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Learning in immersive environments: results of mixed-method research in university art laboratories

Apprendere in ambienti immersivi: risultati di una ricerca mixed-method in laboratori universitari artistici

di[1]
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Abstract:
The use of Virtual Reality (VR) technologies in education represents a rapidly spreading field that offers, according to the most recent literature, significant benefits for learning. One of the key factors to effectively introduce an immersive experience within any training-didactic pathway is represented by the approach (or preparatory) phase, which is essential to facilitate the student's familiarisation with the experience. This paper aims to discuss the main results of an exploratory mixed-method research that had as its primary objective to understand how different approach phases impact on the immersive experience in terms of learning outcomes, engagement and perceived sense of presence among a group of students of the Master degree in Philosophy. The paper concludes by sharing

[1] The article is the result of the authors' comparisons and reflections, who shared the entire structure. According to the author declaration system CRediT: IT: Conceptualization, Investigation, Writing original draft & review, Visualization (par. 1, 2, 3, 4, 5, 6). FC: Conceptualization, Investigation, Writing original draft & review, Visualization (par. 3, 4).

instructional design tips for effectively introducing immersive technologies in educational contexts.

Keywords: virtual reality, immersive technologies, introductory phase, learning outcomes, higher education.

Abstract:
L'utilizzo delle tecnologie di Realtà Virtuale (VR) in ambito educativo rappresenta un campo in rapida espansione che offre, secondo la più recente letteratura, benefici significativi per l'apprendimento. Uno dei fattori chiave per introdurre efficacemente un'esperienza immersiva all'interno di un qualsiasi percorso formativo-didattico è rappresentato dalla fase di avvicinamento (o preparatoria), indispensabile per facilitare la familiarizzazione dello studente con l'esperienza. Il presente contributo vuole discutere i principali risultati di una ricerca esplorativa mixed-method che ha avuto come obiettivo primario quello di comprendere in che modo fasi di avvicinamento diverse impattino sull'esperienza immersiva in termini di risultati di apprendimento, engagement e senso di presenza percepito da un gruppo di studenti della laurea magistrale in scienze filosofiche. L'articolo si conclude con la condivisione di indicazioni di design didattico per introdurre efficacemente le tecnologie immersive in contesti formativi.

Parole chiave: realtà virtuale, tecnologie immersive, fase introduttiva, risultati di apprendimento, educazione universitaria.

1. Introduzione

The introduction of a lesson, whether at school or university, is a crucial moment in the effectiveness of the whole teaching process. This initial phase not only prepares students for the content to be covered, but also plays a fundamental role in activating their interest and motivation. During this phase, in addition to presenting the specific learning objectives, the teacher can contextualise the material and stimulate students' curiosity through preliminary questions or introductory discussions. Adequate and engaging preparation can facilitate understanding of subsequent concepts, create a positive learning environment, and encourage active participation.

This introductory moment is arguably one of the most difficult for a teacher to prepare for (Garavaglia & Petti, 2013). Starting from scratch, the teacher should provide a stimulus that makes the object of study interesting and challenging. It is essential to try to make it clear from the outset why what is being presented is important enough to prompt the student to engage, focus, and analyse in depth the issues that will be presented.

The preparatory phase should make it possible to approach the field of study and is considered essential to situate the students and relate them to the content to be proposed. In particular, the preparatory moment should fullfil six primary functions (Ferrari, 2013). First, it should play a role in restoring the prerequisites for effective participation in the lesson or experience that is about to take place. In this case, the initial activity of the preparatory phase serves as a bridge, i.e. a point of connection with what has been done before or with what the learner already knows. The second and third functions concern the ability to draw out the student's representations (Moscovici, 1976) and practices in relation to the new concept or subsequent experience. In this case, the aim is to get students to make their point of view explicit, so that they can then enter into a dialogue with what is later discovered. The fourth function concerns familiarisation with the specific vocabulary of the

discipline or experience. At this point, the activity can perform the task of "semantic cleaning" and the subsequent construction of a specific glossary to help the student access the content.
The fifth function is exploratory: in this case it can be very important for students to activate an initial search that allows them to retrieve information useful for an initial mapping of the topic. This function of initial documentation can activate: a) a process of individual (or group) exploration leading to a subsequent moment of elaboration, reflection or research; b) a structuring process in which the student tries to organise the material by exercising his perceptual and cognitive skills. Mapping thus allows the learner to situate him/herself in relation to the content to be presented, manipulated or experienced, activating it in advance.
When the learning path introduces some kind of technology or the use of immersive devices (Buccini, 2023; Cuomo & Ranieri, 2022), such as Virtual Reality (VR), the preparatory moment becomes even more crucial (Castaldo, 2004). At this point, the initial phase not only prepares students for the content to be covered, as mentioned above, but also plays a key role in familiarising students with the VR technology, from both a software and hardware perspective (Marcuccio et al., 2003) and contextualising its use within the lesson. During this phase, the teacher should provide any technical instructions needed to use the VR viewers. In addition, ways of interacting with the virtual environment are outlined so that students can navigate effectively and safely. This aspect is important to consider because immersive technology is often unfamiliar and therefore challenging for the average user, as explicitly acknowledged in the literature (Checa & Bustillo, 2019). An important dimension in this regard is control, that is, the extent to which one feels able to use the device to perform the desired actions in the virtual environment (Nirchi, 2015).
According to Witmer and Singer (1998), control is a key dimension of presence in VR, and in the related field of game studies it is also considered crucial for engagement (Fredricks et al., 2004), especially in its kinetic component (Calleja, 2011). Conversely, a lack of control is likely to be detrimental to the user's experience.
This preparatory moment is also essential to ensure that all students are comfortable with the technology and understand how it can enhance their learning experience by allowing them to explore immersive environments, visualise complex concepts in three dimensions and participate in realistic simulations (Corrias, 2021). A well-structured introduction can thus facilitate understanding of subsequent concepts, as well as create a positive learning environment and encourage active and informed participation. From the perspective of the development of knowledge and cognitive skills, activating the class on content to be learned or explored can help students to better understand the meanings and features of the learning experience and to better master the preliminary knowledge. Furthermore, the introduction phase can be a crucial entry point to activate students in the subsequent exploration of the learning objects (Gardner, 1999). Some recent studies (e.g. Ferrari & Terrenghi, 2021) show that anticipating information about something to be learned improves understanding of theoretical elements, and also helps to focus on theoretical details that would otherwise have been missed. Therefore, the preparatory phase of a VR lesson is crucial to lay the foundation for effective learning and to fully exploit the potential of immersive technology.
In conclusion, the preparatory phase of the lesson is an important moment for cognitive activation of the student and for fostering those emotional and social conditions that can have a positive impact on the learning process. This phase becomes even more important when immersive technology is introduced: in this case, it is key to prepare the classroom for the use of immersive devices,

anticipating moments of their concrete use and allowing students to familiarise themselves with the device to increase their technical control over it. However, there are no systematic studies in the literature that provide precise, comprehensive, and effective guidelines in this regard.
The purpose of this paper is to present a pilot study in which we explored how different approach phases impact the immersive experience in terms of learning outcomes, engagement, and perceived sense of presence among a group of students of the Master degree in Philosophy.

2. Research questions

Based on the theoretical premises above, this paper aims to explore the potential of medium-specific introductory phases to prepare the learner for an immersive VR experience. To this end, we selected the VR artwork "Rosetta Mission 2020", created by Italian artist Luca Pozzi, and curated by Elisabetta Modena and Sofia Pirandello, in collaboration with Swan Station (2021). The work consists of a comet floating in space on the surface of which are works of art by famous artists: Luca Pozzi himself, Carlo Rovelli (theoretical physicist), Alain Connes (mathematician), Michelangelo Pistoletto (artist) and Garrett Lisi (physicist). The visitor, after choosing their avatar in the form of a particle (quarks, protons, etc.) can freely explore the spatial exhibition area.
The choice of this particular work is due to the fact that the immersive experience was designed to be enjoyed after a preparatory phase in which the student could visit a virtual atelier with explanatory panels.
In this environment, which resembles a real exhibition, students can explore and read the explanatory panels that anticipate the content of the immersive experience: they show the structure of the comet, the locations, and the meaning of the artworks.
To conduct the study, we developed a printed version of the original VR introduction to the artwork, designed to be used like a conventional leaflet. This enabled us to create two distinct experimental conditions: one involving preparation with VR, and the other with a traditional paper approach. The first group enjoyed the preparatory moment in immersive mode (Figure 1), using the Meta Quest 2 visors, while the second group prepared by reading the explanatory panels in printed form (Figure 2).

Figure 1 - The preparation room in immersive mode

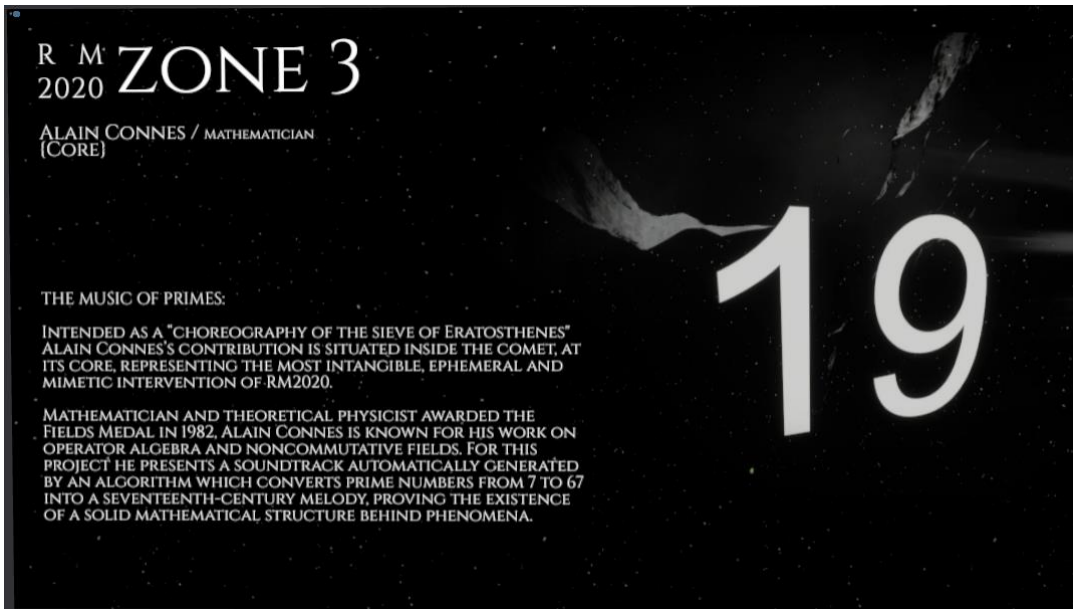

Figure 2 - Paper-based preparatory materials

This allowed us to test the following hypotheses:

1a – Preparation with VR will increase the students' mastery of the preliminary knowledge required to understand the chosen work of art – compared to traditional paper preparation;
1b – Preparation with VR will increase the students' sense of control on the technology – compared to traditional paper preparation;
2 – Increased mastery and increased control will make the students more satisfied with the experience of the chosen work of art – compared to traditional paper preparation.

We tested these hypotheses in an exploratory pilot study using a mixed-methods approach. The study took place within the framework of the laboratory "Immersive stories and memories. From virtual arts to video games", held by professor Elisabetta Modena, and proposed to the students of the Master Degree in Philosophy at University of Milan (a.a. 2022/2023). We chose this lab because it already included the use of immersive devices, so we did not have to change the syllabus agreed with the students. After approval by the ethics committee (protocol n. 105/22, 5th December 2022) we started the experiment.

3. Method

To explore the impact of different preparatory phases on the immersive experience, a mixed-methods survey was conducted according to the Explanatory Sequential Mixed Methods Design QUANT->Qual model (Creswell & Plano Clark, 2007). The primary data matrix is derived from a series of questionnaires, some ad hoc based on the literature and others validated; these quantitative data were then integrated and analysed in a closely linked way with qualitative data from in-depth interviews conducted with a small sample.

3.1. Sampling and research design

The sample was done arbitrarily: the participants were selected from the "Immersive stories and memories" workshop, which is part of the curriculum of the Masters in Philosophical Sciences. Students were allowed to choose whether or not to participate in the experiment, with the assurance that their choice would not influence their final evaluation. After viewing and signing the information material provided by the researchers, 12 students volunteered to take part in the study (10 males and 2 females; mean age: 38). 9 out of 12 students declared they had at least one immersive experience with VR headset and controllers. Most participants had never visited any online virtual world (10 out of 12) nor any immersive exhibition (9 out of 12).

The experimental design consisted of three primary data collection sessions (Table 1): the first session (phase 1) collected some quantitative data using the "Pre-experience Questionnaire". This phase was important for profiling the students and dividing them into two groups with comparable familiarity with immersive media: we formed two groups of 6 participants each. Most of the participants were university students aged 22-25, with two outliers aged 64 and 65, who were assigned to separate groups. One week after the first phase, we ran the main experiment. Participants joined their assigned groups: virtual reality (VR – group 1) or paper (P – group 2). In both conditions, participants received preparatory materials about Luca Pozzi's VR artwork Rosetta Mission 2020, followed by the actual experience of the artwork.

Phase 1	**Phase 2**	**Phase 3**
Collection of initial sample data, profiling, division into experimental groups. ➢ Pre-experience Questionnaire	Immersive experience preceded by an introductory phase. Quantitative data collection. ➢ Post-experience Questionnaire	Post-experience qualitative data collection. ➢ In-depth interviews conducted online

Table 1 - The three phases of data collection

Participants completed the preparation phase independently, monitored by four research assistants who only intervened to resolve technical issues. The artwork phase was guided by Professor Modena, who acted as a museum guide. After completing the artwork phase, all participants, regardless of their group, were asked to complete three-part Post-experience Questionnaire to explore their perceptions of both the introductory phase and the actual experience (phase 2). Participants were then informed that they could voluntarily take part in an additional phase of the experiment (phase 3), which involved in-depth interviews about specific aspects of their experience. Three participants chose to participate in this phase: the first two were included in the VR Preparation group and the third in the Paper Preparation group.

3.2. Instruments and data analysis

The study collected both quantitative and qualitative data. The former was collected through four questionnaires: the first of them was administered before the participants underwent the VR experience (phase 1); the second, third, and fourth afterward (phase 2):

1. The "Pre-experience Questionnaire" was specifically developed to gather participant

information necessary for forming comparable experimental groups. This initial questionnaire contained 5 open-ended profiling questions and 18 further open-ended questions designed to investigate participants' prior experiences with VR, video gaming, and virtual environments (i.e. Second Life). It also inquired about any stressful incidents related to these technologies or media.

2. The "Preparatory Moment Questionnaire" aimed at capturing the students' evaluation of the perceived impact of the preparatory moment on the learning processes. It was composed of 12 statements that had to be rated on a 7-point Likert scale. Each statement was based on the circular model proposed by Schwartz and Hartman (2007), which describes learning outcomes connected to four different actions: to see (perceived details and information, e.g., "The preparatory moment allowed me to collect useful information for the experience"); to say (explanation of a fact, e.g., "The preparatory moment allowed me to better understand the general meaning of the experience"); to do (attitudes or skills developed by students, e.g., "The preparatory moment helped me to foresee some elements of the experience"); to motivate (perceived engagement and interest, e.g., "The preparatory moment allowed me to apprize the experience").
3. The "Engagement Questionnaire" included 7 open-ended questions designed to capture student feedback on their perceived learning and interactions during both the preparation and immersion phases. It included a validated set of questions from existing research (Georgiou & Kyza, 2017) to assess students' level of engagement. This section consisted of 15 statements, such as "I was curious about how the activity would go", which students rated on a 7-point Likert scale.
4. The "Presence Questionnaire" is a validated instrument developed by Witmer and Singer (1998). We selected 14 questions from the original survey, ensuring that they were coherent to our immersive experience and covered all four subscales of the original. Participants rated each question on a 7-point Likert scale.

All questionnaires were created in Microsoft Forms and shared with participants via links. Each student completed the questionnaires using their device, with the assurance that all responses would be pseudonymised. The data were analysed in aggregate by descriptive analysis.

As for the qualitative data, they were collected through in-depth non-structured interviews with students who were willing. All interviews were conducted with the aim of respecting the student's schedule as much as possible: it was decided to conduct the interviews either by telephone or through a video call with Microsoft Teams; the latter option being preferred because of the possibility of transcribing the interview verbatim in real time. Precisely because the interviews were conducted a few days after the experiment, the first question served to help the subject remember and focalise as much as possible about the immersive experience during the experiment. The interview then continued with the request to focus on and deepen some of the details that the subject would mention (Zammuner, 1998).

Once the qualitative data collection phase was complete, the researcher cleaned up the data and made it ready for analysis, following some basic precautions: all verbatims were transcribed using automatic transcription and arranged in a non-invasive way, without changing the sentences to make them appear cleaner or more fluent. In addition to the interviewee's verbal expressions, some notes

on the paraverbal part were added (Anolli, 2012), by inserting indicators such as [laughs]. They then carried out a thematic analysis, in which both researchers analysed all the interviews conducted separately, to compare and discuss their respective outcomes and thought later on.

4. Results

In this section we present our preliminary findings, discussing quantitative data already laid out in a previous article (Cavaletti & Terrenghi, 2023) and integrating them with the themes emerged from the interviews. The results of the exploratory pilot study included 36 questionnaires analysed (12 respondents per Post-experience Questionnaire) and 3 in-depth interviews.

Taking an overall average of all students' responses in the Preparatory Moment Questionnaire, there are a few items that averaged over 5 points. Indeed, the preparatory period was considered to be very useful in understanding the general meaning of the experience (M=5.3) and in helping the student to remember certain elements of the immersive exploration that took place afterwards (M=5.5). If we look at the differences between the two experimental groups (Figure 3), it is interesting to note that, on the one hand, the group that enjoyed the VR preparation benefited primarily in terms of their ability to orient themselves in space; this item was the one with the largest difference between groups, 3.2 points on a scale of 7. On the other hand, the group that prepared on paper stated that the preparatory moment was useful above all for them to better focus on non-spatial, but theoretical/cognitive information. Indeed, the participants of Paper Preparation group claimed that the preparatory phase helped them to memorise some elements of the immersive visit (+1.1 average point compared to VR group), and to understand some theoretical elements too (+0.5 average point). These preliminary data are confirmed and supported by the qualitative data from the interviews. The subject who went through the preparatory experience with the HMD (Head Mounted Display) stated that he found it very difficult to concentrate on reading the preparatory exhibition panels:

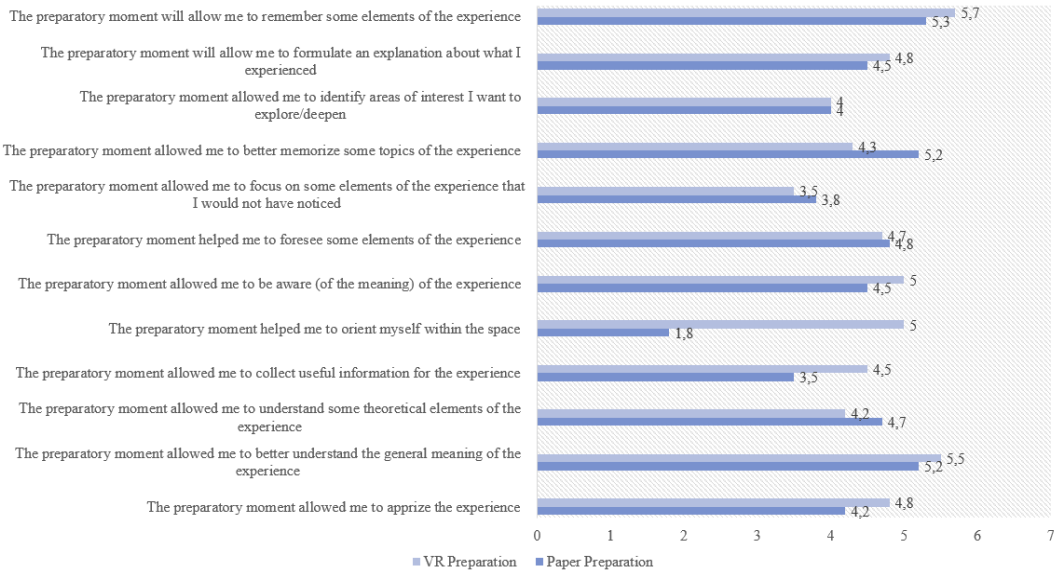

Figure 3 – Results from the Preparatory Moment Questionnaire – Average between VR group and Paper group

"*I think the hardest part (...) was reading the slides, you know? Keeping focus on the slide*"

(Interviewee n.1). In contrast, those who experienced the paper-based preparation said that they felt very focused on the content presented in the panels, but had more difficulty orienting themselves in the room: "*I noticed that putting me in the reading group put me in a cognitive mode (...). Then when we put the visor on, I said - I know what [the work] is about, I know how they made it, what it means, yes, but I don't have the visual experience*-" (Interviewee n.3). Confirming this, the same subject at another point in the interview states that he felt disoriented when he arrived on the comet: *"I clearly remember that the very first detail I noticed when I was fully immersed in the experience was the... this sensation… that I had lost the orientation"*.

Analysis of the Engagement Questionnaire shows that participants particularly enjoyed the immersive experience, reporting very high scores, particularly in terms of curiosity about how the activity would unfold ("I was curious about how the activity would progress", M= 5.9 points) and the perceived sense of involvement ("The activity became the unique and only thought occupying my mind", M= 5.3). A sense of fun and interest also emerges from the interviews: "*it was pretty fun. I mean, it was fun trying to stay inside* [an artwork that could be explored from within], *not going overboard. Was a little fun minigame*" (Interviewee n.1). And "*learning while I was moving around the statue looking at all the symbolism that where, for example, on their canyons, looking at how I could interact with the statue like move around freely it was really interesting"* (Interviewee n.2).
Figure 4 shows the difference in scores collected between groups. The participants of the Paper Preparations group stated that they had not thought about anything outside of the immersive experience they were having. (+1.1 average point compared to VR group), and that the latter became the unique and only thought occupying their mind (+0.9 average point). The VR group participants, instead, revealed that they were so involved, that they felt that their actions could affect the activity (+1.2 average point compared to P group), and that, if interrupted, they looked forward to returning to the activity (+0.7 average point). However, the score with the greatest variance concerns the student's perception of the application: participants of the VR group declared that, according to them, the VR application was unnecessarily complex (+1.2 average point).

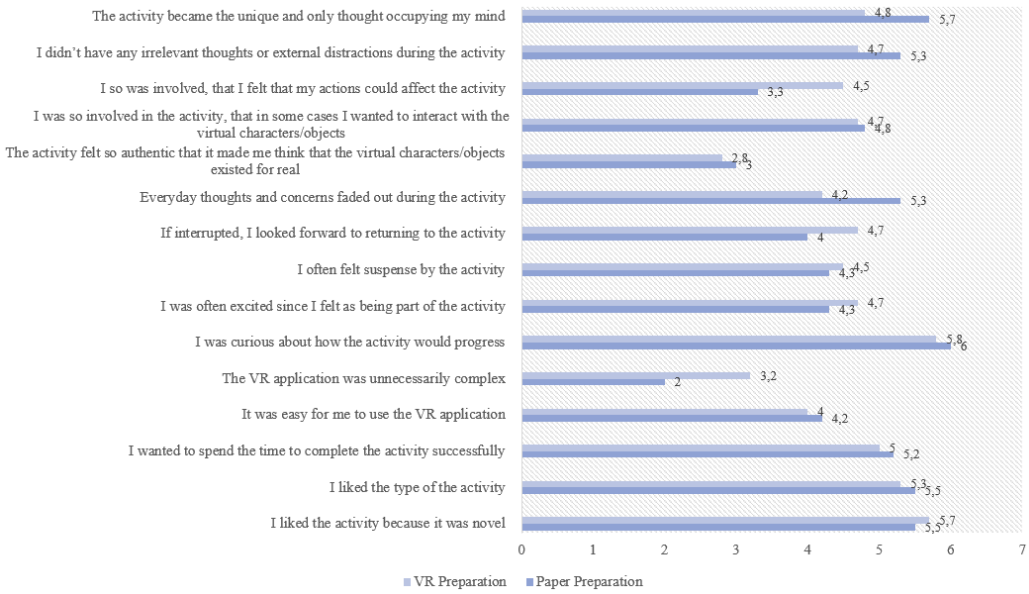

Figure 4 – Results from the Engagement Questionnaire – Average between VR group and Paper group

Taking the final post-experience questionnaire, the Presence Questionnaire, the data shows that the students enjoyed the visual aspects of the experience very much. One of the features that was particularly appreciated was the possibility to visit and observe the work very closely and internally. This was appreciated even by students who were used to video games, because this was a freedom of exploration that was not so common. "*A thing that I really… really liked both as a concept as an idea, it's the fact that they allow you to go inside the comet. It's something that I really, really liked. Because I usually play lots of video games, so usually in video games you don't get to. I mean, if you get to go inside a wall or inside something, usually it's because the game is not quite polished, but in this case it's… it's a feature and it's really cool*" (Interviewee n.2).

Comparing the results from the two different groups (Figure 5), it is interesting to notice that the group most visually involved is the one belonging to the paper preparation condition. (+1 average point compared to VR group), and that the participants affirmed that the vision particularly helped them to explore the environment (+1.2 average point). On the contrary, in the VR group the majority said that all the senses were engaged (+0.8 average point compared to Paper Preparation group).

The participants of the VR group stated to be less aware of events occurring in the real world than the other group participants (-0.5 average point). The qualitative analysis of the interviews revealed that in some cases this ability to fully immerse oneself in the virtual experience was sometimes arbitrarily chosen by the subject: in fact, one of the participants make explicit that he was aware of the physical environment he was in during the experiment, but still chose to focus all his attention in the virtual world: *"I knew that there were people around me. I was still conscious and I could still somehow feel the word around me. The real world around me, but I could also just decide to ignore all of this and go straight into the world that I was seeing"* (Interviewee n.2). Finally, even though VR participants perceived the control mechanism as less distracting (-0.8 average point), they found that it interfered more with their tasks in the virtual environment (+1.3 average point).

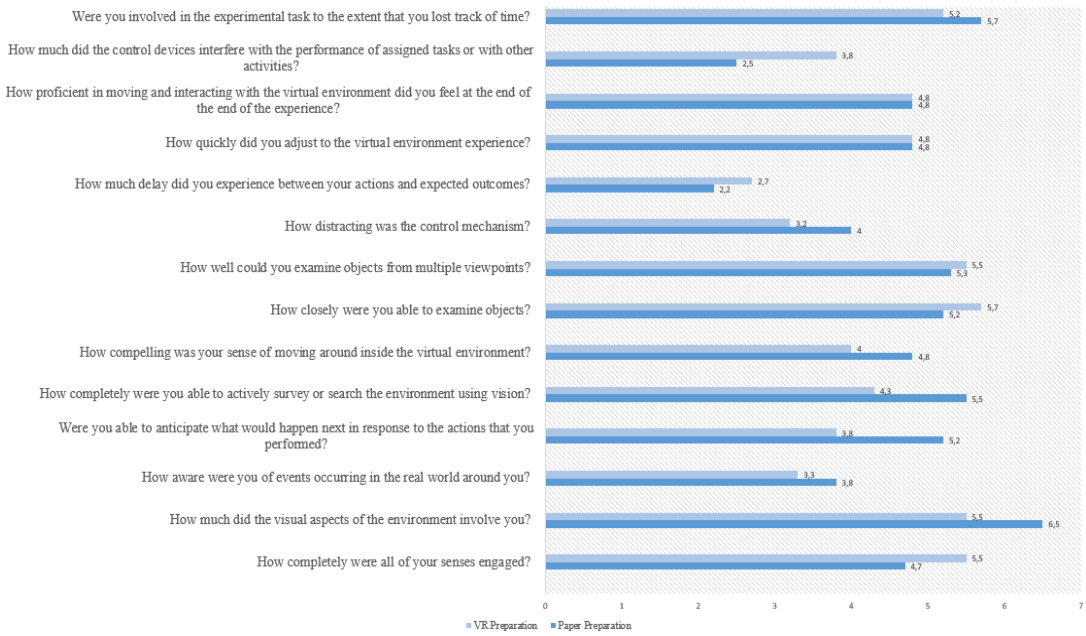

Figure 5 – Results from the Presence Questionnaire – Average between VR group and Paper group

5. Discussion

The descriptive analysis of the questionnaires and the thematic analysis of the interviews yielded very interesting results for understanding the required characteristics for an introductory moment to be effective in preparing for the immersive experience. Below is a discussion of the main results, one hypothesis at a time.

The first hypothesis (1a) was that the use of VR during the preparation phase would improve students' mastery of the prior knowledge needed to understand the artworks. This hypothesis was not supported by the data. According to the preliminary results, students in the VR group found the preparation session useful for gathering information about the immersive experience on the comet especially concerning to the visual and spatial aspects of the environment. Students reported an improvement in their ability to navigate the immersive space and, conversely, the group using printed materials showed better results in memorising and understanding theoretical content, thus improving their theoretical knowledge.

Nevertheless, our findings suggest that students perceived traditional media (such as printed paper) as more effective for assimilating and memorising information, while VR was seen as a more effective tool for exploring the visual aspects of a learning object. This first finding remind to the studies by Höffler and colleagues, who argued that dynamic images are preferable to static images or symbolic mediators when the student needs to learn a procedure or skill, or needs to memorise iconic aspects of a concept or environment (Höffler et al., 2013). It is also interesting to note the study by Makransky and colleagues (2021), who reported that although students preferred learning in Immersive Virtual Reality (IVR) and felt a greater sense of presence, their conceptual learning did not improve compared to traditional methods.

Our second hypothesis (1b) was that the use of VR for preparation would increase students' sense of control over the technology, a key aspect of the overall sense of presence. However, our data did not fully support this hypothesis. First, the Presence Questionnaire showed that participants in the VR group found the control mechanism less distracting than those in the Paper Preparation group; however, they also reported that it interfered more with their tasks during the experience. We interpret this seemingly contradictory result as follows: in the preparation phase, participants using VR became familiar with the control mechanism, reducing the need for focused attention on the controls themselves. However, the subsequent experience required different movements and actions, such as floating in space rather than walking through a simulated museum space, which differed from the initial VR preparation of navigating a virtual exhibition. This discrepancy is likely to have caused the reported interference during the actual experience. The data seem to suggest that not having any exposure to VR at all, as happened to the paper preparation group, might be preferable to one that asks you to take slightly different actions than you should in the actual experience. This is also supported by interview data, which showed that all participants, regardless of the experimental condition, had to go through a more or less complex familiarisation phase with the device. On the one hand, familiarisation was necessary to calibrate a slightly different use of the controllers: "*I just used the time to get familiar with the motion control, going forward, going backward, rotating. I remember having some problems with the rotating vision*". On the other hand, this phase was necessary for those who wore the visor for the first time to experience space without having tried it first in the preparation phase. In any case, the familiarization phase helped participants to become

more confident with the immersive device and its functionality as they went along. This also emerges from the statement of one student who states: "*she* [the guide] *told us to look inside the mouth too. But... I thought, since I'm here, I might see if there's anything else inside the body as well. It wasn't really anything (...) but it was fun anyway. It felt very natural to take the initiative, right? It was just a natural reaction I guess. I think someone else did it*". Even more importantly, another student applied what he learned during preparation, using an analogy between mechanisms observed in the museum and in outer space: "*the first connection I made was "Ok, there's music, there's smoke [...]...well, probably the music will be louder if you go near the smoke", right? Because back when we were in the museum I heard Elisabetta [the Professor]'s voice a lot clearer when I was near her avatar [...] So... I thought there would be something similar going on there".*

Finally, the third hypothesis (2) was also not fully confirmed. However, this is not difficult to imagine as a consequence of the unconfirmed hypotheses 1a and 1b. Compared to the participants in the paper group, those in the VR group perceived the immersive experience as unnecessarily complex, with an average difference of +1.2 points. We attribute this observation to the aforementioned discrepancy between the tasks performed by users in the preparation phase and those required in the actual artwork experience. The Dynamic Occupation in Time (DOiT) model (Larson, 2010) could help us explain the perceived complexity of the experience. According to the model, the complexity and novelty of a given activity contribute to increasing the level of engagement in it. However, if the experience is perceived as too complex, the result will be the opposite, with engagement and participation levels falling: the VR group may have experienced this second condition. On the contrary, participants in the Paper group may have enjoyed appropriate levels of complexity, and thus enjoyed more the artwork experience. Whether they experienced high levels of engagement from the outset or after becoming familiar with it, all participants experienced good levels of flow (Csikszentmihalyi, 2014). This is confirmed by the fact that many participants declared that their everyday thoughts faded out during this experience and that time seemed to pass very quickly. "*The funny thing is that I completely lost the conception of time, it felt like I was inside for 5 minutes, but it lasted much longer. I completely lost the conception of time. Like when you're playing a videogame or you're fully immersed in reading, that's the same feeling".*

6. Conclusion

The experiment provided useful information for designing a preparatory moment that is effective for the class preparing for an immersive experience. Although the results show that the immersive experience can work well and bring the students into a state of flow, after very different introductory moments, it would be desirable for the preparatory phase to be consistent with the experience itself in terms of the movements and procedures required.

This result suggests the need for further, more targeted research involving a larger sample of participants. The pilot nature of our study partly justifies the small sample. However, to validate our preliminary findings, the study should be replicated with a larger number of subjects, with different profiles and also using the same or different VR material.

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References:

Anolli, L. (2012). *Fondamenti di psicologia della comunicazione*. Bologna: Il Mulino.

Buccini, F. (2023). Learning in the metaverse: for an educational use of hybrid environments. *Q-Times Webmagazine*, (3), 121-133.

Calleja, G. (2011). *In-game: From immersion to incorporation*. Boston: The MIT Press.

Castaldo, F. (2004). Un'esperienza di didattica integrata: nuove tecnologie e formazione presso la cattedra di Storia delle dottrine politiche. *Italian Journal of Educational Technology*, 12(3), 13-13.

Cavaletti, F., & Terrenghi, I. (2023). Testing innovative preparation tools for immersive virtual environments. A case study in the didactics of Art. *IUL Research*, 4(7), 88-107. https://dx.doi.org/10.57568/iulresearch.v4i7.422

Checa, D., & Bustillo, A. (2020). A review of immersive virtual reality serious games to enhance learning and training. *Multimedia Tools and Applications*, 79, 5501–5527. https://doi.org/10.1007/s11042-019-08348-9

Corrias, G. (2021). *Progettazione, realizzazione e testing di un ambiente di realtà virtuale immersiva per l'apprendimento*, Tesi di Dottorato.

Creswell, J. W. & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks: SAGE.

Csikszentmihalyi, M. (2014). *Flow and the foundations of positive psychology. The Collected Works of Mihaly Csikszentmihalyi*, (Vol. 10, pp. 978–994). Springer. DOI: https://doi.org/10.1007/978-94-017-9088-8

Cuomo, S. & Ranieri, M. (2022). Immersive technologies for learning improvement in higher education: A study on students' perceptions. *Q-Times Webmagazine*, (2), 369-384.

Ferrari, S. (2013). *Progettare il momento preparatorio dell'EAS*. In P.C. Rivoltella (Ed.), *Fare didattica con gli EAS*, Brescia: Editrice la Scuola.

Ferrari, S., & Terrenghi, I. (2021). Video as an anticipatory tool to deepen and to generate questions. A case study in higher education. *Italian Journal of Educational Research*, (27), 140–159. doi.org/10.7346/sird-022021

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1), 59–109.

Garavaglia, A. & Petti, L. (2013). *La videolezione*. In P.C. Rivoltella (Ed.), *Fare didattica con gli EAS*, Brescia: Editrice la Scuola.

Gardner, H. (1999). *Sapere per comprendere. Discipline di studio e disciplina della mente*. Milano: Feltrinelli.

Georgiou, Y., & Kyza, E. A. (2017). The Development and Validation of the Ari Questionnaire: an Instrument for Measuring Immersion in Location-Based Augmented Reality Settings. *International Journal of Human-Computer Studies*, 98, 24–37. Https://Doi.Org/10.1016/J.Ijhcs.2016.09.014

Höffler, T. N., Schmeck, A., & Opfermann, M. (2013). *Static and Dynamic Visual Representations. Individual Differences in Processing*. In G. Schraw, M. T. McCrudden, & D. Robinson (Eds.),

Learning Through Visual Dysplays (pp. 133–163). Information Age Publishing. http://lccn.loc.gov/2013004595

Larson, E. A, & von Eye, A. (2010). Beyond flow: Temporality and participation in everyday activities. *American Journal of Occupational Therapy*, 64(1), 152–163. DOI: https://doi.org/10.5014/ajot.64.1.152

Makransky, G., Andreasen, N. K., Baceviciute, S., & Mayer, R. E. (2021). Immersive virtual reality increases liking but not learning with a science simulation and generative learning strategies promote learning in immersive virtual reality. *Journal of Educational Psychology*, 113(4), 719–735.

Marcuccio, M., Tassinari, M. E., & Pistillo, M., V. (2023). Immersive virtual reality and learning assessment. An exploratory research in a high school. *Q-TIMES Webmagazine*, 10.14668/QTimes_15317

Mosovici, S. (1976). *Social Influence and Social Change*, London: Academic Press.

Nirchi, S. (2015). Strategies of Virtual reality and Experiential Learning for innovative teaching. *Q-Times Webmagazine* (3), 31-42.

Schwartz, D. L., & Hartman, K. (2007). *It's not video anymore: Designing digital video for learning and assessment*. In R. Goldman, R. Pea, B. Barron, & S.J. Derry (Eds.), *Video Research in the Learning Sciences* (pp. 335–348). Erlbaum. https://doi.org/10.4324/9780203877258

Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence*, 7(3), 225–240.

Zammuner, V.L. (1998). *Tecniche dell'intervista e del questionario*. Bologna: Il Mulino.