exams, better results would be obtained" (p. 55), while 36% "considered it could be a good option" (p. 55). Other authors such as Rivas-Rebaque et al. (2021) say that "AR apps help students to develop their spatial and listening abilities, giving them the opportunity to manipulate and dig in written content (books/stories), a more appealing content than conventional materials which arise their curiosity and interest in magical sensitivity" (p. 66).

How can VR be introduced in the teaching and learning process within the musical curricula? How could an innovative approach to musical instruments in the orchestra, essential content in the subject, be achieved? We suggest an immersive experience for the students developed by setting a metaverse or virtual world, a concept from Neal Stephenson´s novel Snow Crash, published in 1992 (Ball, 2022). Metaverse is the virtual world accessed from a device and makes us feel like we are there (Fernández, 2022).

Our metaverse consists of a concert hall available for the students, to which they can access from the devices located in the laboratory of VR/AR at the Catholic University of Murcia. As shown in Figure 1, this virtual environment includes the instruments from a symphonic orchestra in a performative set and twenty recorded audio pieces in which main instruments from the orchestra can be identified. Each student is assigned an avatar so that s/he can move through the hall and interact with the metaverse, manipulate the instruments, play the recorded audio pieces and even interact with other (virtual) students who are connected. As Sánchez Mendiola (2022) also remarks, it must be said that "the program still works even though not all members are connected" (p. 6).

The foundation for our methodology is the Universal Design for Learning (UDL), from which we include all the innovative possibilities that technology offers to develop open and boosting teaching and learning processes that offer more and varied content, more experiences, communicative and interchanging paths (Anacona Ortiz et al., 2022) and even develops students' empathy, being the latter a more relevant topic for the blended learning undergraduates. According to what Barneche, Mihura and Hernández (2011) say, there is no spatio-temporal distance between the students while they are in the metaverse, and can live, explore and share things together in real-time (p. 371). The learning experience is boosted and enhanced in all aspects: students are more interested, join the classes, have better communication and feel more involved in the project, with a relevant role in the class (p. 371).

Figure 1. Screenshot taken during one of the attended sessions

Suppose we apply these ideas in the musical area, as per Gértrudix and Gértrudix (2012) statements. In that case, immersive worlds can be really helpful to have access to visible representations of an evanescent art, to generate utopian scenarios to play music (e.g. the top of a mountain) or to go to concerts. When talking about immersive experiences, Valdés and Ángel (2023, p. 4) ensure that concepts such as sensorial, activities and pleasure precede and complement the cognitive aspects.

We encounter these three elements within our proposal: we give Early Childhood Education and Primary School Education undergraduates a chance to enter a concert hall where they move freely and can manipulate the orchestra instruments and identify each of them when listening to the recorded pieces. We consider this immersive experience in a concert hall an approaching chance for the students to know the orchestra, due to the temporary condition and the "unsual" environment in which music is settled. It helps the stu-

dents to "meet" and observe the orchestra closely, being able to manipulate and analyse with no restrictions. Gértrudix and Gértrudix (2012) add that "these experiences can be considered more appealing and stimulating for the students" (p. 178).

However, motivation and potential learning improvements technology can bring out are not only the reasons to focus on. It must be taken into account that it is a first "formal" point of contact for the majority of the students in Higher Education with the content of the Bachelor´s Degree. This can generate uncertainty and insecurity within the undergraduate, making him/her to reject learning the subjects. Even though, as per Magallanes-Rodríguez et al. (2021) "virtual reality is a versatile technology with a key role in the educational sector, due to its adaptability to different learning content" (p. 109). Somehow, it also balances the abilities of the students to face new situations and experiences (Pérez-Salas, 2008).

These features guarantee that our proposal can be implemented in such a way that all contents are accessible to every participant. In addition to this, after studying in more detail all the literature and envisioning a wide variety of possibilities, this research has been oriented to VR exploitation and the metaverse as a learning environment for musical curricula in Early Childhood Education and Primary School Education Bachelor´s Degrees.

METHOD

Other metaverse-based learning proposals can be encountered, e.g. Mª del Carmen Gálvez de la Cuesta and Mª del Carmen Gertrudis' project published in their monograph Communication and immersive education (Comunicación y Educación Inmersiva) (Casado, María Del Carmen Gertrudis, María del Carmen Gálvez de la Cuesta, 2011), Icono magazine, 14. Though, the pioneering character of this investigation lies in the introduction of metaverse within musical education at the university level.

This project enhances an initial and exploratory approach to metaverse as a useful tool within teaching and learning processes. Education undergraduates are immersed in classic music world to understand the origins of the music they listened to thanks to devices they will be using in classrooms in their professional career. For this purpose, the value of Immersive Education is remarked, and defined as the tool which Miguélez-Juan (2018), cited in Miguélez-Juan, et al., (2019) assures that: "makes it possible for the person to immerse and project real movements in multidimensional scenarios generated by computer systems and by using viewers or goggles as well as other devices which captures body movements and rotations."

Within the context of this investigation, Immersive Education has been used to locate the students in a big concert hall where they could see a symphonic orchestra in a performative set. Thanks to the immersive devices, each user could move freely, observe, interact, and dig into the designed virtual environment to manipulate the musical instruments from that orchestra and even listen to the sound each of these produces. After this designed "live" experience, students' knowledge about symphonic orchestra setting and distribution, instruments and families, and the context in which this musical collective works would be evaluated. Thus, information was presented in a theoretical and traditional frame, but instead of Figures as supportive material, a virtual tour to a symphonic orchestra in an ad hoc concert hall has been designed for this project.

The above described proposal has been implemented in both, face to face and blended learning modalities, and so the metaverse has been designed to be accessed from smartphones, tablets and pcs, meaning that neither viewers nor goggles are necessary. In one hand, it may be thought that students attending face-to-face classes are the ones leveraging this immersive experience; on the other hand, Jerónimo et al. (2011) are convinced that:

Immersive learning standpoint can be considered an innovative distance learning option, which brings back the achievement motivation within the educational planning and sociocultural approach in virtual worlds, especially when working from the adult education and andragogy perspectives by considering the particular conditions for this learning phase, in which a more experience-related learning path is required, as well as transferring theoretical methodology to daily life (p. 36).

Therefore, The developed research is based on experimental descriptive models, because metaverse experimentation and tour has been chosen to test the changes and effects in the participants.

The first step within the investigational stages was to design and create the metaverse with the technical support of the team from the VR/AR laboratory at the Catholic University of Murcia. Once this metaverse was at a functional level, guidelines for the participants and the activity to be evaluated included for each subject were drafted, and the questionnaire was completed after the activity was finalised. This questionnaire was divided in the following (six) sections:

1) Student's sign up
2) Student's details (Enrolled Bachelor´s Degree, Sex, Age, Autonomous Community of residence), specifying whether there is any musical background/ knowledge before enrolling this subject as well as how often do they go to live concerts.
3) Student's ability to visually distinguish instruments from different families (stringed, woodwind, brass wind, percussion) and associate the pitch and timbre of the sound to the instrument characteristics.
4) Student's ability to distinguish instruments from different families and associate the pitch to the instrument characteristics by hearing.
5) Student's ability to identify specific features of a concert hall which differentiate from other performing arts buildings; to know where the orchestra and the conductor are set in the concert hall and know how families of musical instruments are set within the orchestra; to identify sound control room.
6) Student's knowledge about a concert hall and the orchestra after visiting the metaverse; ability to explain how an orchestra is organised to another person; opinion about the use of the metaverse as a learning tool and willingness to implement in their future teaching experience.

Thanks to this questionnaire, empirical data could be collected directly from this investigation to obtain the results that are presented in the next section.

The population and sample are made up of undergraduates enrolled in the following subjects: Musical education teaching and learning, from Early Childhood Bachelor´s Degree and Musical expression teaching and learning, from Primary School Bachelor´s Degree at the Catholic University of Murcia.

RESULTS AND DISCUSSION

The total number of enrolled participants was 170, from which 131 (77.07%) were women and 39 (22.93%) were men. As shown in Table 1, the age of 101 participants (59.41%) was between 18 and 25 years old; the second biggest group was made up of 56 participants (32.94%) with ages between 26 and 35 years old; the third age group includes 11 participants (6.47%) with ages that goes from 36 to 45 years old and the last age group was made up of 2 participants (1.18%) whose age is between 46 and 55 years old.

First close-ended question answered by the participants was related to musical background and education acquired before they were enrolled in the subject, being the participants requested to choose only one option from the list of possible answers. A total amount of 170 answers were registered, and 132 participants (77.65%) reported having received only the minimum obligatory music education at school or high school; there were 7 participants

Table 1. Participants' age range and sex.

	Man		Women		Total number of participants	
	F	%	F	%	F	%
18 - 25 years old	20	11.76	81	47.65	101	59.41
26 - 35 years old	16	9.41	40	23.53	56	32.94
36 - 45 years old	3	1.76	8	4.71	11	6.47
46 - 55 years old	0	0	2	1.18	2	1.18
Total	39	22.93	131	77.07	170	100

Frequency F=n/1. Percentage %=n/1.

Table 2. Undergraduates' perception to visually identify musical instruments families.

	Stringed		Brass wind		Woodwind		Percussion	
	F	%	F	%	F	%	F	%
Never	0	0	0	0	0	0	0	0
Almost never	3	1.76	20	11.76	17	10	6	3.53
Almost always	81	47.65	87	51.18	95	55.88	58	34.12
Always	86	50.59	63	37.06	58	34.12	106	62.35
Total	170	100	170	100	170	100	170	100

Frequency F=n/1. Percentage %=n/1.

(4.12%) who considered themselves as self-taught, and 6 participants (3.53%) attended musical private lessons. Only 2 participants (1.18%) complement their musical education in music academies and 14 participants (8.23%) were enrolled in music schools. The remaining 9 participants (5.29%) were enrolled in the conservatory.

Secondly, and closely related to the aim of this research and the designed metaverse, participants were asked whether they have ever been to a symphonic orchestra live concert, as it is the collective musical group studied in the subjects, obtaining the following results: 62 of the 170 registered participants (36.47%) had never been to a live concert of those characteristics, 4 participants (2.35%) watched in a concert hall, 80 participants (47.06%) in an auditorium, 18 participants (10.59%) in a theatre and 6 (3.53%) in another space.

Knowing the participant´s musical curricula background and previous experience with regards to this kind of musical collective and the performative environment (from third question onwards), chosen items generate the obtained results after the designed metaverse immersion and the learned content about musical instruments families. Answers about students' ability to visually distinguish the musical instrument families are shown in Table 2, indicating undergraduates are always or almost always able to do so, with stringed and percussion the most recognised families. Similar results were obtained about students' ability to visually distinguish musical instruments belonging to the same family, as only one person (0.59%) indicated s/he could never distinguish; 22 participants (12.94%) confirmed they could almost never distinguish; 113 participants (66.47%) indicated they could almost always do so and 34 participants (20%) ensured they could always do. However, with regards to physical characteristics and generated sound qualities differences between instruments, 8 participants (4.71%) indicated they could never be able to distinguish them, 45 participants (26.47%) could almost never do so, 87 participants (51.17%) could almost always distinguish them, and 30 participants (17.65%) could always do so.

Furthermore, Table 3 shows undergraduates' frequency to distinguish gene-

Table 3. Students' perception to identify musical instruments families by hearing the emitted sounds.

	Stringed		Brass wind		Woodwind		Percussion	
	F	%	F	%	F	%	F	%
Never	0	0	1	0.59	1	0.59	1	0.59
Almost never	5	2.94	23	13.53	19	11.17	9	5.29
Almost always	88	51.76	92	54.12	98	57.65	66	38.82
Always	77	45.30	54	31.76	52	30.59	94	55.30
Total	170	100	170	100	170	100	170	100

Frequency F=n/1. Percentage %=n/1.

rated sounds, in most cases, was "always" or "almost always". Results concerning the ability to distinguish sounds from the same family instruments confirmed that 2 participants (1.18%) could never distinguish, 20 participants (11.76%) could almost never do so, 106 participants (62.35%) could almost always, and 42 participants (24.71%) indicated that they always could. Results reflecting the ability to associate the instrument's physical characteristics with generated sound qualities are similar to the previous section, which meant that 6 participants (3.53%) indicated they could never associate properly, 45 participants (26.47%) indicated they could almost never do, 86 participants (50.59%) confirmed that could almost always associate properly, and 33 participants (19.41%) could always do so.

Results related to the place where the symphonic orchestra is located, the concert hall, show that 2 participants (1.18%) could never identify the specific features of a concert hall which differentiate from other performing arts buildings, 32 participants (18.82%) could almost never identify, 95 participants (55.88%) could almost always identify them, while 41 participants (24.12%) could always do so.

In addition, in cases in which there is a sound control room within the concert hall, students were asked whether they could identify being 4 participants (2.35%) who confirmed they were unable to do it, 34 participants (20%) could almost never identify it, 62 participants (36.47%) could almost always, and 70 participants (41.18%) could always do so.

The following question asked participants was whether they could locate the symphonic orchestra within a concert hall. On the one hand, 4 participants (2.35%) indicated they could never do it, 11 participants (6.47%) could almost never, and on the other hand, 69 participants (40.59%) could almost always locate it, and 86 participants (50.59%) could always do so.

Results related to the distribution of musical instruments from different families within the symphonic orchestra, four undergraduates (2.35%) indicated they could never set them within the orchestra, 26 undergraduates (15.29%) could almost never do so; 103 undergraduates (60.59%) could almost always set the distribution and 37 undergraduates (21.77%) could always do it.

Moreover, participants were also asked about the conductor, and results showed that 1 participant (0.59%) could never identify him/her, 3 participants (1.76%) could almost never do it, but 44 participants (25.88%) could almost always identify him/her, and 122 participants (71.77%) could always do so.

The last obtained results were related to undergraduates' general perspective after the immersive experience in the designed metaverse, and they are included in Table 4: 106 participants (62.36%) considered they feel now completely familiarised with concert hall features, but there are more varied answers when talking about

Table 4. Students' perception about acquired knowledge and metaverse usefulness

		Nothing	Little	A lot	Completely	Total
I feel more familiarised with a concert hall.	F	4	20	40	106	170
	%	2.35	11.76	23.53	62.36	100
I feel more familiarized with a symphonic orchestra.	F	9	59	34	68	170
	%	5.29	34.71	20	40	100
I am able to explain the distribution and setting elements of a symphonic orchestra.	F	10	66	12	82	170
	%	5.88	38.82	7.06	48.24	100
Metaverse has been a useful tool in my learning process.	F	1	11	65	93	170
	%	0.59	6.47	38.24	54.70	100
I am interested in the application of metaverse as a tool within the learning environment in my professional career.	F	0	12	7	87	170
	%	1	7.06	41.76	51.18	100

Frequency F=n/1. Percentage %=n/1.

symphonic orchestra familiarisation: in this case, 68 participants (40%) completely know the facts about it. Eighty-two participants (48.24%) indicated they could explain to another person the distribution and setting elements of a symphonic orchestra. Finally, 93 participants (54.70%), which means more than half of the participants consider the metaverse a useful tool in their learning process. Also, 87 participants (51.18%) of potential teachers indicated they are interested in the application of the metaverse as a tool within the learning environment in their professional career.

Discussion

As a general view, the obtained results are very similar to the ones in the cited references this investigation is based on, confirming the value of the metaverse as an educational tool.

Following the same point of view as Rivas-Rebaque et al. (2021), it has been demonstrated that manipulating objects in the metaverse helps to become familiar with their characteristics. In this context, undergraduates could interact and manipulate the musical instruments included in the orchestra. After the immersive experience in the metaverse, they confirmed that they could visually recognise musical instruments from different families, having more difficulty distinguishing brass wind instruments. Similarly, a considerable group of participants (68.82%) indicated they were prepared to associate the instruments' physical characteristics with the instruments' emitted sound qualities (pitch and timbre) of each instrument.

Similar considerations were obtained when analysing the key element for music education: listening skills. We have followed professors Gértrudix and Gértrudix's (2012) considerations for this research. After immersive experience in the metaverse in which recorded pieces with specific instruments standing out were also reproduced, undergraduates felt more confident to classify (by hearing) different sounds pertaining to different musical instrument families being a wide group of them (70%) also able to identify pitch characteristics between instruments.

This study confirms how useful the metaverse is in creating utopic spaces where the student can get more familiar with the music, as per Gértrudix and Gértrudix (2012). Most students (85.89%) indicated they were very or completely familiar with a concert hall after accessing the metaverse. They could identify the main features within this space and spot its differences regarding other buildings, such as auditoriums or theatres. At the same time, they can easily locate the orchestra and the conductor within the concert hall. There

is a great number of undergraduates who assured they could distribute each musical instrument family on its proper place. A small number of participants (2.35%) confirmed they could never identify the sound control room.

Furthermore, another fact this study confirms, similar to Fernández's (2022) approach, is that the metaverse can be defined as a virtual world students are discovering in real-time, making them feel inside it. Considering the questions related to students' musical background, 36.47% of the students indicated they have never been to a symphonic orchestra concert. However, after the metaverse immersive experience, only 5.29% answered they are not familiarised with the symphonic orchestra.

Reaching Anacona, Millán and Gómez's (2019) concepts regarding communication and exchange possibilities, the results show that 92.94% of the students consider the metaverse a useful learning tool. In addition, the same percentage of surveyed students would choose the metaverse as an interesting resource for their professional careers. The flexibility metaverse offers for learning eases natural comprehension and assimilation, discarding learning topics and materials by heart. This means students are able to explain and describe to any person the distribution and composition of a symphonic orchestra.

CONCLUSION

In order to develop this research, technology has played a key role, being the main foundation for developing an investigation based on a generated learning space conceived as a metaverse for the students. Learning environments and VR spaces were joined to generate a high-motivational experience for the undergraduates. Thanks to this teaching innovation project, students had the opportunity to "play" with the instruments included in a symphonic orchestra within the metaverse, which can be described as a promising and attractive resource for musical teaching in the near future after the consulted literature used and the above experiment.

It is difficult to forecast the progress metaverse will have within the educational area, even though positive predictions revolve around its implementation due to the fast evolution of this technology. From our view and experience, students have greeted this tool, which has come to stay with the aim of expanding its functionalities and features even more.

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