HYBRID ENVIRONMENTS OF LEARNING: POTENTIAL FOR STUDENT COLLABORATION AND DISTRIBUTED KNOWLEDGE

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An exploratory study of the impact on transforming mathematics teaching and learning practices into the classroom is presented by means of introducing a hybrid learning environment, in this case, designed to address the topic of functions in the first year of finance at college. This topic is normally covered in two weeks in the classroom. In this exploration, the students worked independently on the topic using materials or resources available in a digital teaching platform throughout the first week. In addition, the topic was addressed in the classroom under the teacher's guidance during the second week. The results show collaboration between students to refine or validate their conceptions, which also could support connectivist hypothesis of distributed knowledge.

Key words: Teaching tools and resources, distance education, post-secondary education, communication

Introduction

According to Heffernan et al. (2012, p.101), if school practices must change in order to keep pace with the development of new technologies and to meet students' expectations regarding their use, then the efforts on teacher's education and in-service teacher development must be altered, there must be a greater number of interactive educational technologies developed in the cloud and implemented in the classroom.

In the exploratory study we are presenting here, we worked on the design and set up of a hybrid scenario of learning. Participant students worked autonomously during one week of the first semester of finance at college. In the following week, teaching and learning were continued now into the classroom under the teacher's guidance. The usage of this hybrid scenario of teaching and learning, in this case on functions, allowed us to investigate possible productive collaborations between students as a consequence of their autonomous work within the activities in the digital platform. Here we report what was done by the students, it suggests a significative transformation of usual teaching and learning of mathematics in the classroom, and also allow us to advance connectivist learning hypotheses.

Theoretical Frame and Methodology

It is noteworthy that the work of Sutherland and Balacheff (1999) early on announced the possibility, now already materialized, of online courses or digital devices for teaching freed from tutoring by the teacher, accessible outside of school and operated via digital media, such as the Internet. By means of online materials or devices, in this case, like videos or forums as digital tools, students are left with the responsibility of unchain their own forms of appropriation of knowledge, and it is mainly through the exchange of opinions between peers that are attained possible advances in one subject's learning. (Downes, 2009).

One of important theories underlying the design and implementation of online and hybrid learning environments is connectivism, mainly developed by Siemens (2006) and Downes (2009). Connectivism is a theory of learning that emerged linked mainly to the use of the Internet, as well as virtual education. Many researchers still question what this theory explains, provides or suggests, for

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example, regarding the incorporation of technology in the classroom (see, for example, Kop & Hill, 2008). Whether it could do this regardless of previous theories or as an extension of some of them, or of theoretical models that have so far been applied to study the integration of technology in school (to see some of these models, see Zbieck & Hollebrands, 2008; Olive et al., 2010; Ruthven, 2014). However, according to Downes (2009), what connectivism has to exhibit is to what extent is an emerging theory, and empirically proving in what sense is a new paradigm that would specifically explain the case of network learning and collective distributed knowledge.

Finally, it is also important to highlight that student productions become registered data when working within a digital teaching platform, and availability of all these records in order to classify and analyze them is one of the advantages of using and designing digital teaching platforms (Dedé & Richards, 2012), since in this way teachers in charge of conducting courses in the classroom can then have in advance these type of records and use them as a diagnosis of difficulties or opportunities for points to be addressed in their classroom.

Thus, for the concentration and interrelation of the students' productions, in this exploratory study an Excel sheet was used and the SOLO taxonomy of Biggs and Collis (1982) was applied. SOLO taxonomy is an analysis tool for a structured classification into four levels of development or evolution of student knowledge around a concept. In general, according to these authors, the four possible levels of classification, starting from the simplest to the most complex, are the following: pre-structural, uni-structural, multi-structural and relational. This taxonomy allowed to identify the refinement and validation of the students' conceptions, formulated through their communication exchanges in the forums on the subject.

Having at hand all these data allowed us the identification of student communication exchanges for productive collaboration. It should be noticed that here the term productive collaboration between students refers precisely to the refinement or validation of conceptions between the students carrying out productive collaboration or critical communication exchange.

Next, in Figure 1, a small part of the concentrate and classification of the students' productions is presented.

Analysis and Results

As previously mentioned, this exploratory study sought to identify cases of collaboration or productive interrelation between students. Below it is shown an image of the classification we accomplished of the different levels of development of the students' conceptions on the subject, extracted from our analysis or classification of their participation in the forums. Likewise, a paradigmatic example of student productive collaboration is also presented.

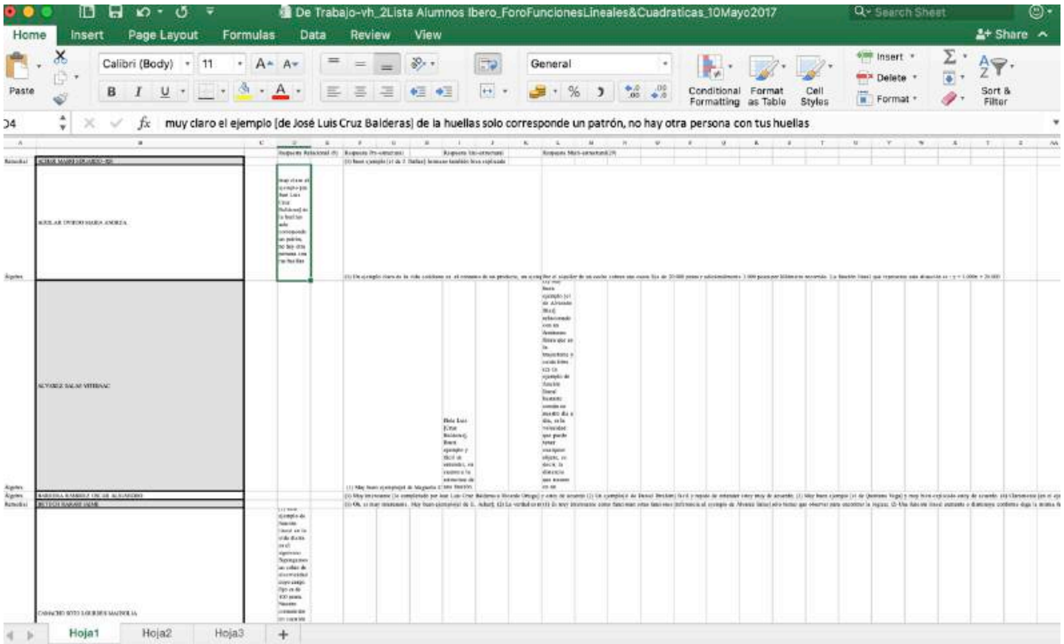

Figure 1. Synthesis of the students' productions, according to the SOLO taxonomy, in search of identifying critical communication exchanges or productive collaboration.

Examples of student production at different levels of development according to the SOLO Taxonomy

Pre-structural level

Student MAA: "A clear example of everyday life is the consumption of a product, an example is the purchase of phones, there are different phones: price levels, with x = the phone and y = the price depending on which phone you would like, the price increases, but all phones have the same function: communicating. [Another] excellent example [in the one given by CS], it was very clear to me how we apply linear functions in daily life. [It is also] an excellent example [the one of AS] because it helps you understand what a linear function is, very simple, with an example from daily life."

Uni-structural level

Student ALA: "When throwing a ball, it first goes up and forward, then falls while continuing to advance, thus forming a path shaped like an inverted parabola."

Multi-structural level

Student YAS: "Very good example [the one given by BA] related to a physical phenomenon that is the trajectory and free fall. [Another] example of a fairly common linear function in our day to day is the speed that any object can have, that is, the distance it travels in a given time. Speaking a little more specifically, assuming that a car on a flat road tends to travel 20 km in 5 minutes, with a linear function, the distance it will travel in 25 minutes could be determined. The algebraic expression, in this example, could be f (x) = 4x. Where x represents the minutes' time you want to calculate to see the distance traveled."

Relational level

Student MAA: "The example [by student JL] of the footprints is very clear, only one pattern corresponds, [because] there is no other person with your footprints"

Student LMC: "Another example of a linear function in daily life is as follows. Let us suppose an electricity charge whose fixed amount is for 100 pesos. Our consumer in question has had a consumption of x watts amount and each watt price is 2 pesos. The function would be expressed in the following way: $f(x) = 2x + 100$. Thus 2 is our value in a, and 100 is the constant that we add. [Also] a very good example [the one of AS] about something that has an application in daily life, although it should be mentioned that this is only valid for uniform movements (where speed is constant). [In addition, I also] understand the example [the one given by CF] and it seems valid to me, but I consider that because having two antecedents for the same image (this does not meet the definition of function) we would need just one person wanting two things at the same time and not that two people are the same since x1 could be equal to x2 without this affecting the function as long as f (x1) is equal to f(x2). [Finally, also] I agree with another example [the one from MAA], two phones can have the same price, therefore, the same image can have two antecedents, but a singular phone would not have two prices (obviously if we only talk from a provider) so an antecedent could not have two images."

From the examples and classification presented here, it is clear, according to Heffernan et al. (2012, p. 92), that the materials and activities developed on a digital teaching platform can be used in a multiplicity of ways, among others, so that students receive feedback from their classmates on their actions, which can later be capitalized on reviewing the topic in class or solving questions associated with feedback on the exam. Furthermore, according to data issued from our exploration, these devices also could serve to unchain refinement or validation of students' conceptions of the subject to be learned, as it will be shown by the following paradigmatic example of this type of interrelation or student productive collaboration.

Productive collaboration between students: A paradigmatic example

An example of feedback, or productive collaboration between students, which from our point of view shows the refinement or validation of the concepts at stake on the subject, is shown below.

JL: "Hello ..... my example is fingerprints. There is only one pattern for each person. "

...

RO: "An example of a function in soccer could be a free kick to the goal because it starts from a zero point, rises and falls again."

JL: "Hello RO, I agree with your example, as long as it is specified that the function is the position of the ball in a certain time when making the free kick."

It is clear, in the case of the communication exchange between JL and RO (given by means of a forum), that the feedback that JL provides to RO is crucial to validate his function's example, which was formulated in a so schematic way. Practically, it is JL contribution that rescues the visualization of the phenomenon provided by RO's example, in fact, completes and reformulates it. It is to say that JL filters, refines, and produces a formulation of a function that underlies in the visualization of the phenomenon initially provided by RO.

In summary, the knowledge or formulation of the function at stake did not reside in a single location but rather through a reformulation of a confluence of information originated, in this case, by the exchange of critical information or productive collaboration between two individuals who sought to investigate mathematical functions, a common subject of interest, that finally produced feedback to each other, what is consistent with connectivist learning or distributed knowledge as pointed out by Downes (2009).

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