The Embodiment Dimension while Learning and Teaching in a Virtual World

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ABSTRACT

The paper focuses on the features of embodiment configurations when using the virtual world in the classroom. The context is a secondary school (students aged 11-15) adopting an educational immersive 3D virtual world. We conducted participant observation, collecting video-audio records supported by a student focus group and teachers' interviews. The analytical framework of this paper draws on the iterative interaction of the complex arrangement of bodies and objects in physical and virtual settings. Our results highlight the dynamic ways in which the arrangement of bodies and material acted as a mediational means between real and virtual settings.

Keywords: Embodiment, Space, Virtual World, Secondary School, Avatars, Learning, teacher's professionality.

1. INTRODUCTION

Educational Virtual Worlds (VW) are an active field in full evolution. Adopting and integrating an educational VW into the classroom requires the teacher to design teaching sessions that change job routines even when they are evolving dramatically. Sessions with VW must mobilize the curriculum content with the teacher's creativity. In this paper, the use of the VW focuses more on incorporation – absorption and transportation – than on immersion. Players are productively bound to these virtual environments via social and cultural codes that are designed into the game; these codes are also acquired through the remediation practices of everyday life by the player [1]. The metaphor of incorporation allows us to avoid such a dichotomous relationship: it expresses the phenomenon of immersion or presence as an assimilation into the consciousness of the game world in a manner that is coextensive with our being in the physical world. This does not imply that the two are equal, but rather that the physical and the virtual are both aspects of what we perceive as real. Thus, the body becomes present in both the physical world and cyberspace: the interface adapts to the body and the body adapts to the interface. Taking into consideration the widespread distribution of this specific technology, the aim of this paper is to analyze the implications of body configurations in sense-making in a physical and virtual learning context. What is at stake through this question is the evolving professionality of teachers constituted by the knowledge, skills and procedures that teachers use, transform and create in their work, which differ from the status-related elements of teachers' work, categorized as professionalism [2].

In the next section, we will briefly discuss our conceptualization of embodiment for the present investigation. Then we will describe the context, methods and findings of a case study involving interdisciplinary learning in a French secondary school. Finally, we discuss the findings and draw conclusions.

2. EMBODIMENT BETWEEN THE PHYSICAL AND VIRTUAL

The concept of embodiment has gained currency in recent years, particularly in the light of new forms of interaction and engagement with technology. Situated learning is deeply rooted in bodily activity. This perspective offers rich reflections for conceptualizing the relationship between the physical actions of the body and meaning-making processes [3] [4].
Embodied interaction claims that any action is constituted by a complex arrangement of multiple semiotic fields (e.g., gestures, the body, language, surrounding objects and images) that are deployed simultaneously and influence each other. C. Goodwin [5] writes that the notion of embodiment encompasses orientation, gesture, and intonation, among other physical aspects of interaction. The moment-to-moment arrangement of these various semiotic fields is called contextual configuration. This contextual configuration changes during the course of action: new semiotic fields can be brought in and old ones treated as irrelevant, adapting with the new proposals.
With VW, the body becomes the main interface of interaction, manipulating the information available. Incorporation into the VW is an experience of involving cognition, emotion, and imagery into a narrative [6]. In such systems, media interface development achieve through the collaboration between a start-up, teachers and researchers, is aimed at providing users with fully immersive experiences, with the ultimate goal of making the virtual experience natural and pleasant. In these systems, the body plays a central role by becoming progressively embodied in the learning process. Therefore, it is challenging to determine how the body and materiality enter into contextual configurations and gain their significance in relation to the physical and virtual setting, a special spatial and temporal configuration of current reality.

3. DISCURSIVE MEDIATION OF THE REAL IN A VIRTUAL CONTEXT

The virtual environment is a communicative context in which the user enters a reconstructed environment and interacts with the environment and interlocutors. The term "interaction"

indicates the complex construction of meaning that human beings perform when acting in a space, be it simulated or not. In this article, we examine how participants, both teachers and students, make sense of the environment and learning activity through their body, discursively negotiated in a space-time dimension.

Virtually mediated reality through an avatarial relationship in virtual worlds (VW) introduces a state of incorporation based on being, to occupy space and time, the here and now, in a virtual present separate from the physical space.

VR in a context of educational virtual worlds is an outcome of a continuous process of social construction engaged in by participants, who embody meaning in the spaces and artefacts around them, according to the activity of the moment [7]. In this context, teaching with an educational VW involves, at the individual level of the teacher who wishes to do so, facing a renewal of the symbolic and physical characteristics of a learning space through the virtual extension of the classroom. This means a conscious and unconscious transformation of the basis of the individual's professionality as a singular unit, nurturing the diversity of ways to appropriate educational VW. We define professionality as: "an ideologically-, attitudinally-, intellectually-, and epistemologically-based stance on the part of an individual, in relation to the practice of the profession to which s/he belongs, and which influences her/his professional practice" pp. 6-7, [8].

4. RESEARCH QUESTION

As stated above, we focus on the configurations of the interactions between embodiment and materiality as well as the characteristics that emerge within a mixed physical and virtual learning context and how they are discursively negotiated. To reach this aim, we analyze teachers and students involved in a physical classroom and online learning activity mediated by the design and uses of an educational virtual world. The research question is: How do embodiment and materiality configurations come to reality in a specific space-time learning setting mediated by the virtual world? Providing an answer to this question will enable us to better understand the ways in which teachers' professionalities are changing through individual and collective explorations of the uses of VW in its technical, corporeal, social and cognitive aspects.

5. METHODS

Context: Virtual World in a French Secondary School
This study is embedded in an extended project that takes place in a secondary school (between 11-14 years old) in south-eastern France. This school is part of a technological experiment in line with the Digital Plan for Education launched by the French government in May 2015. In 2016, the school joined the "Connected Schools" digital experiment, which supports and finances the use of digital tablets in the classroom. The main aims of the institutional project are 1) to propose a scientific study of the technological and social conditions of appropriation of an educational VW; 2) to support, within the territory of the regional education authority via a collaborative network, the sharing of knowledge resulting from the joint work of researchers and teachers; and 3) to create a training guide for trainers or teachers wishing to get involved in this field. Participatory and collaborative processes are developed between teachers, the researchers and ITC staff of a startup,

and institutional partners through continuous spirals of planning, action, observation, reflection and re-planning [11]. The aim is to sustain the development of teachers' professionality in a context of students' new expectations and heterogeneity, through achieving a critical change of their digital literacy by using the potentialities of the VW.

The project adopted the open source software similar to Open simulator technology but with new proprietary developments purpose-designed educational adapted to educational uses and. After entering the virtual space via their avatars, participants meet and interact with one another and with 3D objects in real time. At the beginning of the project, all the teachers and students involved in the VW attended an initial one-hour training session, where they learned some basic notions of the human-machine interface. At the end of the session, all participants were already able to manipulate the avatar (to walk, jump, fly, dress) and the environment (to find a landmark, search the inventory, etc.). Almost all the students already had experience with video games, with different levels of expertise. This is not surprising considering that over 91% of children over the age of two play video games and are therefore familiar with them and are probably accustomed to their structure [5].

The educational VW is adopted by the teachers on the base of three main immersive pedagogical projects, co-developed with the start up support and research team:

1) The "Interdisciplinary" project is a 3D scriptwriting of lessons combining English, Italian, French, history, mathematics, and technology. It is dedicated to 5th-year classes with the main aim to build 3D objects and give meaning to them by integrating photos, drawings, texts, or information picked up on the internet, within the framework of a tailored scenario in which they have to complete quests leading the students through a storytelling on themes such as "The great explorers".

2) The "Language and International" project focuses on linguistic exchanges between the French school and an Italian secondary school. Their respective avatars explain to the others the meaning of a virtual exhibition prepared beforehand and show photos or drawings of their favorite places in their city or other cultural features of their locality (such as culinary specialties or cultural events).

3) The "Homework done" project helps small groups of students, who face difficulties with the subjects, to benefit from remote homework support provided by a school teacher. The students are connected one day per week in the VW using their avatar from their home environment during one hour when they have no other classes.

The group of teachers using the VW platform interacted from the beginning of the project in 2017 mainly through an interdisciplinary perspective applied to one or two classes. They have abandoned this perspective in 2020, less due to the differences in technological skills of each teacher than to a complexity that is difficult to manage at the administrative level, considering the teachers' time schedules and their class assignment. The most recent scenarios have been adapted by the teachers according to a disciplinary logic. However, despite being disciplinary scenarios, the logic of a collective effort of development persists and leads towards didactic innovation through mutual technical aid, the sharing of ideas for scenario design, and the migration of ideas within a discipline and across disciplines. The proposed scenarios often involve the manipulation of objects in virtual reality and in an inquiry-based approach. The disciplinary dimension of the scenarios (in mathematics, French language, documentary research, foreign

languages) is due to the teachers' need to use their previously developed technical skills in favor of more classes and students. The group of teachers is characterized by their dedication and implication in a collective exchange with the management authority as well with as the start-up providing the VR platform and university researchers.

Data Collection and Corpus of Data

A systematic collection of data concerning the three pedagogical scenarios described above started in September 2018. Regular visits to the school are made by the research team, supporting a dialogue of trust and familiarity with students and teachers. All the data are anonymous and the children's families have given their authorization for video recording.

Data collection consists of ethnographic observations (with note-taking and photos), full video recordings of classroom lessons (50 minutes), automatic recording of log data and virtual activities, including chat discussion. Specifically, we focus on a dataset consisting in five video recordings of teaching lessons (of about 45 minutes), one teacher interview (37.41 minutes) and a focus group with students (37.09 minutes). The five teaching sessions consist of:

- Four sessions in the classroom with the use of VW concerning math, French, English and Italian, taking part in the Interdisciplinary and Language projects. The classroom is composed of 20-22 students (about 11-13 years old). All of them are very familiar with the VW.

- One VW session in math from the "Homework done" project. The session involved 3-4 students (10-11 years old) guided by a teacher. The students involved in this little group have some difficulties with the subject and require extra support. They have limited experience of this secondary school VW due to the scarcity of in-classroom use by other teachers. They only know some spaces explored with the mathematics teacher. Table 1 shows a summary of the data selected.

Table 1: Nature of the data collected

Didactic project	Subject	Teacher	Class	Data
Interdisciplinary (teacher and students in classroom and VR)	Math	Mathy	5C - 22 studs.	VR and classroom audio-video recording; Teacher interview; Students focus group
	French	Ketty	5D- 22 studs.	VR and classroom audio-video recording; Teacher interview
Language and International (teacher and students in classroom and VR)	English	Carmen	5D- 22 studs.	VR and classroom audio-video recording;
	Italian	Alice	7 studs.	VR audio-video recording
Homework done (students at home; teacher and students in VW)	Math	Sally	4 studs.	VR audio-video recording

Data Analysis

Our main data were the audio-video recordings; the other data sources were used to clarify and enrich our interpretation of the students' and teachers' activities. The main data were catalogued [8] and organized in a coding grid. The analytical framework of our study draws on an iterative analysis with a focus on embodied interaction. Iterative refers to a systematic, repetitive and recursive process in qualitative data analysis. An iterative approach involves a sequence of tasks carried out in exactly the same manner each time and executed multiple times.

We started by reviewing each video recording session closely to understand its structure and interactional ordering from the participants' perspectives. For this, we repeated our searches in the data to find relevant clips based on the criteria above. We selected topical episodes [9] [13] to carry out a more detailed embodied interaction analysis, which was transcribed and qualitatively analyzed. Table 2 shows the three conceptual dimensions that we found in the data analysis. Each dimension is characterized by indicators that enabled their categorization. Only three main examples will be presented in the text.

Table 2: Conceptual dimensions and sources of indicators

Conceptual dimensions	Sources of indicators
Physical and virtual incorporation in the virtual world	Spatial actions and movement references, absorption and transportation, differentiated perceptual components through the extended physical-virtual space of action
Embodiment and Embodied learning	Situated content and resources mobilized in their technical, social and cognitive aspects through action
Meaning-making and Multimodality	Resources activated in the classroom, in the VW, and in the territory, coherence and conflict of media in the allocation of time and organization

6. RESULTS

Negotiation of physical and virtual body boundaries

With regard to this dimension, we find continuous references to the physical and virtual setting, both contributing to what we perceive as real. Teacher stress over behavior in the VW can be discussed online or in the classroom, in continuity between the two dimensions. The potentiality of the VW is to allow the subject to enter an extra dimension of the self, bringing with them a personal story and the knowledge of their own social and cultural area to be shared with others. What is interesting indeed is this double physical and virtual absorption and transportation in a single space-time of the physical and virtual class.

For example, in his math session, Mathy, the teacher, uses the VW and the interdisciplinary scenario to explore different geometric shapes and their volume perceptions. The goal of the sessions is to understand how to build a 3D pentagon in the VW on the bases of a cube and a pyramid by using a building module (Figure 1). Once decorated, these 3D pentagons will symbolize the explorer's blazon and will be placed in a street in the virtual pirate port. The purpose of this storytelling is also to materialize the place where the students can meet with their team during quests in which they embody great explorers.
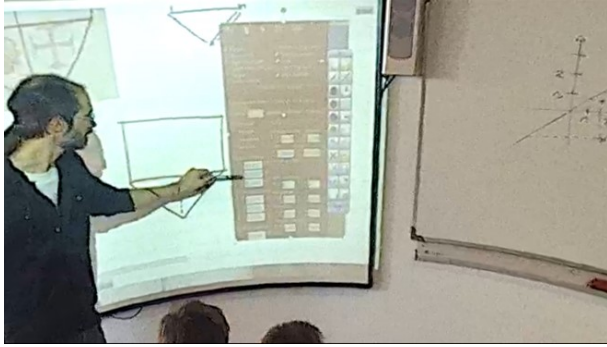
Figure 1. Blazon design and buttons to change the spatial coordinates of a volume.

First of all, Mathy activates his avatar by manipulating his mouse to position the cube he has generated in order to change its spatial position. The parameters of the 3D position in the VW and their modification are visible in a window in real time, as well as the length, width and height of the cube that students can change proportionally or not. Then, using the classroom whiteboard, he points to the buttons students have to use to activate functionalities. The students are confronted at the same time and space with the consistency of the teacher's body and avatar in front of them. (Figure 2). The transition is continuous between the use of the virtual world in which the avatar moves and the overhead projector to help students visualize and locate the buttons on their screen. Thus, there is a constant interruption of the flow of observations. After this phase, students connect to the VW and approach their teacher via their avatar in order to build their own 3D volume respecting the instructions. Some student-avatars are lost and cannot reach the teacher in the same VW space. Mathy starts to search for them and teleport them thanks to the presence of his avatar in the virtual space. He successively brings all the students' avatars close to him to assemble them in the same space, reproducing the context of the social presence of the classroom in the VW. The teacher searches for those that are still missing and finally finds his avatar surrounded by the student-avatars, who jump on him, a collective act they never would have dared to do in the physical world with their teacher.
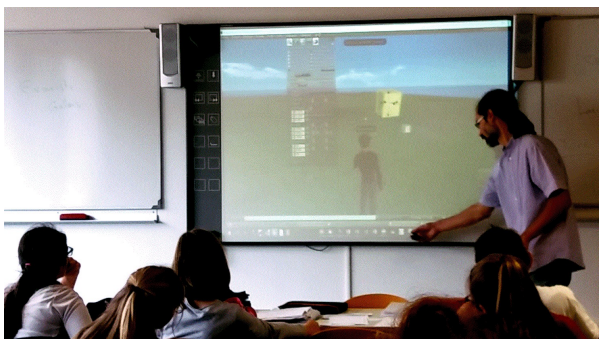

Figure 2: Math teacher physical and virtual body

The virtual is no longer experienced as an experience in itself, because it is based on the frame of social meanings in which each individual is able to place it. It is in this sense that the VW can be considered experiential, in which the perceptual component (visual, tactile, kinesthetic) merges with interactivity. This perceptual component has cognitive and social effects. On the cognitive side, in a student group interview, some of them said that they like to work in the VW because "it is different than sitting and using a workbook on the desk in the classroom". On the social side, in the event reported above, the teacher noticed that the first student avatar to jump on his own avatar body, before it was followed by the others, was usually a person who remains physically and socially distant. The VW thus conceived becomes a communicative tool which acts not only among users but also between them and the environment in which they are immersed. It enables imagination building and a transformation of possible actions through situated learning that do not only deal with negotiations on content and their architecture but also with the visual, tactile and kinesthetic perceptual components of action in the VW.

In sum, the boundaries between the physical and virtual body are negotiated to make sense of the activity. The avatars are considered an extension of the body, at the same time they are both discursively negotiated powers (go through another avatar; enter in the body of others) and represents limits and responsibilities (to be lost and need help; not to jump on the teachers; not to push colleagues; to avoid punishment with good behavior).

Multimodality in action

In sum, with this second dimension of "Multimodality in action: disruption and recall" we would like to stress how communication between users takes place through the continuous negotiation of meanings that the actors bring out in their interactions with the virtual environment.

In one example that illustrates this dimension, Flora, the math teacher, is connected with four students from their homes. She had time in the physical classroom to assess the students' progress and to understand their difficulties in the discipline, which allows her to adapt the instructions and exercises to each student in the small group. The aim of the session studied here is to recall the previous lesson about angles and to help the students complete some exercises. In the virtual space, there are some panels with exercises to do and the four avatars explore them. Flora invites them to read the panels. Some students zoom on it without moving their avatar. Others, as shown in Figure 3, move their avatar to come close to the panel without zooming, reproducing a common physical behavior – to move closer to see clearer. It must be noticed that all the students have been trained to use the zoom application.
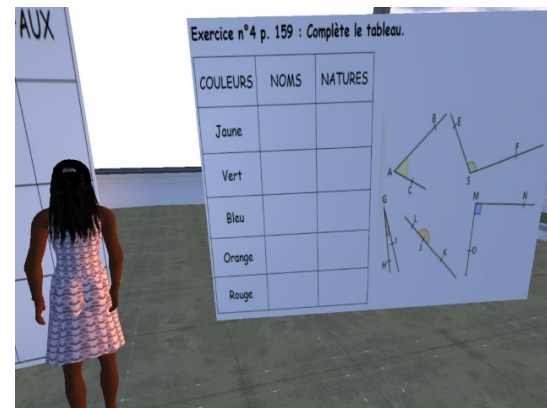

Figure 3: Lilly moves close to the panel

The teacher's instructions are distributed between the online panel, the sheet of paper given in the classroom, her body and the avatars. The instructions given have a spatial connotation with reference to the avatar body, strictly referred in a real physical dimension. At the same time, the teacher's avatar comes closer to the student's avatar to talk to her when she meets difficulties to solve the problem (Figure 4). The interaction goes on in a continuous interaction between the physical and virtual dimension (avatar body and personal body; online space and virtual space).

Figure 4: The teacher's avatar comes closer to the sudent's avatar

It must be highlighted that in this scenario, the students to whom the teacher proposed distant classes are those with weak skills in the discipline, and who do not benefit from adapted help at home. This device therefore enabled the teacher to evaluate its direct positive impact on the students' skills through the progress of their grades after three of four hours of remote classes.

Moreover, the comparison during the covid-19 crisis of the practices of the two math teachers using the remote device to help small groups of students at home helps us to reveal strong differences in the orientation of professionalities and the way they are enacted through the social and technical issues of multimodality. Flora is the teacher who first implemented VW remote teaching and was followed by Sylvain one year after she started the experiment. First of all, they use their avatar bodies in different ways. Sylvain's body does not move, and the students' bodies reflect this immobility, all seated in front of the panels. By the same token, Sylvain has asked the startup to develop an interesting multimodal device, in which students take a photo of their work done at home on paper and send it to an application enabling it to be shown in the virtual space where Sylvain and his students are seated.

At the beginning of the covid-19 crisis and due to the sanitary lockdown, the remote device was cancelled by the head of the establishment. The explicit argument was because it was not used by all the teachers and students. Therefore, only traditional video conferencing tools (virtual classes) for teachers were selected for everybody. More recently, some teachers using the VW for a language club have asked for authorization to pursue the club activities remotely. The head of the establishment agreed to relaunch the remote uses of the VW, including the "Homework done" device. However, Sylvain and Flora have refused to resume the activity for very different reasons. While Sylvain evokes inequalities of treatment among students, Flora puts forward the mental workload created by using the two devices (video conferencing tools and VW).

Sylvain: "I do not plan to repeat the sessions I was doing: I would feel uncomfortable helping only a few students in what are almost private lessons."
Flora: "For my part, I have no qualms since I make videos with the students every day. However, I do not wish to multiply the support media. Setting up a room in the virtual school [VW] takes much longer than with the virtual classroom. I don't know if this has the same effects on the students ... We can talk about it another time. I will gladly resume in September".
This observation shows that while Sylvain evokes ideological reasons not to resume using the VW, Flora expresses a rational approach that takes into account the conflict of the multimodal media and raises the intellectual issue of their comparative effects on learning.

Exploration to build meaning
In the educational field, one of the opportunities of VW is represented by the possibility to enable the subject to actively participate in the creation and development of their own knowledge. In the example in Figure 5, the English teacher, and two students are trying to understand a technical problem. One student, considering there are some problems to see the panel with the English instructions, has called the teacher. Through searching together they quickly find an autonomous solution to outline the technical problem. The teacher is surprised by the creativity of the students to implement autonomous strategies with respect to her modality and prescription. The students mobilize the resources around them to achieve their goal, demonstrating their commitment to the task and the building of meaning during their action.
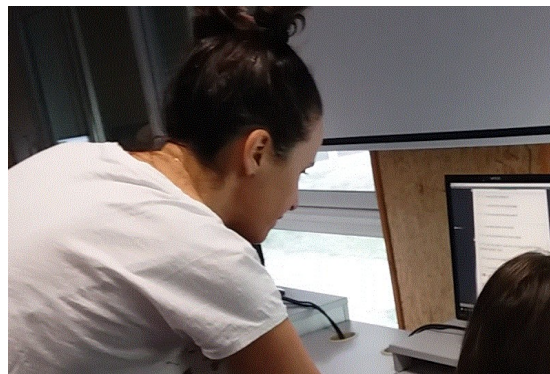

Figure 4: Help of the teacher in a mixed reality

To place the participants in an active situation of narrative, social and sensory incorporation [10] it is important that the interface becomes transparent and the controls implemented by the user are fluid [11] in relation to the network infrastructure and characteristics of the equipment. This requirement for fluidity in the usability of technology has led teachers and their supervision to develop skills of negotiation with local authorities to obtain equipment and network infrastructure with sufficient high-speed Internet access within a policy context that fosters the autonomy of educational establishments and accountability for the management of technology. The instructional design [12] of educative virtual worlds involves both a renewed organization at school and an agency with relevant and more diversified actors of the educational territory.

This was also the case when the three types of actors (teachers, researchers and the platform provider) negotiated wayfinding solutions for all students in order to reduce the disorientation of avatars in the virtual world. The collective agreement was to build a teleportation room representing all the virtual places where students can go. This teleportation room can be used alternatively with signs and pavement markings, personal landmarks in the students' inventory, virtual maps for active orientation (Figure 5).
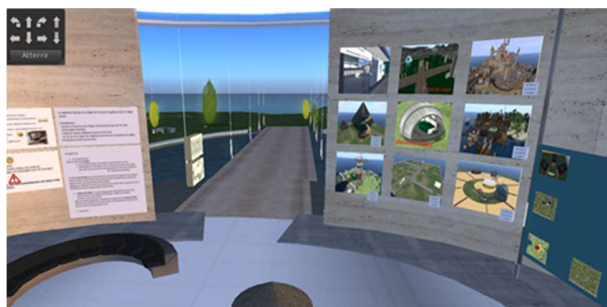

Figure 5. Teleportation room

7. DISCUSSION

In this article, we discuss implications of the students' and teachers' embodied configuration for sense-making between the physical and virtual world in the context of learning activities in a secondary school. Our results highlight the dynamic ways in which the arrangement of body and material act as a mediational means in a physical and virtual setting.

In sum, we explored how, in reality, sense-making is interconnected with the physical and virtual body of the participants, negotiated discursively. This study was born of a participative observation of the students' and teachers' interactions, enabling to grasp the richness of the data. The pedagogical scripts analyzed are reformulated by the teachers, trying to better adopt the willingness of the students, along with the didactical prescription, oriented to a more collaborative task in the classroom and in the VW.

From the proposed analysis, we can consider that the use of a virtual space in the classroom can introduce new opportunities for teachers who desire instructional changes through authentic tasks involving 3D object manipulation, creativity and corporal mobility.

In this secondary school, the uses of avatars and a virtual environment are aligned with the transformation of the individual's professionality within a small group of teachers whose exploration seems to converge on how the learner constructs, acquires and applies knowledge.

It is useful to consider that students have diverse levels of computer skills, which in some situations that require the manipulation and importation of texts, photos and sounds can become an impediment to the implementation of the activity, thus compromising their experience in the virtual context. In fact, the student may have understood the delivery and the content but encounter difficulties in the technical execution. The professionality of the teacher has to adapt to this diversity of skills and strive to help those who need it in the physical classroom or in the remote device.

The limits of the use of the VW in the classroom, and especially at the middle school level, is often linked to the consideration of possible improper uses of the instrument. In the case analyzed, these improper uses occurred in a very limited way. For example, we report an occasion when a student created a glass bubble around an island, preventing avatars from accessing and achieving quests. This limited episode ended with the student's self-denunciation, which led to the student being symbolically suspended from the virtual (and not the real) school for three days, to his great disappointment. Indeed, the pleasure of participating makes such actions marginal. In fact, all the regulations enforced in the middle school are adapted, ensuring that the VW instrument is perceived with seriousness and formality by the students. This example shows the students' pleasure in learning and their involvement, which we can summarize in two quotes from students, who said "I like to hear the sea" and "I need imagination to learn". The sensory underlines the value of corporality in learning.

At the same time, one of the pitfalls we faced was the attempt during a first stage of scenario design by some teachers to replicate the teaching practices implemented in the virtual dimension in the classroom. This attempt to transpose the practices proves not to exploit the potentialities of VW, which are often not completely measured by the teachers in the various technical, social and cognitive aspects. We consider that this attempt by some teachers is based on the desire to find references in the practice already implemented in the classroom. What is needed is a real transformation of the cognitive representation of teaching and learning through experiencing VW, which entails a loss of real references and an acquisition of a new competence in virtual management. For this reason, teacher training must be able to adapt to these changes and propose a curriculum in step with the evolution of technology and structured around the difficulties, representations and obstacles concerning the adoption and appropriation of new pedagogical models.

With regard to the disciplinary impact of VR on the students' performance, a reflection on evaluation is essential. In fact, as seen in the context, the teachers proposed disciplinary scenarios. However, the evaluation of the virtual device is only partially aimed at a quantitative evaluation of the student's performance. In fact, all the teachers involved enhance the virtual experience with the transversal dimension of pleasure, involvement and a feeling of belonging to the class group and virtual school. From the collection of findings by teachers, we can grasp the richness of the virtual experience, whose direct impact on performance can be assessed in some specific situations. For example, the reconstruction of the relationship between participation in virtual reality and the progress of performance through school grades can be done in the "Homework done" device.

In the other cases of the scenarios analyzed, participation is collective, making the impact of VR on performance less clear for the teacher. This also takes into account that the proposed activities are complex and structured, for example, in a problem-solving approach. A more focused analysis of the indicators of well-being due to participation in the virtual will be made. Based on observation and participation, we can therefore see an impact of the virtual on the emotional dimension of the students involved, in line with the concepts of absorption and transportation [1], enabling embodiment and sense-making through negotiation [3] [4]. Thus, in the case of the study proposed here, the development of transversal skills on the learning dimension is privileged. Therefore, research design did not impose a selection of the most suitable disciplines for the integration of virtual reality, but favored the

free participation of teachers interested in the transformation of their professionality through their practices and exchanges with other professionals, such as the company that developed the VW platform and the research team. All disciplines are therefore involved in this transformation process conveyed by the teacher, according to the potential of the scenario developed with the support of the technical and research team.

In this perspective, the teacher's professionality [2] cannot be assimilated to the notion of professionalism defined as status elements of teachers' work [17]. In a VR platform open to teachers' autonomy for the definition of their scenarios, but also in the design of new pedagogical functionalities requiring software development, the span of professionality development is larger than that of less communal and open VR platforms [18] [19].

8. CONCLUSION

In conclusion, we can consider that the introduction of the VW as a type of VW allows a questioning of the training project and the operating methods of the school through informal learning in elective activities where adolescents forge their character. However, even if it is the object in a given architectural space, rituals to discipline, monitor, and control the student's body are not a central element in the academic and didactical concerns for learning. Yet it is through the body that emotional engagement occurs in the interaction, allowing people to be affected by what they experience. In this soft gamification of learning, the exploration of embodiment gives space to discover new processes of meaning-making that are enacted by students and teachers. Through such a process involving complex multimodality, teachers explore and consolidate the renewal of their individual professionalities underpinned by an evident diversity of outlook, attitudes, values, ideologies and approaches to teaching. These negotiated and embodied professionalities are at the heart of the changing dynamic undermining the communal components of the teachers' professionalism, such as collective representations and beliefs of what is required or even demanded. In such a context, the use of virtual worlds as a medium for learning new knowledge and skills [14] emerges as an original research track by highlighting, both in class or out of class, the knowledge that arises from the manipulation of a second (virtual) body, that of the avatar, invested by the subject.

However, most research on the virtual worlds of education has focused on student learning without the organizational and institutional conditions of their use. This situation leads to the neglect of the creation of meaning in changing professionalities at the heart of the transformation of the representations and beliefs that underpin teachers' professionalism. These dimensions of change are at stake to transfer this experiment to other schools. To achieve a larger use of educational VW, the main pitfalls are not the creativity and capacity of teachers to organize techno-pedagogy through a community of practice. The limits of the appropriation of VW are mainly the way in which the centralized institutional framework in which their tasks are anchored does not take into account the extent to which class organization has to be restructured and the time that must be devoted to innovate and radically experiment with new technologies.

Future research leads should be interdisciplinary in order to articulate the institutional and organizational pitfalls with the pedagogical and didactic pitfalls in the construction of

teacher's professionality to ensure the transfer of such experiences.

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