The impact of a visual language for learning to learn together on Brazilian students

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Abstract

One of the most important topics in computer supported collaborative learning is self-regulated learning other than with the support of teachers. The self-regulation of collaboration can be defined as the social processes students use to coordinate their joint effort on an activity. This paper presents a Brazilian case study that examines the impact of the Metafora computational platform for supporting the regulation of collaboration amongst Brazilian students. Our goal is to investigate whether the use of the Metafora visual language helps students in learning to learn together (L2L2). L2L2 encompasses the development of the ability to coordinate collaborations. To pursue this goal, we provide evidence of coordination mechanisms and emotional responses behind the use of Metafora planning tool by students. The results of this case study demonstrate that students' interactions using the Metafora Planning tool influenced their development of L2L2 in such a way that the students experienced it as natural and engaging. Metafora planning tool provides students with a friendly environment to regulate group processes. It has the potential to modify students' thoughts concerning the coordination of collaborative processes.

Keywords

Visual language – Collaborative learning – Learn to learn together – Coordination of group processes.

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O impacto, sobre estudantes brasileiros, de uma linguagem visual para aprender a aprender conjuntamente

http://dx.doi.org/10.1590/S1517-9702201604145153

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Resumo

Um dos temas mais importantes na aprendizagem colaborativa apoiada pelo computador é a autorregulação da aprendizagem sem o apoio de professores. A autorregulação da colaboração pode ser definida como o conjunto dos processos sociais que os alunos usam para coordenar o seu esforço conjunto em uma atividade. Este trabalho apresenta um estudo de caso brasileiro que examina o impacto da plataforma computacional Metafora para apoiar a regulação da colaboração entre os estudantes brasileiros. Nosso objetivo é investigar se o uso da linguagem visual Metafora ajuda os alunos a aprenderem a aprender em conjunto (learn to learn togueter – L2L2). L2L2 abrange o desenvolvimento da capacidade de coordenação da colaboração. Para perseguir esse objetivo, são fornecidas evidências de mecanismos de coordenação e as respostas emocionais subjacentes ao uso, pelos alunos, da ferramenta de planejamento Metafora. Os resultados deste estudo de caso demonstram que as interações dos alunos, ao usarem a ferramenta de planejamento Metafora, influenciaram o seu desenvolvimento de L2L2 de maneira natural e envolvente. A ferramenta de planejamento Metafora proporciona aos alunos um ambiente amigável para a regulação dos processos de grupo e tem potencial para modificar os pensamentos dos estudantes com respeito à coordenação de processos colaborativos.

Palavras-chave

Linguagem visual – Aprendizagem colaborativa – Aprender a aprender conjuntamente – Coordenação dos processos em grupo.

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Introduction

One of the most important topics in Computer Supported Collaborative Learning (CSCL) is self-regulated learning other than with the support of teachers (ABDU, 2013). Self-regulation of collaboration can be defined as the social processes students use to regulate their joint effort in an activity (ROGAT; INNENBRINK-GARCIA, 2011). Indeed, social regulation is an inherent aspect of collaborative learning underneath the definition of collaboration elaborated by Roschelle and Teasley (1995, p. 70): "Collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of the problem."

Wegerif (2006) explains that successful collaborative problem solving depends on the extent to which the solvers open up a shared reflective conversational space, where new ideas can emerge. Efklides (2006) highlighted the students' spontaneity of coordinating their own cognition in such a dialogical space and the influence of each individual monitoring their own cognition on others' monitoring of their cognition.

When we consider students' collaborative coordination of learning within Wegerif's dialogic space, we are taking into account the implicit norms followed by effective groups. But, what if the collaborative coordination of learning were an explicit process and an integral part of the collaborative solution? (ABDU, 2013). Could the students develop the ability to monitor their group processes with no teacher help? Could all the group members be able to monitor group learning by pondering issues of individual ability, motivation and expectations by means of continuous discussions?

Rogat and Linnenbrink-Garcia (2011) report that, when students engage in regulating collaborative work, the quality of social regulation is low if no teacher support is provided. In CSCL, traditionally regulation of collaboration is approached under pre-structuring learning situations provided by the teacher, such as collaboration scripts (O'DONNEL; KING, 1999) and exploratory talk (MERCER, 1995).

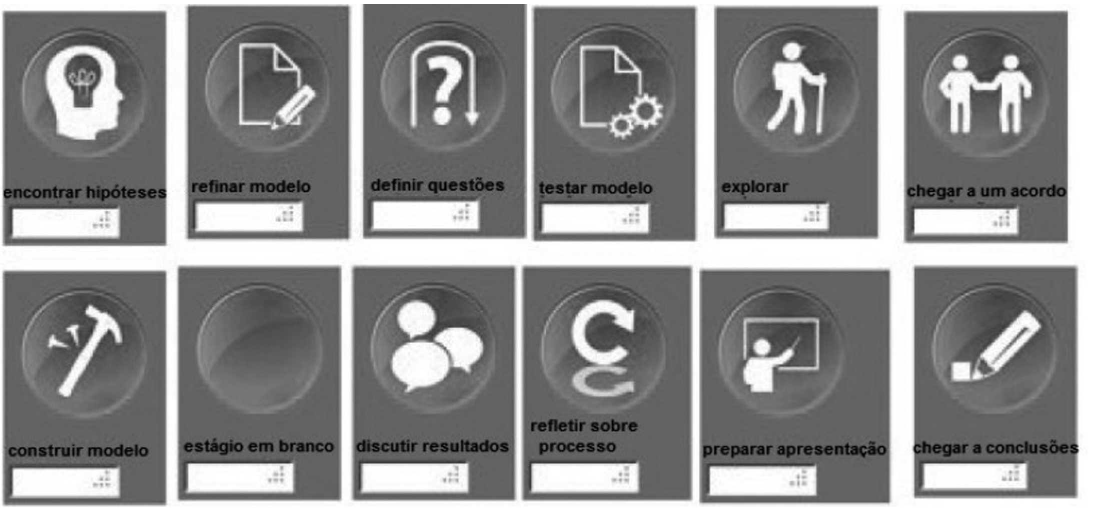
The Metafora System (WEGERIF et al., 2012) attempts to support the complex competence of Learning to Learn Together (L2L2) via integrated tools as well as through an innovative pedagogy. L2L2 is an intricate competence that requires group members to be able, with no teacher aid, to coordinate the collaborative learning task by balancing matters of individual ability, motivation and expectations through constant dialogue. Distributed leadership, peer assessment, group reflection, and mutual engagement form the theoretical basis for this concept, embracing the coordination processes underneath L2L2.

The Metafora System's unique contribution to the CSCL area is its explicit representation of the collaborative effort as a visual and interactive artifact (WEGERIF et al., 2012). This artifact intends to allow students to focus on the metacognitive understanding of how they enact their collaborative learning.

Metafora planning tool (WEGERIF et al., 2012; DRAGON et al., 2013) is a visual language for socio-metacognitive elicitation of collaborative learning processes. This tool aims to encourage students planning and reflecting on collaborative processes. It enables students to create and map representations of their collaborations. It is a shared space where students can collaboratively build plans and reflect upon their work without teacher assistance.

The main feature of this tool is the use of icons and connectors to create a metacognitive plan that represents collaborations to be followed during problem-solving in groups. The icons represent different stages and processes belonging to inquiry-based learning and problem-solving, such as experimentation, building models, making hypotheses, and also attitudes taken towards the group work, such as being critical and being open. Some planning tool activity stages are shown at Figure 1.

Figure 1- Visual representation of learning processes in Metafora planning tool



Source: Research data

The principal idea of Metafora planning tool approach is that bringing students to perform explicit discourse upon the visual language, within the context of the solution process of a specific challenge, facilitates the learning of social, metacognitive and problem-solving skills (ROGOFF, 1990).

Metafora planning tool was designed to prompt students to improve higher-level collaborative learning skills. This tool allows students to elevate their thinking beyond the content of their task, and boosts reflection on how they could succeed in collaborative problem-solving. This higher-level student effort is detailed as learning to learn together, a learning process involving coordination skills, which are: distributed leadership, mutual engagement, peer assessment, and group reflection on the learning process.

This paper presents a case study with the aim of investigating the impact of Metafora planning tool on Brazilian students in early childhood, primary and secondary education. First, we investigated whether this new technology brings education to a higher level, verifying if the students achieve the learning to learn together collaborative skills needed to engage in and self-regulate collaborative learning experiences. Second, we looked into emotional aspects of learning.

An important issue to be scrutinized in this work is its link with emotional aspects. The nature and assumptions underlying self-regulation in learning have been broadly discussed (ZIMMERMAN, 1989; WINNE, 1995) and, more recently, linked to emotion and motivation in learning environments (BOEKAERTS; CORNO, 2005). One of the questions raised in this literature is how self-regulating learning is itself a skill powered by will, and directed and regulated by motivation.

Learners' adaptation to collaborative learning situations, such as sharing knowledge and maintaining coordinated activity requires cognitive, motivational, and socio-emotional responses that are often more challenging than those used in more conventional learning situations (ROSCHELLE; TEASLEY, 1995). So, investigating emotional aspects is very relevant to ensure the effectiveness of Metafora planning tool.

In this work, we investigate the evidence of L2L2 by means of coordination processes expressed by exerting leadership moves, understanding of mutual engagement, performing peer assessment, and reflecting on group processes, and also exploring affective aspects of students' experience when learning to learn together mediated by Metafora planning tool. The results of this Brazilian case study reveal that Metafora planning tool enables learners to learn together in an engaging, motivating and pleasant way. In section 2 we shall review some related works. The case study will be detailed in section 3. The work conclusions are presented in section 4.

Related work

Modern society demands that people possess adequate skills to participate actively in collaborative and creative practices (MINOCHA; THOMAS, 2007). These skills go beyond merely performing task-related and social activities. People also need the skills required for the considerable regulation of these activities (ERKENS, 2005; VAN DER MEIJDEN; VEENMAN, 2005). Collaboration also involves coordination of task-related activities. Self-regulating activities and sharing responsibility for learning are critical for students to learn nowadays.

Self-regulated learning is essential in collaborative learning. Students need to learn how to take responsibility for monitoring and adjusting. Monitoring is supervising one's progress toward goals. Adjusting refers to modifications students make, based on monitoring, in what they are doing to achieve their aims.

For a productive collaboration, group members need to discuss collaboration strategies, monitor the collaboration process, reflect on the manner in which they collaborate, and evaluate their progress. Studies by (HADWIN et al., 2010; YAGER; JOHNSON, D; JOHNSON, R, 1986), and Johnson D. et al. (1990) demonstrated the positive influence of regulating group processes. These studies showed that when group members evaluate the group performance and how it may be improved, it really is increased.

Planning is one of the three phases of cognitive regulation, along with monitoring and evaluating these plans, and it is of particular importance for researchers in the context of constructionist environments (YIANNOUTSOU; SINTORIS; AVOURIS, 2011). Planning is also considered a key tool for guiding students to solve complex problems by means of strategic solutions.

Applying computational educational tools can enhance the coordination processes described previously. Designing meaningful computational tools allows students to gain from various kinds of informal computer-supported collaborative experience. Apart from the Metafora planning tool, there is no other specific web-based tool designed to support students to coordinate collaborations.

The Metafora Project, funded by the EC Framework 7 ICT program, encompasses a web-based tool to support learning to learn together. In Metafora planning tool, a visual language to generate collaborative plans plays an essential role in supporting the learners' mutual engagement and in turn creating a shared space to coordinate collaborations. Shared plans in the Metafora planning tool can be considered as a rich repertoire of referential anchors for collaborations and their regulation. In the next section we will present a successful case study that assesses the Metafora planning tool in a Brazilian context.

Case study in Brazil

In order to analyze the impact of the use of the planning tool of the Metafora Platform in Brazilian students group learning, we investigated school students from Centro de Ensino e Pesquisa Aplicada à Educação (CEPAE) of Universidade Federal de Goiás (UFG). The research question of this work was:

Did the use of Metafora platform planning tool help Brazilian students on learning to learn together and did the students have a good experience when using it?

Brazilian context

CEPAE-UFG was the school randomly chosen for this case study. CEPAE stands for

Centre for Teaching and Research Applied to Education and UFG, for Federal University of Goiás. The principles that guided the creation of CEPAE, as well as other schools linked to universities, led them to be known as lab-schools, whose mission is an innovative educational approach, directed to the development of students and teachers.

The CEPAE is a public, free school, whose functions are: basic education, research development, experimentation with new pedagogical practices, teacher training, creation, and implementation and evaluation of new curricula. In this school, there is a friendly environment for a variety of research that can be conducted by teachers of elementary and secondary education, university professors, trainees and others. The people involved also aim the creation, testing, implementation and evaluation of new curricula and teaching strategies.

The teachers of CEPAE have the same career path and remuneration as the teachers who teach undergraduate and graduate students at UFG. Most of them hold a Master's degree or a Doctorate. The students are used to working in groups and have classes at informatics laboratories, where they experience new technologies and pursue innovative activities that integrate the use of computational tools in teaching and learning practices. Although CEPAE was randomly chosen, it is a conductive environment for the application of Metafora platform. In informatics laboratory classes there was room for Metafora activities.

Research setting

We worked with two school classes of Sixth School Year: Sixth year A and Sixth year B. The students were from 10 to 12 years old. Students in this group were chosen because Metafora System was preferably designed to them. There were about 30 students per school class. We subdivided the students into groups of 5 students. Each school class has two classes (50 minutes each) per week. The case study took place during 14 classes. The students performed 6 activities and attended to 2 lectures during the 12 classes. The researcher elaborated all activities, however, the teacher participated actively in all activities. The activities and lectures are described in Table 1.

Table 1- Activities and lectures involving Metafora planning tool.

Lecture 1	The teacher exposed the concepts underlying stages and processes of the Visual Language.
Activity 1	The students were asked to define the concepts and create their own examples of the stages and processes of the Visual Language.
Lecture 2	The teacher explained how to use the Visual Language and provided some examples of its usage.
Activity 2	The students went to the lab to make the login in the Platform and create a map in the Visual Language. They created a random map, just to learn the interface.
Activity 3	The teacher asked each group to use the Visual Language to model the ways they normally work in groups.
Activity 4	The teacher promoted an ethical discussion about recording the teacher during the class and uploading the video on the Internet. They were expected to use a map designed to guide the discussion. This map was based on controversy talk (LOWRY; JOHNSON, 1981). The activity map given to students is described in Figure 2.
Activity 5	The teacher stimulated a discussion about Internet bullying. We asked the group to create their own discussion map.
Activity 6	The teacher asked each group to use the planning tool to try to improve the ways they usually work in groups.

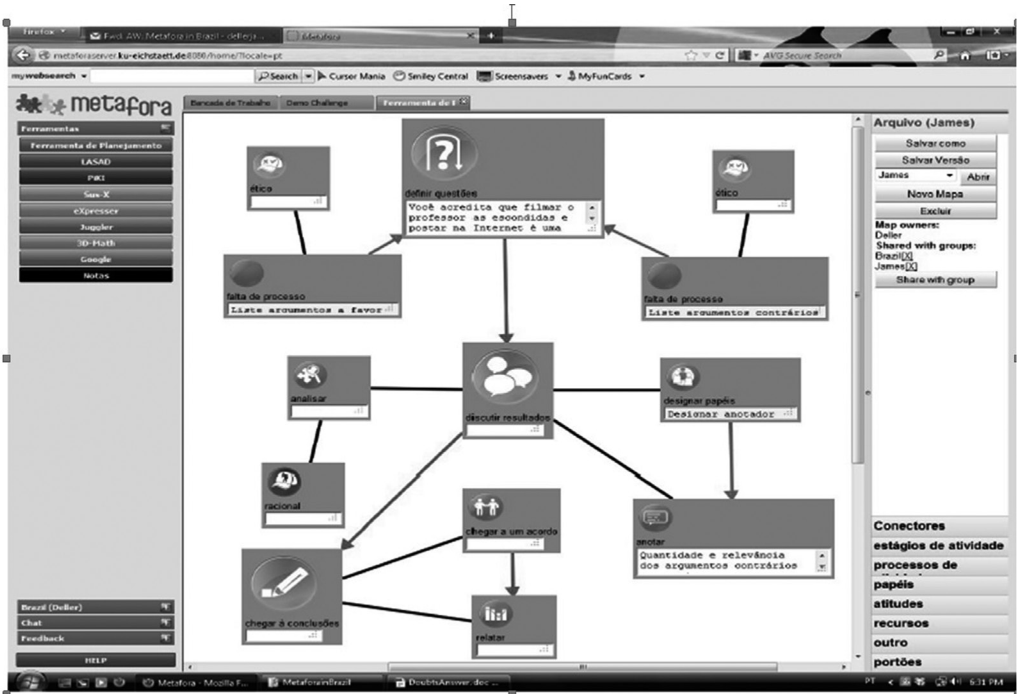
Source: Research data

The map in Figure 2 starts with "Define questions" phase. The question is "Do you believe that recording the teacher and uploading it on Internet is a good thing to do?". The students are invited to post arguments for or against this idea. Next, they need to engage in the processes "Discuss results" and "Reach an agreement".

Data analysis framework

Considering learn to learn together skills, when students start to perform a collaborative

Figure 2- Map based on controversy tal



Source: Research data

activity, they need to be able to motivate one another, favoring engagement (mutual engagement), reflect on the group learning process to monitor the quality of products generated (group reflection), reflect on the group achievements and participation and deal responsibly with it (distributed leadership), and assess group members to certify that all group members are following what is expected (peer assessment).

In order to investigate whether Metafora planning tool improves Brazilian students L2L2 experience, we detail the processes that depict leadership moves, mutual engagement, peer assessment and group reflection as follows. During the students' usage of the Metafora planning tool, we searched for evidence of these mechanisms due to the fact that they integrate the definition of L2L2 made by YANG; WEGERIF; GWERNAN-JONES (2012). We also looked into emotional aspects when students interacted via the learning tool.

Distributed leadership

Collaborative learning is a learning method in which students work together in small groups in order to achieve a common goal. Moreover, they are liable for their own learning, but they are also responsible for others' learning. Every student must adopt a responsible and proactive attitude concerning the collaborative learning process, trying to coordinate it with the aim to improve the knowledge advancement within the group. So, distributed leadership is one of the fundamentals of L2L2.

Regarding distributed leadership, the leadership is not just the labor of the leader but also requires the collaborative efforts of others (HOLLANDER, 1978). In collaborative learning, leadership responsibilities are shared among group members (LI et al., 2007).

The first coordination process regarding distributed leadership is a precondition for this to happen and it is described in Process 1:

Process 1. Being aware that every group component must be responsible for group learning and act as a leader.

LI et al. (2007) addressed different types of leadership moves by analyzing children's discussion groups, described as follows. The processes from 2 to 5 show these leadership moves.

Process 2. Directing turns to those who had not contributed with ideas and eliciting opinions from them.

Process 3. Soliciting reasons, evidence, clarification from others, and ratifying other's arguments.

Process 4. Making suggestions about what has to be done and summarizing different opinions.

Process 5. Asking group mates to look at another topic, or to look on the other side of the issue, or to go back to the original topic.

Mutual engagement

Mutual engagement is an essential component of any community practice (WENGER, 1998). By understanding the mutual engagement via joint attention, we can explore how the group members coordinate collaborations, negotiating and establishing their intersubjectivity. Evidences of mutual engagement considered here are described on processes from 6 to 10, as follows:

Process 6. Feeling able to ask for help and being willing to give help.

Process 7. Negotiating a variety of views that emerged during collaboration.

Process 8. Taking on the perspective of the other.

Process 9. Seeing from two or more points of view at once.

Process 10. Turning conflicts into constructive points for discussion.

Peer assessment

Peer assessment is also related to responsible and proactive attitude concerning the collaborative learning process. YANG et al. (2012) proposed some specific criteria to evaluate peer assessment, i.e. individual-peer-group's assessment. These criteria for the individual-peer-group' assessment are presented as follows.

Processes from 11 to 20 depict the criteria to evaluate group learning:

Process 11. Taking initiatives while respecting other people's work.

Process 12. Being proactive but also able to take advantage of peer's feedback and experience.

Process 13. Freely and autonomously administrating the time and effort devoted to learning while taking into account the group's needs and constraints.

Process 14. Expressing personal emotions as well as being in tune with the general atmosphere.

Process 15. Evaluating the work towards useful group outcomes.

Process 16. Evaluating group engagement in terms of distribution of labor and expertise towards the group goals.

Process 17. Trying to develop togetherness and trust, which leads to deeper discussion in the group.

Process 18. Developing collaborative learning relationships and seeking to strengthen the bonds.

Process 19. Making reasonable decisions considering group schedule and task allocation.

Group reflection

The purpose of reflecting and acting on group processes is to make group members aware of the ways by which they are deciding on their goals and achieving their goals. The group reflection evidence to be checked is whether the students are able to adapt the collaboration plan they are used to and create new collaboration plans. In other words, they can be able to conceive and follow new forms of how the students execute collaborative tasks, and also to decide which collaborative tasks are going to be done. Criteria 20 and 21 show the processes subjacent to group reflection.

Process 20. Planning collaborative plans, acquiring new ones, creating new ones, and adapting existing ones.
Process 21. Following collaborative plans.

Emotional aspects of learning

Significant evidence supports the position that human beings are inherently emotional beings and that emotion and affective development affect human development and behavior in many different important ways. The word emotion culturally refers to affectively charged cognitions, feelings, moods, affection, and well-being (BOEKAERTS, 2011). Frijda (1988) cleared up that emotions afford people with energy and affect all our cognitive processes: attention, analogical reasoning, creativity, recall, decision-making, and problem-solving. Motivation has been an important issue in the study of human behavior, since it is at the core of cognitive and social processes (PINTRICH, 2003).

The affective experience of learners is probably the strongest determinant of learning. Feelings and emotions provide the best orientation to where we need to devote our attention (BOUD; MILLER, 1996). Motivation is essential for learning, being a necessary precondition. Due to a great impact on student learning, motivation is of particular interest in education. Motivation in education can have several effects on how students behave towards a subject matter and interact with content (ORMROD, 2003). Motivation provides direction and initiative, increases energy and overall effort, enhances cognitive processing abilities, highlights reinforcing consequences, and improves one's overall performance.

Motivation is a very important aspect for successful learning. It is especially relevant in collaborative learning contexts, where social interaction plays an important role. Motivation can improve active learning because it concerns energy, direction, and persistence, which are mechanisms of activation and intention (RYAN; DECI, 2000). In a practical way, motivation is highly valued, because of its consequences. It helps to produce positive educational results.

Intrinsic motivation refers to doing something because it is inherently interesting or enjoyable; such motivation is an important phenomenon for educators because it is a natural wellspring of learning and achievement that can be systematically catalyzed or undermined by instructor practices, and because intrinsic motivation produces results in high-quality learning and creativity (RYAN; DECI, 2000).

Another very important aspect for successful learning is satisfaction. Satisfaction implies noticeable impacts on learning. Satisfaction can be considered as a student emotional state that initiates, maintains, and boosts the learner's engagement in learning processes (SOREBO et al., 2009). The importance of satisfaction for web-based learning systems has long been noteworthy (LIMAYEM; CHEUNG, 2008). User eXperience (UX) metrics has been used to measure satisfaction and motivation in e-learning platforms.

The concept of emotional design has a long-standing place in human interaction design concerning how to design everyday things (NORMAN, 2004). The UX concept is a new trend of how to understand the emotional responses to human-computer interactions. According to the Nielsen Norman Group, UX encompasses all aspects of the human-computer interaction. The UX highlights the experiential, affective, meaningful and valuable facets of users' interactions. Additionally, it includes a person's perceptions of the practical aspects such as utility, usability and the efficiency of the Platform.

UX involves person's emotions using a particular computational platform. UX is subjective in nature because it is about individual perception and thought with respect to the Platform. UX is dynamic as it is constantly modified over time due to changing circumstances and new innovations. UX is a dynamic process that changes over time and involves two important qualities: traditional human-computer interaction usability and accessibility balanced with hedonic and affective design.

Many UX research efforts have been applied to Virtual Learning Environments (SAVIN-BADEN et al., 2011). Some research related to UX include the design of educational activities (KARAPANOS et al., 2009), while others research efforts emphasize the interdependent relationship between design and learning evaluation approaches (OBRIST et al., 2011). The importance of User experience (UX) factors related to learner use continuation and increased learner motivation and satisfaction has also been studied and verified (HASSENZAHL; TRACTINSKY, 2006).

In order to evaluate students' UX, motivation, satisfaction, and its relationships when using Metafora Platform, we constructed a questionnaire. The questionnaire built in this case study was based on User Experience (UX) dimensions (POELS; IJSSELSTEIJN; DE KORT, 2008). The UX dimensions used during the questionnaire elaboration were:

1) Immersion and Flow: while the user is using the Platform he forgets everything around him.
2) Tension: the user feels tense while using the Platform.
3) Competence: the user thinks that he is good at using the Platform.
4) Negative Affect: the user feels bored while using the Platform.
5) Positive Affect: the user has fun while using the Platform.
6) Challenge: the user puts some effort while using the Platform, but he takes pleasure from overcoming obstacles.
7) Fellowship: good experiences are produced during social interactions.
8) 8) Discovery: the user is pleased to learn new things.
9) Expression: the user is pleased to express new things and may improve his/her self-esteem.

We also considered Bloom's emotional domain category valuing while elaborating the questionnaire. The categories used are described as follows:

1) Receiving Phenomena: motivation to hear.
2) Responding to Phenomena: motivation to respond.
3) Valuing: The worth or value a person attaches to a particular object, phenomenon, or behavior.

Data analysis mechanism

For the purpose of answering the research question, the systematic of data analysis pursued the following four steps:

Step 1. Check students' understanding of learning stages and processes depicted by the interface icons.
Step 2. Check students' understanding of how collaborative plans are built and used during collaborations.
Step 3. Check whether there was knowledge advancement concerning the coordination of collaborations (L2L2). We examined students' interactions and maps created by the students and detected changes in their conceptions in the course of activities from 1 to 6 shown in Table 1, and showed some evidences of students processes underneath L2L2 acquisition, regarding the criteria from 1 to 21 presented in this section.
Step 4. Perform descriptive statistic analysis of data generated by the UX questionnaire application.

Data analysis

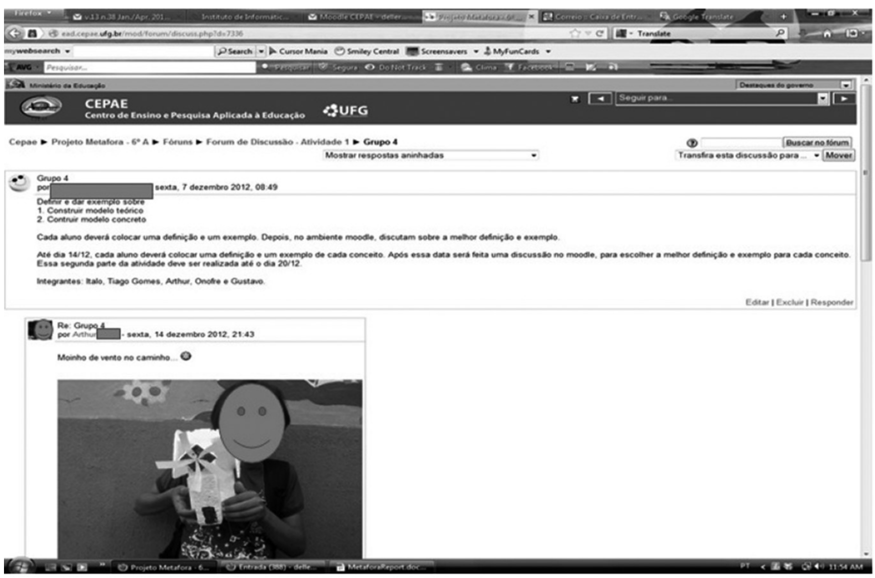
The inspected data were student-student interactions, student-Metafora Planning Tool interactions, and collaboration maps created along activities in Table 1. The first issue we had in mind was that the planning tool usage demanded metacognitive understanding of collaborative processes and collaborative plans. Thus, we needed to verify Steps 1 and 2. Most of data analysis concerned Step 3 that was taken in consideration to a framework analysis that encompasses evidences of distributed leadership, mutual engagement, peer assessment, and group reflection. We also regarded emotional aspects of learning in Step 4. But we also noticed an important unforeseen aspect during students' maps observations. This unexpected aspect was that the planning tool visual language fostered students to create unusual forms of collaboration, including collaborative stages and processes not present at the Metafora Planning Tool.

Metacognitive processes acquisition – Steps 1 and 2

Students learned new collaboration processes. In figures 3, 4, 5, and 6 we show a group of students working on the collaboration process "building a model".

In Figure 3, there is a screen where Arthur says "Windmill on its way" and shows a windmill model.

Figure 3- Modelling a windmill model using concrete materials.



Source: Research data

In Figure 4, there is a screen where Arthur says "Building" and shows a picture of them building the windmill using concrete materials.

In Figure 5, there is a screen where Arthur says "Is the bar completed....or not..." and shows a picture a bar model.

The group conclusion in figure 6 is written in the next screen and it is translated as:

"Theoretical model: includes the study of what you want to accomplish and how to accomplish. At this moment, we define what we are going to create, and what materials and actions are necessary for the theory to become something concrete. In our case, we chose to build a farm, presenting construction features like a wind mill, a barn, animals and vegetation, among others.

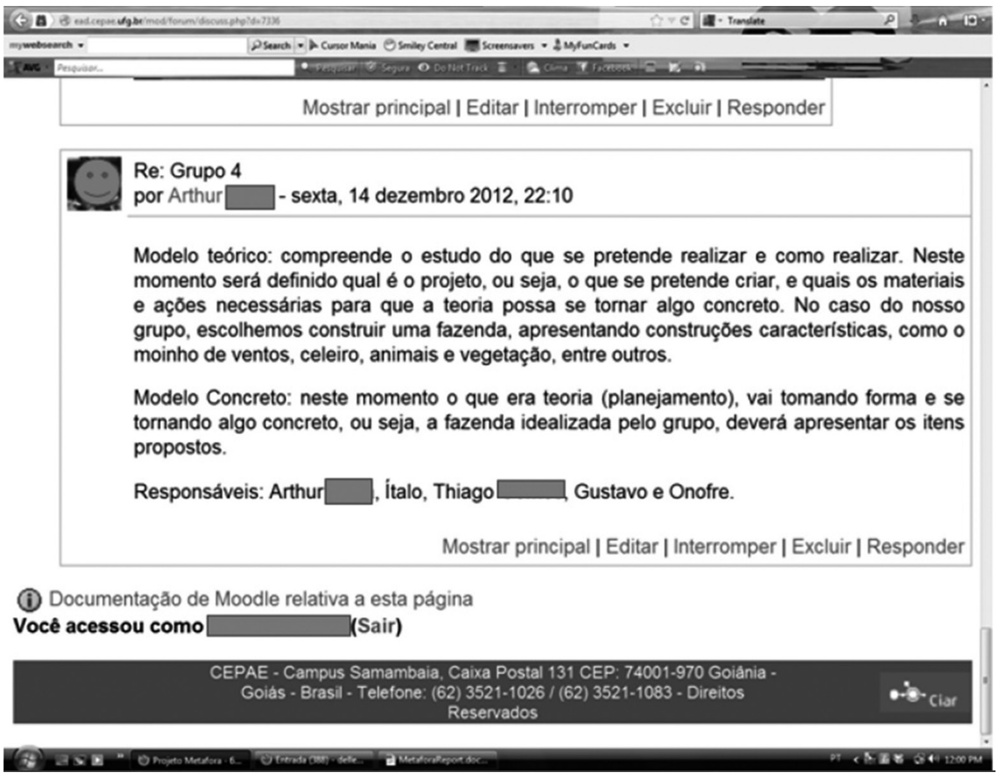
Figure 4- Modelling a bar model using concrete materials.

Source: Research data

Figure 5. Bar model.

Source: Research data

Figure 6- Group understanding of building a model.



Source: Research data

Concrete model: At this moment, the theory planned is taking shape, becoming something concrete; in other words, the farm idealized by group that must present the proposed items."

Concerning the collaborative plans understanding, students learned that collaborative processes can be inter-related in new ways of working in groups. For example, in figure 10 we have a simple and clear group map. This collaboration map is a consistent map depicting a collaborative script to be followed. First they had to define questions and then had to conceive possible answers. This figure also depicts an explicit mapping of the collaboration process and the expected activity product to be generated in each process, showing that the students know how to create maps and use them, according to educational situations. In the process "define questions" they wrote "Who created the windows?" and in the process "Find Hypothesis" they wrote "I think that Osama bin Laden did." and "I don't think that Barack Obama did."

Distributed leadership and peer assessment – Step 3

Considering evidences for Processes 1, 11, 12, 13, and 14, being aware that everyone in the group should feel able to take responsibility for the group's progress and intervene in order to take the group forward, we observed univocal leadership in just three groups among the twelve groups.

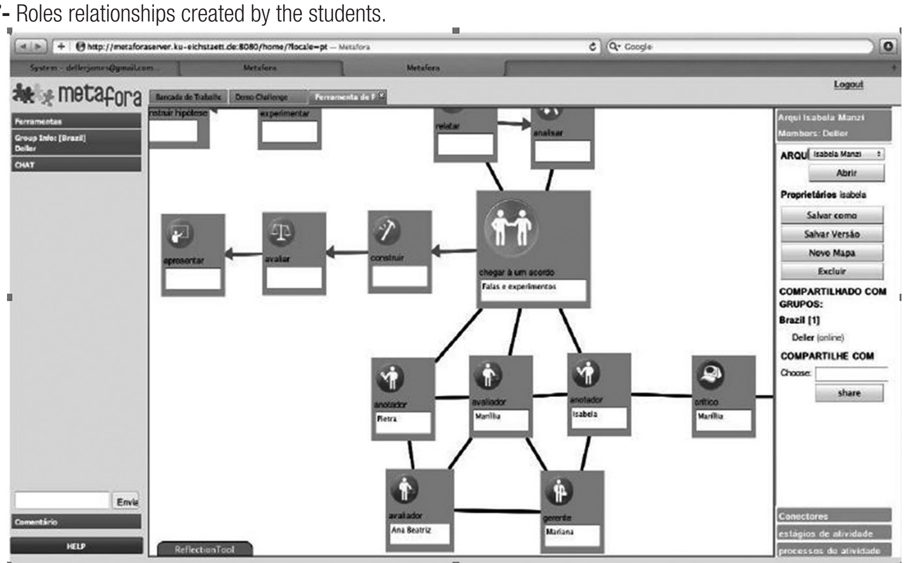
We defined distributed leadership to the students and also explained to them the meaning of the icons representing roles related to distributed leadership. Besides, we oriented the students to act as a leader and assume one leadership role. However, we observed that there was no shift from univocal leadership to distributed leadership moves in two groups. There was one leader that performed all the activities alone in the computer while the others just watched. We intervened in some classes, calling students' attentions to distributed leadership. But, the students' behaviors remained the same.

In the third group, we detected evidence for Processes 2, 13, 14, 15, and 16, there were two male students that did not want to collaborate while just four girls were working. After a while, having heard many complaints, one of the girls called the teacher and asked her to talk to the boys. It happened during the second activity. After this episode, the boys started to collaborate, participating actively during the next activities.

There was one group in particular where we got evidence of Processes 4 and 18. They built an unusual and interesting relationship. As the teacher had not taught the students to relate the roles, only the meaning of the roles individually, we became curious and asked the group what they intended to represent. They related the roles to each other, indicating that each person had to help the other. The Visual Language allowed the students to have a creative use of the interface. There is no reference to linking roles icons in the User Manual. The Metafora Platform designers have not foreseen linking leaders at the interface, however this action is not prohibited.

From the distributed leadership literature different roles are assigned or emerge naturally among group members. Leaders are supposed to play distinct functions, interacting with group members. Although it is clear in literature that leadership is not just the responsibility of a specific leader, requiring the cooperative efforts of others, there is no explicit allusion to a coordinate effort among leaders at Visual Language interface. So, the students used the interface in an innovative way, getting the essence of distributed leadership. Their interactions with the Platform allowed them to view leadership as a reciprocal social process, instead of the property of an individual. The Visual Language affordances enabled students to express themselves and at the same time have a clear understanding about the distributed leadership. We can see the roles relationships in Figure 7. In Figure 7, "anotador" means "writer", "avaliador" means "evaluator", and "gerente" means "manager". The students understood that, in order to reach a consensus, they needed

Figure 7- Roles relationships created by the students.



Source: Research data

Figure 8- This group map represents new ways to collaborate.

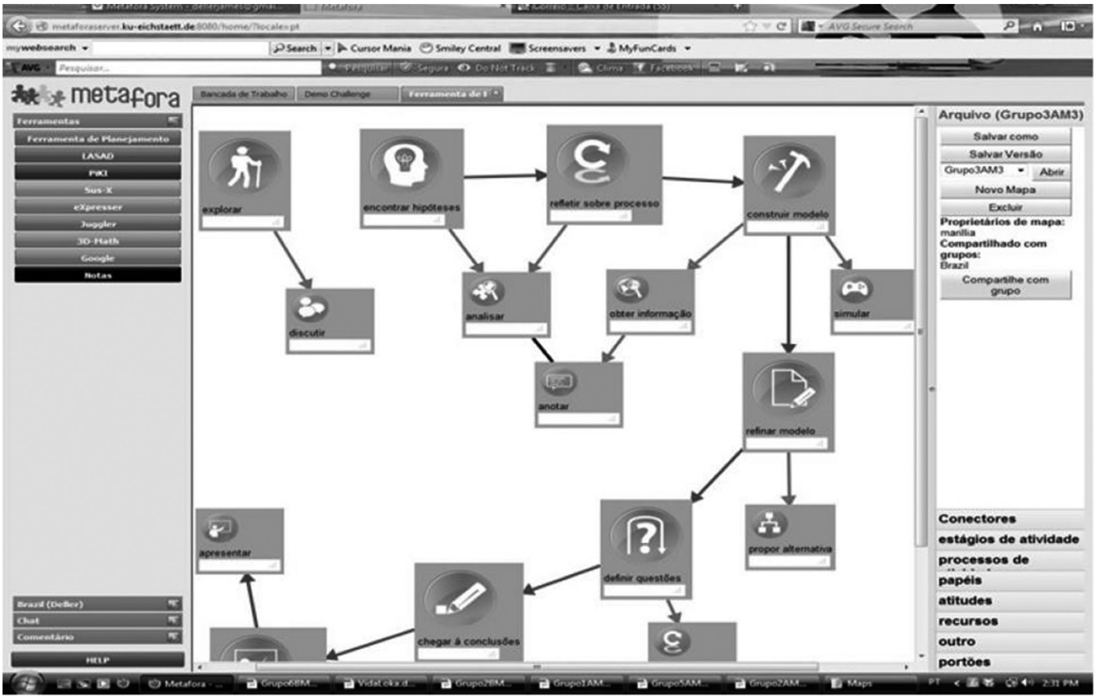


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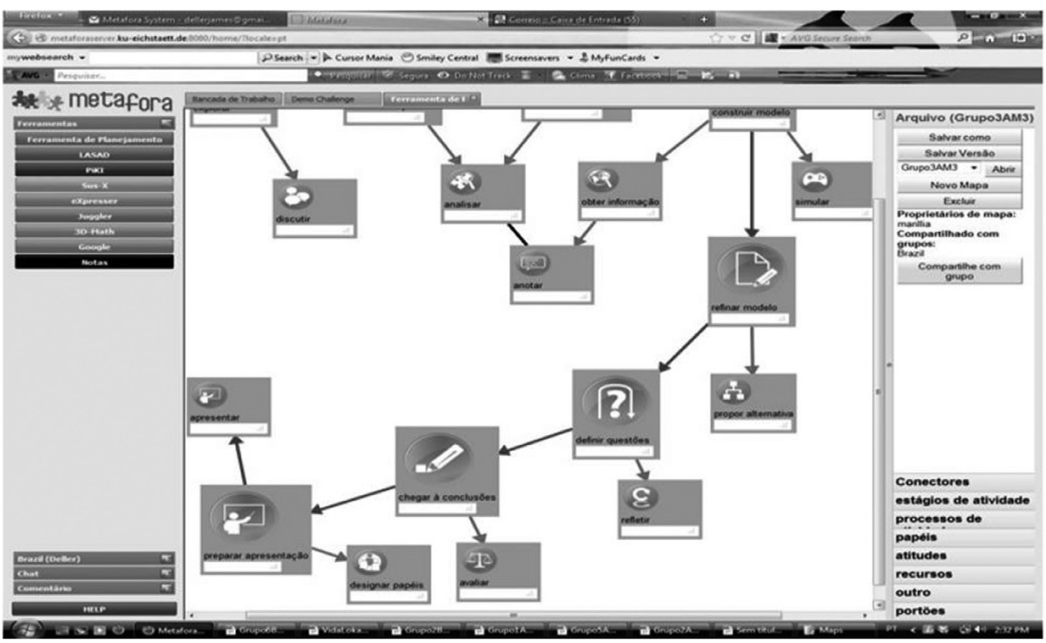
Figure 9- This group map represents new ways to collaborate.



Source: Research data

simultaneously to talk and experiment, being critical and also performing a joint leaders' effort.

A member of one group called the teacher and explained that they have not used any leadership role, because all of the students in the group wanted to be the leader and perform all the different leadership roles activities. We see this fact as an evidence of a shift in students' beliefs, but again in a way not anticipated by the Metafora Platform designers. They have chosen to represent this situation omitting the leader's role. This indicates a movement to a new concept of leadership, however the students decided not to distribute the roles, they wanted to be free to perform any role according to the circumstances. This makes sense, as social and collaborative relationships progress over time, different arrangements of leadership may also emerge. The distribution of leadership must be negotiable according to social and situational changes. Again this enlightenment to a new way of seeing leadership emerged from Metafora Platform mediated interactions among students.

In the other groups, we noticed that all members took responsibility for the group's progress. We notice an active participation on the part of the students. They were willing, motivated and pleased in constructing the maps and participating in discussions. Turn management leadership moves were frequent in the groups.

We observed that planning and organizing, and argument development leadership moves were strongly interrelated. The sociocognitive processes came after metacognitive processes. The students planned and organized the maps and then followed them, performing the sociocognitive processes chosen. For example, in the following map (Figures 8 and 9) the students began the collaborative process placing the exploration metacognitive icon process and linked the discussion icon to it. The same happened to all the other metacognitive processes; all of them are linked to sociocognitive processes that were thereafter activated.

Mutual engagement – Step 3

The analysis of the discussions in activity 4 showed evidence of Processes 8 and 21. The students easily followed the map in Figure 2, which explicitly considered two opposite points of view. The students elaborated on others' argument, taking the perspective of the other. This map is a representation of controversy talk (LOWRY; JOHNSON, 1981). Unfortunately, we could not find evidence of Processes 7, 9, and 10, because all groups listed only contrary arguments concerning the proposed theme and reached the same unanimous conclusion, that filming a person without her consent is not a good thing to do. No student could see any perspectives in favor, because no one was in favor. They did not have to reach a consensus from opposing points of views. They only exposed their opinions, agreed, and helped each other, which is evidence of Process 6, possibly because the assigned theme involves deep ethical issues.

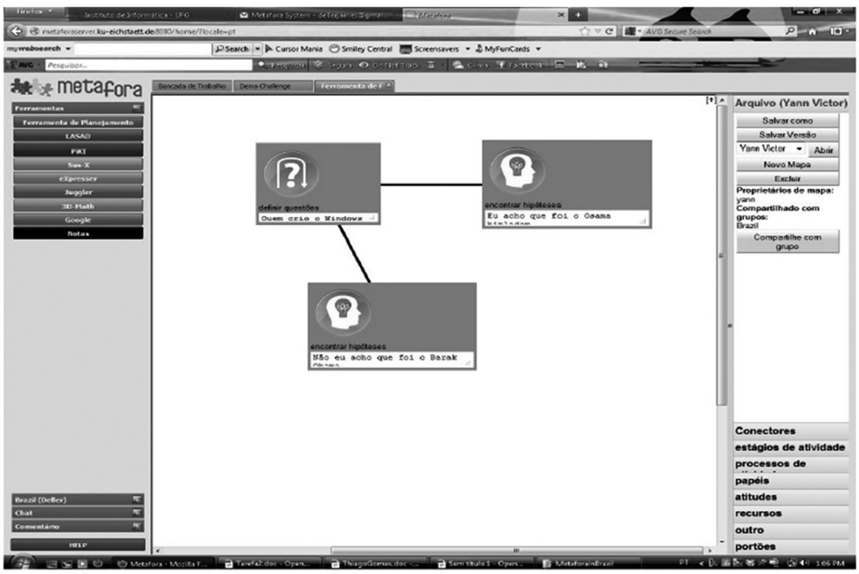
Activity 5 was very successful, the students followed the processes they planned at the Visual Language, strongly interacted during all the processes in the light of multiple views, and constructively integrated different ideas. They built their arguments and came to conclusions based on different examples of bullying taken from experience of group members and information obtained from Internet. For instance, in Example 1, the students have obtained information, recalling known cases and episodes found at Internet, and afterwards they have built hypothesis grounded on these situations and also turned conflicts into constructive conclusions. In this activity there is evidence of Processes 6, 7, 8, 9, and 10.

During activity 6, students were asked to use the Visual Language to show how they could collaborate in the future. Some evidences in the processes modeled suggest they are willing to share distinct perspectives. This is evidence of Process 9.

The map in Figure 5 indicates that the group learned to analyze a subject from different perspectives. The students relate two different perspectives to the icons “Find hypotheses” (“Encontrar hipóteses”) that are linked to the icon “Define questions” (“Definir questões”). The question posed was: “Who made the windows?”. And the two different hypotheses were “I think Osama bin Laden did.” and “I do not think Barak Obama did”.

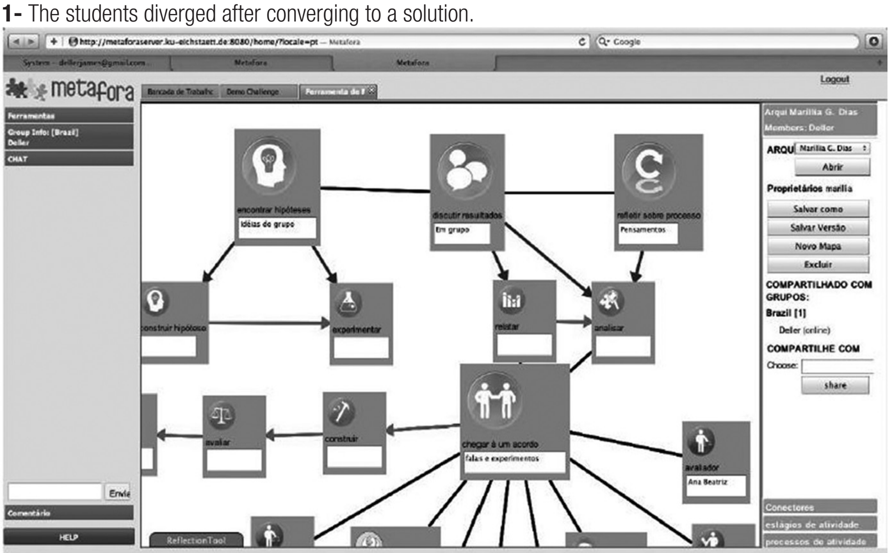
In figures 10 and 11, there is also evidence that they learned to see a solution under different perspectives. Also we have evidence of Process 7. In Figure 10, in the icon “Find hypotheses” they wrote “the group’s ideas”. In Figure 11, as they wrote, they started exploring to find different information and then they discussed results

Figure 10- The students started the discussions considering two different perspectives.



Source: Research data

Figure 11- The students diverged after converging to a solution.



Source: Research data

in order to find the best one. They followed the sequence of the stages, which is “Find Hypothesis”, “Discuss Results”, “Reflect”, and “Reach an Agreement”.

Group reflection – Step 3

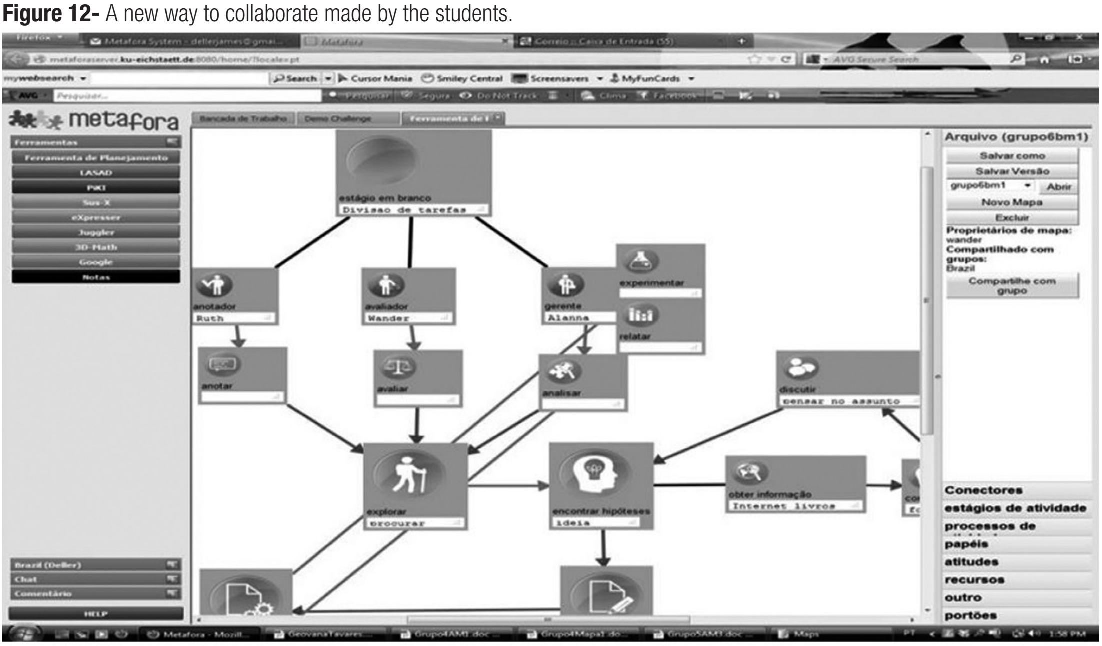
In activity 4, although the students had not been able to approach a subject from two radically different perspectives, the experience helped to organize the discussions in the next activities, since they learned a new form of collaboration. This is evidence of Processes 20 and 21.

In our research we have become aware that group reflection was favored by the Metafora approach. Considering the role of technology in helping students regulate their collaborations, we detected important aspects related to the Metafora Platform, which boosted group reflection. The first one is that during Platform learning, the students had to acquire knowledge about metacognitive and cognitive processes. The second facet noticed was that the Platform can successfully be used by the teacher to explore different forms of productive collaborations taken from literature. The third particularity found was that the Platform usage encourages the students to create unusual forms of collaboration. This is also evidence of Process 20.

The Visual Language is generic, enabling infinite combinations of stages and processes. Additionally, there are blank stages and processes that allow the creation of any desired stage or process. Also, the maps are created by direct manipulation without constraints. These features together encourage the students to create unusual forms of collaboration.

In activity 3, each group of students was asked to use the Visual Language to model the ways they normally work in groups. Before this activity we asked the students in class how they used to work in groups. The unanimous answer was: “We get together in the house of one group participant, bring all the necessary materials and work.”

Figure 12- A new way to collaborate made by the students.



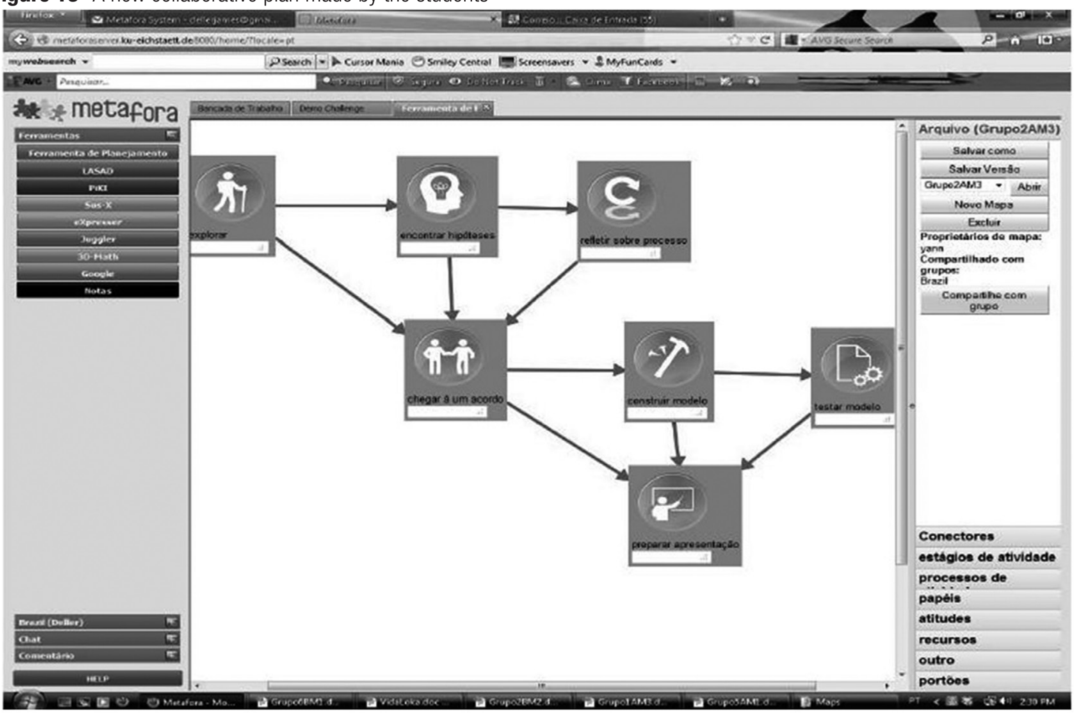
Source: Research data

The maps created in activity 3 clearly show that they created new forms of collaboration while building the maps. This is evidence of Process 20. There is an example of it in Figure 12.

In activities 5 and 6 the students continued creating new forms of collaboration. See the following example in Figure 13.

In the previous sections we discussed how Metafora planning tool was used as an instrument that favored the emergence and representation of students' collaborative plans. These plans were built together, shared and followed by the students. The use of Metafora planning tool triggered the emergence of key coordination processes. The

Figure 13- A new collaborative plan made by the students



Source: Research data

students shared a space for group reflection and learned together how to collaborate in better ways. They increased their repertoire of group processes and their coordination. In the next section we present an analysis of emotional aspects that are behind the usage of Metafora Planning Tool.

Questionnaire description and analysis – Step 4

Fifty-eight students have answered the questionnaire. The Metafora Platform assessment questionnaire and its answers and evaluation are shown below.

1) Did you like to use the Visual Language of the Metafora Platform?
2) Did you feel at ease using the Visual Language of the Metafora Platform?
3) What did you learn using the Visual Language of the Metafora Platform?
4) Did you like to participate in this study?
5) Did you feel at ease during this study?
6) Did you like to discuss about posting videos on Internet without consent?

7) Did you like to use a map in the Visual Language when discussing about posting videos on Internet without consent?
8) Did you learn when using a map in the Visual Language when discussing about posting videos on Internet without consent?
9) Did you like to discuss about bullying in Internet?
10) How did you like building a map to discuss about bullying in Internet?
11) Do you feel the map helped the discussion about bullying in Internet?
12) Did the use of the Visual Language of the Metafora Platform help the group collaboration while they performed the activities?
13) Did the group members have a good relationship while performing the activities?
14) Did you feel at ease when performing the activities?
15) Did you discover new things using the Visual Language of Metafora Platform?
16) Do you think the use of the Visual Language of Metafora Platform is likely to influence the ways you will work in groups from now on?
17) Were you able to express yourself while using the Visual Language of Metafora Platform?
18) Were the members of your group able to express themselves using the Visual Language of Metafora Platform?
19) Did you overcome obstacles when building maps in the Planning toll?
20) Did you have good interactions in your group while using the Visual Language of Metafora Platform?
21) Were you willing to discuss in the lab using the Visual Language of Metafora Platform?
22) Were you able to concentrate yourself while using the Visual Language of Metafora Platform?
23) Did you get nervous/anxious when using the Visual Language of Metafora Platform?
24) Did you feel bored when using the Visual Language of Metafora Platform?
25) Do you think that you were good at building maps? Is the Visual Language user-friendly?
26) Did you have to make some effort when building maps?
27) Did you have fun when building maps?
28) Do you find the overall balance of this experience was positive?

Considering Table 2, we found that 90% of students really liked to use the Visual Language of the Metafora Platform (question 1). We found that 76% liked to follow the map provided in the Visual Language to direct the discussions about posting videos on Internet without consent. In addition, 88% of students liked to build a map to discuss about bullying in the Internet. These observations indicate a positive affect concerning different aspects of the Visual Language Usage.

Most students said they were able to concentrate on tasks most of the time when using the Visual Language of Metafora Platform; see Figure 14 (question 22), which indicates a good degree of immersion when using the platform.

Among the 58 respondents, 97% said that the use of the platform helped group collaboration during the implementation of activities, 70% said they could express themselves using the visual language tool appropriately, and 100% said that members of their groups were able to express themselves using the platform; this indicates that they are competent using the tool; see Table 2 (questions 12, 17 and 18). Based on this fact, one may suppose that they did not have self-esteem problems when interacting with the visual language tool.

Regarding the answers to question 13, we can observe that most of students had a good relationship during the execution of activities. This can also be noted in question 20, when 95% of them answered that the group interaction was good when using the tool. Based on this, we have evidence that students had a good social experience.

Table 2 shows that 74% of the respondents were not nervous/anxious and 66% did not feel bored when using the tool. In

Table 2- Percentage of students' responses by categories.

Questions	Category			
	Not True	Seldom	Frequently	True
1	0	10	71	19
2	16	14	19	52
3	0	24	29	47
4	0	10	69	21
5	19	10	7	64
6	0	9	63	28
7	0	24	57	19
8	0	13	42	45
9	0	7	74	19
10	0	12	64	24
11	0	3	47	50
12	0	3	26	71
13	0	3	57	40
14	19	69	12	0
15	0	9	47	45
16	0	0	66	34
17	0	2	70	28
18	0	0	66	34
19	3	28	42	27
20	0	5	67	28
21	0	0	31	69
22	0	0	64	36
23	74	12	14	0
24	66	34	0	0
25	0	3	59	38
26	21	40	36	3
27	0	14	57	29
28	0	0	64	36

Source: Research data

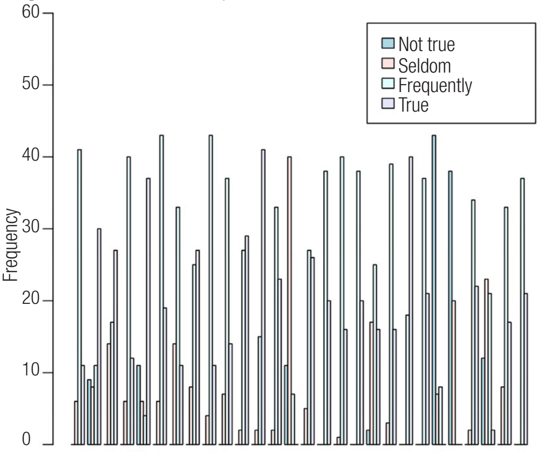
addition, 59% found the platform easy to use most of the time, indicating that affordances of the visual language are well designed.

As shown in Figure 14, answers to the questions 4, 6, 9, 13, and 21 indicate that the students were motivated to work in groups when using the Metafora planning tool. Ninety-seven percent answered positively to question 19 (Figure 14), which indicates that the students had pleasure in overcoming challenges.

As shown in Figure 14, answers to the questions 3, 8, and 16 indicate that students' perceptions concerning their knowledge advancement were positive.

Finally, most students enjoyed themselves when building the maps, see Figure 14 (question 27).

Figure 14: Students' responses



Source: Research data

Conclusions

In this study, we focused on the impact of the use of Metafora platform on Brazilian students. We investigated the evidence of L2L2 regarding distributed leadership, mutual engagement, peer assessment, and group reflection mechanisms. We also explored students' User eXperience and emotional aspects that could possibly influence their L2L2 development. Data analysis results show that both teacher and students' use of the Metafora planning tool facilitated the development of the ability to plan and follow collaborative plans, improving their capacity to coordinate their collaborations. Also, students were motivated and had a good user experience during their activities.

The students learned how to use the planning tool in order to plan collaborative processes for problem-solving, and to follow these plans to engage themselves in new forms of collaboration. Students used the planning tool to express different viewpoints on a subject, to promote discussions among students, and to elicit students' reasoning and arguments. The Metafora platform acted as a mediation tool during this case study. It mediated and helped the acquisition of coordination skills to regulate group processes.

The results of this case study show that Metafora planning tool provides students and teachers with a friendly environment for L2L2 development. It has the potential to modify students' thoughts concerning collaborative problem-solving processes, favoring the development of learning to learn together.

We conclude that the overall balance of this case study was very fruitful to the students. The answer to the last question of the questionnaire, where all the students answered that the overall balance of this experience was great, corroborates our final conclusion about the Metafora experiment carried out in CEPAE School. Besides, in informal conversations, some students demonstrated their willingness to know and learn more about the Metafora Platform. This expresses an intention of future use of the platform, indicating that Metafora Platform has the potential to be applied in schools in Brazil, and become a long-term asset.

Unfortunately, the students' interactions were not recorded during the lab activities. This case study was limited to teachers' observations of students' interactions and the information contained in the maps created and registered in the Metafora Planning Tool. Thus, it was not possible to conduct a deeper analysis of L2L2 development. However, this case study is in line with the results of other case studies performed in the United Kingdom, Spain, Israel, and China (YANG; WEGERIF; GWERNAN-JONES, 2012).

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Received on January, 22nd 2015

Accepted on September, 1st 2015

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