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Educational tasks with GeoGebra in the Higher Mathematics I to Accounting and Finances

Tareas docentes con GeoGebra en la Matemática Superior I para Contabilidad y Finanzas

Tarefas de ensino com GeoGebra em Matemática Superior I para Contabilidade e Finanças

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ABSTRACT
The current development claims the formation of competent professionals able to use the scientific and technological development. In this investigation the historical-logical, hypothetical-deductive, systemic-structural methods, documentary analysis, observation, pedagogic tests and statistical methods were applied. The Carried out diagnosis allowed to detect Insufficient academic results in the students of this career in three successive school courses, as well as the use of the computer resources is limited in the process of Teaching L earning of the Higher Mathematical I. The objective of this paper consists on proposing a system of educational tasks with the use of the GeoGebra in the Process of Teaching Learning of the Higher Mathematical I in the career Degree in Accounting and Finances of the course for encounters of the Municipal University Center of Consolacion del Sur that allows to elevate the quality of the learning in these students. These tasks were characterized to use the GeoGebra like half of teaching learning, learning object and work tool, establishing excellent bonds among the mathematical contents of this subject with the relatives to the professional profile keeping in mind the individual differences of the students. In the instrumentation of the educational tasks computers, telephones and pills were used. When introducing the tasks in the practice you could verify that the students reached improved outcomes in relation to those obtained in the three previous courses.

Key words: Educational tasks; GeoGebra; Mathematics; Teachin g Learning Process.

RESUMEN
El desarrollo actual reclama la formación de profesionales que utilicen los avances científico y tecnológico en su esfera de actuación. En esta investigación se

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aplicaron los métodos histórico-lógico, hipotético-deductivo, enfoque de sistema, análisis documental, observación y métodos estadísticos. El diagnóstico realizado permitió detectar insuficientes resultados académicos en los estudiantes de esta carrera en tres cursos escolares sucesivos, así como que es limitada la utilización de los recursos informáticos en el proceso de enseñanza aprendizaje de la Matemática Superior I. El objetivo de este trabajo consiste en proponer un sistema de tareas docentes con el uso del GeoGebra en el proceso de enseñanza aprendizaje de la Matemática Superior I en la carrera Licenciatura en Contabilidad y Finanzas del curso por encuentros del Centro Universitario Municipal de Consolación del Sur, que permita elevar la calidad del aprendizaje en estos estudiantes. Estas tareas se caracterizaron por utilizar el GeoGebra como medio de enseñanza aprendizaje, objeto de aprendizaje y herramienta de trabajo, estableciendo vínculos relevantes entre los contenidos matemáticos de esta asignatura con los relativos al perfil profesional teniendo en cuenta las diferencias individuales de los estudiantes. En la instrumentación de las tareas docentes se utilizaron computadoras, teléfonos y tabletas. Al introducir las tareas en la práctica se pudo constatar que los estudiantes mejoraron sus resultados académicos que los obtenidos en los tres cursos anteriores.

Palabras clave: GeoGebra; Matemática; proceso de enseñanza y aprendizaje; tareas docentes.

RESUMO
O desenvolvimento atual exige a formação de profissionais que utilizem os avanços científicos e tecnológicos em seu âmbito de atuação. Nesta pesquisa foram aplicados os métodos histórico-lógico, hipotético-dedutivo, abordagem sistêmica, análise documental, observação e métodos estatísticos. O diagnóstico realizado permitiu detectar resultados acadêmicos insuficientes nos alunos desta carreira em três anos letivos sucessivos, bem como que a utilização de recursos informáticos é limitada no processo de ensino-aprendizagem da Matemática Superior I. O objetivo deste trabalho consiste em propor um sistema de tarefas pedagógicas com a utilização do GeoGebra no processo ensino-aprendizagem de Matemática Superior I no curso de Bacharelado em Contabilidade e Finanças do curso por meio de reuniões do Centro Universitário Municipal de Consolación del Sur, o que permite elevar a qualidade de aprendizagem nesses alunos. Estas tarefas caracterizaram-se por utilizar o GeoGebra como objeto de ensino-aprendizagem, objeto de aprendizagem e ferramenta de trabalho, estabelecendo ligações relevantes entre os conteúdos matemáticos desta disciplina com os relacionados com o perfil profissional, tendo em conta as diferenças individuais dos alunos. Computadores, telefones e tablets foram utilizados na instrumentação das tarefas de ensino. Ao introduzir as tarefas na prática, constatou-se que os alunos melhoraram seus resultados acadêmicos do que os obtidos nos três cursos anteriores.

Palavras-chave: GeoGebra; Matemática; Processo de ensino e aprendizagem; tarefas de ensino.

INTRODUCTION

Higher Mathematics I Course provides the knowledge and skills that requires professional model for the Bachelor of Accounting and Finance to exercise their profession effectively. Its contents are used in other disciplines of the study plan of this career and in the exercise of the profession.

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Higher mathematics I was taught in the first half of the career in both modes, with 80 hours classroom and 32 for a blended format. It is designed to lay the foundations so that the student can appropriate the power that Mathematics grants to study and solve the problems of today's world in a dynamic context and fulfill the professional role assigned to them today.

He is the antecedent of the subjects Higher Mathematics II, Operations Research, Mathematical Statistics and Econometrics. This subject teaches most of the basic concepts related to elements of logic, work with functions, as well as the differential and integral calculus of real functions of a real variable, which are important preconditions for the mathematical subjects that follow.

In order to achieve an efficient Learning Process in Higher Mathematics I, it is pertinent to carry out actions, in the form of a system, by teachers and students according to the objectives of the program.

From the systematization of the studies carried out by Álvarez (1999); Silvestre and Zilberstein (2002); Mass (2010), Asencio (2020); López, Castro and Baute (2017); García, Leyva and Guerra (2017), among others, the teaching task has been characterized as the activity where the actions and operations to be carried out by students and teachers are specified, according to certain objectives, based on certain didactic requirements in contextualized conditions.

According to Alvarez, CM (1999) in the teaching task teacher an objective, knowledge to assimilate, an ability to develop a value to form are present. The method in the task is the way in which each student acts in order to appropriate the content and the evaluation checks if it was executed correctly.

At present, it is recognized at a worldwide that the use of new Technologies of Information and Communications (ICT) in the Process of Teaching and Learning (PEA) of the different curriculum subjects enhance the quality of learning the students who participate in them .

Among the technological resources that are used in education for these purposes is GeoGebra, which is considered by Hohenwartery Hohenwarter (2009), as an "interactive mathematics software that dynamically brings together geometry, algebra and calculus" (p.13).

This was created at the University of Salzburg, Austria, in 2001, for the teaching of Mathematics. He is currently continuing his development at Florida Atlantic University, United States, with a collaborative mindset. The official page has help, forums and wikis that users worldwide keep in constant renewal.

This software establishes a permanent connection between algebraic symbols and geometric graphs; it has the characteristics of the Dynamic Geometry and Symbolic Calculus and incorporates a spreadsheet. Among its features, it makes it easy to create dynamic web from constructions, it addresses geometry in a dynamic and interactive way to visualize mathematical content that is difficult to deal with with static representations.

The teacher, using the GeoGebra, can create static or dynamic materials that support the Process of Teaching-Learning; In addition, you can design activities for students to perform manipulations based on finding relationships, obtaining assumptions, and checking results.

The student can manipulate already elaborated constructions, transform them according to their needs and carry

out constructions following the step-by-step method (directed) or carry them out independently for the solution of exercises or research (open).

Since the very emergence of the Computer, computing resources have been used in the Teaching-Learning Process of Mathematics. Mathematical wizards can be grouped into algebraic calculus system and dynamic geometry system. In particular, Geogebra, is a dynamic geometry system that contains elements of the algebraic calculation system.

For the use of GeoGebra, Borbón (2010, 2018) has prepared materials that illustrate the use of GeoGebra features in the form of a manual.

At the University of Pedagogical Sciences "Enrique J. Varona" in Havana, an investigation is being carried out on the use of Geogebra in the PEA of Mathematics.

Robaina (2017) referred to the intention of the systemic integration of GeoGebra as a teaching and learning medium, learning object and work tool in the PEA of Mathematics. This systemic integration constitutes a gradual process of interactions, in which one passes from interdependence to independence, which constitutes one of the basic requirements for the so-called *developer learning.* It is also aimed at achieving *significant learning* from the motivation for the learning of Mathematics and GeoGebra of the students in the social and instrumental mediations, which occur in the use of GeoGebra in the PEA of Mathematics.

According to Rodríguez, R. *et al.* (2000), the GeoGebra can be used as:

- *A teaching and learning means* where the teacher must make tampering with the software and the student imitates the behavior (autoplay drawn animation, hand -drawn animation or moving objects that can include the work with sliders). The student takes the teacher as a model.
- *Learning object* where the teacher works with step-by-step constructions and the student, following directions, meets the requirements. This includes preparation for the creation of teaching and learning media. It is recognized that when using it as a teaching and learning medium, t he construction protocol should be used to prepare the student for the performance of the tools.
- *Working tool,* the teacher should lead to situations where students use performance tools for the production of assumptions, verification of results and solving exercises.

From our point of view, the advantages of using GeoGebra in the PEA of Mathematics are:

- Focuses the student's attention on the conceptual aspect as the basis of mathematical knowledge, fostering the conditions for the systematization of mathematical knowledge from the recurrence to the conceptual.
- Contributes to raising motivation towards learning Mathematics, enabling a more dynamic and interactive learning.
- It reinforces the subject-object interaction of knowledge, since the student can corroborate their results, repeat actions autonomously, feeling part of and responsible for their actions when interacting with the software.
- Stimulates the development of different ways of thinking, particularly divergent.
- Reinforce the use of heuristic resources, using mathematical

content for obtaining and applying knowledge to interact with the software and with others in the pursuit and application of knowledge.

- Propitiate the development of independent work, reduces the time spent learning new content and enables more efficient learning.
- Reinforce educational activities of the teacher to the sustained debate and reflection, encouraging cooperative learning by using the constructive use of the error.
- Improve the differentiation of teaching based on the real needs of students from the multiple relationships that are established with the use of GeoGebra.
- Systematize the theoretical aspects of mathematics from its practical application to situations of the educational context.
- Stimulates the use of ICT, developing skills in managing them.
- It enables the use of other technological resources such as telephones, depending on the possibilities of each student.

Among the investigations carried out by the authors, investigations were found where GeoGebra was used as a teaching and learning medium, as a learning object or as a work tool, with limited integration of these. No history of its use in the Bachelor of Accounting and Finance career was determined.

Therefore, it is intended to solve the following *problematic situation:* the need to raise the quality of learning of the Higher Mathematics I subject in students of the Bachelor of Accounting and Finance course of the course by meetings.

To this end, it is proposed as the main objective of this paper a system of teaching tasks using the GeoGebra in the Teaching-Learning Process of Higher Mathematics I in the Bachelor career in Accounting and Finance course for meetings of the Municipal University Center (CUM) of Consolacion del Sur, which allows raising the quality of learning in these students.

MATERIALS AND METHODS

Dialectic was used as a general - materialistic method, to guide the research process. In order to perfect the PEA of Higher Mathematics I in the Bachelor's degree in Accounting and Finance, and in particular the quality of student learning, the following methods were applied: historical-logical , which allowed the study of its trajectory, operation and developing; hypothetical-deductive, to forecast, verify, infer hypotheses and establish predictions from their knowledge system; The system approach was directed to its modeling from the determination of its components and relationships; the non-participant observation, to determine the use of computer resources during development face meetings and the participant to assess the effectiveness of the introduction of teaching tasks using the GeoGebra and, statistical methods, were applied to describe and analyze the data obtained from the quantitative information collected. A place stands do during this process took the method of a documentary analysis that allowed the review of:

The attendance records and evaluation of school years 2015-2016, 2016-2017 and 2017-2018 , to determine the academic results obtained by the career in Accounting and Finance Degree Course Higher Mathematics I that conform to

categories E, B, R or M established by the normative documents of the MES.

The lesson plans of this subject, to assess the incidence of teaching work on the insufficient academic results of the students.

The guidelines, for the training of the Bachelor of Accounting and Finance (MES; 2016), the programs of the Mathematics discipline and the Higher Mathematics I subject.

The material resources used consisted of the use of computers, tablets and mobile phones.

The population used in the diagnosis stage was the students of the 2015-2016, 2016 - 2017 and 2017-2018 school years of the first year of the Accounting and Finance career of the CUM Consolación del Sur meeting course , while in the stage empirical validation he worked with students of first year of the current school 2018-2019 .

RESULTS

During the diagnosis stage, when reviewing the documents related to the academic achievement of the students, the results that are reflected in the following table were obtained:

Table 1- Results in the evaluation categories during three school years.

COURSES	FINAL ENROLLMENT	EVALUATION							
		E	%	B	%	R	%	M	%
2015-2016	20	0	0	3	15.0	7	35.0	10	50.0
2016-2017	15	0	0	3	20.0	5	33.3	7	46.7
2017-2018	18	0	0	2	11.1	6	33.3	10	55.6
Total	53	0	0	8	15.0	18	34.0	27	51.0

When analyzing the lesson plans for this subject used in the three aforementioned school years, it was possible to determine:

- A limited design for the interaction of students with teaching - learning computer means.
- Insufficient planning of the use of computer resources for solving exercises.
- The dynamic potentialities of computer resources were not used for the treatment of the mathematical conceptual basis.

The initial observation carried out to determine the use of computer resources during the development of the face- to- face meetings allowed to establish:

- An insufficient use of computing resources face meetings.
- Students are not offered opportunities to use computer resources.

In the normative documents of the grade, the need to use computer resources is recognized, but suggestions for students to master their services independently are not established in the methodological guidelines.

In integrating the above results could infer the relevance of developing a scientific result that allow to elevate the quality of the learning in Higher Mathematics I course using the GeoGebra. The conceptual base of the contents of Higher Mathematics I of the Accounting and Finance Career constitutes the premise for the use of GeoGebra. The way of establishing integration is based on a system of teaching tasks that resort to the use of Geogebra as a means of teaching - learning, learning object and work tool.

The teaching task system has the following structure:

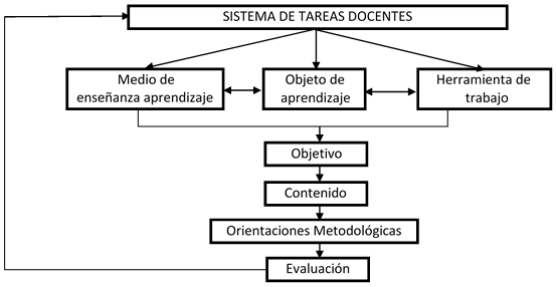

Chart I. Structure of system of teaching duties

This system has been characterized by:

- Establish close links between the mathematical contents of the subject Higher Mathematics I with those related to the professional profile of the career.
- Use GeoGebra in mathematical instrumental mediation as a teaching - learning medium, lear ning object and work tool.
- Differentiate each task according to the individual diagnosis of the students.
- Promote motivation for learning Mathematics by gradually increasing communication and activity.

Within the system of teaching tasks used in this research process, an example will be presented here:

Homework 1:

Objective: To solve problems of the economic sphere approximated by applying the differential of a function using GeoGebra as a teaching - learning.

Content:

I. The daily production of the "El Mamey" mini canning factory, located in the town of Herradura, is given by Q where x represents capital in hundreds of pesos. If the current capital is $ 1 5 0 1 and it increased by $ 40 per day.

a) Determine approximately by how much the daily production increased.

b) Find this increase more precisely.

c) Compare the results of the previous sections.

II. Function $B(x) = 60\sqrt{x} - x - 100$ represents the profit that a manufacturer obtains from producing and marketing a certain product, where "x" represents the number of units sold each day. If 25 units are currently being manufactured and sold daily, roughly estimate the additional profit generated by the production and sale of unit 27. Interpret the result.

III. Visit a productive entity in your locality to collect information from the previous month on the daily behavior of cost, income or benefit.

a) Use the data to model your behavior using a function.

b) From this function and specific data, I elaborated a problem related to the approximation of the increment of the function by means of the differential.

c) Solve the problem with pencil and paper and check the results using the GeoGebra.

Methodological Guidance for carrying out the task:

For exercise I

a) The student will be motivated by raising the need to use the meaning of the derivative to find a way to solve this problem in an approximate way. For this purpose it is used the dynamic potential

of the GeoGebra for this approach in general (a teaching - learning).

b) The problem will be solved more precisely using the student's knowledge of the increment of a function. GeoGebra will be used to verify this result using the step-by-step method (learning object).

c) It will be verified that the results are similar and this conclusion will be justified from the mathematical point of view.

For the years II and III

To solve this problem, using GeoGebra as a working tool, three phases are considered: before, during and after construction.

The preliminary phase is developed with paper and pencil to determine the characteristics that must be present in the construction. Conclude with the development of a construction plan.

In the act of construction, what is planned is executed. In some cases, certain innovations are made as a way of perfecting what is planned.

After the construction, the efficiency of the planned and executed actions, as well as the elaborated plan, is evaluated. Perspective views of the instrumented benefits are made.

Evaluation: It will use the potential of self - assessment, peer assessment and hetero to integrate valuations of actions performed. The stimulation of individual and collective progress will be taken into account.

The teaching tasks were introduced during the second semester of the 2018-2019 school years in the development of the face-to-face meetings and also in the self-preparation of the students. They were controlled in the consultations and the meetings themselves.

The main limitation detected was that not always all the technological resources were available for its effective implementation.

The participant observation carried out allowed to verify that, progressively, the students improved their learning in the contents of this subject and at the same time reflected a growing motivation towards study, both of the subject and of the career. The latter was verified when verifying how punctuality and attendance at face-to-face meetings and consultations, participation in the meetings, as well as the quality of the performance of the tasks improved.

As a measurement criterion to determine how the quality of learning in these students has increased, the increase in the evaluative categories obtained in the pedagogical tests applied as the final exam of the Higher Mathematics I subject was taken into account.

The following table compares the results of this learning of the students of this career in the first year as a historical average in the three courses prior to 2018-2019 with those of the latter.

Table 2- Comparison of results in the evaluation categories of different school years

Courses	Final Enrollment	Evaluation							
		E	%	B	%	R	%	M	%
2015-2018	53	0	0	8	15.0	18	34.0	27	51.0
2018-2019	10	1	10.0	4	40.0	4	40.0	1	10.0

DISCUSSION

From The diagnostic step performed between 2015-2016 and 2017-2018 school years it should infer that the academic performance of students in this career were not enough, to having a historical average of 50% of students tested poorly and none evaluated excellent, so the quality of their learning

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is not adequate. These results could be improved if computer resources are used in the Teaching Learning Process this subject, particularly GeoGebra, taking advantage of their potential, to being created for education and possess a dynamic and interactive environment that connects a graphical view, algebraic view and spreadsheet. This enables the use of this software as a teaching - learning medium, learning object and work tool.

Carrillo de Albornoz (2013) referred to the use of GeoGebra in symbolic calculation, emphasizing the benefits of the software for the PEA of Mathematics. Notably, it was not necessary a hierarchical order in the didactic actions to implement in classes for learning the GeoGebra.

On the other hand, Hernández, Briones, Serdeira and Medina (2016) addressed the instrumental and social mediation in the use of GeoGebra based on student-student, student-teacher, and student-group and teacher-group communication.

Yemail (2017) uses GeoGebra for modeling and simulation in the study of situations with area and volume measurements.

López, AM, Arnaiz, I., Barrios and Rodríguez, JA (2018) used GeoGebra to solve geometric optimization problems.

These results agree with those used in this investigation. A new aspect has been incorporated learning in the GeoGebra Process of teaching Learning Mathematics, from the use of a system of teaching tasks.

During the implementation of the teaching tasks in the PEA of the Higher Mathematics I subject in the Bachelor's Degree in Accounting and Finance, the elevation of the quality of learning of these students was confirmed, based on the increase in the evaluation categories obtained in the final exam of this subject. Another positive aspect detected consisted in the progressive increase in the motivation of these students for the subject and for the career itself.

However, it could be more effective if a greater amount of technological resources had been available to support a better visibility of the GeoGebra software.

In the future they could be conceived teaching tasks where other established inter relations discipline with the use of GeoGebra as a valuable teaching resource and that this part of the mathematical content to study .

For the above, it can be established that use of the GeoGebra software in the PEA of Higher Mathematics in the Bachelor career in Accounting and Finance course for meetings of the Municipal University Centre (CUM) Consolation del Sur, allowed to raise the quality of learning in these students.

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Conflict of interest:

Authors declare not to have any conflicts of interest.

Authors´ Contribution:

Manuel Capote Castillo: Conception of the idea, general advice on the topic addressed, literature search and review, translation of terms or information obtained, preparation of instruments, application of instruments, compilation of information resulting from the applied instruments, statistical analysis, preparation of tables, graphics and images, database preparation, writing of the original (first version), review and final version of the article, correction of the article, review of the applied bibliographic standard. .

Ildefonso Robaina Acosta: Conception of the idea, general advice on the topic addressed, literature search and review, translation of terms or information obtained, preparation of instruments, application of instruments, compilation of information resulting from the applied instruments, statistical analysis, preparation of tables, graphics and images, database preparation, writing of the original (first version), review and final version of the article, correction of the article, review of the applied bibliographic standard.

Marisol Capote Areces: Conception of the idea, general advice on the topic addressed, literature search and review, translation of terms or information obtained, preparation of instruments, application of instruments, compilation of information resulting from the applied instruments, review and final version of the article, correction of the article, review of the applied bibliographic standard.

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