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Abstract. The purpose of this article is to explain the importance of adapting the teaching and learning methods of mathematics through the use of ICTs. It is suggested that it is necessary to do so, because at present, we are in the knowledge and information society. For this, we use the literature review as an investigative method, with which we hope to explain the disadvantages of continuing to use traditional methods and the importance of innovating it through reflective practices and collaborative projects. Then, we will address the skills that need to be developed, to adapt students to the demands of today's societies. Similarly, we will explain the characteristics of modern students through the concept of digital natives, to identify what tools and methods can be used in order to facilitate meaningful learning of mathematics. Finally, we will be offering a discussion about the method that should be implemented and what studies exist to support its use. It is concluded that the Tics must be included in the teaching of mathematics because they are necessary to adjust to work and professional life.

1. Introduction

Over the last ten years, access and coverage of higher education has tripled in the Latin American and Caribbean context. However, according to the world bank the individuals who manage to access this type of education, only half of these are able to graduate to the estimated time, so it affirms that there is still much to be done, if spoken in terms of effectiveness and "quality". At present, educational coverage has had a great advance, since it is reported that around 20 million apprentices attend more than 10000 institutions, which provide around 60000 professional preparation programs [2].

However, higher education finds itself in a kind of ambivalence and a crossroads. Coverage has made progress, but the limited ability to adapt teaching and learning methods to the particularities of current apprentices and lax regulations by governments, have led to inquire, worry, reflect and question the quality of careers professionals. All these elements have also given rise to another concern: Students who have just graduated from a professional career are not prepared to face the demands and demands of working life; aspect that continues promulgating the questioning to the quality imparted of the higher education, within the Latin American and Caribbean context [2].

In Colombia, these phenomena are not unrelated, therefore, they are promulgated with greater force. According to the ministry of education of Colombia (MEN), the academic dropout rate reached 52% in private universities and 46% in public universities [11]. For the year 2016, the same MEN reported that desertion reached 46%, which means that almost half of the population that enters the university drop out academically and the figures have not had the expected reductions [10].

Against this, according to the MEN one of the aspects that are associated with this phenomenon are the so-called "institutional factors", which refer to the problems of administrative inefficiency, careers or obsolete programs, learning methods and outdated teaching and low levels of educational quality by the institution. Many times, these aspects hinder the integral development of the students [11].

In connection with the above, in accordance with these problems, we are interested in reflecting and addressing the importance of coupling teaching and learning methods in 21st century learners, that is, using and introducing information and communication technologies (ICTs) in the formative processes. This is because, it is possible to mitigate the impact of institutional factors, for which reason we argue that: “It should be further positioned to distance education and virtual, as this methodology seems to be really associated with the required inclusion, equity and social justice, these methodologies are emerging as the privileged means of access to higher education and consequently, as the most appropriate means to achieve a massive impact on the improvement of education levels and on the use of knowledge to increase productivity and competitiveness, without the endemic exclusions” [12].

Consequently, the inclusion of ICTs is an essential resource to strengthen higher education, since they promote social inclusion, and of course, significantly improve teaching and learning processes in relation to the biopsychosocial characteristics of students. This is why the following manuscript is intended to explain the importance of introducing the use of ICTs with current learners, which will be based on the teaching of mathematics. Indeed, at first, we will be explaining the disadvantages of continuing to use a traditional method of teaching mathematics. Then, we will explain the competences that students must develop based on the teaching of mathematics. Likewise, we will be explaining the learning styles of current students to argue why ICTs should be used within the educational processes of mathematics and finally we will be proposing a pedagogical proposal based on the fundamentals of flip teaching.

2. Method

The development of this article used as research method the bibliographic review of different academic articles. This method consists in preparing a text, based on the synthesis of different readings during the documentary research phase, followed by conclusions or a discussion [3]. With this method, we seek to systematize a variety of ideas by other authors, to allow the creation of other useful, original and practical text. Therefore, we propose to reference each of the objectives based on recognized authors, in order to offer scientific validity to the above.

3. The traditional method of teaching mathematics: Do you need to rethink?

The traditional way of carrying out the teaching of mathematics, is particularized by having as premise that the apprentice does not have previous ideas, and this is waiting to receive knowledge of this discipline through the transmission of their knowledge. Consider that the learner is empty with respect to mathematical knowledge, so the teacher must equip them with advanced content to develop their skills of quantitative reasoning. For this, the apprentice needs to maintain a passive attitude and total attention to what the teacher teaches, and students are expected to memorize and practice their teachings through the algorithmic solutions of academic exercises [13].

In addition, it is a teaching method that requires and requires classroom attendance, with the aim of directing learning through the teacher, who in his traditional role explains, clarifies and communicates experiences and ideas, which automatically makes the teacher and the apprentice are in the same space-time dimension. In this sense, the teacher has a role to guide the doubts of the students and they have the obligation to attend classes at a predetermined time to enter and exit.

In this context, the teacher is in charge of guiding the process, establishing the lines of learning that trainees must follow and providing them with educational resources. In fact, under this modality the teacher is the main protagonist who combines the use of resources such as his voice and the blackboard, through which he seeks to achieve an objective: "transmit knowledge". Based on these assumptions, it can be said that it is an academic, transmissionist, repetitive and memorial method, since the educator

expects that his apprentices replicate and reproduce as many times as possible, the solution of mathematical exercises [13].

In this model, the main indicator of learning is referred to in an evaluation of "technical knowledge", that is, the mechanistic application of mathematical processes. Through the teacher's judgments, it is determined if the student "understood" the nature of these processes.

However, the research and reflections of Larrañaga illustrate that the transmisionist and traditional method is associated with inert and isolated knowledge, and, therefore, lacking in meaning and functionality for apprentices. According to this author, face-to-face and traditional education can be understood as a passive and unidirectional process on the part of the apprentice, since everything depends on the teacher and the protagonist role that the student should have is left aside, which hopes to obtain a knowledge with meaning that can be used in everyday life. Even within their conceptions, they recognize that young adults tend to develop advanced functionalities of mathematics outside of school or university as a way to respond to the solution of problems that arise in everyday life [13].

For this reason, we recognize that there is a need to rethink pedagogical and didactic approaches to the teaching of mathematics, since practically their teaching is becoming a "waste of time" if not focused on a more functional, practical and "meaningful" direction. In addition, as could have been examined, this method is very rote, when the apprentices are expected to develop other more advanced cognitive functions, such as interpretation, decision making, understanding, the use of numerical data, analysing graphs and information quantitative and apply mathematical principles. Next, we will develop this topic.

4. Psychodidactic-constructivist approach: What mathematical competences should young people develop beyond mechanical memorisations?

The traditional method recognizes that learning is "Learning is acquiring and increasing my knowledge", "Learning is memorizing and reproducing knowledge" and "Learning is knowing something I did not know before"[9].

However, as we mentioned earlier, this conception of learning is associated with the decontextualization and inertia of memorized knowledge. This is because students do not develop the ability to "transfer knowledge" to factual reality. To do this process required to "assimilate", "understand" and "interpret" knowledge in a new meaning. That is, having the ability to "relate" the information assimilated with a relevant concept that exists in the previous ideas of the subject, in such a way, that it is possible to understand its transcendence and meaning in everyday life [9].

For this, it is necessary the importance of identifying the "learning by repetition" and "learning by understanding", because the first style is reduced to exact copies of the information acquired, however, the second style implies other more advanced processes, such as the interpretation and translation of information collected based on our previous ideas; something that allows the formation of new knowledge and more lasting discoveries [7].

But, why is it important to construct meanings, to memorize only the information? This is because the human memory tends to degrade or forget the inert and not very functional memories for the subject; on the other hand, the understanding, interpretation and construction of meanings allows "to find meaning"; which translates into the creation of new knowledge in an original and personal way. Therefore, the authors clarify that understanding should not be confused with an exact memory, but as a personal "translation" of what we learn [7].

Now, taking into account the above, what competencies should be developed so that mathematical knowledge becomes something meaningful and useful in current learners? According to the organization for economic cooperation and development (OCDE) are "mathematical competences", which refer to: The ability of an individual to formulate, employ and interpret mathematics in a variety of contexts. It includes mathematical reasoning and the use of mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena [1].

That is, what was mentioned previously: extrapolate the knowledge of this discipline to practical reality to carry out the description, explanation and prediction of the events experienced and experienced by the learner. Therefore, it is necessary to explain and demonstrate in the learners the meaning of this

knowledge, rather than being emphasizing the solution of decontextualized and meaningless exercises. To demonstrate these competences, it is necessary to apply the "formulation of mathematical situations", "the use of mathematical facts, concepts, procedures and reasoning" and the "interpretation, application and evaluation of results" [1].

The mathematical formulation is developed through the identification of events that involve the use of mathematical knowledge. In cognitive psychology, it is called "problem identification". Thanks to this process, it is possible to apply the "simplification" of the problem to establish the relevant mathematical "analysis". With these procedures, the subject will have the ability to translate the problem based on the concepts or representations of mathematics. Of course, the advanced manifestation of these processes also requires the use of "tics" to carry out the representation of mathematical relations inherent in a situated problem [1].

With respect to the use of facts, concepts, procedures and mathematical reasoning, these capabilities are manifested through the application of facts, rules, algorithms and mathematical structures, which facilitates the manipulation of numbers, data, graphic and statistical information, in addition to understand the expressions and the algebraic equations, as well as the knowledge of geometry. When these capacities are used in a significant way, the subject can carry out the "reflection" based on mathematical arguments, as well as the justification of the mathematical results [1].

Finally, the interpretation, application and evaluation of mathematical results are manifested through the interpretation of mathematical results within a situation, event or real context, which facilitates the rational evaluation with respect to the mathematical solution used. This allows the learner the ability to understand the degree and limits of concepts and mathematical solutions. Consequently, criticism and the identification of a mathematical model can be carried out to solve or evaluate the problem experienced [1].

To encourage these three fundamental skills, the teachings of mathematics should contemplate learning from: Changes and relationships: Refers to formulate and promote during teaching the identification of variables and relationships between quantitative data within a problematic situation, Quantity: refers to teaching the application of knowledge and numerical operations in different contexts of real life, Space and form: Refers to teach and encourage geometric reasoning, including visualizations, measurements and spatial algebra, Uncertainty and data: refers to teaching and proposing situations where variation, quantification, probabilities and possible margins of error occur with respect to the measurement of data and the results achieved, in the face of a problematic real-life event [1].

Now, taking into account the above, we will proceed to explain how the inclusion of ICTs allows the development of these skills and the significant assimilation of mathematical knowledge.

5. 21st Century students and knowledge and information societies: Arguments to include information and communication technologies in the teaching and learning of mathematics

Currently, the education system is submerged in the "information and knowledge societies", which are understood as those societies that develop and grow around the use of digital information, thanks to the massive use of ICTs. Without the Tics, the construction of new knowledge would not be possible, because there would be no way to use technological tools to help transmit and process information, and of course, the knowledge that is updated [8]. Consequently, in this type of society it is expected that apprentices can build new knowledge based on the information they have, so that in the long term they suggest new discoveries, reflections and solutions in relation to the concrete problems that arise in everyday life. through ICTs. For this, the educational system has as a challenge to promote the ability to generate knowledge about their reality and their environment, and with the capacity to use that knowledge in the process of conceiving, forging and building their future. In this way, knowledge becomes not only an instrument to explain and understand reality, but also an engine of development and a factor that encourages social change [8].

In essence, to promote the above, it is necessary that teachers promote the use of these tools to reorient the construction of knowledge in the apprentices, in such a way, that allows them to possess the critical thinking to take a position, and thus, solve a problematic through self-regulated learning.

On the other hand, it is also important that teachers promote the use of these tools to avoid students being excluded by the "digital divide", that is, they do not have access to information and knowledge, and consequently, can not develop his "digital skills"; aspect does not reduce the possibilities of adapting to the labor market [8].

Therefore, as a result of ICTs, according to Unesco, what is now known as "digital literacy" arises, which is currently a modern challenge of the educational system to encourage learners to analyze, organize, evaluate and understand the information making use of digital technologies. For this reason, millennial education has the challenge of forming "digital competences" in them, that is, developing in young people a series of knowledge, skills and attitudes associated with the effective use of information [8].

For this reason, another argument by which ICTs must be included, within the teaching and learning processes of mathematics, are the new features that the current students have developed. With the boom that ICTs have had in modernity, young people today are developing in the digital generation. Consequently, in the words of Marc Prensky we refer to the "digital natives", which refer to "the first generation that has grown with digital technologies and that are native to the language of computers, video games and the internet" [5], that is to say, this concept supposes the present apprentices are specialists in the use of computers, they possess abilities and ways of communicating with others and they have a great accessibility to the information. They are producers and consumers of most things that exist on the web and have created a new gap, called "alphabet-generational".

The previous thing, has caused that the present students want to obtain the information of immediate way, they feel tuned by the parallel processes and attracted by the multitasking, that render and work better when they are given the opportunity to work in network [4] , prefer the presence of graphics in texts and problem solving, have knowledge about the latest trends, which generates immediate reward and satisfaction and have a great sympathy for training in a playful way, which embark on the traditional methodology [6].

Indeed, these new trends, rewards and rewards that have generated ICTs in students, have caused them to develop other cognitive skills, very different from those used fifty years ago. Among these, we find the ability to analyze and read images, as they are considered as intuitive visual communicators [5], more developed visuo-spatial skills, due to their continuous experience with games, where they have the opportunity to integrate the physical with the virtual, quicker response times, because they have the ability to act quickly and expect to change responses quickly, the ability to discover inductively, because they can learn better through discovery, instead of having to give an explanation of things [6] and have the ability to do the attention deployment, since they have skills to suddenly divert attention from one task to another and may decide not to pay attention to aspects that do not interest him.

Consequently, apprentices have changed significantly, largely as a result of their experiences with ICTs outside the classroom. Therefore, it is necessary to understand that digital natives process and think the information in a very different way than their predecessors. So, what do digital natives expect from the education system? It should be noted that digital natives will not be satisfied if they do not receive an education that is not rigorous or is not directed immediately to the reality in which they develop, and even less, if they do not use the technological tools of their time. [5]. This is because digital natives do not want to reduce themselves to only theoretical talks, they want to be valued, respected, trusted and their comments are valued so that they are taken into account, prefer to follow their interests and passions, want to create using the technological tools of their time, want to constantly do their work with their peers in projects and avoid at all costs that the vagrants travel free, have a strong need for autonomy, so they hope to share control and make decisions, permanently wish to connect with their peers to express and share their comments in class and possibly around the world, want to compete and cooperate with each other and receive an education where it is not only relevant, but is connected with practical reality [6].

6. Implementation of the flip teaching method and discussion

Based on the above, we especially propose applying a more participatory, cooperative and active method for learning, than simply preparing a content and exposing it. Therefore, we recommend applying more challenging and reflective activities, as a way to leave evidence about what students build. In effect, we recommend applying "Inverted Teaching" or "Flip Teaching," which consists specifically of investing the classroom or, in other words, developing the lessons at home and homework in class. The logic of this method is based on reducing classes to receive knowledge based on an evidence-centered model. On the other hand, if the classes are transformed into spaces where reflective and challenging activities are carried out, depending on what the students do from their homes, the application of these activities is expected to make the training space more active, participatory and cooperative [15].

The important thing is that the apprentice arrives at the class with the lessons learned, so that this helps to have previous ideas to put into practice in the function of the activities proposed by the teacher. It is expected that these lessons learned will be carried out through the use of ICT to carry out a research project on the subject to be known [15].

In essence, to put the above into practice, it is advisable for students to: offer previous videos about the class they plan to teach. The idea is that it be observed in the house of learning in their free time, provide an activity, aimed at promoting the investigation of the subject and the meaning and use of the content to be taught. For that, you can offer forums, doubts, questionnaires or reflective questions that help the cognitive system of learning and create a series of previous ideas, simple and basic problems for the student to solve based on what he investigated and lead to conducted specific forums in the research activity [15].

In the case of the teacher, it is advisable to: select the learning outcomes, that is, specify the performance indicators that specify the conceptual change on the subject taught, perform feedback processes specified in the assigned research activity, provide explanations of the topic based on the students' misunderstandings, taking as reference the evidence of the research activity, select a real-life case where to use the knowledge researched and taught, so that the student can have a contextualization of the learning contents, seminar with the teaching of the subject through a group, research and reflexive activity, where students can exchange opinions, experiences and understandings. For that, it can be very useful to request learning blogs, infographics, abstracts, scientific research articles, request that they design examples of the contents learned [15].

As evidence of this method, we can find the case of Lluch, Pérez and Sanabria, who control a teaching experience in relation to the use of this methodology in university students. In their results, identifying that this method allows the acquisition of transversal competences, the finding of the meaning of the classes, allows to demonstrate what the students build and especially what fits different learning styles [14]. Similarly, we can find the case of Ortiz, who led a study applying this same method in high school students. In your results, conclude that these types of methods help the learner to learn "doing", that is, creating new content, reflecting and modifying them through feedback. For all this, the author states that it is specifically required that learning weaves an active willingness to participate as an essential condition of learning [16].

7. Conclusions

In general, we can conclude that the insertion of ICTs in the teaching of mathematics is a way to mitigate the negative impact that institutional factors can generate, especially when it comes to traditional methods. In general, we propose to include these tools and guidelines from a constructivist approach, so that apprentices can build new knowledge and discoveries based on the use of these tools. In the same way, with respect to the learning contents, we propose and focus under the PISA model, with the aim of the results of the mathematical competences and concordance with the current parameters (understanding the relationships, the quantities, the relation of variables, etc.). Likewise, we conclude that the inclusion of ICT is a way to promote digital literacy, which contributes to the apprentices being coupled under the demands of knowledge societies. In the same way, it is a way to facilitate the teaching of students because it adapts to their cognitive learning styles. Finally, we propose to apply the flip

teaching method, since it is a methodology that promotes the activity and the participation of the apprentice. This method can promote the construction of knowledge and allow evidence about the creation and meaning of students.

References

[1] Rico L 2007 La competencia matemática en PISA *Revista de Investigación Didáctica de la Matemática* **1(2)** 47
[2] Baisoti P 2018 *Higher education and citizenship in Latin America* (China: Sun Yat Sen University)
[3] Gómez L, Navas D, Aponte M and Betancourt L 2014 Metodología para la revisión bibliográfica y la gestión de información de temas científicos, a través de su estructuración y sistematización *DYNA* **81(184)** 158
[4] Ayala T 2011 El aprendizaje en la era digital *Revista Electrónica Diálogos Educativos REDE* **11(21)** 3
[5] Prensky M 2003 *Nativos e inmigrantes digitales* (Ciudad de México: Institución Educativa SEK)
[6] Prensky M 2001 Digital natives, digital immigrants, Part II: Do they really think differently? *On The Horizon* **9(6)** 1
[7] Pozo I 2008 *Aprendices y maestros* (Madrid: Editorial Alianza)
[8] Pérez R, Mercado P, Martínez M and Mena H 2018 La sociedad del conocimiento y la sociedad de la información como la piedra angular en la innovación tecnológica educativa *Revista Iberoamericana para la Investigación y el Desarrollo Educativo* **8(16)** 1
[9] Agama A and Crespo S 2016 Modelo constructivista y tradicional: Influencia sobre el aprendizaje, estructuracion del conocimiento y motivación en alumnos de enfermería *Index de Enfermeria* **25(1-2)** 109
[10] Ministerio de Educación de Colombia 2016 *Cómo va la graduación y la deserción en la educación superior* (Bogotá: Ministerio de Educación de Colombia)
[11] Ministerio de Educación de Colombia 2009 *En la educación superior colombiana* (Bogotá: Ministerio de Educación de Colombia)
[12] Orozco L, Suarez J, Olarte M, Cabanzo C and Beltrán A 2016 Estudio factores asociados a la deserción estudiantil en la Universidad Minuto de Dios de la sede virtual y a distancia *VII Conferencia Latinoamericana Sobre El Abandono En La Educacion Superior* (Cordoba: Universidad Tecnológica de Panama) p 1
[13] Larrañaga A 2012 *El modelo educativo tradicional frente a las nuevas estrategias de aprendizaje* (La Rioja: Universidad Internacional de la Roja)
[14] Lluch C, Pérez M and Sanabria E 2014 Investigación de impacto en un aula de matemáticas al utilizar flip education *Revista Pensamiento Matemático* **4(2)** 9
[15] Aguilera-Ruiz C, Manzano León A, Martínez-Moreno I, Lozano-Segura M and Casiano Yanicelli C 2017 El modelo flipped classroom *International Journal of Developmental and Educational Psychology Revista INFAD de Psicología* **4(1)** 261
[16] Ortiz I 2017 Flipped classroom en el aula de matemáticas (Almeria: Universidad de Almeria)