Section A-Research paper
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Learning and reasoning through software, a proposal for the sustainability of higher education and foreign language proficiency in Ecuador

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Abstract. The development of computational thinking and the construction of digital citizenship is part of Ecuador's approach to education in digital skills to understand the risks and challenges that life imposes in the digital age, in this way the human being must acquire the capacity to solve problems, design systems and understand human behavior with a variety of mental processes linking active methodologies that allow the teaching-learning process to adapt to digitalization, so this research project aims to implement GeoGebra software in the study of the definite integral for the determination of the incidence in the academic performance of the high school students of the Educational Unit San Francisco, developing under a quantitative approach with a quasi-experimental design with a sample of 110 students belonging to the third year of high school separated into two groups: 38 control group and 72 as an experimental group. During the diagnostic phase, a survey was applied to the students who estimated that it is important to implement technological tools in the study of the definite integral to motivate, improve the teaching process, develop skills and improve their academic performance, estimating in this way as software To GeoGebra, the same pre test that determined the homogeneity of the groups was also developed; Continuing with the research process during the foundation phase, the operation of the software was investigated as well as the distribution of the contents of the defined integral to design the plans in phase 3 and apply them during the implementation phase, being the second part of the second semester. ; At the end of the implementation for the respective validation, a post test was carried out, obtaining an average of 6.32 for the control group and 7.18 for the experimental group. Using the T Student analysis, a calculated t of 2.09 and a Critical t of 1.98, thus rejecting the null hypothesis and accepting the alternative. This is how it is concluded that the implementation of the GeoGebra software in the study of the definite integral has a significant impact on the academic performance of the high school students of the San Francisco Educational Unit.

Keywords. Integral, academic performance, digitalization, sustainability, foreign languages.

I. INTRODUCTION

The teaching of mathematics has become a challenge for secondary school teachers who, in search of achieving the learning expected by their students, have used different methodologies and resources that the medium offers them (Rivera, 2014), however, despite the fact that technology is an ally in the education of the XXI century, the traditional methodology is still used with tools such as: TPL (chalk, blackboard and tongue).

In this way, the way in which the teacher presents mathematics is evidenced worldwide a high rate of low performance due to the rejection and detachment that the student has towards it (López-Quijano, 2014), being necessary to reflect on the didactic resources that can be used according to the sociocultural environment of the student to maintain an interaction between teachers, students and a half, even more so in the virtual stage.

According to the results of the PISA-D 2018 tests, it shows that in Ecuador learning in Mathematics is not significantly achieved, showing difficulties to function in situations that require the ability to solve mathematical problems, having as results 377 out of 1000 remaining within level 2 of performance. Jorge Vielma, Ph.D in Mathematics, director of the Department of Mathematics of ESPOL states that Ecuador is in intensive care in Mathematics according to the results, so it is important to look for strategies, resources, tools, to improve the process of teaching and learning of Mathematics at all educational levels. (THE UNIVERSE, 2019).

Previous research shows that one of the most modern ways to bring students closer to reality is the use of technology, mathematical concepts are not real objects so incorporating educational software for the teaching and learning of mathematics is a necessity in the current context at different levels (Mamani, 2020). The dynamic geometry software GeoGebra has been promoting new forms of interaction inside and outside the classroom, which is why there is currently several investigations that

point to its use to improve the academic performance of students.

According to the analysis of the SWOT established by the students of Third B.G.U. of the Educational Unit "San Francisco" is considered as a research problem the scarce management of mathematical software that links the contents of Mathematics with everyday applications, thus becoming a repetitive study topic full of formulas to be used and hundreds of exercises to solve. Similarly, teachers of Mathematics and Physics state that the academic performance of students is low in Mathematics, even more so when working the integral calculus unit, which must be worked quickly without fully reaching the skills with both basic and essential performance criteria.

Within this context, the research problem in the "San Francisco" Educational Unit has different causes such as the outdated teaching technology, inadequate didactic methodology, absence of activity planning, time, limited use of didactic technological resources, scarce relationship of application problems with the contents; having as effects the disinterest of students to handle technological tools, unsatisfactory understanding, improvisation, monotonous classroom work, lack of development of skills with performance criteria and therefore low performance.

The present work focuses on determining how does the implementation of GeoGebra software contribute to the study of the integral defined in the academic performance of high school students of the San Francisco Educational Unit?

2. MATERIALS AND METHODS

Research, methods and approach

The present degree work is based on a quantitative approach because it is oriented to experimental studies, maintaining a quasi-experimental design where we will work with two groups, the control and the experimentation, aimed at third year high school students.

Explanatory research was also considered, since it established how the implementation of GeoGebra software contributes to the study of the defined integral in the academic performance of students.

With the two groups we worked on the same contents of integral defined during a period of 2 sessions per week, being an approximate time of 14 sessions for each group according to the class schedule. For their respective treatment, their grades obtained in the pre-test as well as in the post-test were analyzed and through a statistical analysis it was known how the implementation of the GeoGebra software influences the academic performance of the students.

The methods used for the implementation of GeoGebra software in the study of the integral in high school students were inductive, deductive, statistical, analytical-synthetic, comparative, bibliographic and heuristic.

In the research, the study population was worked on the high school students of the San Francisco Educational Unit belonging to the 2020-2021 school year, being a total of 377 students, however, the third year high school students enrolled in parallels "A", "B" and "C" were considered as a sample, given that they maintain connectivity for two sessions of 60 minutes a week, being a total of 110 students, distributed 38 of control and 72 of experimentation.

The techniques used were observation, survey and test, while the instruments were observational registration, questionnaire and objective test; Excel and SPSS were used for data processing.

Didactic methodology

For the present research study was developed during 5 phases, being the following:

Phase 1: Diagnosis: Diagnose the level of management of the GeoGebra software in high school students of the San Francisco Educational Unit.
Activities:
Survey application.
Application of the pre test.

Phase 2: Foundation: Substantiate the information in a scientific and theoretical way about the GeoGebra software as a didactic technological tool and the integral defined as study content.
Activities:
Application bibliographic method

Phase 3: Design: Design experimental practices in the GeoGebra software for the study of the defined integral.
Activities:
Lesson plan design.
Use of the heuristic method.

Phase 4: Implementation: Propose the experimental practices designed in the GeoGebra software to the experimentation group to improve academic performance during the second partial of the second semester of the 2020-2021 school year.
Activities:
GeoGebra software application through lesson plans.

Phase 5: Evaluation: Validate the implementation of the GeoGebra software in the study of the defined integral through a statistical analysis of data on the academic performance of the control and experimentation group.
Activities:
Application of post test to the experimental and reference group.
Hypothesis demonstration.

3. RESULTS

For the present research it should be considered that there is equivalence between the two groups, thus avoiding the deviation of the results, so for the control group the traditional methodology was maintained, while for the experimentation group the GeoGebra software was implemented as a heuristic method for the study of the defined integral. therefore, in order to maintain equivalence between the groups, the following was considered.

- Same teacher.
- Same study content.
- Same number of sessions.
- Virtual development of classes.
- Same autonomous activities, workshops and lessons.

It is important to mention that the Educational Unit "San Francisco" during the virtual stage is teaching virtual classes every day through the Zoom platform from 8:00 a.m. to 12:30 p.m. at a set time, while for the evaluation process it managed its evaluation instrument based on autonomous activities, workshops, lessons.

Survey Analysis

For the validity of the survey applied to third year high school students, 13 questions were analyzed using the expert judgment technique, with 3 experts selected according to relevant aspects such as experience within the area of study and research, while reliability was analyzed using the Cronbach alpha coefficient in view of the fact that its measures are not dichotomous. having as a result 0.753 according to SPSS according to table 1, being in the high reliability range, in this way its format is accepted, these results served to develop the proposal for the implementation of the GeoGebra software for the study of the defined integral.

Board 1: *Reliability analysis in SPSS questionnaire-survey.*

Estadísticos de fiabilidad

Alfa de Cronbach	Alfa de Cronbach basada en los elementos tipificados	N de elementos
,753	,729	13

Source: SPPS Software.

Pre Test Data Analysis

For the validity of the objective test applied to the control and experimentation group, the expert judgment technique was used, for which there were 3 teachers from the study area, while the reliability was used the Kuder Richarson coefficient or KR-20 in view of the fact that a 10-item test was developed with questions of success and error, being valued with 1 point for the correct answer and 0 points for the incorrect answer, allowing to determine the reliability of internal consistency having a value of 0.72 being in a high value, in this way its format is accepted.

For the calculation of the descriptive statistics of the two groups, the SPSS software was used, being:

Board 2: *Descriptive statistical, pre test control group.*

Descriptivos

			Estadístico	Error típ.
CONTROL	Media		6,50	,287
	Intervalo de confianza para la media al 95%	Límite inferior	5,92	
		Límite superior	7,08	
	Media recortada al 5%		6,53	
	Mediana		7,00	
	Varianza		3,122	
	Desv. típ.		1,767	
	Mínimo		3	
	Máximo		10	
	Rango		7	
	Amplitud intercuartil		3	
	Asimetría		-,388	,383
	Curtosis		-,352	,750

Source: SPPS Software.

Board 3: *Descriptive statistical, pre test experimental group.*

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Descriptivos

			Estadístico	Error típ.
EXPERIMENTAL	Media		6,61	,274
	Intervalo de confianza para la media al 95%	Límite inferior	6,07	
		Límite superior	7,16	
	Media recortada al 5%		6,69	
	Mediana		6,50	
	Varianza		5,396	
	Desv. típ.		2,323	
	Mínimo		1	
	Máximo		10	
	Rango		9	
	Amplitud intercuartil		4	
	Asimetría		-,197	,283
	Curtosis		-,537	,559

The normal distribution of data for the control group is analyzed using the Shapiro-Wilks test in the SPSS software, because it has 38 students, being a value less than 50.

Board 4: *Normality test, pre test control group.*

	Shapiro-Wilk		
	Estadístico	gl	Sig.
CONTROL	,946	38	,064

When obtaining a significance level greater than 0.05 being 0.64 is considered a normal distribution.

In the same way, the normal distribution of the data for the experimental group is analyzed using the Kolmogorov Smirnov test in the SPSS software, because it has 72 students, being a value higher than 50.

Board 5: *Normality test, pre test experimental group.*

	Kolmogorov-Smirnov[a]		
	Estadístico	gl	Sig.
EXPERIMENTAL	,104	72	,053

When obtaining a significance level greater than 0.05 being 0.053 is considered a normal distribution.

For the verification of homogeneity between the control and experimental groups, the F test for variance of two samples is used, which is developed in Excel.

Board 6: *F-test results for variance of two samples.*

	CONTROL	EXPERIMENTAL
Media	6,50	6,61
Varianza	3,12	5,40
Observaciones	38,00	72,00
Grados de libertad	37,00	71,00
F	0,58	
P(F<=f) una cola	0,04	
Valor crítico para F (una cola)	0,61	

According to the results, F = 0.58 is obtained while critical F = 0.61, since F is critical greater than F, the groups are considered homogeneous.

Post Test Data Analysis

For the validity of the objective test applied to the control and experimentation group, the expert judgment technique was used, for which there were 3 teachers from the study area, while the reliability was also used the Kuder Richarson coefficient or KR-20 in view of the fact that a 10-item test was developed with questions of success and error, being valued with 1 point for the correct answer and 0 points for the incorrect answer, allowing to determine the reliability of internal consistency having a value of 0.758 being in a high value, in this way its format is accepted.

For the calculation of the descriptive statistics of the two groups, the SPSS software was used, being:

Board 7: *Descriptive statistical, post test control group.*

Descriptivos

			Estadístico	Error típ.
CONTROL	Media		6,32	,356
	Intervalo de confianza para la media al 95%	Límite inferior	5,59	
		Límite superior	7,04	
	Media recortada al 5%		6,38	
	Mediana		7,00	
	Varianza		4,817	
	Desv. típ.		2,195	
	Mínimo		1	
	Máximo		10	
	Rango		9	
	Amplitud intercuartil		3	
	Asimetría		-,394	,383
	Curtosis		-,076	,750

Board 8: *Descriptive statistical, post test experimental group.*

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Descriptivos

			Estadístico	Error típ.
EXPERIMENTAL	Media		7,18	,235
	Intervalo de confianza para la media al 95%	Límite inferior	6,71	
		Límite superior	7,65	
	Media recortada al 5%		7,26	
	Mediana		7,00	
	Varianza		3,981	
	Desv. típ.		1,995	
	Mínimo		2	
	Máximo		10	
	Rango		8	
	Amplitud intercuartil		3	
	Asimetría		-,300	,283
	Curtosis		-,427	,559

The normal distribution of data for the control group is analyzed using the Shapiro-Wilks test in the SPSS software, because it has 38 students, being a value less than 50.

Board 9: *Normality test, post test control group.*

	Shapiro-Wilk		
	Estadístico	gl	Sig.
CONTROL	,960	38	,197

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When obtaining a significance level greater than 0.05 being 0.197 is considered a normal distribution.

In the same way, the normal distribution of the data for the experimental group is analyzed using the Kolmogorov Smirnov test in the SPSS software, because it has 72 students, being a value higher than 50.

Board 10: *Normality test, post test experimental group.*

	Kolmogorov-Smirnov[a]		
	Estadístico	gl	Sig.
EXPERIMENTAL	,104	72	,053

When obtaining a significance level greater than 0.05 being 0.053 is considered a normal distribution.

Hypothesis testing

To test the hypothesis, the T-Student test was used for independent samples to have normal distributions, using the results obtained in the post test.

$H_0: \mu_1 - \mu_2 = 0$, The implementation of GeoGebra software in the study of the defined integral does not significantly affect the academic performance of high school students of the San Francisco Educational Unit.

$H_1: \mu_1 - \mu_2 > 0$, The implementation of GeoGebra software in the study of the defined integral significantly affects the academic performance of high school students of the San Francisco Educational Unit.

Determination of significance level: When analyzing academic performance through the implementation of a didactic strategy, the research uses a significance level of 0.05 and reliability of 95%.

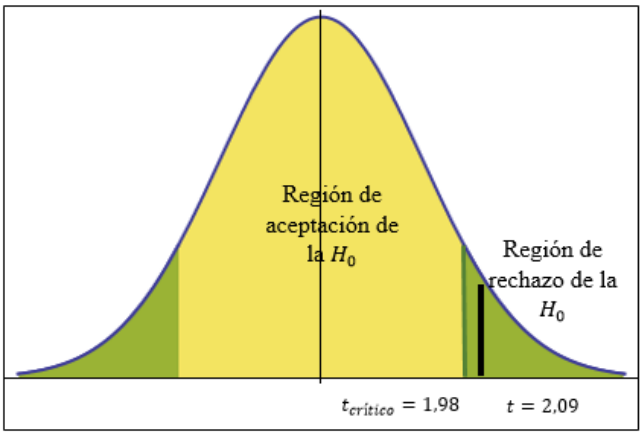
The T-Student test is applied because they are normal distributions, its calculation is developed in Excel.

Board 11: *T-Student test objective test post test.*

	GRUPO DE EXPERIMENTACIÓN	*GRUPO DE CONTROL*
Media	7,18	6,32
Varianza	3,98	4,82
Observaciones	72,00	38,00
Varianza agrupada	4,27	
Diferencia hipotética de las medias	0,00	
Grados de libertad	108,00	
Estadístico t	2,09	
P(T<=t) una cola	0,02	
Valor crítico de t (una cola)	1,66	
P(T<=t) dos colas	0,04	
Valor crítico de t (dos colas)	1,98	

Analysis of results and decision making

According to the Excel software is obtained as results and, so before accepting or rejecting the null hypothesis we proceed to analyze the regions of acceptance or rejection in the following figure:$t = 2{,}09 t_{crítico} = 1{,}98$



Graphic 1: Identification of acceptance and rejection zones.

As , the null hypothesis is rejected and the alternative hypothesis is accepted, in this way it is concluded that$t > t_{crítico}$, the implementation of the GeoGebra

software in the study of the defined integral significantly affects the academic performance of high school students of the San Francisco Educational Unit, where the means between the experimental and control groups in the objective test (post test) are significantly different, being higher the value of the mean in the experimental group.

Analysis of the observation sheet

According to what was evidenced during the research, the data collected in the observation sheet is analyzed and the following aspects are interpreted:

Management of GeoGebra software: When implementing the GeoGebra software in the experimentation group, it was evident that the students easily handled it for the development of activities both in class time and in autonomous activities.

Motivation and interest: Students in the experimental group showed interest and motivation in learning the defined integral, while students in the control group were easily distracted by watching repetitive classes.

Skills with performance criteria: With the experimental group, the development of skills with performance criteria was focused more than on the content, since activities were promoted that allowed the active participation of the students.

Methodology: The methodology used in the control group did not project a towards significant learning working only with TPL (chalk, blackboard and language), while in the experimental group its constructivist approach together with the heuristic method allowed the student to be the protagonist of his learning.

Academic performance: There was evidence of better academic performance in the experimental group unlike the control group.

Planning: By implementing the GeoGebra software, improvisation of activities was avoided.

4. CONCLUSIONS

According to the analysis and interpretation of results according to the objectives set out in the research, it is concluded:

The free mathematical software GeoGebra was accepted during the diagnostic phase through the application of a survey to third year high school students of the Educational Unit "San Francisco", who determined their level of management as well as the predisposition of its use as a didactic technological tool that allows to improve academic performance, empowering the construction of the advanced methodological and technological proposal for the study of the integral Defined; In the same way, through the application of the pre-test and under the statistical analysis, the homogeneity in the level of previous knowledge that each group maintained at the beginning of the research was determined.

The foundation based on the application of the bibliographic method during phase two allowed to argue and support in a scientific and theoretical way the variables of the research, being the implementation of the GeoGebra software as a didactic tool, as well as the integral defined as study content to thus link them to the academic performance of the students of third year of unified general baccalaureate of the Educational Unit "San Francisco".

The advanced methodological and technological proposal developed during phase three was based on the design of the lesson plans through the use of GeoGebra software for the study of the defined integral, as well as on the heuristic method for problem solving, in the same way the design was developed according to the Prioritized Curriculum presented by the Ministry of Education of Ecuador during the COVID-19 pandemic, as well as the time of application.

The application of the advanced methodological and technological proposal designed for the study of the defined integral was developed in the experimental group during the second partial of the second semester of the 2020-2021 school year virtually due to the COVID-19 pandemic where interest and motivation for the study of the defined integral was awakened, as well as the improvement in the academic performance of the students, thus guaranteeing the methodological proposal as a didactic tool; while in the control group we worked with the traditional methodology: chalk, blackboard and language (TPL).

The validation of the implementation of the GeoGebra software for the study of the integral defined as a methodological proposal and advanced technology, was determined by applying an objective test to both control and experimentation groups during the evaluation phase, thus allowing through a statistical analysis T-Student to verify the hypothesis that the implementation of GeoGebra software in the study of the defined integral significantly affects the academic performance of high school students of the San Francisco Educational Unit, since it was obtained as results $t = 2{,}09$ and , being

greater the calculated value than the critical one.$t_{crítico} = 1{,}98$

5. RECOMMENDATIONS

With regard to the conclusions established, the following recommendations are made:

Analyze the level of knowledge, management and access of both students and teachers before implementing any mathematical software during the teaching and learning process.

Investigate the different technological mathematical tools for their application and the contents that can be addressed with them.

Socialize the importance of applying technological tools in the teaching and learning process to both teachers and students to avoid traditional methodologies.

Constantly validate the application of didactic resources or technological tools to prevent the academic performance of students, as well as their learning from being affected.

BIBLIOGRAPHY

Açıkgül, K. (2021). Opinions of mathematics teachers about a learning kit supported by GeoGebra for teaching polygons. *International Journal of Mathematics Education in Science and Technology*. Retrieved from 10.1080/0020739X.2021.1895339

Álvarez, M., Cordero, J., González, J., & Sepúlveda, O. (2019). GeoGebra software as a tool in teaching and learning Geometry. *Education and Science*, 387-402. Retrieved from https://revistas.uptc.edu.co/index.php/educacion_y_ciencia/article/view/10059

Áviles, J., Morales, A., Cuevas, R., & Alonso, A. (2015). *Application of geogebra in the determination of maxima and minines online.* Mexico: Universidad Autónoma de Guerrero.

Çekmez, E. (2020). Establishing the link between the graph of a parametric curve and the derivatives of its component functions. *International Journal of Mathematical Education in Science and Technology*, *51*(1), 115-130. doi:10.1080/0020739X.2019.1663950

Clavijo Gañan, E. E. (2017). *V International Meeting on the Teaching of Exact and Natural Sciences.* Retrieved from Graphical visualization with GeoGebra in the calculation learning: https://www.researchgate.net/profile/Juan_Bedoya16/publication/344932659_Graphical_visualization_with_GeoGebra_in_the_calculation_learning/links/5f998f23299bf1b53e4bda2e/Graphical-visualization-with-GeoGebra-in-the-calculation-learning.pdf

Diaz, L., Rodríguez, J., & Lingán, S. (2018). Teaching geometry with GeoGebra software in secondary students of an educational institution in Lima. *Purposes and Representations, 6*(2), 217-251. Obtained from : http://

ECURED. (n.d.). *Academic performance*. Retrieved from https://www.ecured.cu/Rendimiento_acad%C3%A9mico

Escoda., A. P. (2017). *Media literacy, ICT and digital skills.* Barcelona: Oberta UOC Publishing, SLU.

Espeso, P. (3 of 2 of 2021). *Geogebra, a practical tool to learn mathematics.* Retrieved from https://www.educaciontrespuntocero.com/recursos/herramienta-aprender-matematicas/

Fredy Barahona Avecilla, O. B. (2015). GeoGebra for the teaching of mathematics and its. *Revista Tecnológica ESPOL – RTE*, 121-132.

Godino, J. (2011). Indicators of didactic suitability in teaching and learning processes of mathematics. *XIII Conferência Interamericana de Educação Matemática (CIAEM-IACME).* Retrieved from https://www.ugr.es/~jgodino/eos/jdgodino_indicadores_idoneidad.pdf

Grisales, A. (2018). Use of ICT resources in the teaching of mathematics: challenges and perspectives. *In: Lattice, 14*(2), 198-214. Retrieved from http://www.scielo.org.co/pdf/entra/v14n2/1900-3803-entra-14-02-198.pdf

Helengineer. (January 13, 2021). Retrieved from https://www.youtube.com/watch?v=7XpoibFcCwk

Jiménez, J., & Jiménez, S. (2017). GeoGebra, a proposal to innovate the teaching-learning process in mathematics. *Electronic Journal on Technology, Education and Society, 4*(7), 1-17. Retrieved from file:///C:/Users/hp/Downloads/654-Texto%20del%20art%C3%ADculo-2631-1-10-20170120.pdf

Loyola, J. (2019). *Memories of the I Ecuadorian day of GeoGebra.* Ecuador: Universidad Nacional de Educación-UNAE. Retrieved from https://unae.edu.ec/wp-content/uploads/2020/03/GeogebraMemorias.pdf

Mamani, M. A. (2020). The GeoGebra in the learning of the definite and indefinite integral in students of

the Professional School of Systems Engineering of the UNA Puno. Puno, Peru: Repositorio Institucional UNA-PUNO.

Martinez. (2014). *Theory of education for teachers. Didactics to teach skills.* (Vol. Volume 2.). Madrid.: Madrid: Biblioteca Online.

Ministry of Education of Ecuador. (2010). *Updating and strengthening curriculum.* Quito.

Ministry of Education of Ecuador. (2016) . *EGB and BGU Mathematics curriculum.*

Ministry of Education of Ecuador. (2019.). *Instructions for the application of student evaluation.*

Ministry of Education of Ecuador. (2020). *Prioritized curriculum.*

Ministry of Education of Ecuador. (2020). *Instructions for student assessment.*

Ministry of Education of the Government of the City of Buenos Aires. (20 of 05 of 2021). *Geogebra tutorial*. Retrieved from file:///C:/Users/hp/Downloads/e3ec38-tutorial-geogebra%20(1).pdf

Ministry of Education. (2016). *Mathematics Curriculum.*

Ministry of Education-Undersecretariat of Educational Fundamentals. (2020). *Prioritized Curriculum.*

Moral. (2013). *Final Report of the Graduation Work or Degree prior to obtaining the Degree in Education Sciences. Education.* Retrieved from http://repositorio.uta.edu.ec/bitstream/123456789/5089/1/teb_2013_858.pdf

Núñez, M. M. (2019). Mobile GeoGebra in the teaching of Mathematics. *Memories of the I Ecuadorian Conference of GeoGebra.* , 41-47.

Osman, B., & Acar, H. (2020). The effect of computer-aided collaborative learning using GeoGebra software on 11th grade students' mathematical performance in exponential and logarithmic functions. *International Journal of Mathematical Education in Science and Technology*. doi:10.1080/0020739X.2020.1788186

Paucar, N. T. (2019). Geogebra Software in the learning of derivatives and integrals in university students of Cañete. Lima, Peru: César Vallejo University Graduate School.

Pico, C. M. (2018). *Significant learning experiences for the appropriation of knowledge in economic, administrative and accounting sciences.* Cop. Colombian GRan Polytechnic.

Ponce, J., Roberts, K., Wegener, M., & McIntyre, T. (2019). Dynamic visualization of line integrals of vector fields: a didactic proposal. *International Journal of Mathematical Education in Science and Technology, 50*(6), 934- 949. doi:10.1080/0020739X.2018.1510554

Rivera, J. P. (2014). Use of educational software and its efficiency in the academic performance of integral calculus at the Universidad Peruana Unión, Tarapoto subsidiary. *University Notes*, 43-56.

Roberto, D. M. (n.d.). Retrieved from http://www.une.edu.pe/Titulacion/2013/exposicion/SESION-4-Confiabilidad%20y%20Validez%20de%20Instrumentos%20de%20investigacion.pdf

Sampieri., R. H. (2014). *Research Methodology. 6th. Edition.* McGRAW-HILL / INTERAMERICANA EDITORES, S.A. DE C.V.

Tatar, E., & Zengin, Y. (2016). Conceptual understanding of the integral defined with GeoGebra. *Computers in Schools, 33*(2), 120-132. Retrieved from 10.1080/07380569.2016.1177480

Trejo. (2012). *Methodology of the teaching-learning process.* Mexico: Trillas.

National University of Education of Ecuador. (2019). *Memories of the I Ecuadorian Conference of GeoGebra.* Azogues: EditorialUNAE.

Zamudio, A. L. (n.d.). *Latin American Committee of Educational Mathematics A.C.* , 1351-1358.

Zengin, Y. (2017). The effects of GeoGebra software on the attitudes and views of mathematics teachers in training towards testing and demonstration. *International Journal of Mathematics Education in Science and Technology*, 1002-1022. doi:10.1080/0020739X.2017.1298855