Implementing Flipped Classroom in Blended Learning environments: a Proposal Based on the Cognitive Flexibility Theory

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Abstract: Flipped Classroom is an issue that gains increased attention in Blended Learning models. Generally, in the traditional classroom, the teacher uses the time in the classroom to explain the theoretical and conceptual body content and leaves the practices and exercises as extracurricular activities. In the Flipped Classroom, students study at home the theoretical component of the course and the classroom time is designed for practical activities and exercises monitored by the teacher. Although the definition presents an apparent simplicity, the Flipped Classroom model implies deep structural changes in the traditional classroom. The objective of this paper is to discuss the pedagogical changes and affordances brought by the methodology of Flipped Classroom and propose a model to implement Flipped Classroom based on the Cognitive Flexibility Theory.

Introduction

The digital information and communication technologies (ICT) have increasingly permeated our lives, causing changes in various sectors of society and in the education could not be different. These technologies have created significant changes and new challenges in both face to face classroom teaching as well as distance learning. However, according to Valente (2014b, p. 83), the impact caused by ICT was much higher regarding distance education, creating changes at theoretical, pedagogical and assessment levels as well as in the core purpose of distance learning. These changes, together with the easiness of access to broadband Internet, allowed the emergence of Blended Learning. Researchers differ in the precise definition of Blended Learning, however, despite the lack of consensus about this term (Fernandes, 2015; Lencastre, 2009) all agree with the idea of combining different components (teaching and / or technology) with the objective of improving the process of teaching and learning (Marques, 2011, p. 83). In this paper, we will use the definition proposed by Staker and Horn (2012, p. 3), which describe the Blended Learning as a formal education program that has moments in which the student studies the content through online resources and moments when teaching is supervised in the classroom. Furthermore, according to these authors, in online learning the student has elements that allow you to control the time (when), place (where), path (how) and speed (pace) of your study and also emphasize that the presence times must have with the help of a supervisor linked to school, or a teacher, a coach, etc.

A trend that is gathering attention inside the Blended Learning models is the Flipped Classroom. Generally, in the traditional classroom, the teacher uses the time in the classroom to explain the theoretical and conceptual content and leaves the practices and exercises as extracurricular activities. According to the principles of the Flipped Classroom (Bergmann & Sams, 2012, 2014) students study at home the theoretical component of the course, using multimedia resources, and the time in the classroom is devoted to practical activities and exercises monitored by the teacher.

Although the definition presents an apparent simplicity, we defend that the Flipped Classroom implies deep structural changes to the traditional classroom. The objective of this paper is to discuss the changes brought about by the Flipped Classroom model and submit a proposal for the implementation of Flipped Classroom Based on the Cognitive Flexibility Theory.

For this, first we will present the main features of Flipped Classroom. We will discuss how this method "invert" some aspects of the classroom about leadership, educational objectives, time and space where there is the teaching process. Then, we will present a proposal based on the Cognitive Flexibility Theory and the change caused by the Flipped Classroom. Finally, we conclude with final remarks and future work suggestions.

The Flipped Classroom

Despite the expression "Flipped Classroom" be credited to teachers Jonathan Bergmann and Aaron Sams (Fonseca, Moura, & Fonseca, 2015; Oliveira, 2015), the term had been used by Strayer (2007) in his doctoral thesis, which reports the use of this method in an experiment with university students. In his thesis, the author concluded that the students felt more innovation and the need for cooperation when comparing the new method with traditional classes. However, it warns that students felt less satisfied with the structure of the proposed activities in the classroom. According to the author, this was because of the large amount of tasks proposed to the students which helped them feel "lost" feeling that students of the traditional class did not show (Strayer, 2007, p. 180).

The method became popular in 2011 when the founder of Khan Academy, Salman Khan, proposed at a TED (Technology, Entertainment and Design) conference, teachers reverse the logic of the classroom giving students video lectures to be assisted at home, and let the "homework" for the classroom with the teacher available to help (Khan, 2011). Currently, Khan Academy is a free platform that provides multiple videos with lessons on various subjects, such as physics, mathematics, chemistry, and others.

In 2012, teachers Jonathan Bergmann and Aaron Sams launched the book "Flip Your Classroom: Reach Every Student in Every Class Every Day" (Bergmann & Sams, 2012). In this book, describe an experiment conducted between 2006 and 2008 in which developed a project that aimed to help students who, for some reason, could not be present in the classroom. When reading an article about software that would record the PowerPoint presentation including voice and notes, they began to produce videos with the content of the classes and provides them online for the missing students could follow the matter. However, not only the missing students but other students became interested in the material. So the authors realized that they could propose a new way of organizing the classroom and called this method "Flipped Classroom." Since then they become the best known promoters of the method including creating an organization called the Flipped Learning Network, which propose not just "flip the classroom", but to shift the whole process of learning, in other words the terms “Flipped Classrooms” and “Flipped Learning” are not synonymous (Hamdan, McKnight, McKnight, & Arfstrom, 2013; Yarbro, Arfstrom, McKnight, & McKnight, 2014). In this paper we will specifically discuss the Flipped Classroom and not the broader proposal Flipped Learning.

In short, Bergmann et al. (2013) shows what they consider what is or is not the Flipped Classroom (Tab 1).

The Flipped Classroom is NOT:
× A synonym for online videos. When most people hear about the flipped class all they think about are the videos. It is the interaction and the meaningful learning activities that occur during the face-to-face time that is most important.
× About replacing teachers with videos.
× An online course.
× Students working without structure.
× Students spending the entire class staring at a computer screen.
× Students working in isolation.
The Flipped Classroom IS:
✓ A means to increase interaction and personalized contact time between students and teachers.
✓ An environment where students take responsibility for their own learning.
✓ A classroom where the teacher is not the "sage on the stage", but the "guide on the side".
✓ A blending of direct instruction with constructivist learning.
✓ A classroom where students who are absent due to illness or extra-curricular activities such as athletics or field-trips, don't get left behind.
✓ A class where content is permanently archived for review or remediation.
✓ A class where all students are engaged in their learning.
✓ A place where all students can get a personalized education.

Table 1: Criteria that distinguish the Flipped Classroom Model (Bergmann et al., 2013)

Even without a precise definition, it is perceptible that the adoption of the model causes several structural changes in the conduction of the learning activities. By analyzing the literature on the Flipped Classroom, we realized that this approach involves a series of "inversions" that we consider to name as inversions of place, time, roles and educational objectives. The details of each of these investments are presented below.

Inversion of the Place

The first change, and perhaps the one that is most emphasized in the literature, is the shift on the physical space where it favors the exposure of the content to be learned. In traditional teaching models, the classroom's physical space is the environment for the teacher to present the proposed content of the curriculum for students. It is in this environment that is expected that the student understands the concepts, theories and laws of a particular field of knowledge. Eventually, there are moments when the teacher proposes exercises or practical activities, but only as a complement to the lecture. The place intended for training or content revision is out of the classroom with exercises known as homework. It is hereby that the student effectively puts into practice the concepts learned in the classroom. The student must remember the explanations given by the teacher and the notes taken in class to answer correctly to the tasks. In other words, the classroom would be the natural place where effectively the student is introduced to a new content, while the house would be the natural place for the exercise and application of what was presented in the classroom. The flow of activities is represented in Figure 1.

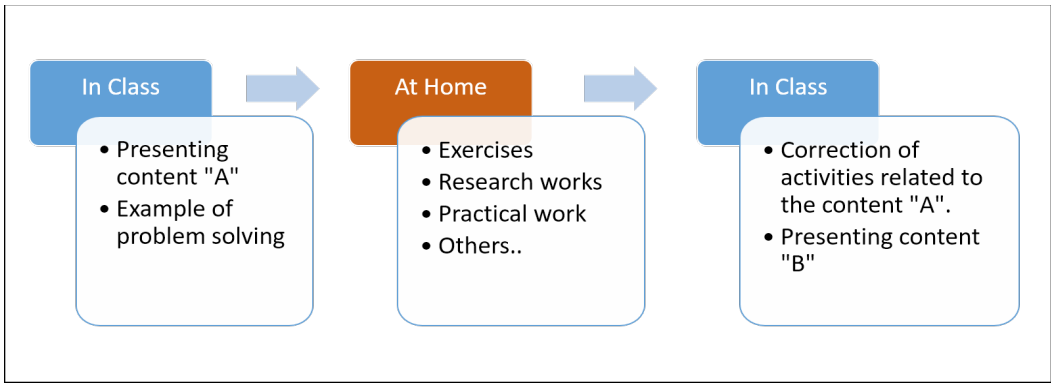

Figure 1: Activity sequence in relation the place in the traditional teaching.

In Flipped Classroom, spaces for learning are reversed. The activities designed for the home are performed in the classroom, while at home, the student studies the material prepared by the class teacher as discussed in the introduction of this article. Thus, the teacher prepares instructional material on a particular content "A" in a video, commented slides, learning objects, etc. and makes it available to students so that they watch and study the material at home before going to class. Thus, the house becomes the place for the exhibition of the new content reversing its role in the classroom.

The main advantage for the student is that the study at home through learning objects like videos, for example, enhances the control student gets on his own learning pace. It can return a point of the explanation or the complete video when necessary. Once the content has been presented and studied at home, the classroom becomes the place for activities in which students need to apply the knowledge studied, promoting active and collaborative learning. Another positive point is that the doubts that arise are resolved promptly, since the activities are being performed in a room in the presence of the teacher. The flow of activities in Flipped Classroom is shown in Figure 2.

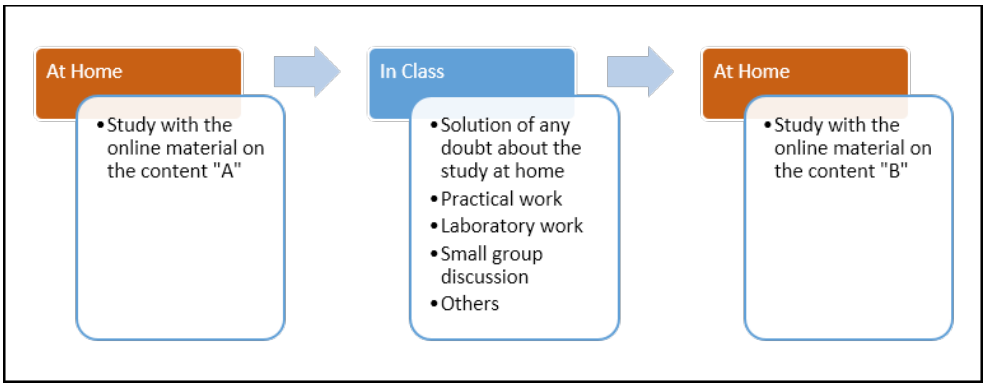

Figure 2 - Activity sequence in relation the place in the Flipped Classroom.

Comparing the Figures 1 and 2, it is easy to realize the inversion that occurs inside and outside the classroom. However, it is important to note that, according to Bergmann et al. (2013), this method should not be seen as a replacement of the teacher for videos or other learning materials. Moreover, Valente (2014b, p. 90) assert that care should be taken in relation to the number and length of videos, since the idea is not to replace the actual classes for videos because, for the author, if a lecture is "boring" and that same class is available in a video format, will become even more boring.

Inversion of the Time

Another inversion in the Flipped Classroom occurs in the time distribution of activities in the classroom. In traditional classes, there is a time management that favors the exposure of new content during class and leaves limited time for collaborative activities in the classroom (Marzano & Toth, 2014). Flipped Classroom in this division of time is reversed favoring the more active learning activities that engage students in problem-solving, laboratory practice, etc.
In Table 2, Bergmann e Sams (2012) present an example of how it would be a new organization of time when comparing planning a traditional classroom and one based on the Flipped Classroom.

Traditional Classroom		**Flipped classroom**	
Activity	Time	Activity	Time
Warm-up activity	5 min	Warm-up activity	5 min
Go over previous night's homework	20 min	Questions and answer time on video	10 min
Lecture new content	30 - 45 min	Guided and independent practice and/or lab activity	75 min
Guided and independent practice and/or lab activity	20 - 35 min		

Table 2 – Example of time management in the Traditional and Flipped Classroom (Bergmann & Sams, 2012)

Bergmann e Sams (2012) exemplify that usually students come into the classroom with the questions in the exercises that should be resolved at home. Generally, considering the class 90 minutes, spend about 25 minutes with first activities and correction of homework. Then the new content introduced would be between 30 and 45 minutes, leaving 20 for 35 minutes to practical activities. In the Flipped Classroom, students come into class with some questions about the video watched at home. The teacher would spend around 15 minutes for the warm-up activities and the clarification of doubts, leaving about 75 minutes for more extensive activities involving practices and problem solving. Thus, the authors assert which the greatest contribution of the method is the time management in the classroom that allows a better use of it.

Inversion of the Roles

Inversion of place and time caused by the Flipped Classroom also leads to a shift on the roles of the protagonist in the classroom. Generally, in the traditional classroom, the teacher takes the role of the one who has the knowledge and needs to present it to the students. This model is called by Don Finkel (2008, as cited in Moreira, 2010, p. 1) "Teaching as telling" where the teacher presents the content orally while students should copy, store and reproduce what was said. This design realizes that teaching is focused on the teacher taking the starring role in a classroom where the student becomes just a spectator.

The ideas that lead student-centered learning are not new as argued by Moreira (2010, p. 4) stating that have been proposed, for example, by Carl Rogers, Postman and Weingarten. This conception of education that focuses on the student the main role in the process of teaching and learning has been implemented with different strategies such as project-based learning, supervised research, laboratory work, among others. In the Flipped Classroom, the use of active learning activities makes teaching ceases to be focused on the teacher and pass to be student-centered. In others words, by proposing activities where the student has greater control and participation, teachers assume the role of mentors in the learning process. Thus, teacher ceases to be a "sage on the stage" and becomes a teacher "guide on side", as described by King (1993, p. 30).

Inversion of Educational Objectives

The inversions caused by the Flipped Classroom also influence the educational objectives. The Taxonomy of Educational Objectives was proposed by a team of researchers, led by Benjamin Bloom, to create a theoretical framework that could facilitate communication among researchers and stimulate research on assessment and education (Bloom, Englehard, Furst, Hill, & Krathwohl, 1956). This taxonomy has six categories: knowledge, comprehension, application, analysis, synthesis and evaluation. All categories have subcategories, except for evaluation, and are organized hierarchically and cumulatively. In others words, to master one of these levels, it is necessary have mastered the previous levels (Krathwohl, 2002).

The original taxonomy was reviewed in 2001 where there were changes in the names of the categories, which changed from nouns to verbs and a shift in the last two levels. The Figure 3 shows a hierarchical representation of the levels proposed in the original taxonomy and reviewed. This representation is a simplified way to present levels since each of them have subcategories that make the complex taxonomy than shown in the figure.

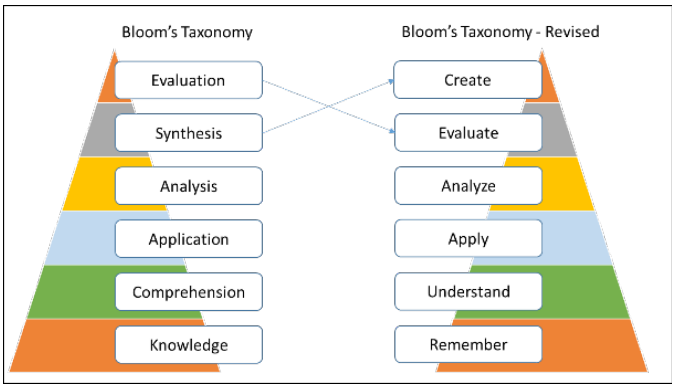

Figure 3 –Bloom's Taxonomy based on Krathwohl (2002)

Currently, two inversions on Bloom's Taxonomy are proposed when it is desired to implement the Flipped classroom. One of them is the direct impact of the inversion of the time previously discussed and the other is the shift of the pyramidal structure proposed Bloom.

In relation to time, Bergmann e Sams (2014) argue that, generally, in the classroom, teachers spend most of the time giving priority to remember, understand it and some application of what was learned, devoting a little time for higher skills: analyze, evaluate and create. The development of this last level is in activities designed for home,

away from the collaboration of colleagues or teacher guidance. The Figure 4 illustrates the distribution of time in relation to Bloom's Taxonomy.

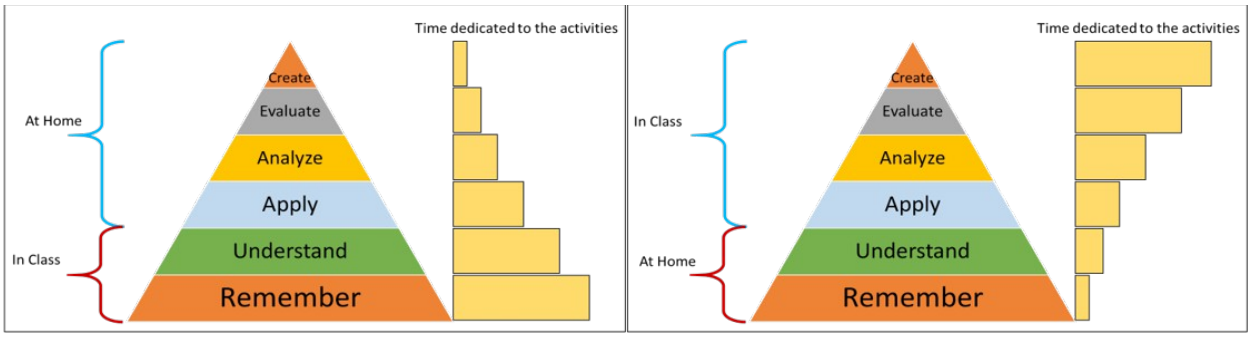

Figure 4 – Distribution of the time devoted to activities in the traditional class (left) and Flipped Classroom (right) based on Bergmann e Sams (2014, p. 30)

Bergmann e Sams (2014) suggest is that the videos created by the teacher must be watched at home and used as tools to develop the two lower levels of the taxonomy. Thus, allows the teacher to spend more time in the classroom involving students in activities that develop the skills of higher levels of the taxonomy. Comparing Figures 5 realize the inversion about the objectives educational with respect to time and place for each. In other words, in accord with the proposal, there will be more time for the development of levels apply, analyze, evaluate and create in the classroom, while the Remember levels and understand occupy less time and would be developed at home.

The second form of inversion for the objectives educational defended by Bergmann e Sams (2014) and also by Wright (2012) proposes reversing the pyramid itself of educational goals. That is, the Flipped Classroom, the education process would start by higher levels (Create) and then "come down" to the most fundamental levels (Fig 5).

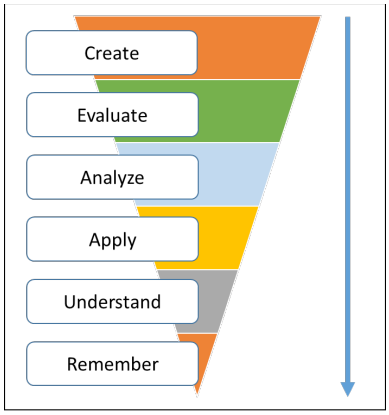

Figure 5 – Bloom's Taxonomy Revised and Inverted based on Bergmann e Sams (2014, p. 34)

Wright (2012) describes an example that uses Inverted Bloom's Taxonomy in a class of ionic compounds. She starts the activities with his students in the lab doing conductivity tests on some substances. From this activity it takes to do the analysis of the results and classify and only then it introduces the concepts of ionic and covalent bonds. Bergmann e Sams (2014, p. 34) also cite some examples on the same direction: initially develop a project (Create) to only after reaching the lowest levels (Remember). Furthermore, the authors state that this type of approach is more natural and values the interests of the student not requiring a mastery of content to start the creative process. For Marquis (2012), this process follows the principles inquiry or discovery-based learning, where students are presented with a problem or should explore something to see its operation; then they work to develop an understanding of the principles underlying the discovery.

Recent Examples of Implementation of Flipped Classroom

In the previous section, we present four inversions caused by the Flipped Classroom model. The inversion of time and place are required conditions, i.e., according to the definition used in this article, it makes no sense an inverted classroom without also a shift in the time and place where learning occurs about the traditional classroom. However, we believe that to be able to take advantage of all potential of Flipped Classroom, is must also take into consideration the other inversions proposed (main role in the classroom and educational objectives). Thus, we present some examples of Flipped Classroom implementations, driven from literature, that gather the four categories of investments described in this article.

Schneider, Munro e Krishnan (2014) applied the Flipped Classroom in a subject on Pharmacokinetics to encourage active learning and develop high-level learning. The authors designed the course using the inverted Bloom's taxonomy defining the "levels" Remembering and Understanding with activities such as self-study, videos and reading to be done outside the classroom. While for the "levels" apply, evaluate, analyze and create active learning activities were assigned to be performed in the classroom. The authors argue that when comparing with the same subject taught in the previous year, they found a higher level of satisfaction by the students. Also, the students said that the course developed through this methodology provided challenges that led them to expand their learning and better achieve the objectives of the discipline.

Santos, Guimarães e Carvalho (2014) applied the flipped classroom in a mathematics discipline in a school of basic education, with the specific content of geometry. As is characteristic of Flipped Classroom, the authors sent to students by email, the materials required for the previous study outside the classroom. This material consisted of links to Youtube videos and the Khan Academy, a web page with explanations on the subject and a text document with a form of areas and volumes of geometric solids. For the moment in the classroom, the authors used various activities such as the question type quizzes and games and response with limited time for the answer to be given. These activities were carried out on smartphones or tablets from the students themselves. According to the authors, students not only liked to use this methodology associated with mobile devices as well as they would like to repeat the experience.

Much of the work related to the Flipped Classroom is focused on the change in the traditional face-to-face classroom. However, Schneider, Suhr, Rolon and Almeida (2013) propose a model of Flipped Classroom directed for distance learning. The authors also use inverted Bloom's Taxonomy to guide the structure of the model that aims to an organization of time and place education aiming for a greater protagonism of the student.

Some model assumptions are: the student-centered learning; access to knowledge and technologies through physical and digital media; the student must develop the self-study and autonomy in the construction of knowledge; teaching and learning strategies are aimed at the acquisition and creation of knowledge; the didactic sequences of activities divided into classroom and distance. The authors conclude that to implement a model as proposed is essential the involvement of teachers, tutors and students in addition to the support of the management team of educational institutions.

Although the Flipped Classroom has several features that guide its implementation, this method does not have a fixed model, i.e., the teacher can implement it using the activities, resources and theories of teaching and learning most appropriate to each specific context. To make a contribution to the state of the art, we present a possible model to implement a Flipped Classroom guided by a theory of learning that satisfies the four inversions mentioned above.

Our proposal: Flipped Classroom Based on the Cognitive Flexibility Theory

The Cognitive Flexibility Theory (CFT) is a theory of teaching / learning, with constructivist perspective, developed by Rand Spiro and collaborators (Spiro, Vispoel, Schmitz, Samarapungavan, & Boerger, 1987). Its purpose is to acquire the advanced level of knowledge in Ill-structured domains and to facilitate the transfer of knowledge to new situations. The ability to restructure this knowledge to solve a new situation or problem is called Cognitive Flexibility (Carvalho, 2000; Feltovich, Spiro, & Coulson, 1997; Spiro, Coulson, Feltovich, & Anderson, 1998). A well-structured domain knowledge is characterized by a regular structure allows the identification of general rules, relationships and conceptual models to fit most cases (Pessoa & Nogueira, 2009). On the other hand, in Ill-structured domain Spiro and colleagues identified five characteristics that can define them: i) there are no general rules apply to all cases (problems or situations); ii) each case has its hierarchical conceptual framework; iii)

the use of prototypes induces errors; iv) the meaning of the concepts depends on the context and v) which makes the particular cases are the relationships between the various concepts involved (Pessoa & Nogueira, 2009; Spiro et al., 1987).

The approach taken by the CFT is centered on the case. A case can be an event, a chapter book or some particular event (Carvalho, 2000; Pessoa & Nogueira, 2009; Spiro & Jehng, 1990). Each case must be decomposed into smaller units called mini cases that will be analyzed according to different themes, principles, concepts, views or perspectives. The analysis process of mini-cases through the issues is through the development of thematic commentary which shows how assured theme has been applied to that particular mini-case. This process of analysis is called deconstruction (Carvalho, 2000, 2004). Another process of fundamental importance in the theory are the pre-defined thematic criss-crossings. Each thematic criss-crossings presents a theme or combination of themes over mini-cases of different cases so that the subject can understand that the same theme can be present in very different situations (Marques & Carvalho, 2005; Spiro, Feltovich, Jacobson, & Coulson, 1992).

Thus, according to CFT, learning occurs through the crossing of conceptual landscapes or by making multiple crossings of the concepts in different contexts, where the concepts are shown as highly interrelated and contextualized conducted flexible and multidimensional way (Pessoa & Nogueira, 2009). Thus, Spiro et al. (1987, p. 8) propose two processes to develop cognitive flexibility during learning particular subject: i) mini-case deconstruction through different points of view (themes) and ii) establish relationships between mini-cases of different cases (thematic criss-crossings).

However, these processes, as it was originally proposed, can reduce the role active of students once the deconstructions and crossings are previously provided in the study material can transform students´ into simple readers. To make the student most active, several authors have kept the deconstruction processes and crossings, however, also proposed different ways to accomplish this process, for example, through chats, forums, quizzes, Webquest, and others.

Following this perspective, we propose an implementation model of Flipped Classroom which uses the inversions previously presented and which seeks a greater role for students in the deconstruction process and thematic crossings guided by the Cognitive Flexibility Theory.

The CFT has been researched and mainly applied in the context of the Distance Leaning, where the processes indicated by the CFT are performed in online mode through forums and chats (Carvalho, 2000; Marques, 2011). As the Flipped Classroom is based on the interaction between activities distance and face-to-face, we divide the processes recommended by CFT in activities outside the classroom (online) and in the classroom (face-to-face) described below.

“At distance” Moments

According to the proposed model, the distance moment is divided into two steps. The first is intended for students to read the cases, mini-cases and themes provided by the teacher. In the second stage, after reading, students are instructed to carry out the deconstructions of mini-cases (thematic commentary) according to predefined themes. To carry out these activities the use of a Virtual Learning Environment can facilitate this process, however, the teacher can also choose to use email or document shared resources such as Google Drive, Onedrive or other of his choice. The most important are that the teacher has the record of the thematic comments of the students, because as a basis for the face-to-face steps of the model. Also, the teacher can use these thematic comments to identify what type of difficulties the students had to deconstruct a case using the themes and, from that information, better plan the activities of classroom time.

“Face-to-face” Moments

The class time is divided into two phases. Once in possession of deconstructions produce by each student, the first step is dedicated to discussing the deconstructions collectively and then the development of a thematic commentary that comes from the discussion. This is the time for the negotiation of meanings between the different answers given by the students and the teacher. In other words, the objective is to discuss the various deconstructions and find a thematic comment that could synthesize the range of ideas produced by the students. The second step is for thematic criss-crossings and the creation of new cases. In this model, the thematic criss-crossings can be worked out in the form of questions, challenges, problems, i.e., active learning activities for students to analyze, implement and evaluate the themes through the various mini-cases. This step is also required students to create new cases

according to the topics proposed by the teacher. These cycle of activities is illustrated in Figure 6 may be repeated according to the number of cases where the teacher chose for the study.

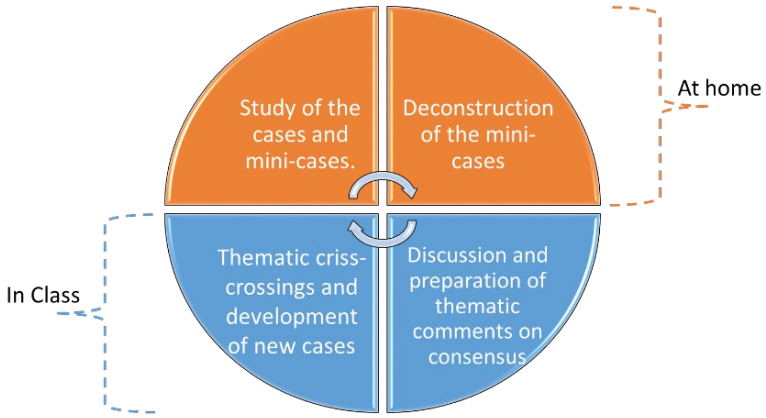

Figure 6 – Flipped Classroom Based on the Cognitive Flexibility Theory

Conclusion

In this paper, we present a discussion that sustains the Flipped Classroom as a method that brings significant changes in various aspects of the educational process including the organization of the place and time of learning, the roles of the main actors involved in the teaching and learning process and educational goals. We also present some recent examples of implementation of Flipped Classroom following the inversions discussed above. In addition, we present a proposal for a model based on the Cognitive Flexibility Theory and also meets the inversions discussed in the article. In our proposal, there is a shift of time and place when it is intended the active learning activities for the classroom environment. Also, there is an inversion the role and educational objectives as it is for a longer time for the superior skills of Bloom's Taxonomy. This model is being implemented and will be the subject of future investigations.

Like any pedagogical innovation, Flipped Classroom raises doubts both about how to implement and consider whether, in fact, this approach deserves such prominence in the literature. Thus, once the popularity of Flipped Classroom is recent, the subject still needs more research, mainly involving areas such as teacher training, curriculum and technology, looking for ways to help the teacher in the implementation of inversions discussed in this work.

Finally, we agree with Valente (2014a, p. 162) when he says that for the transformations enabled by technology, and in the case of Flipped Classroom, are deployed in education, a cultural change is necessary and a great effort of educators and every society.

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