Wiki as a Tool for Engaging Students with a Science Problem Solving Activity

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Abstract

This study aims at knowing how students experience wikis while they are involved in a problem solving science activity. The study took place in a physics and chemistry 8th grade class (13 years old), where teacher implemented a problem solving activity about acid-base reactions, using a wiki. Participants were 20 students, of which 12 were female students. The activity involved six different working groups. Wikis were analyzed with the goal to identify students' level and quality of participation. Furthermore, in order to understand students' experiences concerning the learning situation six focus group interviews were carried on. Three highly participating groups presented successful strategies and achieved the learning goals. These students used complex strategies for analyzing the information and used theoretical knowledge to make sense of information gathered. The collaborative processes were essential for enabling a feeling of competence and for assuring a successful learning experience. These groups revealed a high level of cognitive engagement. In comparison, poorly participating groups didn't present a successful strategy of knowledge co-construction and revealed difficulties in understanding the scientific concepts involved. Furthermore, each poorly participating group experienced the learning situation quite differently. Results suggest that students' engagement with a problem solving activity using a wiki is affected by a complex interplay of emotional, technical and social issues. Some recommendations for facilitating students' engagement with wikis emerge from the study: to carefully support collaborative processes and to create safe learning environments in which error is valued as an opportunity for learning.

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Introduction

We live in what is commonly recognized and called “the knowledge society”, which means that knowledge is not only the subject of labor, but also it is a means for labor. Indeed, knowledge and information are the raw material that will be transformed by the human action, but also, labor itself involves information processing as well as knowledge production and exchange. It is a learning society, based on innovation and constant re-creation, which implies accessing and sharing of knowledge, and as such it involves communication, negotiation and collaboration among individuals (Hargreaves, 2003). So in order to understand and to act in this complex society citizens have to develop competencies of analysis, reflection and critical thinking, creativity, digital and communication competencies, as well as social and intercultural competencies (Griffin, McGaw & Care, 2012).

Many authors consider science education a powerful means to facilitate the development of some of these mentioned competencies (Osborne & Dillon, 2008). Indeed, if properly explored within the context of inquiry learning environments the very processes of knowledge construction inherent to the scientific activity will facilitate the development of some of these competencies (Lederman, 2006). Due to their unique characteristics digital tools have also been recognized as a useful classroom resource for enacting some of these competencies. According to several authors, it is precisely the asynchronous characteristic of some of the digital tools, allowing students to control their own pace of posting ideas and of sharing comments, reflections, arguments and questions that will provide them with opportunities for reflective, higher order, thinking (Garrison, Anderson & Archer, 2001). The permanent record of students’ posted contributions and the possibility of using it during the process of learning (Garrison et al., 2001; Zhu, 2007) are additional advantages of these tools. Finally, other authors highlight the potential of these tools for facilitating interaction, meaning negotiation and mutual constructive critique (Naismith, Leet & Pilkingzont, 2011; Zhu, 2007).

Wiki is one of the many digital tools currently available within the educational context and its potentialities are frequently acclaimed (Bates, 2011; Parker & Chao, 2007; Wheeler, 2011). However, studies exploring the wikis’ use within the educational context reveal a complex situation. While some studies show the potential and benefits of wikis’ use for the development of competencies of critical analysis (Su & Belmont, 2010), of collaboration (Su & Belmont, 2010; Wheeler et al., 2008), as well as advantages associated with the engagement of students with learning (Hazari, North & Moreland, 2004), other studies reveal some difficulties. Indeed, some studies show lack of students’ participation (Cole, 2008; Witney & Smallbone, 2011), problems and frustration with its use (Witney & Smallbone, 2011; Wheeler et al., 2008) and difficulties in developing collaborative work (Elgort, Smith & Toland, 2008; Karasavvidis, 2010). Furthermore, other studies suggest that students’ interventions do not reveal mobilization of complex cognitive strategies and competencies (Elgort et al., 2008). Finally, Raman, Ryan and Olfan (2005) suggest that the degree that students are willing to work in a more active way affect the quality of the construction of knowledge using wikis.

So, in order for wikis' potentialities to be fully explored, firstly it is necessary that students are willing to use these tools, and secondly that they are willing to collaborate with each other. Furthermore, it is necessary that students are committed with playing an active role in their own learning. Nevertheless, not all the students show the same level of commitment and enthusiasm with this tool. Thus considering the wikis' advantages and potentialities within education as well as the difficulties involved with its use, it is important to understand the role played by social, technical and emotional issues in facilitating (or inhibiting) students' participation and engagement with wikis. The present study aims at knowing how students experience wikis while they are involved in a problem solving science activity.

Theoretical framework

Engagement with school is an important theoretical construct as it has been shown to be positively associated to school achievement (Fredericks, Blumenfeld & Paris, 2004; You & Sharkey, 2009). Furthermore, according to You and Sharkey (2009), this construct reveals itself suitable for explaining students' involvement, commitment and investment in school as well as their school trajectories.

Fredericks and col. (2004) define engagement as a multidimensional construct that involves three components (behavioral, emotional and cognitive), which interact in a complex and dynamic way. The behavioral dimension has to do with participation in academic work and in social or extracurricular activities, and with conformity to the school and classroom rules; the emotional dimension refers to the affective experiences lived inside classroom and in school and to experiences related with the creation of affective bonds with teachers and peers. Finally, the cognitive dimension is based on the idea of intellectual investment and effort to understand academic themes and to develop complex competencies (Archambault et al., 2009; Fredericks et al., 2004). According to Thijs and Verkuyten (2009), engagement results from the satisfaction of some basic needs, such as a sense of belonging and psychological safety, a sense of autonomy and competence. Furthermore, engagement results from a complex interaction of individual, familiar, social and school factors and thus it can be changed (Archambault et al., 2009; Fredericks et al., 2004; You & Sharkey, 2009).

In what concerns factors related to school and class, studies reveal that teachers are key elements for creating engaging classroom environments and learning situations. Clear and structured guidelines for supporting work development, the affective tone of those guidelines and also students' perceptions of those guidelines are important factors facilitating learning and the development of a sense of competence which ultimately affect students' engagement (Laukenmann et al., 2003; Thijs & Verkuyten, 2009; You & Sharkey, 2009). In addition, facilitating students' engagement also implies creating nurturing environments that enables emotional well-being (Wentzel & Watkins, 2002). Classroom environment that facilitates the development of a sense of belonging and the development of significant social relationships contributes for positive psychological experiences that affect students' engagement (Laukenmann et al., 2003; Thijs & Verkuyen, 2009). According to Wentzel and Watkins (2002), "perceiving positive relationships with peers is likely to promote students' sense of emotional well-being and social relatedness; in turn, this positive sense of self and relatedness is likely to support positive engagement in classroom activities" (p. 368).

The previous mentioned studies stress the effect of teachers' actions on students' engagement with learning. Other studies center on learning environments and on activities enabling students' engagement. For instance, some studies highlight the association between engagement and the possibility of deriving a personal meaning from the school subject. According to Schussler (2009), this meaning making activity can enact a sense of agency and control over learning that is essential for engaging students with learning. Blumenfeld, Kempler and Krajcik (2006) highlight the feeling of competence and autonomy, along with the value that students attach to the learning situation as well as the possibility of developing meaningful relationships with others.
So, having autonomy, controlling learning and feeling empowered for constructing knowledge and for deriving personal meaning from the activities are essential elements for engaging students with learning. These elements can be enacted on inquiry learning environments. According to Blumenfeld et col. (2006), inquiry learning environments characterized by the authenticity of the learning situation, the possibility of collaboration and of using technology have the potentiality of making students cognitively engaged with science subjects. However, these authors point out that these aspects interact in complex ways and, as such, these same characteristics pose certain challenges that if not properly managed, can lead to students' disengagement. Indeed, as within the new learning environments students have the responsibility of constructing knowledge and of controlling and making decisions considering the processes of learning, they also have to self-regulate their learning. However, if they do not have this competence, the learning situation might be perceived too challenging by those students, who in turn might not remain engaged with it. In the same line, Rotgans and Smith (2011) evidenced that cognitive engagement changes throughout the process of learning. In their study about cognitive engagement and problem-based learning, they observed that students' engagement was not so high during the initial phases of information seeking and problem definition. Due to their lack of specific knowledge students were not very much autonomous and as such they were not as engaged as they became during later stages of the problem solving activity. Indeed, later on, when they started building knowledge and deepening their understanding about the topic and thus when they felt more autonomous, they became much more cognitively engaged with the activity.

Methodology

The goal of the present study is to know how students experience wikis while they are involved in a problem solving science activity. In this study we used a qualitative research with an interpretative orientation (Erickson, 1986), as it is a powerful means for assessing students reasoning and experiences while they are involved in a problem solving activity using wikis.

Curricular context

The study took place in a physics and chemistry 8th grade class, of a Portuguese public middle school, where teacher implemented a problem solving activity about acid-base reactions, using a wiki.

In Portugal, compulsory schooling ends at 9th grade. So these students were following the elementary physics and chemistry curriculum. Elementary science education seeks to provide students with the ability to raise questions about the natural world, to acquire a general understanding about science ideas and about the explanatory structures of science as well as about its processes and, finally to empower students for appraising the relationships between science, technology, society and environment (Galvão, 2004). In order to achieve this overall goals, the Portuguese elementary science curriculum is organized around the notion of competence, it emphasizes a constructivist approach and it values the endorsement of critical thinking strategies, the creation of inquiry learning environments, and the promotion of self-regulated learning based on problem solving and decision-making. It is organized around four organizing themes, namely Earth in Space; Earth in Transformation; Sustainability of Earth and Better Living on Earth (Galvão & Freire 2004; Galvão et al. 2002; Galvão et al. 2006). Acid-base reactions are explored within the theme Sustainability of Earth. Usually, this theme is developed during the first two trimesters (from September until February) during 8^{th} grade. Students have chemistry and physics classes once a week for 90 minutes.

Activity description

The problem solving activity focused on acid-base reactions and it was designed and implemented in accordance with the curriculum guidelines. Furthermore, the activity was built within the context of a European project aimed at training teachers for using strategies that promote the development of scientific, digital and communication competencies among the students. Within that context, training courses were implemented and inquiry activities using the tools of web 2.0 were created and tested in the classroom. The teacher involved in the present study participated in one of those training courses, where she created, collaboratively with other teachers, this problem solving activity using a wiki. This activity was then implemented in her class and it was evaluated regarding students' scientific knowledge and comprehension, as well as enacted communication and digital competencies. Furthermore, students' participation with the activities and teacher's experiences with wikis were also assessed. In the present study we focus on students' experiences.

The teacher had a graduation in physics and chemistry and she had been teaching for seven years. The teacher acknowledges the curriculum guidelines and during her in-service training she had been introduced to inquiry learning environments. Furthermore, she has been a participant of a study aimed at implementing inquiry activities in science classes, where she developed some expertise. Collaborative work is fully encouraged in inquiry learning environments and so she has some expertise in collaborative work.

The teacher used wiki as a classroom resource for the first time during this training course. Students, too, used wikis as a classroom resource for the first time. So, before introducing the problem, the teacher introduced them to the wikis, explained how it works and she created an account for each of the students. According to the teacher, most of the students reacted enthusiastically to the wiki and learnt to use it fast, during the demonstration class.

Concepts covered within this activity were: acid and basic solutions, acid-base reactions, neutralization reactions, and pH indicators. The activity was developed using a wiki and it was introduced by a text dealing with the pain caused by bee and wasp stings: *Mr. Jones works as a beekeeper. Sometimes, he doesn't use his protection equipment and as such he gets stung by bees, causing a lot of pain!! Because of this, he always carries a sodium bicarbonate solution with him in order to relieve the pain. One* *day, Mr. Jones and his granddaughter went for a walk and suddenly she was in a lot of pain. Her grandfather quickly applied the sodium bicarbonate solution to the area where she had been stung. However, instead of relieving the pain, the pain got worse. How can we explain this situation?*

After reading the text – the problematic situation, students were encouraged to formulate and register some questions about it using the wiki. Next, students had to search for relevant information and share it with the other group's members. In order to find a solution for the initial problem, they had to evaluate and to organize that information and to insert their answer on the wiki.

Although the students had used and worked on the wiki outside of the classroom, the problem solving activity was discussed during the chemistry class as key scientific concepts were introduced over a month and half time period. So during the lessons students were able to discuss particular theoretical issues related to the problem. Even though much of this activity was developed outside of the classroom, the assignment was formally assessed and its' results were included in the final grade.

Wiki was built using the wikispaces platform, as it is free of charge, it is easy to use, it has the potential for visual image and only members can post information.

Participants

Twenty students (12 female students) from an 8th grade science (13 years old) class participated in this study. According to the teacher, in general these students enjoy physics and chemistry and they get easily involved with science classes. Nevertheless, these students differed in their level of achievement concerning physics and chemistry, as assessed by the teacher.

The problem solving activity involved group work. In order to work on their assignment, students selected their own groups. There were six different groups. Groups A and B were each formed by three high achieving girls. Group C was formed by four girls, three of which were high achieving and one presented some difficulties with physics and chemistry. Group D was formed by four male students, from which one was high achieving and the other three were low achieving in physics and chemistry. Group E was formed by three low achieving male students. Finally, group F was formed by three average students (two girls and one boy).

Data collection and analysis

In order to know how students experienced wikis, data was collected by means of written documents (i.e. text posted on the wikis) and focus group interviews with the students. After activity conclusion, wikis were analyzed with the goal to identify students' level of participation and the quality of process of knowledge co-construction. In order to identify groups' level of participation, we considered activity conclusion (the group presented or not a written answer to the initial problem) and the number of interventions (written postings) of each element of the group and of the overall group.

For analyzing the quality of the process of knowledge co-construction we focused, on (a) the nature of conversational exchanges between students and (b) the type of self-regulation strategies displayed. The nature of conversational exchanges was coded according to a scheme proposed by Kaartinen and Kumpulainen (2002) (Table 1).

Table 1. Conversational exchanges

Conversational exchanges	**Description**

Initiation moves	Students begin new thematic interaction episodes based on close domain-specific analysis of discourse.
Continuing moves	Students continue to elaborate either their own or their peers' reasoning.
Extending moves	Students bring in new perspectives which expand joint explanation-building under the same theme
Referring back moves	Students refer back to the ideas which have already emerged in the flow of discourse.
Agreeing/disagreeing moves	Students accept or reject ideas and explanations proposed in the previous conversational turns.
Replying moves	Students respond to an explicit answer
Commenting moves	Students make personal remarks or evaluate the situation
Concluding moves	Students draw together explanation-building processes, integrating elements within a coherent whole

(Adapted from Kaartinen & Kumpulainen, 2002)

For analyzing data concerning self-regulation strategies, we used categories described in literature (Paraskeva, Mysirlaki & Choustoulakis, 2009; Pintrich, 1999; Quintana, Zhang & Krajcik, 2005), but given the specificity of the study, some categories have emerged from the analysis of the wikis (Table 2).

Table 2. Self-regulation strategies

Self-regulation strategies	**Description**
To plan the learning process	- To identify or to analyze the learning problem (*What am I supposed to do? Where do I want to reach?*) - To identify the starting point (*What do I know that can be useful for achieving the learning goals? Which difficulties do I have to overcome?*) - To identify or to define strategies for achieving the learning goals (*How should I reach the learning goals? Which are the best options?)*
To monitor the learning process	- To analyze progresses (*Where am I? What have I reached?*) - To identify or to analyze difficulties and barriers which inhibit progress (*What is inhibiting progress?*)
To regulate the learning process	- To redefine strategies (*Which other option do I have in order to achieve the initial goals?)* - To mobilize knowledge (*What do I know that can be useful for correcting mistakes or overcoming difficulties?*) - To add or to search for additional information (*What do I need to know more in order to correct mistakes or overcome difficulties?)* - To call for others for help (e.g., teacher) - To manage negative emotions (such as frustration)
To evaluate the learning process	- To evaluate goals, tasks and strategies (*Did I reach goals? Were goals and tasks adequate? Were strategies efficient?*) -- To evaluate the learning experience (*How did I experience the process? What costs and gains has it involved?)*

In what concerns interviews, a total of six focus group interviews were carried on, with the goal of characterizing students' experiences while participating in the activity, their appraisal about wiki's use and about the activity and their perspective considering their own learning and engagement. Interviewed groups were the same as the working groups. Interviews lasted around 30 minutes and were carried on after the activity conclusion. Interviews were analyzed inductively, as the goal was to identify themes, patterns and regularities in students' responses that emerged from their own answers (Miles & Huberman, 1994).

Teacher participation in the wiki was analyzed considering the quality (type of information provided and guidance) and the number of interventions. The inductive analysis of the wikis and interviews were performed independently by the researchers, who discussed and reviewed the analysis to assure greater reliability.

Results

Level of participation in the activity

In what concerns participation, we observed two different types of groups (highly participating and poorly participating) (Table 3).

Table 3. Students' level of participation in the activity

Group	**A**	**B**	**C**	**D**	**E**	**F**
Level of participation	High	High	High	Low	Low	Low
Number of elements in the group	3	3	4	4	3	3
Activity conclusion	Yes	Yes	Yes	No	Yes	No
Number of interventions by the group as a whole	22	29	24	8	2	2
Number of interventions by each element of the group	Student 1-11 S2-10 S3-1 Teacher - 4	S4-11 S5-11 S6-7 T - 4	S7-11 S8-7 S9-3 S10-3 T - 2	S11-4 S12-4 S13-0 S14-0 T - 0	S15-1 S16 -1 S17-0 T - 1	S18-2 S19-0 S20-0 T - 0

Analysis of the final answer evidences that four groups (A, B, C and E) accomplished successfully the activity. They provided an explanation to the original problem (*Why didn't the sodium bicarbonate relieve the pain from the bee sting?*) mobilizing knowledge about acid-base reactions and presenting well supported explanations. Despite presenting a more confusing explanation, Group E has also used scientific knowledge on the final answer.

Three of the groups that concluded the activity (A, B and C) participated considerably on the wiki construction and on the problem solving activity (highly participating). Indeed, these groups presented between 29 and 22 interventions, comparing to eight and two interventions made by the remaining groups. Nevertheless, mention should be made that we observed some degree of variability considering each student's intervention even in highly participating groups: some of the students had a high number of interventions (such as student 1) while others students did not intervene as much (such as students 3).

In what concerns the group E that also concluded the activity, despite having posted an answer to the initial problem, the use made of the wiki was reduced (2 interventions) (so this group was categorized as poorly participating). The remaining groups (D and F) neither concluded the activity nor used significantly the wiki (respectively, 8 and 2 interventions) (poorly participating).

Quality of students' participation

In order to appreciate the quality of the students' contribution, we considered the quality of the process of knowledge co-construction (focusing on the nature of conversational exchanges and on the self-regulation strategies used).

Considering the process of knowledge co-construction, students in the groups A, B and C (highly participating) jointly resolved the problem. Despite having worked collaboratively on the problem solving activity, each highly participating group followed a different dynamic. Group A started the problem solving activity by presenting three hypotheses. However, as the groups didn't have a clear idea about the problem nor about what they needed to know, they had several, discrete, information search initiatives. The initial conversational exchanges (until16th intervention) clearly reflect this state of intense not-directed-activity: students display several initiation moves and refer back moves, as if they were walking in circles. It is from the moment that the students started framing the problem in terms of acid-base reaction, that they were able to identify their difficulties and to define new goals and strategies in accordance with those goals. Then their conversational exchanges became more complex: students started extending and commenting on each other's ideas, and finally they drawn a conclusion, as is evidenced on the following excerpt (Table 4).

Table 4. Excerpt of the conversational exchanges of group A

Intervention		**Conversational exchanges**	**Self-regulation strategies**
16 (S1)	I have one doubt. In the last class, the teacher presented a slide stating that: "The baking powder contains sodium bicarbonate". Baking powder makes things grow. There is no doubt about that. But does it mean that baking powder is a basic substance that "makes pain increase too"??	Initiation Referring back	Adding information Calling other for help
	I talked to my brother… I don't know if my idea will help our reasoning. In any case… He told me that it might not have been a bee sting. Sodium bicarbonate is not the right remedy for all the types of stings. The text states that the grandfather usually uses sodium bicarbonate for relieving the pain of a bee sting. The bee sting contains acid formic. So, it might not have been a bee sting. In other words, whatever the sting was, it didn't contain any formic acid. So sodium bicarbonate wouldn't work on it.	Extends Concludes	Mobilize knowledge
17 (S2)	You are right, S1. I am going to think about what you've just said!!	Agreeing	
18 (S2)	I was thinking about what you said, S1, and here is what I think: "The treatment of a bee sting should always begin by removing the stinger in order to prevent it from injecting more poison. After that, the area where the sting occurred should be disinfected with an antiseptic; the pain can be controlled with local application of ice and with moistened compresses of bicarbonate or ammonium in order to neutralize the acid characteristics of the poison (...)."	Continuing	Adding information
19 (S1)	If your theory is right, it means that the injected substance didn't contain any acid… Now we have to confirm this idea. I am going to search for more information.	Commenting	Search for information
20 (S2)	I was searching and here is what I found: "When the sodium bicarbonate is mixed with an acid, carbon dioxide and water are released".	Continuing	Adding information

21 (S1)	I was thinking about your theory. If the bee sting is an alkaline solution and the formic acid is an acid solution, then sodium bicarbonate reacted with the acid and caused pain. The pain the girl experienced. Hmmm… I don't think that this is the solution to the problem… I am going to search a little more…	Commenting	Analysing progress
22 (S2)	I think that you are right. Your theory is right. I am going to keep searching and see what I find…	Agreeing	Search for information
23 (S1)	According to my theory, the poison injected by a bee is an acid and the sodium bicarbonate is an alkaline solution. So the sting should be treated with the "opposite" solution. If it was a bee that stung the girl, the sodium bicarbonate solution should have worked, as it was "an opposite solution". As it didn't work, we might wonder whether the injected substance was alkaline or not? So, since sodium bicarbonate is an alkaline solution and the injected substance is alkaline too, instead of relieving the pain it made it worse. I am going to search for this…	Extending	Mobilizing knowledge Search for information
24 (S2)	Yes, what you are saying makes sense. I'll see if I can find more stuff too!	Agreeing	Search for information
25 (S1)	OK. I think I have the solution: During the lesson, the teacher gave the example of heartburn; we would treat it with sodium bicarbonate. If the girl had been stung by a bee, then the sodium bicarbonate would have relieved the pain, as an acid solution (the bee sting) is treated by an alkaline solution (sodium bicarbonate). As it didn't t relieve the pain, the sting was not from a bee, but from another insect whose poison is made up of an alkaline solution, causing the opposite reaction. As the injected poisoned was an alkaline solution: a BASE IS NOT CURED BY A BASE. In comparison, a BASE IS CURED BY an ACID and an ACID IS CURED BY BASE!!	Concluding	Mobilize knowledge
26 (S2)	Yes, you are right, S1. The insect wasn't a bee but a wasp as a wasp injects a poison that is an alkaline solution or a BASE". WE DID IT!!!!!!	Agreeing Extending	Adding information Evaluating goals

In what concerns group B's process of knowledge co-construction, there were six cycles of initiation / continuation / agreeing, followed by the moves: extending and / or commenting earlier contributions. One common pattern was: one of the students initiates and continues a cycle of ideas and then the other student extends or comments on those ideas, or even draws a conclusion. Nonetheless, it should be noted that the conclusion is not used by the next student, who in turn initiates a new cycle of ideas. It is like a closed circle: when they arrive to a conclusion, they start exploring other reasoning paths. This is what S5 posted on the 5th intervention about an initial hypothesis that would lead to the solution of the problem: "*I might be saying a silly idea: But the truth is that the text does not say that the girl was stung by a bee. So, if sodium bicarbonate is an antidote for the bee sting, it could have the opposite effect on the sting of another "bug"*. The same student (S5) presented the same, more elaborate, hypothesis at the 12th intervention. Then on the 15th intervention S4 presented the solution to the problem as if S5 hadn't shared the idea, as evidenced by the next excerpt.

> Well, I think that by now we should discard the allergy theory. First the teacher's clues are not in that direction. Secondly we haven't gotten anywhere following that theory.
> I didn't understand S6's first remark.
> I think that neither of the two theories proposed by S5 leads to the right way…
> What I am going to do now is to combine all of our ideas with what we learnt in class: First, we know that sodium bicarbonate is an alkaline substance and that formic acid is an acid. Second, we know that the alkaline substance (sodium bicarbonate) cancels out the acid (formic acid). So, considering these ideas the sting might not have been from a bee. It could have been from any other insect whose poison is not an alkaline substance, but rather an acid. So it had an effect opposite to the expected one. I am going to do some further searching on this :)

Due to these parallel reasoning paths, the group took a long time to finally present a supported solution to the problem, one that was based on scientific knowledge. Moreover, it was S6, the member with the least amount of written inputs, who ended up integrating all the information and mobilizing the right scientific knowledge to a conclusion, as shown in the next excerpt:

> This is my theory: The poison injected by a bee sting is acid. Now, we have only to deduce: What is necessary to neutralize that poison? A base. This is the exact treatment for a bee sting: To apply "milk of magnesia" (*sic*) (which is a base), in the area of the bee sting. One can also apply ammonium bicarbonate solution; both solutions are basic. The reverse occurs in treatment for injuries caused by wasp stings. This insect injects a poison into the skin, which has a basic character. To relieve the pain, one applies vinegar (acetic acid).
> I DID IT!!!! (S6 - 29th intervention)

Despite this type of conversational exchanges, which seemed inefficient in what concerns knowledge co-construction, the group demonstrated good self-regulation strategies. Initial interventions centered on the definition of strategies and on the analysis of the problem. For instance on the 3rd intervention, S4 questions: "*Why is sodium bicarbonate used for relieving the pain of stings?*" Besides, quite initially students started to use their knowledge about acid for reformulating the problem in terms of an acid-base reaction and to use it for guiding their information search about the chemical nature of the stings of different insects. Finally, as students kept constantly on analyzing progress, and at defining the problem and new strategies, they were able to overcome the gap that resulted from parallel reasoning paths and they were able to reach a conclusion.

In what concerns the other highly participating group (C), all collaborative work was made according to two main cycles (until 15th intervention/ after 16th intervention). Students built on the ideas of each other and used diverse self-regulation strategies that supported them in the process of problem solving. These students began to jointly analyze the problem and to raise a number of hypotheses about why sodium bicarbonate didn't relieve the child's pain. In this initial phase, they defined strategies for solving the problem; they shared information and evaluated that information concerning their progress on the problem solving activity. The initial conversational exchanges (mainly initiation and continue moves) evidence this phase of meaning negotiation and decision making concerning next steps. On 12th intervention, S7 introduced the idea that sodium bicarbonate is a base and also exposed her difficulties ("*In the last lesson, the teacher said that sodium bicarbonate is a base. But, I cannot see the connection...*"). This idea was then taken up and extended by S8, and, on 14th intervention it culminated in a conclusion ("*Then, one uses sodium bicarbonate against bee and ant stings, because their poison contains formic acid. As sodium bicarbonate is a basic solution, it "cuts" or cancel the acidity of the formic acid!*"). In this intervention, S8 also introduced a new problem: "*if the solution in the sting was basic (and sodium bicarbonate is a base) then it wouldn't cancel… But then, why did the pain increase??? That is the BIG question!*" At this point, the group started a new, small, cycle of problem solving. Students shared relevant information and, on 20th intervention, S8 introduced a new hypothesis: "*Is it possible that the insect that stung the girl might not have been a bee and as such its' poison didn't contain an acid but something else that would have caused this reaction?*" Then S7 continued and extended S8 reasoning, mobilized her knowledge about acid-base reactions and used new information. Finally she reached a conclusion, explaining why the granddaughter's pain increased (22nd and 23rd interventions).

In what concerns the remaining groups (poorly participating groups), interventions were parallel and did not build in each other. Group D is a clear example of two monologues, not related to each other. These interventions were unconnected to each other and there were no reply to the each member's interventions (Table 5).

Table 5. Excerpt of the conversational exchanges of group D

Intervention		**Conversational exchanges**	**Self-regulation strategies**
1 (S11)	The first thing to do is to find out which insect stung the girl.	Initiation	Defining the strategy
2 (S11)	I read in my classroom notes… Sodium bicarbonate is an alkaline solution. So, I think that alkaline solution cancels each other???? I don't know… I am going to check to see if I've got it right.	Initiation	Adding information Defining a new strategy: to check his ideas
3 (S11)	I read the work of the other groups. Group B says that acid solutions cancel alkaline solutions. I was not able to see much more, as they might have already finished. But I am going to check to see if they got it right.	Initiation	Adding information Defining a new strategy: to check if others groups arrived at the correct solution
4 (S11)	I was not able to find anything more concrete.	Initiation	Analyze progress
5 (S12)	Why didn't the pain stop?	Initiation	Defining the problem (rephrasing the problem)
6 (S12)	I am going to see if I got it right.	Initiation	Defining a strategy: to check if he got the problem right
7 (S12)	I checked group C's answers and I also cannot relate this problem to alkaline and to acid solutions.	Initiation	Analyzing progress: he

			identifies difficulties
8 (S12)	Teacher, in the next class you have to explain what are alkaline and acid solutions.	Initiation	Calling the teacher for help

In what concerns self-regulation strategies, there are also considerable differences amongst the groups. Considering group D (see Table 5), despite S11 starts by identifying the problem or part of the problem ("*Which insect stung the girl?"*), his subsequent actions were not congruent with the first formulation. He defined new strategies and developed isolated actions, which had no clear finality: First, he checked his classroom notes. But, what was he looking for? He then checked the other groups' works. But, what was he looking for? In what concerns S12, he rephrased the problem and he checked its correction by looking at other group's work instead of asking for help inside his group. Finally, when he faced a difficulty, instead of involving the members of his group, he immediately called for the teacher's help.

It is important to highlight that group D presented reduced content knowledge. Posted messages reveal students' difficulties in understanding some of the involved scientific concepts (such as basic and acid solutions, acid-base reaction), for instance, when S11 writes "*Sodium bicarbonate is an alkaline solution. So, I think that alkaline solution cancels each other???? I don't know…*" or when S12 explicitly asks the teacher to explain them what is an alkaline and acid solution. These difficulties were also observed on other poorly participating group. For instance, one student from group E posted on the wiki the following statement:

> "I read that when we add an acid-base solution to an aqueous acid solution, the base will react with the acid, making the solution less acid and as a result the pH increases. I didn't understand this part: If the solution becomes less acid, why does pH increase?" (S16)

This intervention shows students' difficulties in understanding pH and the acid-base reaction. Nevertheless, despite of being confuse, this group's final explanation was correct and based on scientific knowledge. During the interview students from this group (E) evidenced some difficulties in working together and in using the wiki. Besides, during the interview it became clear that S16's written conclusion was removed by S17 (although it was not clear if it was purposely or not intentional). So, the difficulty in understanding some scientific concepts hindered the mobilization of the scientific knowledge for making sense of a daily problem. This was also clear in group F. Mention should be made that this difficulty was also somewhat present in high achieving (and participating) groups (namely A and C). Indeed, despite using scientific knowledge in the final answer, these groups didn't mobilize the right scientific knowledge from the start. In addition, in what concerns group A, they only started using scientific knowledge after a clear suggestion from the teacher ("*Girls, don't waste your time… Try to remember what we have studied today. Check today's slides. Check the last slide*"). It is from the moment that the groups started framing their reasoning within a scientific mind set, that they started reasoning efficiently and to build in each other reasoning, ending up to find the solution, explaining the problem using scientific concepts, i.e., the notion of acid-base reaction.

To sum up, concerning the process of knowledge co-construction, despite presenting very different strategies of negotiating meaning and co-creating knowledge, groups A, B and C were able to co-construct a final explanation to the situation. In comparison, groups E, F and G didn't present a successful strategy of knowledge co-construction, and they also revealed difficulties in understanding the scientific concepts involved.

Teacher's intervention

The teacher had a reduced participation on the wikis. Besides, her participation and the quality of the interventions differed from group to group. The teacher participated more significantly on the wikis of the highly participating groups (A, B and C). She guided and supported these groups, by making contingent interventions, encouraging students and alerting them for possible divergence from their goals. For instance, in what concerns group B, on the 17^{th} intervention teacher wrote: "Girls, now you are going in the right direction… Good!!" In comparison, teacher never intervened on the wikis of groups D and F and she did intervened only once on the wiki of the group E. However, her intervention centered on students' grammar errors and it ended up with a negative appraisal of the groups' work (*"Boys, pay attention to your grammar errors… You have been working very little"*).

Students' reported experiences

Interviews reveal that students experienced the wikis and the problem solving activity differently and that not all of the students (or groups) valued the same issues of the learning situation. Emerging issues were (a) the nature of the learning activity (b) the learning strategies, (c) evaluation of the learning situation (problem solving activity using a wiki), (d) appraisal of wiki use.

Table 6. Resume of the dimensions emerged from the interview

Dimensions		**A**	**B**	**C**	**D**	**E**	**F**
Nature of the learning activity	Minds on activity (questioning, discovery, thinking)	+	+	+	0	0	0
	Open activity	+	+	+	+	-	0
Learning strategies	Collaborative work	+	+	+	0	0	+
	Autonomy	+	+	0	0	-	-
Evaluation of the learning situation	Enjoyment with the learning situation	+	+	+	0	0	+
	Different way of learning	+	0	+	0	0	+
	Amusing way of learning	0	0	+	0	0	+
	Efficient way of learning	+	+	+	+	0	+
	Challenging way of learning	0	0	0	+	0	0
Appraisal of wiki use	Requires autonomy	0	+	0	0	-	-
	Requires collaborative work	+	+	+	0	0	+
	Requires familiarity with digital resources	+	+	0	-	-	0
	Allows public visibility of ideas	0	0	0	0	0	-
	Requires time and will to use	0	0	0	0	-	-

(+) positive emphasis; (-) negative emphasis; (0) not mentioned

Students in the highly participating groups (A, B and C) enjoyed the learning situation very much, as is evidenced in the following excerpt,

> "I was hooked with the wiki. While working on the bee problem, I checked the wiki almost every day. I just wanted to see: - "Hmm, nobody has posted anything yet!" And then I would call my group and I would ask them: - "Have you written

> anything?" And that was it: I was hooked" (Focus groups interview, S1- Group A).

Similarly, S9 states that "(…) if I were at home and I didn't have this activity to do, I would not read my physics and chemistry's textbook in order to study. But with the wiki, I pushed myself to do this, as I liked it" (Group C).

These students' enjoyment with the learning situation is associated with the nature of the learning activity, which made them questioning, relating, thinking, arguing and discovering relations. For instance, S1 states that "I learned that not everything is right in front of our eyes! We have to search, to reread several times until we understand…" (Group A). Other students highlight similar dimensions related with the nature of the problem solving activity.

> "It also forced us to broaden our horizons and to think as the answer is not given ahead of time. It is a mixture of all the information and then we have to relate back our notes and then continue thinking until we find the solution" (S9 - group C)

One characteristic of the activity that was perceived as very stimulating by the students in the groups A, B and C was having to think, having to go beyond the information given and to analyze the information, and based on that analysis to find a solution. Other mentioned issues were autonomy, collaboration and the fact that the learning situation was a different, but amused and efficient way of learning.

Some of these students mentioned that their positive experience with the learning situation derived from the possibility of making decisions concerning their work and from the sense of control over the activity, as evidenced by the following answer: "It is as we were learning by ourselves! (…) We had to go by ourselves, and have our own ideas and to try to reach a solution with no help" (S3 – Group A). The absence of the teacher was perceived as one more advantage. Indeed, having to overcome difficulties by their selves made the problem more challenging. S5 explains, "If this activity was done during the class, we would be able to ask the teacher for help all of the time. But when we use the wiki, we cannot do that. We had to search for the things. While we wrote a lot of mistakes, we also wrote a lot of accurate things, too" (Group B).

Along with the autonomy, collaborative work emerged as another dimension highly valued by these students. One of the students described the group process in the following way:

> "We talked to each other. We used to say: "I think this…" Or then we used to say: "I posted something new, go check it". Sometimes, the other students didn't check the wiki as frequently as we expected, so we used to call to each other in order to remind each other: "I posted something there!" Or: "I think that… Please check what I posted, in order for us to relate our things!" It was always like that!" (S5 – Group B)

Thus, the possibility of making questions and solving doubts, of helping each other, of presenting their ideas and hearing others' opinions, of comparing perspectives and ideas and of building on each other's ideas, were learning strategies identified and valued by these students.

Other issues mentioned by these students concern their evaluation about the learning process: a different, joyful and effective way of learning. The high participating groups felt that they learnt. Students mentioned that they were able to better understand the learning topic, that they were able to memorize it for longer periods and also that they learnt it more promptly. On the interview, S9 states that,

> "Concerning myself, I think that I memorized the subject more easily! If I had studied the concepts just to answer an exam question, I wouldn't have retained the information for so long! But, in this learning situation… I don't know… We were involved with the topic!" (Group C)

S1 states on the written notes that "This activity helped me to better understand acid-base reactions and it made it easier to use that knowledge in my daily life, in the exams and during the classes". In the same direction, S4 writes, "it was an excellent way of understanding the topic without having to memorize it mechanically" (group B).

Enjoyment with the learning situation and the feeling that they have in fact learned was not unique to highly participating groups. Group F (poorly participating) also mentioned the enjoyment with discovery, the challenging character of the activity and also the fact that they have learnt. On the interview, one of the students stated that

> "First, I like to solve problems as this one. Secondly, I think that this type of activities helps me to develop (…). It is like… in a moment I hardly know anything… and then… after a while we know almost everything. (…). The topic is transmitted in a simpler format". (S20 – group F)

This group also highlighted the advantage of collaboration. Concerning this issue, S18 explains "[we like teamwork] as together we know many more things than each of us individually! Usually one says that a group thinks better than a person alone. And I think that this was the case". This issue was also valued by S20, who described the advantages of teamwork: "We had several ideas and each of us showed his ideas. Then we joined everything and we ended up with just one idea! We always used all the information!" Despite their reduced level on participation in the wiki, these students mentioned that they developed the problem solving activity collaboratively, by sharing information at school and by jointly thinking about the problem. These students explain that they poorly participated in the wiki due to time constrains and mainly due to their fear of making mistakes, as evidenced by their answers:

> "Posting wrong things and then everyone being able to read it… And then everyone sees those wrong things instead of reading accurate things". (S18 – Group F)
>
> "In a certain way, what we say inside the class remains in the class! While when we use the wiki, if we make any mistake it will be fully accessible for all". (S20 – Group F)
>
> [Inside the class] "we feel more confident" (S18), as "we have teacher's help". (S19)

Students' lack of confidence and their fear of failure, the possibility of error being recorded and appraised by everyone, and the absence of the teacher from the learning situation were issues that emerged in these students' interview. These issues were exclusively mentioned by the elements in the group F, with the exception of teacher's absence. One element of group E also mentioned teacher's absence as a disadvantage of the wiki. According to him, "I would rather develop this activity inside the class, as we would have teachers' help. It is always a support" (S17). The possibility of having support from the teacher sustained this element's preference for developing this activity in a traditional way. Besides, the group also pointed as reasons for not using the wiki, their lack of free time and also their unwillingness to study.

> "We had to work outside school. (…) I practice sports… and then the tests… It is difficult" (S17 - Group E)

Finally, these students considered that to find out the right information and to use it for building an answer was a difficult task and as such they also found the learning situation demanding: “On the net, I could find everything except what I wanted to find” (S16 - Group E).

In comparison, some members in the group D valued this characteristic of the problem solving activity – having to arrive at a solution These students faced such characteristic as a challenge that they were able to manage successfully: “It was difficult to find the answers, but we were able to learn many things” (S13 – Group D). S11 states that, “[I liked] being able to manage … to search on sites that I had never seen before. We had to know several things about acid substances, about bees and other things!” Despite saying that they learnt, they poorly participated on the wiki and they didn’t conclude the problem solving activity. Their arguments for not using the wiki were: difficulties with accessing the wiki and lack of free time to access it.

Discussion

The results show that different groups (and students) experience wikis in quite distinct ways, that they manifest different levels of cognitive engagement and that their engagement is affected by diverse reasons.

Highly participating groups reveal high cognitive engagement. Many of the students in these groups use complex strategies for processing information, namely they search, analyze and synthetize pertinent information and use relevant theoretical knowledge to make sense of information gathered. In addition, they debate their ideas, expand each other ideas, propose explanations, and show a deep understanding about the topic under study. Finally they try to control the process of problem solving, by monitoring their progress, by evaluating the situation and by making decisions according to the objectives and definitions made. In literature, these actions are considered as indicators of cognitive engagement (Blumenfeld et al., 2006; Zhu, 2007).

Most probably, a sense of efficacy (not only in what concerns their competencies for solving a problem within the context of science classes, but also in what concerns their competencies for using digital tools) affected their initial engagement with activity using the wiki. According to Schunk (1989), if students believe that they are able, they will be willing to make efforts in a particular learning situation, and they will remain involved with it even when facing difficulties. And indeed, these are good students in what concerns physics and chemistry, as revealed by the teacher, and they also showed appropriate knowledge about the topic under study, which they were able to mobilize in order to explain the situation and to solve the problem.

In addition to their initial engagement, these students remained cognitively engaged throughout the learning situation. Feeling able to deal with difficulties and to progress in the problem solving activity played an important role in the maintenance of their cognitive engagement (Laukenmann et al., 2003; Thijs & Verkuyten, 2009; You & Sharkey, 2009). Besides, collaborative processes also proved a key element for sustaining a sense of competence and thus cognitive engagement. Indeed, these processes were essential for helping the students to deal with frustrations and difficulties, for facilitating knowledge construction as well as for nurturing a sense that they would successfully achieve the learning goals. Besides, other important component of the collaborative process was the emotional dimension, which was quite evident in these students. They, in fact, felt good in the group; they developed positive social relationships, and they supported (and felt supported by) each other. Literature about engagement shows how enabling positive emotional and social experiences affects students' engagement (Laukenmann et al., 2003; Thijs & Verkuyen, 2009; Wentzel & Watkins, 2002).

So, a sense of competence affected the engagement of highly participating groups. Besides, experiencing positive emotions within the group and perceiving the group as a facilitator of the process of knowledge construction were also key issues for sustaining their engagement.

High achieving groups experienced the wiki quite differently from group D, who had a reduced participation in it and who didn't evidence cognitive engagement with the learning situation. While in the interview students in the group D reported that they have learned from the activity, they in fact did not conclude it. There was an initial effort to access wiki (eight interventions from two students) and in the interview one of the students mentioned that he have read, have selected information and have thought about the solution. Despite had identified the problem, students did not explore it, they did not gather relevant information, and they did not identify useful knowledge or try to overcome the difficulties associated with their limited knowledge about the topic. These students gave up and asked the teacher to help, when they faced difficulties in constructing knowledge.

According to Rotgans and Smith (2011) usually students are less cognitively engaged during the initial phases of problem solving activities because they have less knowledge to make sense of new information and therefore they are less autonomous and more dependent on teacher. Likewise, Blumenfel and col. (2006) mention that complex learning situations that requires from the students high degree of autonomy and great control over their own learning processes, may make students feel overwhelmed by the different demands of the situation and thus may cause them to disengage from the learning situation (see also Zhu, 2007). Thus, in order for students to engage with complex learning situations, they must possess specific relevant knowledge and appropriate competencies (Blumenfeld et al., 2006). And in fact, unlike the highly participating groups, group D revealed greater difficulties in understanding the scientific knowledge necessary to answer to the problem. Besides, they were described by their own teacher as students with more difficulties regarding physics and chemistry.

Collaboration can be an essential means to overcome some of these difficulties. In one study about asynchronous online discussion, Zhu (2007) observed that "the action of sharing, exchanging, and defending one's ideas helped students remember and understand the learning material" (p. 470). But in this case, students did not collaborate successfully. Their interventions were parallel, not contingent; students did not co-construct knowledge, nor supported each other when facing difficulties. Collaboration requires competencies for clearly communicating ideas, for critically appraising and discussing ideas, for challenging each other's positions and comparing different points of view, and for monitoring and understanding the process of knowledge construction (Blumenfeld et al., 2006). However, students in the group D did not reveal some of these complex cognitive, self-regulation and communicative competencies. Most probably, the way that they experienced the group also affected their engagement. They didn't feel as making part of a group and they didn't get involved with each other, as is evident in the interviews. Now, as pointed out by Wentzel and Watkins (2002), students have to acknowledge the intellectual and emotional benefits of collaborating with each other in problem solving activities for engaging with learning.

So, in a context where they did not feel able, where they faced many difficulties and where they did not receive emotional and intellectual support from each other, students disengaged and gave up from the learning situation. Furthermore, mention should be made that these students didn't receive online feedback from the teacher. According to Zhu (2007), posting a message may require significant effort by students with poor prior knowledge. So, if they do not receive timely information about the results of their efforts, students may not engage with the learning situation. Prompt online feedback is thus an important means for improving students' self-confidence and, as such, students' engagement (Su & Beaumont, 2010; Zhu, 2007).

As well as with the group D, lack of online feedback from the teacher and of emotional and intellectual support from her might have also affected group F's engagement. These students enjoyed the activity, which they consider that helped them learning. In addition, despite not having used the wiki (two interventions) nor having completed the assignment, apparently they searched, they shared information and they tried to solve the problem together. A very salient reason for not using the wiki was these students' fear of making mistakes which would be visible to the entire class. So, in this case, it was not so much the activity itself, but the fact that the wiki makes visible the reasoning processes and the mistakes, that justified students' reduced participation. In her study with university students, Cole (2009) noted that, although a third of students have accessed the wiki, no student posted a message. When questioned about this behavior, students reported doubts about the quality of their contributions. Similar results were reported by Su and Beaumont (2010), who state that fast feedback, focused and embedded in the wiki page is essential for students to overcome the fear of posting their still-imperfect-work, and they call attention for the difference between delivering work in progress to the teacher and exposing it to all the colleagues.

One final point related to this group must be highlighted. In making sense of these groups' behavior, one should not rule out that there are different ways of participating in activities using wikis and that these different forms of participation should not always be associated with poor cognitive engagement (Elgort et al., 2008; Garrison et al., 2001; Hrastinski, 2008; Wheeler et al., 2008). Students from group F might have not engaged with the learning situation or rather they may have been working within their individual space. These students may have read what others have written, they may have expanded individually on others ideas, they may have explored relations and reflected on all the information and knowledge posted on the wiki, and at the end they may have chosen not to share their ideas on the public online space. Why did they make that decision? Would it be different if the teacher would have had a more, initial, active role? Would it have been different if the learning situation wouldn't have required such a degree of autonomy from the students? These questions have no answer within this study. But, certainly, this might have been the cases of students in group F, who didn't post any idea on the wiki (or only made a reduced number of interventions), but who, in the interview, expressed their enjoyment with the learning situation. (This might also have been the case of S9, in group C, who made a reduced number of interventions on the wiki, but who during the interview showed great enthusiasm with the wiki and with the activity). Or this even might have been the case of S6 in group B, who made a reduced number of interventions in the wiki, but who had a key intervention during the process of knowledge construction, revealing that she reflected on others' posted messages and that she expanded and integrated all the information and knowledge shared in the wiki.

Finally, students from group E poorly participated in the activity using the wiki, and they expressed disengagement with the overall learning situation. These students are low achieving in physics and chemistry and during the interview they presented as arguments for not participating in the wiki their lack of free time and also their unwillingness to study. One important issue to have in mind is that developing a problem solving activity using a wiki demands an active and autonomous role from the students, which places high cognitive and self-regulation demands on them (Raman et al., 2005). Yet, these students acted as if they were searching for an immediate answer to the problem and so they didn't actively analyze information, organize it, select relevant information, mobilize their previous knowledge in order to make sense of the information or use it for building an answer to the problem. They didn't assume an active role with their own learning, which is not compatible with the demands of this specific learning situation. Failing to find the solution made them appraise negatively not only the problem solving activity as also the utility of the wiki. This in turn might have made them disengaged from the learning situation.

Conclusions

Results show different experiences with wiki as well as different levels of cognitive engagement. Furthermore, results show that issues that affected students' cognitive engagement were different from issues that affected to students' experience of disengagement.

High achieving groups were more engaged with wiki's use. Their positive experience is related to an experience of constructive and significant peer collaboration, and of enjoyment related to the nature of the activity as well as to the possibility of controlling their own learning and of making significant and successful learning. Poorly participating groups (and/ or students) revealed a more complex situation.

- Some students (in the group E) didn't participate and didn't express enjoyment or engagement with the learning situation. These students were low achieving in physics and chemistry. The most salient issues related to their poor participation were lack of willingness to use the wiki and time constraints.
- Students in the group D didn't participate, but some of them revealed enjoyment with the problem solving activity. Within this group, it is evident, a complex interplay between their difficulties (associated to limited content knowledge) and the ineffective collaborative processes that, on the one hand did not allow overcoming difficulties associated to the limits of knowledge, and on the other hand, did not facilitate creating an emotional positive group experience.
- Finally, some students had a reduced participation in the wiki but showed cognitive engagement with the learning situation. Some of these students (for instance, S6) have constructed knowledge in their individual space from the information and knowledge posted on the wiki. Other students (for instance, those students in group F) explicitly mentioned their fear of posting mistakes. Besides, they mentioned that they feel more confident in participating within the classroom as they perceive it as a closed space and as they feel ensured by the presence of the teacher and by the possibility of being immediately corrected.

Acknowledging wikis potentialities, we cannot ignore students who do not participate in wikis or who show poorly engaged with it. These students have a barely visible participation in the public virtual space. Therefore, it is difficult to capture the process of knowledge construction in which they are engaged with (Garrison et al., 2001; Hrastinski, 2008). In spite the analysis of interactions in online environments is a potential tool for analyzing students' processes of knowledge construction, as well as students' interaction and their cognitive engagement (Zhu, 2007), it is also necessary to have in mind the limits of focusing the analysis solely on the number of written contributions (Hrastinski, 2008). It is essential to use different data (wikis, interviews, online surveys) in order to capture a more complex picture about the process of engagement and of knowledge construction.

One of the potentialities of wikis, as shown with the present study, is to sustain the collaborative processes for constructing knowledge as well as for managing negative emotions, which are essential aspects affecting students' engagement. However, difficulties with the problem solving activity using a wiki, a sense of lack of competence for dealing with difficulties arising from it and the feeling that errors are visible for everyone, emerged in the poor participating groups. So, the present study supports two recommendations for promoting students' engagement with a problem solving activity using wikis. Teacher intervention, stimulating initial participation of all students, by proposing small tasks and raising specific questions, might work as a starting point. Besides, providing no personally threatening guidelines might enable students to deal positively with the public exposure. It is also important that teacher makes available precise guidelines that create successful learning experiences and that allows students experiencing positive emotions, namely associated with favorable social relations. This intervention could be essential to maintain all students' participation and engagement. Moreover, satisfaction with group work, not only because it is efficient in enacting students learning but also because it fosters positives relationships, was another important result of this study. Positive peer collaboration was highly associated with engagement. So, other important recommendations for facilitating students' engagement with wikis are to carefully form the groups, monitor group work and support group work development, assuring an effective collaborative process within each group.

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