Mobile devices for the development of critical thinking in the learning of differential equations

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Mobile devices for the development of critical thinking in the learning of differential equations

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Abstract. The purpose of this research was to establish a relationship between mobile devices and the development of critical thinking in students of the differential equations subject. The research had a quantitative and qualitative methodological approach with quasi-experimental design, the sample was 110 students. Results: The integration of mobile applications favored and motivated the learning of the applications of differential equations, where the student develops critical thinking at the moment that creates, discovers, imagines and assumes. At the same time, when interacting with colleagues, it implements autonomous and collaborative learning, with the ease of access to information. Conclusion: Regarding the perception of students about this tool, 40% highlight its usefulness in understanding the topics and 51.2% step by step methodology. The average age of the students was 20 years with a standard deviation of 2.01 years.

1. Introduction

Differential equations are a discipline of the most important mathematics, due to its applicability in all sciences and areas, that much of the technological development of the XXI century rests on its field of use, therefore it is a mandatory area in the I study exact sciences, social sciences, and basic science careers.

Despite the fact that within the school system, the calculation occupies a privileged place, in the sense that before it is the "elementary mathematics"; and after it begins advanced mathematics, and it is here that one begins with the difficulties and complexities of a relatively new field of study [1]

The teaching-learning problems of calculus at the level of higher education are persistent, so the dropout is alarming. As a response to this problem, several research works have arisen in the field of educational mathematics [2-4].

Of the various studies that have been conducted on how to improve poor performance in mathematics are in 2005, the “Instituto Oficial Mixto Leónidas Méncos Avila, Tiquisate”, said that a determining factor for low academic performance in the area of mathematics was given by the methodology used by the teacher, which was not motivating. On the other hand, universities have determined the importance of building teaching tools that overcome traditional teaching methods, thus making the inclusion of some applications of differential equations according to the different professional profiles of young people in training in different contexts.

According to [5] in France, I determine that students perform algorithmic procedures, without taking into account the concepts. Although we cannot ignore that the problems of failure of the courses of calculation are due to problems of other branches of mathematics such as algebra.

Deepening even further in those opinions, in that if the student does not know how to add, multiply or develop algebra exercises as most of the current traditional calculus courses conceive it, we can say that the reason for his failure in teaching in of this, it is polarized in two extremes, which are: The strong operational load, which causes a conceptual deterioration [2] and the teaching of calculus exercised with a strong inheritance of formal mathematics [2,3].

From the pedagogical point of view, the introduction of mobile devices in higher education causes transformations in teaching and learning processes, in pedagogical strategies, in the use of spaces, in the use of the cultural environment, in the roles of subjects [6]. Currently these are considered a great potential as a tool in the field of teaching [7], where you can get to develop skills of critical thinking and reflective of the student because it adapts to any educational environment and teaching methodology.

The challenge of the current teacher is to take advantage of the potential of mobile devices, where the student is involved in their learning [8], creating teaching situations that develop their skills and skills where they integrate theoretical and practical knowledge, in turn thinking critical thus achieving significant learning through these new technologies [9,10].

The current society that surrounds us is determined by knowledge and information; being very competitive, dynamic and complex [11]. Where the role of new technologies is to generate educational scenarios that help us to motivate learning, where the development of different educational scenarios that lead to a better adaptation of the needs of students is favored [12,13].

The flexibility of access to information collaborates in autonomous learning and teamwork where learning can be developed in different ways, developing professional skills and significant learning [9]. According to [14], critical thinking skills are encouraged to analyze, criticize, judge, evaluate and contrast.

With the above described has generated a cultural revolution with the use of mobile devices, it has changed all the patterns of our lives and therefore, must also make great changes in education [15].

2. Methodology

The methodology of this research is quantitative and qualitative with a quasi-experimental design where didactic activities are carried out with pretest and post-test questionnaires, of a descriptive type, since from a selected sample it is sought to characterize this analyzed group, according to the characteristics and variables of interest of the study and field, since the information will be collected in the field of action and without any manipulation by part of the researchers.

A mobile application with applications of differential equations was designed as a support resource to improve learning in an interactive way, for the elaboration the contents are structured according to the subject that has interest for the student, facilitating a quick location of access to the data that they are required where the learner reaches the necessary knowledge in the training process [16]. For the design of the mobile application requires basic knowledge of XML language (necessary for the design of the graphical interfaces that appear in the app) and Java language (necessary to program the functions of the app and link these with the interfaces). The instrument used was a structured guide that allowed identifying participants' perceptions regarding the fulfillment of competencies and skills in differential equations, as well as detecting needs when using a mobile application.

The design of the research is transversal in nature, since the information was collected and analyzed for a specific academic period. The population was conformed by students of the “Facultad de Ingeniería, Universidad Francisco de Paula Santander”, enrolled in the subject of differential equations.

3. Results

For the characterization of the students, the sample was analyzed according to the age and gender of the students. The sample consisted of 110 students, 54.5% correspond to male students and 45.5% female students. The average age of the group was 19.84 years with a standard deviation of 2.01 years.

Table 1 shows other characteristics of the group that made up the study sample. The majority of the group possess a mobile device, equivalent to 89.1%. Regarding the subject, 78.2% attended it for the first time and approximately 85% of the group came from official institutions. Among other characteristics of the group, it was found that 56% of the students use the mobile device to communicate, and only 18% use the mobile device in the educational environment.

Table 1. Characteristics of the group.

		Gender				Total	
		Male		Female			
		f	%	f	%	f	%
Disp. Mobile	Yes	51	46.4%	47	42.7%	98	89.1%
	No	9	8.2%	3	2.7%	12	10.9%
	Total	60	54.5%	50	45.5%	110	100.0%
Repeating	Yes	10	9.1%	14	12.7%	24	21.8%
	No	50	45.5%	36	32.7%	86	78.2%
	Total	60	54.5%	50	45.5%	110	100.0%
School	Public	47	42.7%	46	41.8%	93	84.5%
	Private	13	11.8%	4	3.6%	17	15.5%
	Total	60	54.5%	50	45.5%	110	100.0%

According to Figure 1, the average performance index in the students' career is 3.55 points with an approximate standard deviation of 0.34.

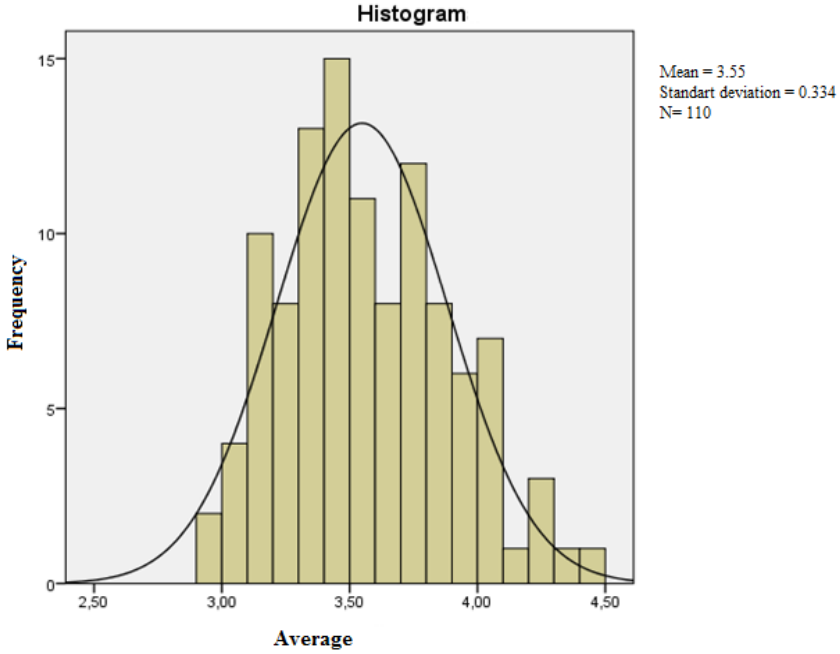

Figure 1. Frequency histogram of student averages.

The evaluation made in the pretest the average was of 3.15 points and in the evaluation of the posttest it was of 4.1 points, what we can affirm that the initial conditions of the group are heterogeneous where students with academic difficulties are presented and in contrast in the results of the posttest after the intervention of the teacher from the strategy of the mobile device reflect better performance.

Regarding the use of mobile devices in the teaching-learning process, the following aspects were considered: the one related to the subject of differential equations and the perceptions of the students; 40% highlight the usefulness in understanding the issues and the applicability to solve real problems

related to the subject, where technology is used as a tool to generate knowledge, through cooperation between colleagues who share their concerns and knowledge.

The preferences found by the students highlights the importance of the step-by-step methodology with 51.2%, at the same time with 33.7% give importance to the content of the theory, examples and exercises to solve, where this helps to promote the interest and approach of different methods of solution.

Table 2 gives other assessments regarding the objective achieved, with 42.7% highlighting the support given by the mobile device as a tool to solve problems related to everyday situations. Using mobile devices, critical and autonomous thinking skills are developed in learning, where the strategies used in the classroom are complemented [17]. The student creates their own criteria that allow them to select the material and decide how they want to carry out their learning process.

Table 2. Objectives achieved through the mobile application, according to the student's perspective.

Objective reached							
Use the mobile application in problem situations with differential equations		Understand the topics with greater complexity using tools that facilitate the development of the subject		Skill and knowledge when solving real-life problems using differential equations		Total	
f	%	f	%	f	%	f	%
44	40.0%	47	42.7%	19	17.3%	110	100.0%

These evaluations show that through innovation in the classroom, on the part of the teacher [18], involving students they appreciate the detail of the methodology when solving problems, they evolve between what they thought they knew and what they know, what they need know, where they recognize concepts, examples and prepare them for their own evaluations of the subject.

4. Conclusions

Through the incorporation of mobile applications in the teaching of differential equations, the student explores, interprets, deduces and develops applications favoring academic performance. The use of the mobile application motivates the learning of the differential equations, achieving a complement to better understand the knowledge, optimizing the classes in the theme of the applications of differential equations.

Reflection processes are developed improving the quality of teaching through the use of mobile applications, where the student feels supported to understand complex subjects of the subject; where he becomes the architect of his own learning by developing his own learning processes.

The teacher must acquire a methodology of change of attitude towards teaching, where the student makes a step by step of the subjects of the subject interacting with their peers in a collaborative and playful way strengthening the learning processes, its use represents a complement tool in pedagogical work. The results obtained with the use of mobile devices determined that these can help students to develop critical thinking and to appropriate their learning. Student interaction with peers stimulated exploration, collaborative work, autonomous learning and reflective thinking.

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