Articles

E-activities for the identification and use of immediate integration formulas.

E-actividades para la identificación y uso de las fórmulas de integración inmediata

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ABSTRACT

The present research work proposes the theory of conceptual fields as a means to reach the use and recognition of the formulas of immediate integration; because through the development of the four essential characteristics of the cognitive schemes, implicit in the e-activities, it is sought to facilitate the teaching-learning process in this part of Integral Calculus. In this way, a research with a quasi-experimental design is carried out, which recognized the veracity of the facts with correlational hypotheses and a test directed to the students; confirming that the theory of conceptual fields does influence the understanding and association of the recognition and use of the formulas of immediate integration.

Keywords: Immediate integrals, conceptual fields, schemes.

RESUMEN

El presente trabajo de investigación propone a la teoría de campos conceptuales como un medio para llegar al uso y el reconocimiento de las fórmulas de integración

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inmediata; pues a través del desarrollo de las cuatro características esenciales de los esquemas cognitivos, implícitas en las e-actividades, se busca facilitar el proceso de enseñanza-aprendizaje en esta parte de Cálculo Integral. De esta forma se efectúa una investigación con diseño cuasi-experimental que reconoció la veracidad de los hechos con hipótesis correlacionales y un test dirigido a los estudiantes; confirmando que la teoría de campos conceptuales si influye en la comprensión y asociación del reconocimiento y uso de las fórmulas de integración inmediata.

Palaras clave: Integrales inmediatas, campos conceptuales, esquemas.

INTRODUCTION

Today's society has evolved in all possible areas, among them we can highlight the school, where specifically the teaching-learning process has sought the necessary mechanisms to reach perfection, especially through theories that propose the student as the main actor of the educational system; thus, changes are observed in the different branches of science. In spite of the fact that for Mathematics there are always the greatest difficulties, here the Theory of Conceptual Fields has been highlighted, which pretends that students come to understand the object of study as a whole, visualizing it through real situations. This is stated by Pabón et al. (2020) who show that the use of conceptual fields oriented with other tools and methodological strategies allows the assessment of the student's formative processes, enabling them to generate a significant context in the analytical and systematic capacity of understanding Integral Calculus (pp.179).

However, one part is the research, which leads us to listen or read a number of steps that sound very good together, and a very different one is to propose it in the classroom, because in the classroom this theory is very little applied, as Mateus-Nieves (2021) says, (Scagnoli, 2006)(Scagnoli, 2006), who mentions that "the lack of a deep conceptual teaching can be evidenced, due to the fact that the most used approach is the mechanical resolution".

del Mastro & Monereo, (2014). All this has repercussions on the student's learning, who, not internalizing what is being executed, will present difficulties during their studies to reach the Third level, even more so in the moments when they must implement them in everyday life situations.

Definitely, the object of study must be internalized regardless of the profession to be exercised in the future, that is, it should not matter whether the trainee is going to become an engineer or a teacher; since, if we speak specifically of the integration formulas, both must have mastery of them, in the case of the engineer for its execution during the calculation of irregular areas or a teacher to exemplify to his students how to implement it.

To this end (Romero, 2016), (Capraro et al., 2010), (Caballero-Montañez & Sime-Poma, 2006)The updating of knowledge on the part of the teacher is indispensable, since this way he can be informed of new methods, activities, strategies, teaching techniques that facilitate or allow the improvement of learning.

From this point of view, the problem that arises can be described from two perspectives: on the one hand, the analysis of the theory of conceptual fields in the use and identification of the formulas of immediate integration in the future mathematics teachers of the pedagogy career of experimental sciences of Mathematics and Physics belonging to the University of Guayaquil and on the other hand, the scarce relevant information on the methodology of conceptual fields that motivates the use of such methodology in the use and identification of formulas of immediate integrals, not only as a concept but as a complex cognitive scheme (conceptual-procedural).

MATERIALS AND METHODS

In order to verify if the Theory of Conceptual Fields helps students to use and implement the formulas of immediate integration, a correlational research with quasi-experimental design was carried out, for which we proceeded to form the research groups with the students of the career of pedagogy of experimental sciences of Mathematics and Physics at the University of Guayaquil Cycle I 2022-2023 and being defined the parallels 4-5 A2 as experimental group with a total of 19 members; while courses 4-6 C2 were designated as the control group, with a total of 22 students.

Thus, it is defined that the experimental group will implement the instructional sequence designed with e-activities, while the control group will only be taught a regular class, as shown in Table 1.

Table 1. *Variables Scheme*

Experimental group	**X**	O1
Control group	---	O2

x: Instructional sequence with e-activities based on CBT on the immediate integration formula with powers

O_1 : Successful identification and use of the formula.

O_2 : Success in identifying and using the formula, which to this group the instructional sequence will not be applied.

Therefore, to collect the data, a test was applied to each research group, which was composed of a questionnaire of 10 questions, valued at one point each; these questions were based on what was taught through the e-activities and the regular class,

respectively. The data collected were analyzed with the help of descriptive statistics, thus giving the study a quantitative approach.
It is worth mentioning that the e-activities were planned and developed based on the information found through the literature review; in addition, the structure and platforms used were incorporated based on this research. Also, the relevant stages of the Conceptual Fields Theory were defined.
The following is a description of the e-activities developed for the experimental group, which allow students to manipulate the object of study and thus achieve the use and application of the immediate integration formulas:

<table>
<tr><td colspan="2">Subject</td><td colspan="2">Integral Calculus Course</td></tr>
<tr><td colspan="2">Unit(s)</td><td colspan="2">Unit 1. Immediate Integrals</td></tr>
<tr><td colspan="2">Topics covered</td><td colspan="2">- Algebraic Immediate Integrals</td></tr>
<tr><td colspan="2">Expected learning. Objective</td><td colspan="2">Apply the algebraic immediate integration formula that relates power to the properties of integrals to solve specific exercises.</td></tr>
<tr><td>Duration of the unit:</td><td>2 hours</td><td>Modality:</td><td>Online</td></tr>
<tr><td colspan="2">Stage</td><td colspan="2">1. Learning situation</td></tr>
<tr><td>Duration</td><td>20 minutes</td><td>Type</td><td>Individual</td></tr>
<tr><td colspan="4">Display instruction</td></tr>
<tr><td colspan="4">The frequent use of the calculus of a variable is based fundamentally on the problem of calculating the area enclosed by the graph defined by a function.

It is often used in economics through statistical analyses, which are closely linked to functions that have powers within their composition.

If it is stated that integration is the inverse operation of derivation, how could the following integral be solved $\int x^n dx$?

Describe at least 2 steps that you consider necessary to solve the integral with their justification.</td></tr>
<tr><td colspan="4">Cross-cutting artifacts</td></tr>
<tr><td colspan="2">Type</td><td colspan="2">Instructions for use</td></tr>
<tr><td colspan="2">Padlet or Forum</td><td colspan="2">Students should access the following link to access the Padlet (an interaction wall) https://padlet.com/jannyest30/sw5shf8k00ye20h4 , in the case of teachers who have a virtual classroom, they can do the same through a forum.</td></tr>
</table>

<table>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Stage</td><td colspan="2">2. Context of the problem</td></tr>
<tr><td>Duration:</td><td>25 minutes</td><td>Type</td><td>Group</td></tr>
<tr><td colspan="4">Instruction screen</td></tr>
<tr><td colspan="4">It is important to keep in mind that to solve this type of exercises we must not only calculate its primitive, but also analyze the integral; which allows us to apply the most appropriate method to solve. Therefore, we can analyze what type of integral it belongs to in order to solve it, through the following steps:
1. Check if it is immediate integral
2. Check if it is almost immediate
3. Check that the exponent is a number and not the same variable
4. Check that the differential refers to the same variable of the function.</td></tr>
<tr><td colspan="4">Cross-cutting artifacts</td></tr>
<tr><td colspan="2">Type</td><td colspan="2">Instructions for use</td></tr>
<tr><td colspan="2">Google Sites

Celeriti Game</td><td colspan="2">It is a blog created with the information that the student needs, where they will have the availability of a previous game to remember the previous concepts seen in the previous section, this web site is available at the following here
For the game, students should go to the following link https://www.cerebriti.com/juegos-de-matematicas/generalidades-de-calculo-integral and complete the activity.</td></tr>
<tr><td colspan="2">Stage</td><td colspan="2">3. Operational Invariants</td></tr>
<tr><td>Duration:</td><td>25 minutes</td><td>Type</td><td>Individual</td></tr>
<tr><td colspan="4">Display instruction</td></tr>
<tr><td colspan="4">To start solving the exercise, it is vital to recognize the terrain first.
So we must list the elements, properties, concepts that we will use to solve it.
Therefore, we will exercise our knowledge trying to decipher which is the rule that the algebraic immediate integrals with powers comply with, which will be done through the following activity by accessing the following link https://es.educaplay.com/recursos-educativos/12685180-integrales_inmediatas_algebraicas.html</td></tr>
<tr><td colspan="4">Transversal artifacts</td></tr>
<tr><td colspan="2">Type</td><td colspan="2">Instructions for use</td></tr>
<tr><td colspan="2">Educaplay</td><td colspan="2">The student must enter the game with the link, which will be provided by the teacher and the student will enter to find the formula that allows us to solve algebraic immediate integrals.</td></tr>
</table>

Stage		4. Feedback and inferences	
Duration	30 minutes	Type	Individual and Group
Instruction screen			
Once the activity has been completed by the students, we now proceed to provide feedback on the concepts we need and use to identify and use algebraic immediate integrals with powers. And at the same time, students exercise the activity a little by solving 5 simple exercises, the activity can be found at the following link https://es.liveworksheets.com/pd3141121tu, where it is important that the teacher guides the feedback and if doubts arise, they can be solved at the same time.			
Cross-cutting artifacts			
Type		Instructions for Use	
Liveworksheets worksheet		The activity will always be available which is automatically qualified for the generation of contributions, for teachers who need it just enter the link and can perform the activity without the need of an account.	
Stage		5. Evaluation	
Duration	20 minutes	Type	Individual
Instruction Screen			
Once the whole learning process is finished, it is important to evaluate, so a google form with four answer options will be made, where students identify and use the formulas of immediate integration with powers, which are self-graded.			
Cross-cutting artifacts			
Type		Instructions for use	
Google Forms		The student enters the link to the evaluation and performs it, he/she must choose the correct answer in each item. If the teacher cannot access the google form, he/she can take the questions and run it on another platform known to him/her.	

Based on the objective of this quasi-experimental study, it is estimated that:

- **Null hypothesis (H0):** The application of an instructional sequence with e-activities based on CBT does not influence the successful identification and use of the immediate integration formula with powers.

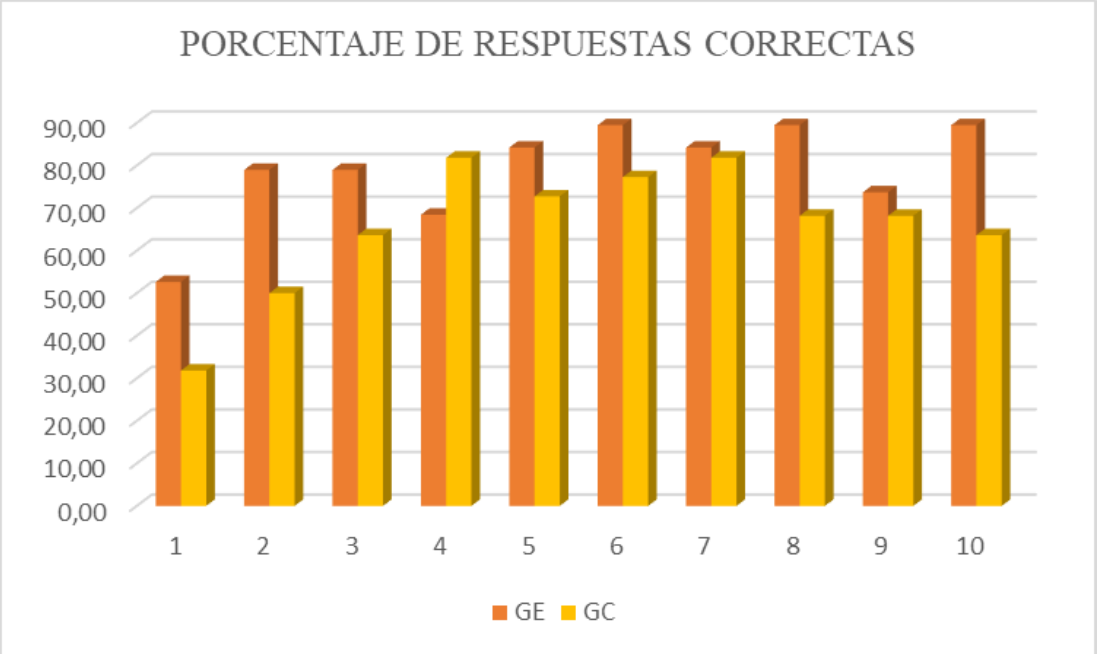
Alternative hypothesis (H1): The application of an instructional sequence with e-activities based on CBT does influence the successful identification and use of the

immediate integration formula with powers.

RESULTS

The results of correct answers are detailed, in percentages, according to the Group in which the test was applied.

Graph 1. Correct Answers



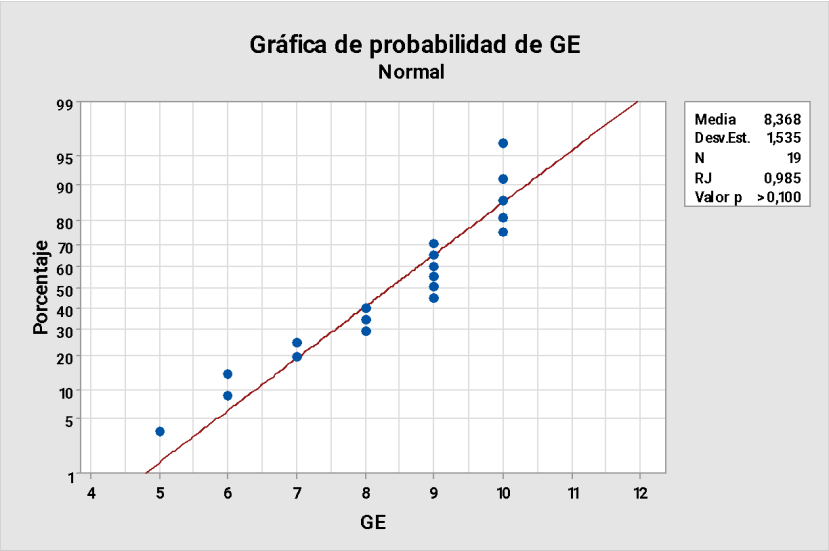
It can be observed that the Experimental Group (EG) outperforms the Control Group (CG) in most of the questions, i.e., the students who made up the EG got to know the steps to develop the power integrals, as well as to assimilate that only constants and not variables can be added at the time of solving and especially to identify in which exercises this immediate formula can be applied. Although, the CG was able to memorize the formula; the GE was highlighted during its application in proposed activities. Since the test has been designed for the first time, it is necessary to submit it to a statistical test to verify its viability, so it was determined through the calculation of Cronbach's Alpha, giving a result of 0.77 and with this we can affirm that the evaluation instrument is Excellently reliable according to the table referring to this coefficient.

Analysis of the test results by means of the T-test

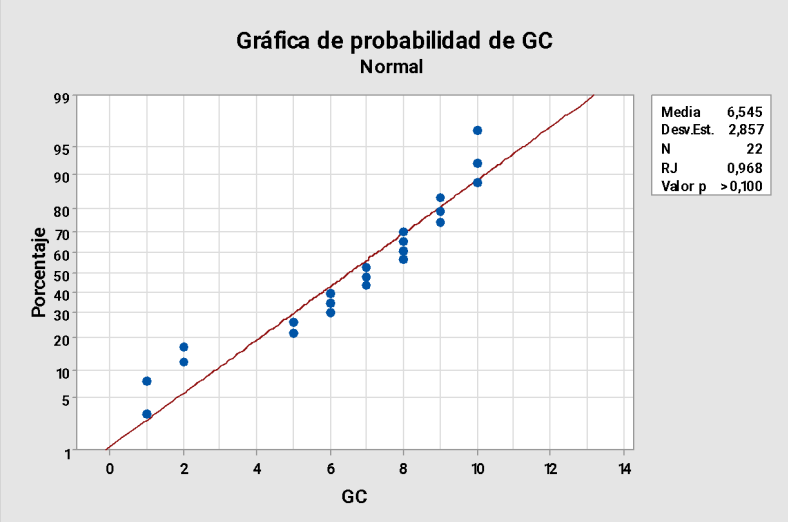
In order to perform the Student's t-test, the normality and the existence of equal variances in the data must be verified, which are detailed below:

Normality of the data Experimental and Control Group

Graph 2. Normality of the data Experimental Group



Graph N° 3. Normality of data Control Group



Once the Ryan-Joiner test was performed, the results collected were found to be normal, since both groups obtained a value greater than 0.1.

Equal Variances

Table 2. *Equality of Variances Test*

Null hypothesis	H_0: $\sigma_1 / \sigma_2 = 1$
Alternative hypothesis	H_1: $\sigma_1 / \sigma_2 \neq 1$
Significance level	$\alpha = 0.05$

Method	Test statistics	GL1	GL2	p-value
F	0.96	18	21	0.131

Consequently, the F test is run where the p value = 0.131, and since it corresponds to the premise of p≥0.05, the null hypothesis, which states that the variances of both groups are statistically equal, can be accepted.

T-test

Finally, once the normality of the data and the equality of variances were confirmed, the T-test was run, for which the arithmetic means of both groups were required, by means of which a gain of 20% can be observed in the experimental group, which obtained 8.37 in the average. Table 3.

Table 3. *Arithmetic Mean of the Evaluated Groups*

Sample	N	Media	Std. dev.	Standard error of the mean
GC	22	6,55	2,86	0,61
GE	19	8,37	1,54	0,35

Thus, with the results obtained and observed in Table 4, the null hypothesis is rejected and it is affirmed that there is a significant difference between the group that received the treatment and the group that had a normal intervention.

Table 4. *Student's t-test*

Null hypothesis		H_0: μ_1 - μ_2 = 0.
Alternative hypothesis		H_1: μ_1 - $\mu_2 \neq 0$
T-value	**GL**	**p-value**
2,59	33	0,007

DISCUSSION

After conducting a bibliographic and documentary research on the theory of conceptual fields, its elements and possible applications in the field of mathematics, it has been decided that the use of cognitive schemes to strengthen mathematical skills such as the recognition and use of properties and formulas in the area of integral calculus is optimal because it allows the teacher to promote a learning environment where the student actively participates in the change of schemes that allow him to execute the algorithms of resolution for various exercises through the linking of their previous knowledge with those that eventually adapts in class.

Subsequently, for the application of the conceptual fields theory, this research work was based on four essential characteristics of the cognitive schemas: goals, subgoals and anticipations; rules of action, information gathering and control; operative invariants and inferences, characteristics that allowed the student to identify the mathematical concepts about the immediate integral of the power, which allow not only to memorize the characteristics of the exercise but also to infer where the mathematical property to be used in the algorithm for solving the integral comes from.

At the end of the application of different statistical tests on the data obtained, it is necessary to mention that the evaluation test went through a validation process through the statistical test called Cronbach's Alpha, where it obtained a value of 0.77 giving the instrument a level of reliability "Excellent". In addition, it was established that the group to which the treatment of the instructional sequence with e-activities based on the theory of conceptual fields was applied had a higher mean than the control group, which had a regular class on the subject.

Analyzing the data through the Ryan-Joiner statistic, the value p>0.1 could confirm the normality of these, therefore it was necessary to calculate the equality of variances through the F test where p=0.131 and with which the equality of variances can be established. Once these results were obtained, it was possible to calculate the Student's t-test for two independent samples taking p=0.007, which being lower than the reference value, the alternative hypothesis of the research is accepted. Concluding that the theory of conceptual fields does influence the understanding and association of the recognition and use of immediate integration formulas.

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