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RESEARCH ARTICLE OPEN ACCESS

USE OF MICROLEARNING AS A STRATEGY TO TEACH MATHEMATICS ASYNCHRONOUSLY

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ABSTRACT

In this classroom experience we seek to innovate the teaching and learning processes of mathematics with a group of high school students (night grade) who learn to identify processes of variation, covariation between magnitudes, independence and dependence between variables and identify functions such as a relationship between two quantities. The descriptive experience with non-probability sampling for convenience, develop from a virtual learning (VLE), as a pedagogical strategy we used microlearning. Highlighting the development of office content, skills to interpret, know and represent functions from every situation that involve relationship between magnitudes.

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INTRODUCTION

Technology is a tool that by itself does not create, store, or disseminate knowledge and therefore is not useful for managing it, if factors related to people and the interactions that occur between them are not taken into account (Alcoba & Sélles, 2014). This technology has implemented eLearning as a tool, to train and educate through the Internet. In recent years, eLearning has developed new methodologies such as microlearning (information compressed into small digital learning capsules), showing that it allows to acquire knowledge quickly and with effective results. This proposal is developed under the Colombian educational model where the variational thinking approach is present in high school, however, the results of the internal and external tests associated with the variational thinking component show that ninth grade students from an educational establishment, from state public character in the city of Bogotá, where this experience was carried out, present difficulties to: "model"[1]" mathematical situations that involve the use of variables; identify dependency or independence between variables; when one changes depending on the other; whether they are directly or inversely related; as well as, interpreting the different representation registers (graphic, tabular, symbolic and natural language). Hence the interest of mathematics teachers in worrying about looking for alternatives that give satisfactory answers in order to overcome these difficulties, we decided to innovate the teaching process from the design and implementation of a virtual learning environment (VLE) for the teaching of the functions. The methodology implemented in the design of the AVA was the use of microlearning, this system allowed us to adapt the mathematical training process, making it easier for us to measure its effectiveness almost instantaneously. We work on microlearning under the premise of "less is more", seeking to provide a higher quality of content in the shortest possible time. This is because we observe students how through social networks and the Internet, they access new content. We notice that the new generations have been modifying the learning methods, preferring short and precise contents that convey a clear and concise idea, compared to the long texts or books that we were used to. What our generation took days to learn, today new generations do in minutes, so implementing microlearning as a technique to train and train in mathematics, from the use of multimedia formats, was ideal to generate this type of content: Tips, short, interactive, dynamic videos, where we talk about specific mathematical topics: variation, covariation and functions.

[1] In this work modeling constitutes an analogous structure of a real world or imaginary situation, event or process that a person constructs in the mind when reasoning. In other words, represent or show ideas and relationships (in this case mathematics through objects, illustrations, graphs, equations, among others), (Moreira & Rodriguez, 2002).

We highlight as the main result, recognizing that virtual learning spaces, the use of digital resources and the flexible possibilities of current platforms; They offer alternatives that, well used pedagogically, help students in the development of mathematical competencies, visible in solving everyday problem situations that involve the use of varying magnitudes, improving communication skills, and office automation skills.

METHODOLOGY

Wehave based this experience on two theoretical axes 1) The levels of covariational reasoning proposed by (Carlson *et al*., 2003), 2) technologically mediated by a Virtual Adaptive Learning Environment.

Covariational reasoning: Thecovariation theory Kelley (1967), establishes that when there are different events that can be the triggering cause of the same event, only those that are shown to be consistently related to it over time will be considered as causes. of the event. Hence, it is possible to understand covariation as the information of multiple observations (relationship between two or more variables). Carlson, Jacobs, Coe, Larsen and Hsu (2003) work on the importance of modeling functional relationships for the interpretation of dynamic event models and for the understanding of the main concepts of calculus. They propose a conceptual framework for the study of covariational reasoning, incorporating five mental actions and five levels. Based on the mental actions (shown in table 1), they classify the students in levels according to the global image that seems to support the various mental actions that this person exhibits in the context of a proposed problem or task. These mental actions are related to the degree of evolution that the student shows when developing tasks that involve covariation. Said mental actions are presented in ascending order of complexity, for our case we consider: identification of variables; determine which is independent and which is dependent; determine the value of one variable in relation to changes in the other; determine change and quantity between variables; define what is the function that relates the variables, and state the type of function that it represents.

Levels of covariational reasoning: Carlson *et al*., (2003) state that students should be able to analyze patterns of change in various contexts, linked to how students interpret and construct sentences. To determine it, they establish five levels of development of the covariation images, (table 2); these levels are raised in terms of mental actions sustained by each image. They associate this concept with the set of reasoning and conceptualization skills that are involved in the compression of dynamic phenomena. They identify the cognitive processes involved in the development of covariational reasoning and establish a framework for the construction of images, which include incident mental actions in the interpretation and representation of the functions associated with said events. When a student interacts in a particular situation where two variables change, one depending on the results of the other, it becomes complex to determine what they are thinking about the situation, hence the behaviors that we observe in them, become elements to know which mental action is associated with said behavior. From these levels of Covariational Reasoning, it is possible to show the degree of covariational thinking developed by the student, considering that each level is reached according to the degree of overcoming of the mental actions shown by the student.

Adaptive Learning Virtual Environments: Technological advances have facilitated access to data, interpersonal communication and the dissemination of all kinds of information; but it has made it difficult to elucidate the pertinent information for the action that generates knowledge. Which allows us to infer that we are in the era of knowledge and at the same time of infoxication[2], we highlight that technology must always be considered a means and not a final objective, hence, the didactic aspects based on technological tools are materialized in models training alternatives, such as widely disseminated eLearning, for example:

MOOCs (Massive Open Online Courses), which are a flexible learning modality «participants can access from anywhere, anytime, and advance at your own pace". During phase one of this exploration experience, we found an exponential growth in the platforms that offer MOOCs; However, in some it is unknown that eLearning has standards associated with two main components: 1) Platforms, information and communication technologies, and 2) ContentBiscay (2005) indicates that information and communication technologies and platforms must meet the following criteria linked to the SCORM[3] standard: 1) Interoperability, offer the ability to display content regardless of who and how they were created. Produce content regardless of the platform on which they will be incorporated. 2) Reusability. focused on reducing production times and increasing the quality of content. 3) Traceability. Ability to register and track each user and the content they access. 4) Accessibility, the necessary contents are available at all times and can be accessed from anywhere through the available devices. 5) Resilience. Principle designed to prevent the technological obsolescence of content and standards. In other words, adaptability. 6) Scalability. Possibility of systematically growing in content, materials, functionality and users. Regarding the contents, it states that they must have at least the following characteristics: 1) Quality of the learning objects, 2) Relevance. The adequacy of the contents and their convenience. 3) User orientation. Satisfaction of user requirements, expectations and needs. Relating user with (managers, staff, teachers) and external (students, society in general).

Under this panorama, we assume Mason, Weller and Pegler's (2003, p. 56) definition of a virtual learning object (OVA) as: “a digital piece of learning material that addresses a clearly identifiable topic and that has the potential to be reused in different contexts”thought of as elements that make up the VPA. For this reason, we include in the definition the means of diffusion, that is to say that the learning object can be diffused through multiple means: computers, tablets, televisions and / or smartphones. Given that with the massification of mobile technologies, virtual objects have been adapted to short but concrete fragments that are capable of fully explaining a concept; Arshavskiy (2019) defines it as microlearning[4]. In table 3 we show some advantages of using microlearning. The main objective of this educational trend is for students to acquire the necessary skills to assimilate information, reflect on it and manage to apply it. Hence, microlearning is a different way of learning, it fragments the didactic content to achieve certain competences. This learning is created in small steps that when reaching each other, creates a complex and deep knowledge. We share the position of Mora &Bejarano (2016) when they state that not all practices mediated by technologies can be considered educational per se, since an educational action requires planning, coordination and evaluation of the activity itself and the results obtained. A, virtual environment is considered learning when one thinks of a pedagogical framework supported by a training model, approach or intention.

Methodology

The experience is approached from a qualitative approach, using action research as "a form of inquiry carried out by teachers to improve their teaching actions and that makes it possible to review their practice in light of the evidence obtained" Latorre (2003, p. 5). We carried out this experience with a population of 120 high school students (ninth grade, each one was assigned a code that begins with the letter S for student and a number from 1 to 120, in order to later

[2]Infoxication, a term coined by Alfons Cornella in 1996, to delimit the informational excess, in which there is more information to process than is humanly possible to deal with, as a consequence, anxiety sprouts.

[3]SCORM (*Sharable Content Object Reference Model*). It includes a set of standards and specifications that allows the creation of structured pedagogical objects, with fundamental objectives of facilitating the portability of learning content, being able to share it and reuse it.

[4]Strategy that bases learning from micro-content (micro-media)

identify and follow up), who belong to a state public institution in the city from Bogota. We use a non-probability convenience sampling characterized by selected students who are readily available and because we know they belong to the population of interest. The experience was carried out in three moments: 1) Exploration and analysis of infrastructure: we determined the possibilities and limitations of the implementation of a digital school environment in the institution. We characterize the sample in terms of digital skills and define the necessary human and technological resources compared to the infrastructure that the school offers us. 2) Intervention: we design and implement a VPA. 3) We evaluate the experience. The proposed methodology implied, in addition to identifying, characterizing tools and strategies for teaching functions using ICT, the proposal of a basic pedagogical model that would answer the questions: what topics related to functions are worth understanding? What aspects of these topics should be understood by students? How can we promote the understanding of said content? And how can we find out what students understand and learn? For the particular case of this proposal, we reiterate the importance of not thinking exclusively about technological resources, but that simultaneously, we pay attention to the pedagogical aspects that allow us to present particular situations that will lead us to identify the mental actions that students They assume, given the proposed situation and according to the identified action, describe the way in which the student reasons covariationally when facing situations of variation «identification of the level of covariation».

EXPERIENCE'S DESCRIPTION

Initially we explored various platforms «Miriada X, Google interactive, Moodle, Future learn», and we chose Moodle because we consider it allows us to develop an adaptive teaching process, intuitive to use and easily accessible for students, given their age of training and the level of access after school hours, from their computers or smartphone. We validated the information with the population in order to select the sample from a participant dialogue, we established an ethical framework that would allow the information collected to be safe and reliable. We found that more than eighty percent of the population uses a smartphone, but only fifty percent have a data plan for internet access, hence for the selection of the sample we consider among the options that ease of accessing the web in any moment; Also that the student had availability and wanted to participate in the experience, besides that he had certain characteristics that we differentiate in three aspects: 1) that it is difficult for him to learn mathematics, 2) that he has medium ability to learn mathematics, and 3) that he likes mathematics. Mathematics, either because he excels at learning them or because he considers they are a science and at the same time a tool for life that motivates his study and learning. Hence, we chose a sample of 50 ninth-grade students belonging to different groups (901, 902,… 905).

We create a virtual learning environment (VLE) on the selected platform, considering the SCORM standards "use of the platform and content"; understood as a system of pedagogical relationships in which training and learning objectives are pursued, in a digital environment (web), from a flexible structure and of student autonomy.

The central axis for the design of the VLE were microlearning because they allow two fundamental factors for its creation. 1) It facilitates the connectivity of our students from the Smartphone. 2) We use micro Tips and micro videos as a communication element, because the field notes collected in the first phase showed that the population is used to using social networks to find out, among other things, (news, entertainment,...) where it is not difficult for them to keep their attention on a text and more if it is of several pages. To achieve this, it was necessary to divide the sample into two groups of 17 students each and a third with 16; train the three teachers who helped us with the experience and who teach ninth grade mathematics in the use and management of the platform. These teachers found the implementation of microlearning as a different way of teaching and learning novel, because the contents were presented as «challenge» activities that had to be overcome in order to go up to the "level" and receive a «different colored belt» label; Figure 1 shows part of this structure. The contents were didactically fragmented to achieve the competences established by the National Education Ministery of Colombia: Tips with specific activities to allow the student to interpret and represent various situations that involve the use of variables, identify which of them are independent and which are dependent; Tips and micro videos with specific activities to formulate and execute actions that involve them. Finally, Tips with specific activities that invite students to argue the advanced actions leading to the construction of mathematical functions. All these acts required the teaching team to encourage observation and active listening in the classroom, taking and collecting data through field journals. Regarding the pedagogical component of the VLE, we seek to answer the questions posed in the methodology from a series of small activities «implementation of microlearning», leading to the platform being adaptive for students, allowing us to observe that students access content according to with the progress that each one showed. With regard to the quality of the learning objects, the interactive activities focused on making students aware of the variation phenomena, for this, we used Tips that allowed them to observe, interpret, interact and analyze various situations of change between two magnitudes, for some we use microvideo, in others we use online Geogebra applets "some explanatory, others showing the situations raised". Tips with the contents to learn «identification of: changing quantities, variables». Tips with specific activities of analysis, interpretation, deduction «dependence and independence between variables». Tips to identify the means of interaction «quantification of the variation». Resources "videos that showed the specific situation, tables of values that had to be filled in, graphics that had to be made on the Cartesian plane using different colors, one for each identified variable." For space reasons, later on we will show some of the situations raised. Regarding relevance, we are guided by the "communication services" «interactive forum to express your feelings, progress, setbacks, successes and failures in the development of the proposed activities»; elements that allowed us to triangulate with what was observed by the team of teachers when they worked in the classroom, the different records related to the type of mental action and to identify the level that the students showed when facing the situations that the VLE showed them.

For the design of the micro contents, we consider the contributions of Posada and Villa-Ochoa (2006), who call attention to the need for these to converge on elements associated with representation systems and mathematical modeling, since they didactically facilitate the understanding of the concept of function «in particular of the linear» from the study of the variation. In the first activities applied to the population we found level N1 of understanding «Coordination», which led us to propose that the study of functions begin by showing the student mental actions that would allow them to identify variables, determine the independence or dependence between them, coordinate the value of one variable in relation to changes in the other. Which led us to propose some Tips, no longer with functions but with situations that involve variation processes. The main intention was to seek that the students of the sample identify the functions as a relationship between two quantities of magnitude, whose rate of change is constant when it is linear. We began to apply it from the systematic study of the notion of variation in different scenarios of everyday life and the same mathematics, ex: filling a container with water; changes in temperature in a given city at different times of the year; cost of a phone call using the rates of some cell phone plans that students had; cost of telephone calls at the regional, national and international levels, among others. As a matter of space, we only show the filling of a container in the chemistry laboratory with water because it allows us to more easily share the type of mental action that the student shows, the level of covariation and the type of competence that the student has achieved. The container was a "graduated 500ml cylinder", we asked them to calculate the time it takes to fill when contemplating the opening of a tap to the aqueduct of the same laboratory. With this exercise we wanted the students to identify which variables were present, which was independent and which was dependent. We wanted the students to determine that the variation implies the covariation and correlation of quantities the set of interpretations that the student can associate with an object due to the functionality it represents will configure its meaning.

Table1. Mental actions of the conceptual framework for covariation

Mental Action	Description of the mental action	Comportment
MA1	Coordination of the value of one variable with changes in the other	Designation of the axes with verbal indications of coordination of the two variables (e.g., and changes with changes in x)
MA2	Coordination of the direction of change in one variable with changes in the other variable.	Construction of an increasing straight line. Verbalization of awareness of the direction of the change in the output value while considering the changes in the input value.
MA3	Coordination of the amount of change of one variable with the changes of the other.	Localization of points / construction of secant lines. Verbalization of awareness of the amount of change in the output value while considering changes in the input value.
MA4	Coordination of the average rate of change of the function with the uniform increments of change in the input variable.	Construction of the average rate of change of the function with the uniform increments of change in the input variable.
MA5	Coordination of the instantaneous rate of change of the function, with continuous changes in the independent variable for the entire domain of the function.	Construction smooth curve with clear indications of concavity changes. Verbalization of awareness of instantaneous changes in the rate of change for the entire domain of the function (inflection points and direction of concavities are correct.

Source: Carlson et al., (2003, p. 128)

Table 2. Conceptual framework for levels of covariation

Levels	Characteristics
Level 1 (N1) Coordination	Image's covariation of the variation can support the mental action of coordinating the change of one variable with changes in the other variable (MA1).
Level 2 (N2) Direction	Image's covariation can support the mental actions of coordinating the direction of change in one of the variables with changes in the other. The mental actions identified as MA1 and MA2 are supported by images of N2.
Level 3 (N3) Quantitative coordination	Image's covariation can support mental actions of coordinating the amount of change in one variable with changes in the other. Mental actions identified as MA1, MA2, and MA3 are supported by images of N3.
Level 4 (N4) Average ratio	Image's covariation can support the mental actions of coordinating the average rate of change of a function with uniform changes in the input values of the variable. The average rate of change can be decomposed to coordinate the amount of change in the resulting variable with changes in the input variable Mental actions identified as MA1 through MA4 are supported by images of N4.
Level 5 (N5). Instant ratio	Image's covariation can support the mental actions of coordinating the instantaneous rate of change of a function with continuous changes in the input variable. This level includes an awareness that the instantaneous rate of change results from smaller and smaller refinements in the average rate of change. Mental actions identified as MA1 through MA5 are supported by images of N5.

Source: Carlson *et al*., (2003, p. 129)

Table 3. Advantages of using microlearning

Advantage	Description
Facilitates training	Small information pills or reduced videos greatly increases the attention and interest of students, better than with traditional written methods.
Greater retention of knowledge	Thanks to the new techniques and training resources that are applied with microlearning, the student remains more attentive and incorporates knowledge more quickly.
Just on time	Training can be accessed at any time. In this way, it is possible to meet the learning needs of the students, avoiding the time constraints that face-to-face training courses have.
Accessible on multiple devices	a plus of micro learning is that it can be designed in such a way that it is possible to view it on multiple devices such as mobiles, tablets, computers ... etc.
Saving time in training	Students spend less time on the learning process than on a face-to-face course. The contents of a microlearning course are short and concise, occupying the student a few minutes a day. Considering the live we lead; this formula is considered a breakthrough for students who want to gain knowledge quickly and do not take long to acquire it.
Motivator	Microlearning courses are divided into different phases or modules that they have to pass to finish the course. By progressively passing these modules, the student motivates himself not to leave the course and finish it. This gets him hooked in such a way that he enjoys the process and encourages him to keep learning, even encouraging him to take new courses.

Source: Arshavskiy (2019, p. 2).

quantified numerically. Figure 2 we show some sections of iconic-verbal text considered in this micro situation, where the student must read the information raised in the statement shown, watch the video where a tap was opened to fill the container with water from two different moments. In the first, the tap was open in a certain position and it took longer to fill; in the second moment the container filled up faster. We sought the possibility that the students verbalized the cognitive processes achieved through written deliverables, which they had to upload to the forum, where they showed the process executed and achieved. They should express the successes, the failures in the process. In this way, we seek that the student associates the nature of mathematical objects with their functional origin and, based on this functionality, constitutes the aspects of representation and meaning that make up the mathematical object. We suggest you make various representations that allow you to express and use the object. This because the meaning attends to the interpretation of the object. Hence, For this we ask you to make use of various representation registers, iconic-verbal, symbolic, tabular, algebraic, geometric. We led the sample to reason if the situation changed when we changed the cylinder for a beaker of the same volume; here, we changed the shape of the container but the variables mentioned above remained constant. The information collected in the forum triangulated with the field notes of the professors and those of the researchers, allowed us to identify progress in the mental actions of the students, it went from AM1 to AM3, we identified verbalization of the awareness of the change in the filling of the container in relation to the time spent; as well as identifying the rate of change between magnitudes. The students were able to construct tables of values to make the records. They will recognize that the change in the shape of the container does not influence the defined variables or their dependence or independence. This allows us to infer that the sample reached level three of quantitative coordination, given that it was able to support the mental actions of coordinating the amount of change in one variable in relation to the changes in the other.

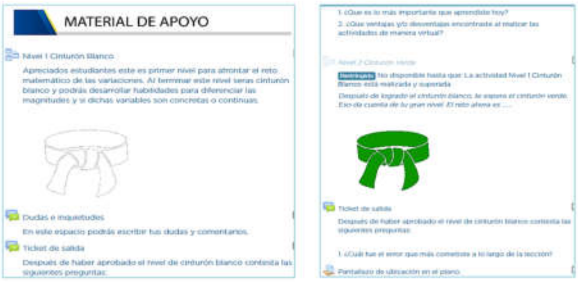
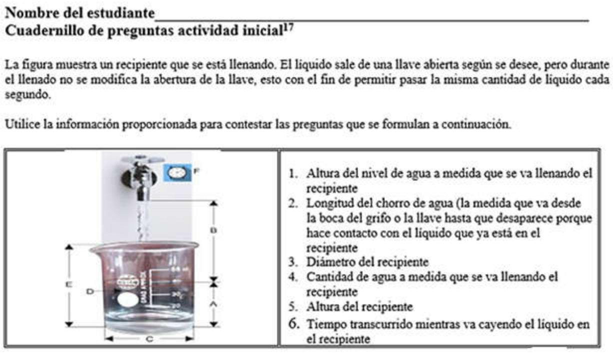


Figure 1. VLE structure design


Nombre del estudiante________________________________

Cuadernillo de preguntas actividad inicial[17]

La figura muestra un recipiente que se está llenando. El liquido sale de una llave abierta según se desee, pero durante el llenado no se modifica la abertura de la llave, esto con el fin de permitir pasar la misma cantidad de liquido cada segundo.

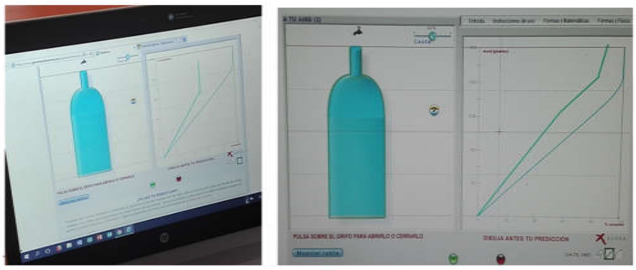
Utilice la información proporcionada para contestar las preguntas que se formulan a continuación.

1. Altura del nivel de agua a medida que se va llenando el recipiente
2. Longitud del chorro de agua (la medida que va desde la boca del grifo o la llave hasta que desaparece porque hace contacto con el líquido que ya está en el recipiente
3. Diámetro del recipiente
4. Cantidad de agua a medida que se va llenando el recipiente
5. Altura del recipiente
6. Tiempo transcurrido mientras va cayendo el líquido en el recipiente

Source: self-made

Figure 2. Situation: Identification of variables.

In this section, the sample manifested difficulties for the construction of graphs supported by the Geogebra online software, perhaps due to a lack of handling of the software commands, even though we had initially given them training on how to do it. We provide feedback on the actions to follow to execute the graphs, aided in records made in their notebooks using paper and pencil. We found that through these activities' students developed skills to interpret quantities as "variables." However, some difficulties persist to represent them in the Cartesian plane when they use pencil and paper, confusion persists to locate the variables on the axes of the plane, this because it is difficult for them to identify which was the independent variable, which was the dependent and the order to locate them on the axes of the Cartesian plane. They noticed the situation when they compared their work to that shown in the AVA. This allows us to confirm the location at level three «of quantitative coordination», where the images of covariation support the mental actions of coordinating the amount of change in one variable with changes in the other. Figure 3 shows the production of students S3 and S7 about this situation.



Source: self-made.

Figure 3. Images of the cartesian graphs made by S3 and S7 in relation to container filling situation

On the other hand, when formalizing concepts in class, we noticed that by assigning the students a formula and requesting them to assign values to later make the graph on the Cartesian plane, they easily identified the independent variable by assigning the x axis and the dependent variable the y axis of the flat. Situation that allowed us to show difficulties in the students to establish the order of the coordinates of the points in the Cartesian plane because, instead of using that plane to work in an oriented two-dimensional space, they limit its use only to the description of pairs negative or positive numbers. Regarding the graduation of axes, half of the sample took the values from the table obtained and placed them directly on the plane without considering an adequate scale. In Figure 4 we show the production of students S4 and S5. The first takes the values directly from the tabular register and places them on the plane; however, it indicates the x and y axes appropriately, on the other hand S5 adjusts the scale appropriately but due to the lack of space on the paper it makes a jump in the last values, this affects an imprecise graph. For these students it was necessary to reinforce what are the absolute coordinates, referring to distances to the origin (0,0) of the Cartesian plane, corresponding to the intersection of the x and y axes, which should be used when we know the precise x and y values of the point. For example, when entering the software (2,3), a point at 2 units on the x-axis parallel 3 units to the y-axis is determined, forming the pair (2,3), a situation that they did not contemplate when they worked with pencil and paper. Hence the difference in the handmade graphics compared to what the software presented to them.

Despite these difficulties, we can place these students already at a level four «of average ratio» given that the images of covariation support the mental actions of coordinating the average rate of change of a function with uniform changes in the input values of the function. variable. In these students, we observe the development of competencies to interpret situations, carry out actions and argue them. But the competition to represent continues to manifest itself weak when they make inadequate adjustments both in the selection of the axes of the plane, and in the scale used in them. For these students, it is fundamental to re-signify mathematics not exclusively in the mechanical application of concepts, but that it is functional for them through the design and modeling of specific situations that require solving.

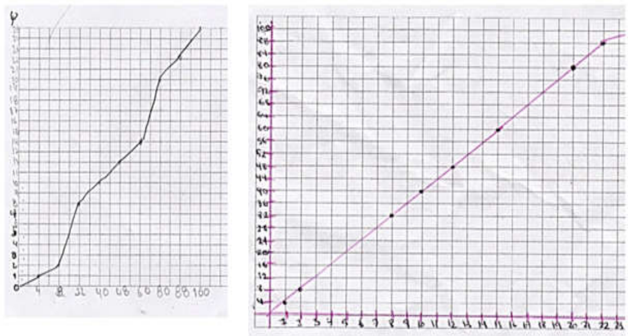


Figure 4. Image of the Cartesian graph of S4 (left) and S5 (right)

The proposed dynamic situations allowed the students to construct mental images of two variables that change simultaneously, considering that said change is determined by the change of an independent variable that causes the change of the other, we could observe it with the productions of the forum, by the type of productions delivered by students we decided to rethink it in two parts: general forum and learning forum. In the first, they presented comments, doubts, experiences about how they approached situations; in the second they presented the advanced academic experiences. In figure 5 we show the dialogue between five students (S51, S37, S23, S54, S60), who interact in the learning forum whose reasoning allows us to place them in an MA4 «verbalization of the consciousness of the reason for change» where the Coordination of the rate of change of one magnitude with respect to the other is not clear enough for everyone. Despite this, we observe development of argumentative competence, the type of expressions that they manifest are coherent, the images of covariation that they have reached allow them to support mental actions to coordinate the ratio of continuous change between magnitudes. This allows us to infer an approximation to level five of covariation, given that we observe in these students, awareness that the rate of change can be increasing or decreasing, this is the product of a refined reasoning about the rate of change between "variable" magnitudes. Some students came to recognize that, to sketch a graph, you do not necessarily have to have an algebraic

Figure 5. Reasoning in the learning forum of five students

identifying which variable is independent, which is dependent, when and under what circumstances this relationship of codependency occurs. Difficulty expressing the algebraic and graphical representation registers for a function; as well as identification and use of variables in the axes of the Cartesian plane. The development of office content, as well as the use of screen capture and file attachment tools was adequate for most of the sample, although they were given training in the use and management of these resources, for some students it was It was difficult for him to send files from the Tablet or his Smartphone since the submenus were not displayed properly, disabling the actions to be followed, not when working from the computer. What stands out is the qualification of the students in the creation of content, which allows us to infer that microlearning can be used as applications in which the teacher determines which learning units to deliver when, where, and in which the learner decides when and how to access learning resources.

Table 4. Advantages and disadvantages of technology-mediated learning models

Advantages	Disadvantages
Encourage collaborative work through interaction tools	Too much responsibility placed on the student, a situation they are not used to.
Variety of possibilities and tools	Abundant information
Flexibility in schedules (asynchronous and diachronic communication)	Contents in which it is difficult to achieve pedagogical quality.
There are no geographical barriers	Some people do not have the necessary technology
Multiple multimedia tools at your fingertips	Lack of knowledge of skills for online learning
Interaction with technology	Digital illiteracy
Promoting responsibility	

expression that supports it by default. This was evidenced when they outlined the shape of the curve depending on the behavior of the changes of one variable with respect to the other, in terms of the qualitative and quantitative coordination of the quantities involved.We identified that it is necessary to reinforce with the students the use of representation registers such as tabular and graphic; because it allows them to interpret and differentiate the notions of magnitude by relating it to the variable; as well as establishing characteristics to identify which is the independent variable. In said reasoning, an approach to various notions associated with the concept of function is evident, such as: independent, dependent variables, which allows to facilitate approximations to: domain, range, maximums, minimums and monotony in the increasing or decreasing behavior of a function.

FINAL REFLECTIONS AND CHALLENGES GENERATED BY THE PROPOSAL: We noticed that the micro information issued in Tips or videos is an important element to tell what we want, it allowed us to be effective communicating and also training, we observed that the students used this micro information to identify variables, differentiate independence or dependence, when they are directly or inversely related, as well as recognizing the different registers: tabular, algebraic and in the Cartesian plane. We emphasize that it was not necessary to include the reinforcement of content, the students themselves took up the micro videos or the Tips to study them. Quality vs quantity. We consider it important to design content material without forgetting that the more precise and easier to understand the information, the more efficient it is to learn. The quality in the production of the material (tips, videos, infographics, tests, micro workshops, Geogebra applets), allowed us to identify that the students, when noticing quality in said material, paid more interest in the content presented. Regarding the use of time, we try to present the contents considering the most relevant information to the topic, investing as little time as possible, so that the student is not saturated with information, wide scope, deep knowledge and use of the topic. Table 4 we show some advantages and disadvantages found when applying this learning model mediated by information and communication technologies. In this classroom experience, from our pedagogical practice, we permanently observe actions that reflect problems in the students about the understanding and use of the Cartesian axes. For example, the non-distinction about which is the abscissa axis and which is the ordinate, the location of points in the plane. We consider that these shortcomings are associated with previous knowledge such as: using letters to represent variables,

We found in students the use of micro-learning units delivered in various ways: presentations, summaries, use of short questionnaires, blogs, and surveys; allowing them to improve communication skills. There were students who progressively refined their thinking, which allowed them to develop autonomously, in some of them we observed meta cognition, when they investigated and commented to their classmates what they had found in textbooks and that they used to find a solution to the situations raised, others asked their colleagues questions related to the possible variations in the proposed situations. This allows us to infer that the technological tools used in the double vision "use of digital resources without neglecting the pedagogical component" become an effective vehicle to facilitate the training process of students.

We suggest that teachers interested in this type of teaching create activities before class: summaries, videos, learning units accessible through a searchable database; discussion messages and questionnaires; training on managing digital resources; short interactive activities that occur outside of the formal course that help students incorporate and apply them in their lives. We believe that creating micro-learning MOOCs challenges popular conceptions about when and where learning occurs, the way we learn, and what we expect from education, because courses can be accessed from almost any type of internet-connected device; where visual communication prevails, with easy access. Elements that significantly improve the experience of students with the learning process, making it simple and practical. We note that the school mathematical discourse lacks significant teaching situations for the student, rather it encourages a prescribed mathematics, where its construction is not necessary. We consider that the design of a specific situation that promotes the need to construct and understand daily situations for the student facilitates the teaching and learning processes, a situation that improves when specialized software is involved, such as the one that exists online today, because it contributes to the resignification of mathematics as something done, finished and for the exclusive use of a few

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