Assessment as Learning in Metaverse: An Experience Report in a Post-Pandemic Blended Learning Scenario

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Abstract: Education has undergone significant transformations in teaching and learning practices during COVID-19, including changes in the way of assessing students, moving from assessment of learning to assessment for learning and finally to assessment as learning. The pandemic also leaves the use and creation of innovative technologies that support education as a legacy. In this environment, new technologies such as virtual environments and the metaverse can innovate the teaching and learning process by allowing teachers and students to extend the real world into virtual learning worlds. Thus, this article presents an experience report on a formative assessment of a database course based in a hybrid educational context, supported by metaverse and active learning approaches. Through a quasi-experimental study, the formative assessment was compared with a traditional summative assessment to analyze the students' satisfaction and perception of learning. As a result, we observed that students felt more satisfied performing the formative assessment in the hybrid context, noticing improvements in learning and their performance concerning the traditional assessment.

Keywords: Assessment, Metaverse, Blended Teaching and Learning, Post-COVID.

Avaliação como Aprendizado no Metaverso: Um Relato de Experiência em Um Cenário de Ensino Híbrido Pós-Pandemia

Resumo: A educação passou por grandes transformações nas prática de ensino e aprendizado durante a COVID-19, incluindo mudanças na forma de avaliar os alunos, migrando de avaliações de aprendizado para avaliações como aprendizado. A pandemia também deixa como herança o uso e criação de tecnologias inovadoras que apoiem a educação. Neste ambiente, novas tecnologias como o metaverso, pode inovar no processo de ensino e aprendizado, ao permitir que docentes e alunos estendam o mundo real para mundos virtuais de aprendizado. Deste modo, este artigo tem como objetivo apresentar um relato de experiência sobre uma avaliação formativa de banco de dados, híbrida, com foco em aprendizagem baseada em problemas, dentro do metaverso. Por meio de um estudo quasi-experimental, a atividade no metaverso foi comparada com uma avaliação somativa tradicional buscando analisar a satisfação e percepção de aprendizado dos alunos. Como resultado, foi observado que os alunos se sentiram mais satisfeitos em realizar a atividade no metaverso, percebendo melhorias no aprendizado e em seu desempenho na atividade em relação à avaliação tradicional.

Palavras-chave: Avaliação, Metaverso, Ensino e Aprendizado Híbrido, Pós-COVID.

1. Introduction

Education has undergone significant challenges and transformations during the COVID-19 pandemic. The need to use Internet-mediated communication technologies has accelerated changes in traditional teaching and learning practices (KADDOURA e HUSSEINY, 2021). Culturally face-to-face courses were forced to migrate to remote teaching, creating several obstacles for involved educational institutions and people (MOTADE e DESHPANDE, 2022).

Education in the pandemic also brought reflections on assessment methods (ALSALHI *et al.*, 2022). Many teachers faced difficulties applying summative and supervised assessments in the face-to-face used model, such as tests, examinations, etc. This led them to look for alternatives

based on formative assessments (ALSALHI *et al.*, 2022; ASAMOAH *et al.*, 2022). In this evaluative model, some teachers adopted active learning techniques since such practices seek a student-centered education, engaging him in problem-solving and stimulating critical thinking, leading him to build his knowledge (KADDOURA e HUSSEINY, 2021; KERRIGAN *et al.*, 2022). Therefore, in this period of remote teaching, there was a change in the assessment paradigm of many teachers, migrating from Assessment of Learning (AoL) to Assessment for Learning (AfL) and finally to Assessment as Learning (AaL) (YANG e XIN, 2022).

With the return of face-to-face activities in institutions, teachers and students need to adapt again to a "new normal" of education after the transformation that occurred during the critical period of the pandemic bringing, at the same time, benefit from the lessons learned during COVID-19 and new challenges, such as blended (or hybrid) learning (ALSALHI *et al.*, 2022; KERRIGAN *et al.*, 2022).

In a hybrid teaching and learning environment, it could be interesting for teachers and students to appropriate technologies that incorporate the concept of virtual worlds as extensions of the real world, exploring new educational perspectives and enabling the use of technologies such as metaverses (SUH e AHN, 2022; TLILI *et al.*, 2022; INCEOGLU e CILOGLUGIL, 2022).

In this context, the metaverse is expected to be actively used in the future of student education, being driven by technologies and educational reflections inherited from the pandemic (KERRIGAN *et al.*, 2022). These virtual worlds could be used as a new social and educational platform where students and educators can engage, even if physically distant, in the teaching and learning process (WANG *et al.*, 2022). However, although it is pointed out as a technology that can innovate the educational context, there are still gaps in studies in educational environments that use metaverses, such as the use of these environments in hybrid learning and assessment processes (TLILI *et al.*, 2022).

Thus, within this context, this article aims to report the experience of a blended formative assessment of a database subject of a higher education course in information systems, using metaverse as an active learning approach. Besides showing the conception and conduction of the assessment task, this article sought to analyze whether the activity contributed to students' satisfaction and learning perception compared to a traditional summative assessment (test). The result of the study shows evidence that the students were more satisfied with this formative task, realizing better learning and performance concerning the concepts of the approached database.

We organized this report into: Section 2 addresses the fundamental concepts related to the understanding of work. Section 3 relates and compares this study to other works. In the Section 4 we described the activity using metaverse in a hybrid formative assessment and its data analysis. And, finally, Section 5 presents the conclusion.

2. Backgrounds

In this section we talk about the conceptual background related to metaverse and assessment as learning.

2.1. Metaverse

Neal Stephenson coined the term "Metaverse" in a 1992 novel called "Snow Crash", in which the main character enters an online universe, in avatar form, to escape from the problems of a dystopian reality. The term is a combination of "Meta", which means virtual, with "Verse", which refers to the world, the universe (STEPHENSON, 2003).

In 2007 the Acceleration Studies Foundation (ASF) published the "Metaverse Road Map" (SMART *et al.*, 2007), presenting four classification criteria for these environments. According to Kye *et al.* (2021), the area among the axes allows classifying metaverses into types: **Augmented Reality:** A method of projecting information using a device so that it provides additional information using a smartphone or smart device on the real world; **Mirror Worlds:** a space that provides new information or activities to users creating a space identical to the real world

in the virtual world; **Virtual Worlds:** a virtual space where users can move their avatars by the environment and interact with objects and themselves and; **Lifelogging:** a virtual space in which data and actions that occur in reality are transferred to the virtual world as they are.

According to Mystakidis (2022), the metaverse is composed of technologies, principles, possibilities and challenges. The different approaches and strategies raise doubts about the issue of openness and privacy, that is, what will be the levels of users' privacy rights. Another question concerns the choice of the metaverse directly implying whether it will be inclusive for students. All these points must be considered depending on the application context, as they will determine whether the metaverse can become a mainstream technology in e-learning (MYSTAKIDIS, 2021).

Within the specific context of education, the metaverse has great innovative potential, meeting people's learning needs, allowing access to a virtual world extended from their real world, from any place or time (KYE *et al.*, 2021; YUE, 2022). New approaches with metaverse technologies emerge, enabling rich learning experiences in online environments. Students can interact with teachers and communicate with classmates through their avatars, providing an immersive and motivating learning experience (TLILI *et al.*, 2022).

Metaverses can break the physical restriction of students moving to attend in-person classes while allowing students to attend institutions face-to-face. It is also simple for students to access study materials, as they can find them in a wide variety of libraries without leaving home, in addition to exchanging content and discussing their reflections with others (KYE *et al.*, 2021; YUE, 2022).

2.2. Assessment of Learning to Assessment as Learning

In this assessment of learning (AoL) process, traditional summative assessments aimed to measure students' knowledge through grades at the end of a unit or subject. The student only has his learning feedback quantified in a number at the end of the correction by the teacher (GROVER, 2021). Up to now, this type of assessment is widespread in different courses, institutions and learning environments.

Due to the delay in providing learning feedback to students, some institutions have started to focus on using formative assessment forms, stressing assessment for learning (AfL) or assessment as learning (AaL). These evaluations seek to monitor the student's learning process and provide feedback to both students and teachers to have a better understanding of learning (SCHELLEKENS *et al.*, 2021; GROVER, 2021). This assessment paradigm change has promoted the transition from summative outcome-based assessments (AoL) to formative assessments centered on the learning process (AfL or AaL) (ASAMOAH *et al.*, 2022).

The most significant difference between AoL and AfL is the paradigm change in how the teacher is seen. In AoL, the teacher has the role of leader, while in AfL, teachers give students an active role in seeking knowledge (GROVER, 2021). Furthermore, there are still differences between AoL and AfL related to AaL. At AaL, students are encouraged to actively participate in discussions and assessments, often leading to self-assessment. In this paradigm, AaL practices consider the same philosophy of active learning, involving students in the process of self-assessment and continuous feedback, improving the learning process(SCHELLEKENS *et al.*, 2021; MOTADE e DESHPANDE, 2022).

Modern assessment practices involve going beyond the ability to remember and reproduce some information. An effective assessment consists of the construction of knowledge, paying attention to the collection and information internalization, reflecting and transforming it into competencies, into skills that allow the student to analyze a situation and choose the best way to solve a problem (SCHELLEKENS *et al.*, 2021; ASAMOAH *et al.*, 2022). Although further studies are needed in this field since recognizing the positive aspects of AfL in learning does not train students in the perception of self-assessment. Still, an approach using AaL rarely reaches its potential in a traditional classroom(IBNU *et al.*, 2020; YANG e XIN, 2022).

3. Related Works

Currently, it is possible to find several works that propose the application of the metaverse in educational contexts.

Masferrer *et al.* (MASFERRER *et al.*, 2014) report the experience of using metaverse technologies like Second Life and OpenSims as learning environments. They say they have seen better results using these environments than other platforms supporting online learning.

Kukhyeon *et al.* (KIM *et al.*, 2022) empirically analyzed the acceptance factors of higher education students in a metaverse-based learning environment using virtual reality. The results indicate that the metaverse environment was one of the significant factors to affect the user's intention, being considered helpful for their learning process.

Jovanović and Milosavljević (JOVANOVIĆ e MILOSAVLJEVIĆ, 2022) introduce a metaverse platform based on a gamified virtual world focused on collaborative learning called VoRtex. As a result, they pointed out that the platform presented good educational outcomes, compared to traditional online teaching and learning platforms, during COVID-19.

Finally, Tlili *et al.* (TLILI *et al.*, 2022) present a bibliographic review focused on using the metaverse in education. In their conclusions, they highlight that the adoption of the metaverse in educational contexts has evolved over the years, but there are still gaps and few studies that focus on mobile and hybrid learning.

This article also addresses the metaverse as an educational environment supported by active learning techniques. As can be seen in Masferrer *et al.* (MASFERRER *et al.*, 2014), the proposal to use technologies based on virtual worlds in education is not novel. However, the COVID-19 pandemic has brought opportunities to explore these virtual worlds to engage students and improve the teaching-learning process and assessment practices (KERRIGAN *et al.*, 2022). Also, this article approaches a gap pointed out by Tlili *et al.* (TLILI *et al.*, 2022), about the low amount of metaverse work in hybrid learning. With the return of face-to-face activities at universities, opportunities have arisen to use the metaverse in a hybrid way, conducting activities with face-to-face students in the classroom and at home.

Another difference this article presents over the others shown here is how the metaverse is used. The proposal we bring focuses on using such technology in an AaL process. Using the metaverse, aligned with active learning techniques within the context of hybrid education, allows students integration and reflection to obtain feedback and continuous evaluation.

4. AaL in Metaverse

To keep the scientific rigor in the paper, this section describe our approach and presents the evaluation process.

4.1. Design of the Activity in Metaverse

The activity was conceived within a formative assessment for a database subject of a higher course in information systems at a Brazilian federal public university. We thought as the **learning objective** that the students could: i) **understand** problem situations related to data management; ii) **apply** concepts and techniques based on views, procedures, functions and triggers; iii) **evaluate** whether the solutions applied can solve the problems, at the end of the activity.

For this purpose, we choose to create an activity supported by **Problem-Based Learning (PBL - active learning)** to simulate a software enterprise. We presented different situations to students, considering data base's issues within a fictitious company. The company needed to solve cases involving data analysis and management during working hours. This scenario simulates a real situation requiring that data analysts create different strategic structures of data recovery in the DBMS (Data Base Management System) to meet the business demand of a company.

Also, we used **metaverse** as an active learn-supported technology, where we designed an environment that allowed students to extend the physical classroom to the virtual environment

in a blended context. The metaverse chosen was the *Gather Town*[*], for enabling the creation of a **virtual world** that promotes students' immersion and interaction. In that world, students can build avatars, navigate environments and rooms, access public and private spaces for discussion through chat or video, access collaborative text editing and DBMS tools, and other features supported by Gather Town. In Figure 1 is possible to see the virtual world of the students' interaction. The panel on the right shows the students connected, the tables on the left are private work environments, and the projectors in the room on the right are where the company's managers deliver the demand to students.

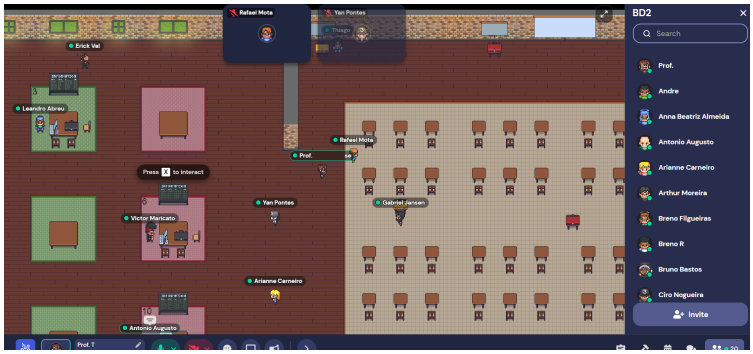

Figure 1. Database assessment activity in Gather Town.

As the metaverse conducted the activity, the class teacher allowed the students to carry out the activity in a **hybrid** way. Some students participated in it, accessing the metaverse from inside the computer lab computers. Other students, who reported difficulty in transport and displacement to carry out the activity in person, worked from their homes. All of them, independently, whether at home or in school, interacted exclusively with each other in the virtual world supported by the metaverse.

The choice of PBL and this type of metaverse allowed simulating an organizational environment. In this environment, the students received the work demand from the company's managers when they met them (other characters or videos on projectors in the scenario). Upon receiving a request, they took it to the private areas and could discuss the issue with another student (understanding), develop their solutions in a DBMS available online within the metaverse (application), and evaluate the best solutions among themselves (assessment). As it is possible to see, each action in the metaverse matches the learning objectives traced to the assessment tasks.

The activity was created to be an **assessment as learning (AaL)**. We designed the activity characteristics aiming that students could learn from their actions, considering aspects such as i) **collaboration**: students could discuss each other techniques and solutions to a problem (chats, private areas etc.); ii) **attempt**: using DBMS, students could try solutions to solve the issues at any time; iii) **immediate feedback**: the student could check if its answers were under what the company manager requested in an "analysis machine" inside the metaverse. This machine was composed of a form in which other students should analyze their colleagues' answers and reach a conclusion if they were right.

For assessment, we considered the entire process of discussion and analysis of the solutions presented by the students. We believed that the learning from this activity happened collaboratively based on the interaction and exchange of knowledge among the students, the self-learning resulting from the discussions, and the immediate feedback using their peers' assessment of the answers. However, the assessment result had to be quantified in a grade (score – points) for institutional reasons. We had to attach rates from 0 to 2 points for each question, considering a total score of 10 points in five issues.

[*]https://gather.town/

4.2. Activity Evaluation

In follow sections we present the evaluation planning, execution and results of this study.

4.2.1. Planning and Execution

To analyze the satisfaction, learning perception, and students' performance with formative assessment supported by the metaverse, we compared this blended active learning activity to a traditional summative assessment in a test format. The content and issues addressed in both activities were similar, covering the use and application of views, procedures, functions and triggers in a relational database applications. The students' scores in both tests were used for comparison purposes only and to observe performance evidence.

Thus, following the GQM (Goal-Question-Metric (BASILI, 1992)) approach, we can define this study such as: **analyzing** the blended active learning formative assessment within the metaverse; **with the purpose of** comparing; **regarding** 1) satisfaction and 2) learning perception; **from the perspective of** students; **in the context of** a database course in a public university.

The study participants were students of a database subject of a higher course in Information Systems at a Brazilian federal public university. Although the assessment activities were not optional for the students, they provided the data and results through a free and clarified term. In total, 19 students answered the survey and allowed their data to be used in the study (consented by on a term of free clarified), knowing that at no time would they be identified.

Both assessment activities (summative and formative) were performed within a time interval of 120 minutes. At the end of the activity conducted in the metaverse, we invited the students to answer a qualitative questionnaire voluntarily about their satisfaction and perception of learning concerning the exercise.

Data analysis used a hybrid approach (quantitative and qualitative). Statistical analysis was the basis for comparing the performance (scores) of the two activities and analyzing the hypothesis by the students' answers. We observed the perception of satisfaction and learning through a qualitative analysis of the students' responses.

In the study, first, we applied the traditional exam. Two days later, we used the activity within the metaverse. The traditional assessment was conducted on July 26, 2022, while the metaverse one occurred on July 28, 2022. The traditional assessment was performed individually. While the evaluation in the metaverse, as already described in the section 4.1, allowed collaboration among students.

Finally, the study validity threats (Table 1) complete the study design, showing the primary threats identified and the treatments to mitigate them.

Table 1. Threats of validity

Type	Threat	Treatment
Conclusion	The statistical power of the analysis method	Scales and statistical methods more consistent with the metrics were selected and applied.
	Violation of assumptions of statistical methods	Use of statistical methods consistent with the scale and characteristics of the data sample.
	Bias in data selection	The data used have been published so that others can repeat the analysis.
Internal	Lack of training	To lessen the threat, Gather was used in previous classes to get the students into the environment.
	Activity historical	Although the students had the traditional test with the same content as the metaverse, the questions were different, although they were similar in terms of complexity.
	Participant fatigue	Assessments are designed to be completed in 120 minutes to avoid fatigue.
	Instrumentation	In addition to the students' grades, a qualitative questionnaire was used only to collect the students' perceptions.
Design External	Planning	To lessen this threat, the assessment was planned considering the design definitions of quasi-experimental studies. (CAMPBELL e STANLEY, 2015).
	Generalization	As they are students of a computing course, it is believed that the results can be generalized to other subjects such as programming, project analysis and others. However, it is understood that carrying out and comparing data in future evaluations with more classes within this area is necessary.

4.2.2. Data Analysis

We used the R Statistics 4.1.3 software to perform the Data analysis. All data were summarized in tables and graphs to preserve the participants' identity and simplify their interpretation. In the

statistical analyses, all results considered a confidence interval of 95% (alpha=0.05). All results were extracted exclusively from the analysis of the participants' data[†]

4.2.2.1. Students' Satisfaction in the Assessment

Figure 2 presented the qualitative analysis of the students' perception of satisfaction related to active learning assessment within the metaverse. In this analysis, we considered the place of execution of the activity (school or home).

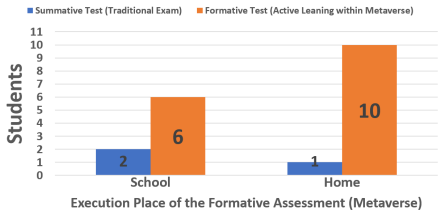

Figure 2. Students' perceptions of satisfaction.

When analyzing Figure 2, it is possible to observe that, in both places (school and home), students showed an improvement in satisfaction when performing the assessment activity using the metaverse environment. It is possible to notice that students who completed the activity at home preferred using the metaverse, which may indicate that they felt more comfortable with remote activities, perhaps as a reflection of the teaching period during COVID-19.

In this context, many students reported that performing the activity in the metaverse at home was more positive and comfortable, as they did not have to displace to the university. This can be observed in their answers, for instance (participants' speeches are in Portuguese): *"this activity takes off a huge amount of pressure from the student, who even knowing the content may not be able to do it because of the pressure, not to mention that students who live far from the university spend energy to get until there".*; *"I prefer the hybrid test, as it allows a degree of freedom as to whether the person has the opportunity to stay at home and avoid traffic"*; *"the test in Gather allowed me to have the test less tense"*.

Regarding the previous use of some metaverse environment, 100% of the students indicated that they were more satisfied with performing the activity in this environment. The students also pointed out that their collaboration and interactivity, stimulated by the assessment task using metaverse and active learning approaches, improved their satisfaction and perception of learning. It is possible to observe in the answers: *"the hybrid activity becomes a more interesting option because it requires teamwork, similar to real work environments, in addition to being a playful form of evaluation"*; *"This activity can show me an application that encourages collaboration among students in the development of SQL query challenges and the like."*; *"I was able to do more exchanges with other colleagues, and I liked being able to check the result before closing the question"*; *This activity can show me an application that encourages collaboration among students to develop challenges of SQL queries and the like."*; *"I can make more exchanges with other colleagues, and I liked being able to check the result before closing the question"*. However, some of them stated that there was no difference in their learning from the traditional assessment and that performed in the metaverse.

According to one student, another interesting point that influenced his satisfaction and learning was the proposal of immediate feedback provided in this evaluation, in line with the philosophy of AfL and AoL. We can observe this in the student's answer: *"I liked being able to check the result before closing the question"*.

However, it is impossible to say that the metaverse is the main reason for that satisfaction. Maybe, the reason is that the set of factors (metaverse, active learning, etc.) incorporated within

[†]https://bit.ly/pdataDbMetaverse23

the activity applied and the novelty of the assessment process could bring those perceptions.

Students' Perception of Learning in the Assessment

This analysis aimed to compare students' learning perception, considering their scores (grade/score) regarding traditional summative and formative assessments in the blended environment described in this paper. For this, these hypotheses – $\mathbf{H_{(null)}}$ were postulated: *Students did not perform better in the blended formative assessment compared to the traditional evaluation*. $\mathbf{H_{(alternative)}}$: *Students performed better in the blended formative assessment than in the traditional evaluation*.

Observing Figure 3(A), there is a perception that the formative assessment using the metaverse got better concerning the traditional assessment. The traditional assessment showed a significant variance in scores, and many students obtained results below grade 9. While in the formative assessment, almost all students got grades above 9.5, promoting the idea that the alternative hypothesis is true.

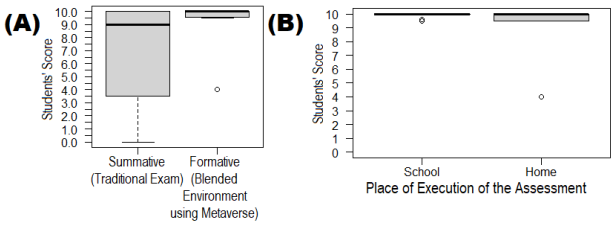

Figure 3. A) Students' scores between the summative and formative assessment. B) Students' scores between places of execution of the formative assessment.

Table 2. Inferential statistics of students' grades in traditional and metaverse tests.

	Normality ***(Shapiro-Wilk test)***	**Hypothesis** ***(Wilcoxon test)***	**Effect-Size** ***(Vargha-Delaney A_{12} test)***
Traditional Test	2,79E-03	0,0176	0,2881
Metaverse Test	1,50E-07		0,7119

To confirm this hypothesis, we applied statistical inference tests (Table 2). The first was the normality test by Shapiro-Wilk due to the small number of participants. When applying it, we verified that both sets of students' grades do not follow the behavior of normality (p-value<alpha). This implies that the most appropriate hypothesis test for these data is the Wilcoxon test (CROWDER *et al.*, 2017).

When applying the hypothesis test, a value lower than alpha (p-value=0.0176) was observed. This allows us to say, with at least 95% certainty, that the blended formative assessment using metaverse and active learning approaches improved student performance within this application context, confirming the alternative hypothesis. When analyzing the values of the A_{12} test (effect size of hypothesis (CROWDER *et al.*, 2017)), we observed that this improvement occurred in 71% of the students.

Considering the statistical righteousness, we also compared the students' scores according to the site where they performed the formative assessment. Even though it was an assessment in a hybrid environment, It was necessary to analyze whether the place where students completed the activity influenced their scores. In Figure 3(B), it is possible to perceive that the students' scores are pretty similar, with grades above 9.5.

We analyze both score groups (Home and School) using inferential statistics. By Shapiro-Wilk's normality test, both datasets do not follow the behavior of normality (School got p-value=1.43E-04, and Home got p-value=5,98E-06). Thus, using the Wilcoxon test, we can not say that there are significant differences among the students' scores between assessments concluded at home or school (p-value=0.2923).

Therefore, we observe evidence that the formative assessment, using metaverse and PBL as active learning approaches in the hybrid educational context presented in this work, could improve students' learning perception and influence their grades.

Nevertheless, it is impossible to argue that a unique aspect of the activity was responsible

for student satisfaction or learning. We imagine that the key elements of AaL, such as discussion, collaborations, identification, continuous feedback, and others associated with immersion and freedom of place given by hybrid environments such as metaverses, can contribute to a new "post-COVID" education age.

5. Final Remarks and Future Works

In this "post-pandemic" world, in which hybrid learning and education is a reality, extending the physical world to virtual worlds is exciting and brings innovative teaching and learning practices to these environments. In these environments, in this new educational reality, teachers and students need to have the means to discuss, collaborate and build knowledge together.

This work contributed to the report on applying a formative assessment using a metaverse environment and PBL as active learning approaches. The students' satisfaction regarding using this assessment process was analyzed, as well as their perception of learning under their understanding of the situation, application of concepts and techniques and assessment of solutions under the database subject.

As a result, we observed that students were involved and motivated by this assessment. We verified that some of them attributed the success in their learning to the immersive and collaborative environment of the metaverse. Analyzing their performance evidenced this observation that the students obtained better results with the assessment performed in the metaverse.

This study's main limitation is that it used the students' score as a performance evaluation. We recognize that in later works, a better qualitative analysis can be made, and conclusions about student performance can be reached without necessarily resorting to assessment scores (grades). Also, as a limitation, we could not describe in detail the design of the formative assessment activity, making it difficult to reproduce. However, in this paper, we presented the foremost essential aspects that allow teachers to try to use the Gather Town in their assessment process.

It is also not possible to generalize the work results by saying that only the metaverse, or PBL, or the active learning, or other individual aspect of the activity was the main reason for improving student satisfaction and learning. We understood that, although the metaverse can immerse students, it is unclear to this study whether the "novelty" criterion of the assessment activity influenced learning and satisfaction. In addition to other questions such as: Were the collaboration among students effective in learning? To what extent does Gather (metaverse used) support educational contexts? These are just some questions that need to be answered in future work before it is possible to generalize the findings of this work.

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