Adolescent thinking and online writing after the use of commercial games in the classroom

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ABSTRACT
This study focuses on the connections between young people's everyday experiences with video games and social networks, and the formal high school curriculum. We assume that digital literacy combines elements of traditional literacy and media education with other dimensions founded on the idea of a participatory culture. The research has been designed from an ethnographic point of view. It has been carried out in a secondary school environment. The main dimensions of the study were the following: participants, 18 boys and girls, the teacher and the research team; the school and, the activities which were organized around the video game, Spore. Our data are discussed taking into account some of Diana Kuhn's (2005) contributions when raising the issue of education for thought. Intellectual skills related to scientific knowledge must be referred to abilities of inquiry and argumentation both of which are carried out in a social context and associated to contextual values.

Keywords
Commercial video games, social networks, adolescents' thinking, Spore, new literacies, external grammars.

INTRODUCTION
This presentation focuses on the connection between young people's everyday experiences with video games and social networks, and the formal high school curriculum. We assume that digital literacy combines elements of traditional literacy and media education with other dimensions founded on the idea of a participatory culture (Jenkins et al., 2009; Kafai et al., 2009), digital education (Burn et al., 2010) and situated cognition, as a way of developing game literacies (Gee, 2010). Moreover, we consider videogames as cultural objects; but it is not clear what their educational value is without referring to the thought processes and cognitive strategies that the gamer puts into practice in that context. In this paper we will explore how to use commercial video games in the classroom interlinked with other technologies, particularly on line social networking to support learning curriculum contents and argument skills.

SHARING AND THINKING FROM THE GRAMMARS OF THE GAME

Learning with games involves building knowledge in specific contexts, and a participation in certain practices. Adopting a situated cognition theoretical perspective (Clark, 2008; Robbins & Aydede, 2009; Shapiro, 2011), we will show first what is meant by learning new literacies interacting with games, taking into consideration that knowledge is dependent on the context in which it is built. Later on we will approach these processes by focusing on two dimensions of video games: first, the rules that lie behind them and guide the mental processes involved in gaming and, second, the practices of the gamer. According to Gee (2007) both of these rules and practices are related to internal and external grammars of the game. We want to erase specific borders between the contexts of leisure and learning and show how thinking can be learned in the classroom, when a commercial video game (in this case, Spore) is present there.

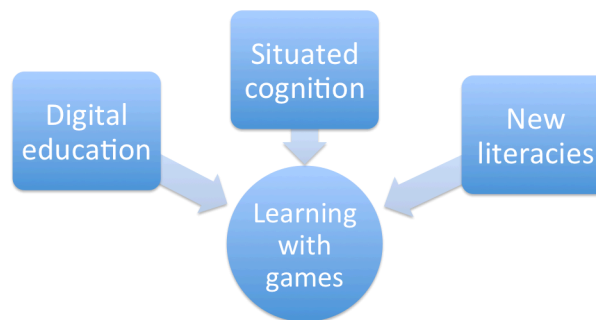### Learning and teaching new literacies from video games

Figure 1. Theoretical frame.

Figure 1 shows the concepts that served as a starting point for defining the objectives behind this experience.

First, we explore the mechanisms that are behind education in the digital universes. These environments potentially change the way in which young people participate socially and culturally in their everyday life through creative and playful activity (Burn, 2009). Digital technologies provide certain tools to make their symbolic practices much more public, more available and more participatory than other traditional technologies used for communication (Dezuanni, 2010). While recognizing that digital technology can make students not only consumers but also producers of popular culture, the question we now ask is, **what are the best strategies to make students develop more advanced ways of thinking and skills related to new forms of literacy in order to enable them to control the discourses they use?** These goals have traditionally been present in Western schools but now they must be rethought. In traditional schools pencil and paper and even photocopies made it difficult to share knowledge, therefore the teacher became the judge of what students had to learn. Schools that rely on these traditional technologies have dominated the asymmetric relations between teachers and students (Burn, et al., 2010). When introduced into the classroom, tools such as commercial video games or other technologies in which young people are more skilled (at least a procedural level), the relationship between teachers and learners can change and make it easier for students to argument either together or independently.

Second, we examine how knowledge is constructed in certain contexts, specifically classrooms where video games are considered as educational tools. From this

perspective the concept of situated cognition was a starting point for this research. (Clark, 2008; Robbins & Aydede, 2009; Shapiro, 2011). This perspective approaches mind and learning by stressing the importance of experiences in the real or virtual world for human thinking and problem solving, by considering the ways in which these experiences are mediated by different tools and technologies. Playing the game, people acquire a specific set of skills to carry them out. This raises a dialectical relationship between practices and abilities. That is to say, activities in different domains produce different results at a cognitive level. For example, participation in complex areas such as physics and mathematics tends to produce experts who generate adequate representations of each specific problem using bodies of rich knowledge, well organized. By contrast, in specific fields related to everyday life problems, experts acquire representation systems readily applicable to a set of questions that may arise even unexpectedly. These systems of representation can be seen as a form of culture in mind, something that is constituted through representation in practice (Hatano & Wertsch, 2001), p. 79).

Third, we explore how to acquire new forms of literacy. Following Gee (2007) we consider that literacy demands not only the decoding of words, images and sounds. It also requires people to be able to participate in certain sorts of social practices that involve realms in which these codes or representations are used (Gee, 2007). From this perspective, teaching and learning from video games include negotiating a multiplicity of discourses when people are involved in the practice of gaming. Several years ago, *The New London Group* (1996) related literacy with a multiplicity of discourses. Firstly, they situated them in the context of our culturally and linguistically diverse and increasingly globalized societies. Secondly, literacy pedagogy must account for a variety of text forms associated with information and multimedia technologies. According to these sources, this includes understanding and competent control of representational forms that are becoming increasingly significant in an overall communications environment, such as visual images and their relationship to the written word.

Thinking from the grammars of the game

To show how learning to think using videogames occurs, it is useful to consider the concept of **semiotic domain** that Gee (2007) introduced. It relates to a set of meanings associated with certain practices. When it relates to the game we speak of internal and external grammars:

> "Semiotic domains have what I call design grammars. Each domain has an internal and an external grammar. By an *internal design grammar*, I mean the principles and patterns in terms of which one can recognize what is not acceptable or typical content in a semiotic domain. By an *external design grammar*, I mean the principles and patterns in terms of which one can recognize what is and what is not an acceptable or typical social practice and identity in regard to the affinity group associated with a semiotic domain" (Gee, 2007, p. 28-29)

Figure 2. Playing the game

Adopting this perspective let us now focus on the process of knowledge that takes place inside and outside the classrooms. The thinking processes present when people play video games, supported by their internal grammars, are tied to experiences of goal-oriented action in the material and social world related to their external grammars. Furthermore, these experiences are not just related to abstract concepts but also to something somewhat more similar to dynamic images tied to a perception of the world and of their own body's internal states and feelings. Moreover, the use of commercial video games for improving cognitive processes could be explored in the classroom as a way of developing new ways of achieving new literacies. In this context videogames can be considered as an interactive text where the player iteratively develops goals, acts, and experiences feedback on those actions, that sifts the goals and actions accordingly (Squire, 2009).

Let us now focus on some cognitive processes related to the game. Reif (2008) discusses intellectual activities, actions, which are present in the processes of problem solving in educational settings and somehow could implement the approach to the gamers' activities. This author is concerned that the performance is clearly measurable, i.e. comparing what a student can do before and after a learning process that involves understanding and explaining certain phenomena. That means that acting is a form of activity that can be observed and moreover, can be expressed in operational terms, i.e. it is necessary to determine clearly whether success has been achieved or not. The processes that the author assigns to knowledge that can be built in the classroom, are related to processes similar to those carried out by the scientist. Reif (2008) in the characteristics of a process of reflection, that appears in Table 1. We contextualize them in a process of play, going further instructional psychology, in which this author is engaged.

Reflection processes.	Contextualized in the game
They may relate to different types of knowledge.	The student may be aware that the game does not include a clear scientific theory.
They require specifying and interpreting concepts.	The concepts of the theory of evolution were raised in class critically.
Memory into action.	To move on the player must remember some of the strategies implemented in previous phases.
Helping to describe knowledge.	Tell to the companion the own strategy

	helps to clarify it.
They help organize knowledge.	As you progress through the game, a more global representation appears and you need a systematic approach based on past achievements.
Put in place methods and inferences.	It is sometimes necessary to build a global representation of the game to move forward and decide from there, specific strategies.
They involve decision making processes.	Playing Spore you may decide for example, if you attack or collaborate with other creatures', cities or civilizations.
They require solving problems.	Overcoming each level involves solving several problems. This is the only way to move through the screens.
Strategies can be applied even when circumstances change.	The same strategies can be applied in different game's situations.
They involve processes that achieve the goals.	Without following the rules of the game it is not possible to advance.
They achieve the desired goals with relatively limited resources.	The last goal is only achieved through specific sub-goals that represent levels that must have been overcome previously.

Table 1. Building cognition with Spore

As we see in the previous table, gamers can implement various processes of thought when games are present in the classroom and the teacher is aware of them and helps to generate different support strategies that make them possible. The role of teachers becomes decisive because the gamer is not always aware of their own mental activities. Underlying this proposal is the idea that organized knowledge is easier to retrieve and apply when people help each other in the task.

SPORE IN A BIOLOGY CLASSROOM: METHODOLOGY OF THE RESEARCH
Taking into account that theory and method are two dimensions that should be convergent in any research project, **this work has been designed from an ethnographic point of view**. Its main goal is to understand the culture of the social groups and is complemented with case studies that provide tools for the design of the project and the data analysis (Green et al., 2006). The present project has been carried out in primary and secondary *school environments where very differentiated experiences took place;* each one of them is defined by the following features: a) the *participants*, namely boys and girls, their teacher and the research team b) *the school*, as the physical and social context where the activity takes place c) *the video game* around which the different activities are

organized. We will now focus on the classroom conversations and the social network created by the research team, as a tool for making an easily situated cognition process amongst students.

We will look at an experience carried out in a bilingual class of secondary education (Spanish and English) during the school year 2009/2010 in Madrid. We analyze how students generate new ways of thinking when they participate in the class through oral discussions and also in a social network, more specifically, a forum created within this specific Website by the teacher to discuss the theories of evolution after playing Spore, a strategy video game. The group consisted of 18 students. Ten sessions were organized as a workshop that took place as part of Biology course. The teacher, who had worked in the past with the research team decided to participate thinking that video games could be a motivating factor in learning and the use of Spore was an excellent starting point to discuss the theories of evolution, a specific topic of the curriculum. All the sessions were videotaped and two people from the research team were present as participant observers.

Our data will be discussed taking into account some of Diana Kuhn´s (2005) contributions when raising the issue of education for thought. According to her, intellectual skills related to scientific knowledge must be referred to abilities of inquiry and argumentation, both of which are carried out in a social context and associated to contextual values. Here are two examples of these abilities.

LEARNING TO THINK WITH SPORE

We might wonder what is learned in school or why we spend so many hours there with so little effect on many occasions. Kuhn (2005) believes that education is associated with the development of certain skills and is particularly concerned with two, these being: to investigate and argument. The following pages show how these two types of skills can be developed from a game like Spore, around which the teacher organized activities. We want to show that in school certain skills can be put into practice and that players engage in leisure situations. The difference between these contexts comes from the role that adults play in schools. Here the adults help to make students aware of the strategies they use when they play, discuss them and gradually acquire control of both the discourses present in the game and the rules which organize it.

SKILLS OF INQUIRY

Generating questions is an important part of the learning process of inquiry. When there is a contrast between theory and evidence it is necessary to put them in order. Strategy games offer an opportunity to learn and teach contrasting evidences. It was from these specific games that some questions arose that served to guide our work when they were introduced in the classroom, i.e.: What is strategy? Are we aware of them when we play? Do we get better results if we have a good game plan? A strategy is a comprehensive plan to act in ways that are available to achieve the goal of the game and go through their screens, each with different challenges for the player. Strategies and rules must be distinguished:

- Strategies are ways in which the player solves the problems. They relate to the rules of the game, but cannot identify with them.

- The rules are the limits imposed by the game and determine the way forward to progress through the difficulties. The effectiveness and potential strategies depend on them.

In this context we are interested in the interaction between the player and the game in specific contexts. Adopting the situated cognition theoretical frame (Robbins & Aydede, 2009) we insist on two fundamental ideas:

- From a functional perspective, the skills needed to carry out certain practices are related to specific domains of knowledge. In this sense, the player must go through specific levels taking into account certain challenges posed by each of them. At this moment, we would be at a micro level of knowledge.

- Skills are also related to general domains. That is, when the player progresses he will have an overview of the game and he/she can abstract, generalize and interpret their actions in the context of this macro level framework.

Now we will show an example of how specific thinking activities were developed in the classroom. Teens and adults explored together real and virtual environments by asking questions about the different theories of evolution present in the game. The educational goals for the teacher were the following:

1. To reflect on the evolutionary strategies present in the game.

2. To establish relationships between the models offered to explain the mechanism of biological evolution in the game and some great scientific theories, such as those of Darwin and Lamarck.

3. To design cells and other creatures based on the best strategies for advancing the game.

Prior to the introduction of the game in the classroom, the teacher had explained the major theories of evolution and teenagers had their own notes or other documents. They played every day working in small groups during the workshop and after having played the students considered relationships between the theory that could be hidden behind the game and the prevailing theories in the scientific world.

We will discuss some of the classroom conversations and online discussions taking into account Diana Kuhn (2005) contributions when she raised the issue of education for thought. According to this researcher the goal of a learning process is to develop not just strategies of knowledge and but also values to facilitate their application. These abilities relate to the processes of searching, analyzing, reasoning and arguing. Moreover, values associated to them represent awareness that these skills are useful and meaningful. To explore teacher and students dialogues during the workshop could be an example of how to develop these abilities in collaboration with others when playing and discussing video game strategies.

Talking in class to develop research skills with Spore
Learning involves changes in understanding the world. People from childhood build theories to explain phenomena and modify them as a result of their interaction with them. The process of theory-evidence coordination has no place in the early years in a conscious or controlled way. Being conscious of the relationships between cause and effect leads to conceptual change. As educators we need to comprehend how to help children to generate conceptual changes in order to understand natural and social

experiences. Kuhn (2005) suggests a model focused on understanding relationships between cause and effect. Students construct theories or mental models of these relationships both physically and socially. The control of these processes of knowledge is related to their development. A key element in building these models is to link evidences with interpretations. Making these constructions possible and practicing with the students in a similar way to which scientists explore nature, is an important task for educators.

Some skills can be identified, according to Khun (2005) to learning by inquiring. One of them is **to identify interesting questions**. This activity was a key phase during the video games workshop. At that time the teacher was an important aid. In the following dialogue one of the students refers to the fact that if it were not for the teacher's questions it would have been difficult to learn about biology from the game.

> Teacher: What do you think about this game?
>
> Student: The game is cool, right? But I don't think that when people are playing at home they think about the theory of evolution. But if you are playing in the classroom then yes, you start to think, but when you're in another place you are more thinking, ah I will kill this stupid, that ... and not because I think that is the theory of Lamarck.

That is, this student was aware of the role of the teacher in the school context. From our view, perhaps this role is to help students to generate their own questions, much more so than looking for close and stereotypical answers, which make sense only in the context of the classroom.

Additional research activity among the students was to carry out **analysis and interpretations**. Let us explore another dialogue when teacher and students discussed the evolution theories.

> Teacher: Okay we start with group 3. What do you think that the game has to do with the evolution theories?
>
> Student: It shows, as Darwin said, that the strongest survive.
>
> Teacher: The strongest survive. But does it always happen? Is it the strongest who survives? Is it always the strongest? Is there another way to survive?
>
> Student: After there is the adaptation to the environment from Lamarck and the cooperation ideas from Kimura.
>
> Teacher: Why do you mention Lamarck's adaptation to the environment?
>
> Student: Because it has to improve with each generation, in that way the best can survive ... like the giraffe, which increasingly has the longest neck to eat higher things. Such as ours creature in Spore, it is has the biggest mouth to eat bigger and stronger enemies.

What is noted first is how students become aware of the evolutionary theories that can be found in the game. They can argue what is representative for each of them and to relate it to what happened during the game. Reading the previous transcript what is seemingly apparent to us, is that the students had a very superficial knowledge of these theories. Sometimes stereotyped answers are considered OK at school because the students don't have any contexts of situations to contrast them with.

Let's see what happened after the oral discussion that took place in the class, when they continued it through an online forum. What is striking is that now the starting point for the dialogue was not the evolution theories, but the value of videogames as educational tools. What it shows from the on-line discussion which is transcribed below, is that it was not the curriculum content that created situations from which to argue. In this case, and through a written text, reflections giving an overview of the evolution theories were more in depth, even the teacher was not asking specifically about them.

The online discussion: looking for arguments
Participating in the forum created by the teacher, the students had to justify their choice of two alternative views on the value of videogames as educational tools. 33 contributions were generated including the research team and the teacher (5 contributions). Let us consider the general question put to the students:

> *Who do you agree with and why?*
> *Please look at the following statements:*
> *"Will Wright, the designer behind Sim City, the Sims, and Spore has suggested we think of games as problem sets which students pay to be able to solve."*
> *Henry Jenkins (2009)*
>
> *"Computer games send the following false messages to players:*
> *1. Problems can be solved quickly and with little personal investment.*
> *2. The best way to solve a problem is to eliminate the source of the problem.*
> *3. Problems are clear-cut: right or wrong, black or white.*
> *4. Use instinctual rather than thoughtful problem solving.*
> *5. Personal imagination is not necessary for problem solving".*
> (Degaetano & Bander, 1966)

As we said before, the teacher posed a question to the students in order to evoke a reflection on a topic that was related only indirectly to the curriculum contents. The previous text, which was presented to the students, contrasted the perspectives of two experts to show opposing views on the pros and cons of video games. Students must demonstrate their agreement or disagreement and justify their answers. Let us see the answer of one student during the forum to examine his argument; his participation included several interventions:

> Student:
>
> I agree with Gaetano and Bander, because in my opinion their perspective on the game play is the way things are (in the case of Spore, the evolution). But because of the limitations of a video game, which first have to cover millions of years in a few hours and, second, has the disadvantage of the logical structure of computers (that will not allow random genetic changes), the evolution appears in the game as going in "jumps."

After some other interventions the same student included a new comment:

> Student:

About these points I agree with most of them, but I would highlight another idea. I think this is not entirely true, that we have only two choices in the evolution theory, black or white. In the play, the gamer has more than two options to choose from (at least where I had come in the game). What changes occurred? Led by genetic or environmental influences? So do we select the best? It is true that for us is better to solve a problem reflexively. But evolution was really "smart"?

I must admit that these games show us how difficult it is to move from one initial phase, one cell, to the final phase. It makes us to reflect on the complexity of natural selection, as well as on the perfection of the features that are necessary to survive (it is possible in the game). For all these reasons, I must admit that it's true what they say Jenkins

Teacher:

Miguel very interesting, but are you sure that evolution occurs in jumps, as Gould suggests, or that the natural selection is the driving force of evolution?

The text above is particularly relevant and suggests a few comments. The first is that the student changes his initial views to move forward in his thinking. Searching for arguments to justify his initial opinion helps him to be more precise and perhaps to be conscious that his arguments were not very strong. In the first paragraph he asked about the game´s limitations for explaining a scientific theory. For example, the gamer has to play in a few hours, something that happened over the course of millions of years. Moreover, everything is conditioned by the logical structure of the computer. The second paragraph goes more directly into the mechanics of the game. He also did not agree that games involve an intuitive thinking rather a reflection. To show this he asked questions that seemed to have been suggested for the game. Finally, in the third paragraph he was forced to acknowledge that the opinions expressed in the two texts, provided by the teacher, seemed to have some truth, even though in the beginning he seemed only to agree with the views expressed in one of them.

It is also interesting to consider the teacher's answer. It does not fit into the theme of the game mechanics, but instead refers to the laws of evolution. She encouraged the student to ask new questions. It was a strategy to help him to keep thinking. To help thinking in the classroom is certainly a task for the teachers, but this is not always easy. Here are some potential pitfalls and here is how Deanna Kuhn (2005) suggests solving them. First reference is made to the fact that during the talks taking place in school situations there is a sequence; speakers are limited to take turns without thinking about what someone else has said. In her opinion there is no direction or sequence in the discussion. In this context it is difficult to generate an argument, and even more so, good arguments. Therefore it is important to clearly define in the classrooms the goals of the explanations and what the purpose of discussion is. We cannot forget that adults must be coordinators of what is learned in the schools; sometimes they even forget the principles that usually organize the youth culture.

Let us return to our example. It is obvious that the question posed by the teacher to raise some thoughts from student (as transcribed in an earlier paragraph) guided the way he then gave some arguments. She has led him to the field in which she considers important to place the process of evolution. Consider the answer given by the student to the teacher's comments:

Student:

"I expressed myself badly, Ana. What I meant is that the game seems to present the organism evolving in leaps (different stages of the game), while it is not certain that it might happen like that (actually). Thinking about natural selection, I completely agree that it is the engine of evolution because, in my opinion, it is responsible for allowing to the most capable individuals to evolve."

Focusing once more on questions that teacher previously introduce, we can see that they relate to the student's argument: "Are you sure that evolution occurs in jumps, as Gould suggests, or that natural selection is the driving force of evolution?". It seems obvious that she helped the student to think in depth about the evolution theories. Now he is able to establish clear contrasts between the game and reality and he even makes reference to one of the laws of evolution that seems to be relevant in the specific context of explaining why organisms evolve.

The above example also shows how the teacher has overcome another difficulty which, according to Diana Kuhn (2005), is usually present in the classroom and inhibits good arguments. This happens when the teacher is not considering the students' answers in depth. In the argumentative dialogue is central coordinating the participants' perspectives. It is usual in classrooms, for the teacher to move from one student to another until she finds the answer she was expecting. If we explore how children talk outside of the classroom we can observe how they challenge one another, moving from one topic to another without making explicit relationships between ideas, which does not mean they do not actually exist. As teachers, we can allow students to participate in real conversations which means that they have, amongst others things, the following elements: a theme, a direction, a goal and furthermore. We have seen how all these aspects are apparently taken into account by the teacher even unconsciously, in order to help the student to respond in the forum by facilitating the way to clarify and justify their opinion.

No doubt there are other causes that are the root of the students' difficulties to argue well. We noted previously that the capacity to argue is not spontaneous but instead must be learned. People need to understand the objectives of the argument and suggest reasons that support his or her position. Diana Kuhn (2005) again suggests some possible causes of these difficulties. Do people not understand the objectives of the argument? Do people have cognitive difficulties? Is it hard to understand the intentions of the speaker? We need to take into account that to analyze an argument it is necessary to consider whether the function of statements refers to the fact of presenting the own goals, or to consider those coming from the opponent. The weakness of an argument may simply be to show a disagreement with the antagonist without giving reasons regardless of their opponent's point of view. In the above example the teacher has directed the student to reconsider his own views through a question and also to consider the arguments of his opponent, in this case her own opinion as the teacher. By re-reading the text we notice that the student said, "I expressed myself badly, Ana."

After analyzing the difficulties that can arise in the classroom when it comes to teaching how to argue, we briefly mention the advantages of overcoming them. At least, argumentative discourse helps people to know what ideas others´ have. There are benefits even if there is no reaction from the opponent, because people who argue are forced to present his or her own reasons, which contribute to transform them. This is precisely what we observed in the previous example. The ability of arguing creates a metacognitive

discourse; at that time the student is forced to reflect on their own processes of knowledge. Moreover, and this is perhaps the most important social and cultural context of Western societies, arguing helps to develop tolerance among speakers, both in relation to others and with oneself. That is, on the one hand people will develop the ability to accept their own limitations and on the other hand, it will be easy to understand that not all opinions are equally valid. In short, knowing how to argue will help participants in the conversation to accept, appreciate and perhaps share the other people's ideas.

CONCLUSION

In conclusion, this paper explores how videogames can be considered a part of a participatory culture when students reflect on them inside or outside the classroom. Games have internal and external grammar and both of them need to be considered in order to explore the educational value of games in relation to developing digital literacies. Moreover, commercial videogames such as Spore allow for the creation of innovative educational settings to generate a situated cognition process and to develop specific processes of knowledge as the capacity of making research and arguing in the real world.

A triple theoretical framework was accepted as a starting point. More specifically, we consider the work of those who consider videogames as a support for developing digital literacies in classrooms (Gee, 2007). These abilities favor the use of multiple discourses (Jenkins, 2009) which includes a combination of images, sounds, speech and written texts. In addition, we considered that knowledge is constructed in specific contexts where its contents and processes have meanings.

From this perspective we looked at the concepts of internal and external grammars of the game (Gee, 2007) to design innovative educational scenarios. We have explored the construction processes of knowledge in a biology class, considering the cognitive strategies that the player has to put into practice, his/her goals and social interactions. We analyze how they were present in the oral discussions that take place in the classroom and in a discussion forum online where students expressed their ideas using the written language.

The Spore video game has become an educational tool that helped the teacher develop students' research skills and the ability to argue (Kuhn, 2005). Empirical data that is provided in this paper was obtained according to an ethnographic methodology and analyzed following the model of discourse analysis proposed by (Green et al., 2006). The results show firstly that participation in the forum, which required students to reflect and rely on the written language, is more effective than oral dialogue to generate questions, thought processes and good arguments about the game. Secondly, the analysis of interventions in the forum shows the possible role of the adult in generating reflection and reasoning abilities. Finally, these results generate new research questions oriented to generalize in new contexts those knowledge processes that were implemented during the game.

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