Resultados de la aplicación de secuencias didácticas para la comprensión del concepto del límite en el bachillerato Nicolaíta

Results of application of didactic sequences for understanding the limit concept in high school

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Resumen

El presente trabajo forma parte de un proyecto emancipador aplicado en el Colegio Primitivo y Nacional de San Nicolás de Hidalgo, en el bachillerato de ingeniería y arquitectura, mediante metodología de investigación-acción y el uso de software para comprender el concepto de límite. Los resultados fueron analizados y posteriormente comparados con la manera tradicional de dar clases, es decir, el sistema constructivo y sin tecnología.

Palabras clave: secuencias, límite, cálculo, aplicación, resultados.

Abstract

This is part of an emancipatory project that was implemented in the Colegio Primitivo y Nacional de San Nicolás de Hidalgo in the Bachelor of Engineering and Architecture with action research methodology. Incorporating software to allow understood the concept of limit. The results are dissected and comparative in the traditional way in which the classes in a constructive way without incorporating technology.

Key words: sequences, limit, calculus, application, results.

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Introduction

DEVELOPMENT

In the 2015-2016 semester didactic proposal for teaching the concept of limit in the course of calculation, the Primitivo and Colegio Nacional de San Nicolas de Hidalgo, Nicolaitan school (Rojas, 2015) sequences was performed. This practice was developed in the classroom and students could use their calculator and / or Smartphone.

Methodology

the quantitative approach with traditional teaching evaluations in previous periods was used, as it was in 2015/2016 when the semester began teaching with the help of the proposed didactic sequences (Rojas, 2015). Later nonparametric statistics were used in order to reach conclusions about the variables considered and establish validation criteria.

Evaluation

The evaluation was done through an examination of up to 4 reagents, in which students had to demonstrate their ability to solve algebraic limits and trigonometry, as well as its ability to link the concept of limit on the item and discern the value of a function. It should be noted that the tests were different for each semester; however, it was careful that all reflect the skill and understanding of the subject. the student is also allowed to consult books, notes or internet to solve the questions. Tests were similar to each other, but all met the parameters indicated. One of the tests that were applied was as follows:

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Examen correspondiente a la unidad "Límites" de la asignatura Cálculo Diferencial del bachillerato de Ingeniería y Arquitectura
10 noviembre de 2010

Nombre:_____

Instrucciones: resuelve lo siguiente utilizando argumentos claros, de lo contrario el examen no tendrá validez.

1) Desarrolla $\text{Lím}_{x\to 0}\frac{xSen(x)}{Cos(x)-1}$ *Valor 2 puntos.*

a) ¿Cuál es el valor de la función cuando x=0? *Valor 1punto.*
b) ¿Cómo es la gráfica de la función cuando x=0? *Valor 1 punto.*
c) ¿Existe alguna diferencia entre evaluar la función y el límite? ¿Por qué? *Valor 1 punto.*
d) Explica con tus palabras qué es el límite de una función. Cualquier definición de un libro será considerada incorrecta. *Valor 1 punto.*

2) Resuelve $\text{Lím}_{x\to\infty}\frac{3x-1}{\sqrt{3x^2+5x-2}}$

3) Resuelve $\text{Lím}_{x\to 0}\frac{\sqrt{x^2+p^2}-p}{\sqrt{x^2+q^2}-q}$

Figure 1. Review of the 2010/2011 semester students evaluating the corresponding unit Limits. Fuente: Rojas, E. (2010).

Results

After evaluating the Limits unit with the previous review, the following results were obtained:

Aprobaron	***20***
No Aprobaron	*30*
No se presentaron	*7*

Table 1. Number of students who passed the assessment incorporating ICT learning cycle 2015/2016. Fuente: Rojas, E. (2015).

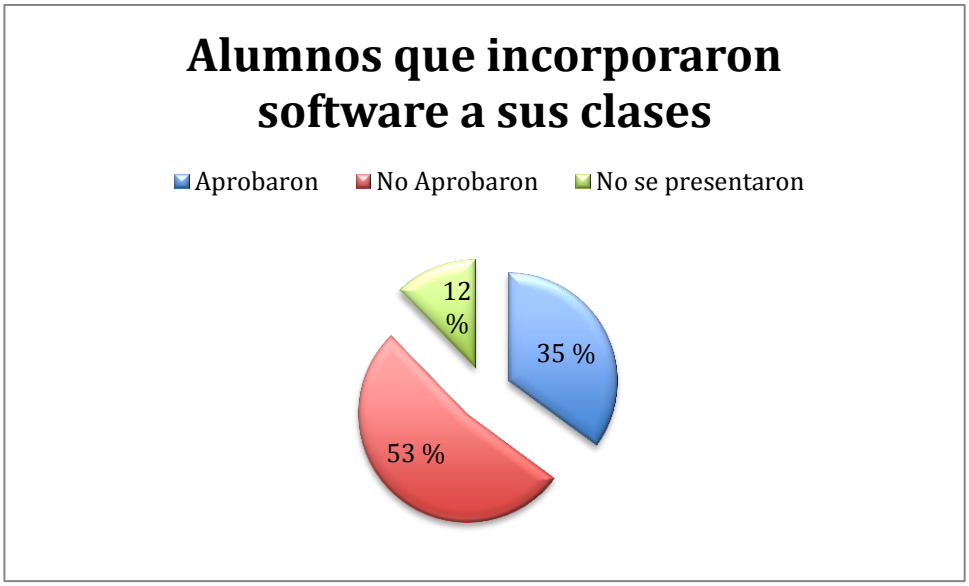


Figure 2. Percentage of students evaluation incorporated ICT learning 2015/2016 Fuente: Rojas, E (2015).

In the 2009-2010 semester is evaluated students of the same school, but this time without incorporating ICT and teaching sequences.

The data obtained were as follows:

Aprobaron	***7***
No Aprobaron	*42*
No se presentaron	*6*

Table 2. Number of students who passed the assessment without incorporating ICT learning cycle 2009/2010. Fuente: Rojas, E. (2009).

Figure 3. Percentage of evaluation to students who were taught by traditional constructivism cycle 2009/2010. Fuente: Rojas, E. (2009).

In the 2008-2009 semester the corresponding evaluation without linking ICT was:

Aprobaron	***9***
No Aprobaron	*34*
No se presentaron	*1*

Table 3. Number of students who passed the assessment without incorporating ICT in their learning cycle 2008/2009. Fuente: Rojas, E. (2008).

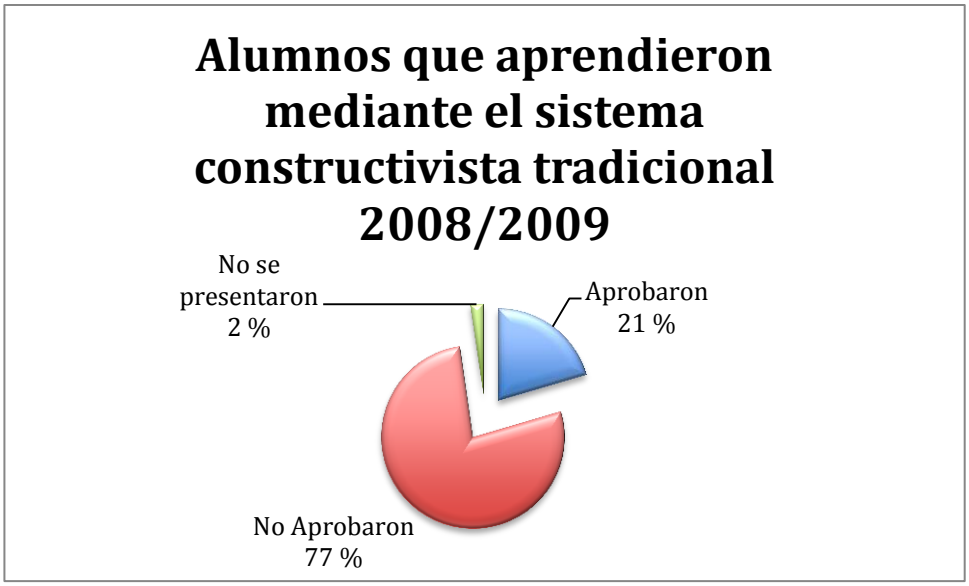


Figura 1. Porcentajes de la evaluación a los alumnos que aprendieron mediante el sistema constructivista tradicional en el ciclo 2008/2009 Fuente: Rojas, E. (2008).

In the first half 2010-2011, the corresponding evaluation without linking ICT was:

Aprobaron	***12***
No Aprobaron	*42*
No se presentaron	*4*

Table 4. Number of students who passed the assessment without incorporating ICT in their learning cycle 2010/2011. Fuente: Rojas, E. (2010).

Figure 5. Percentage of evaluation students who learned through traditional constructivism cycle 2010/2011. Fuente: Rojas, E. (2010).

In the first half 2012-2013, the corresponding evaluation without linking ICT was:

Aprobaron	***16***
No Aprobaron	*31*
No se presentaron	*14*

Table 5. Number of students who passed the assessment without incorporating ICT in their learning cycle 2012/2013. Fuente: Rojas, E. (2012).

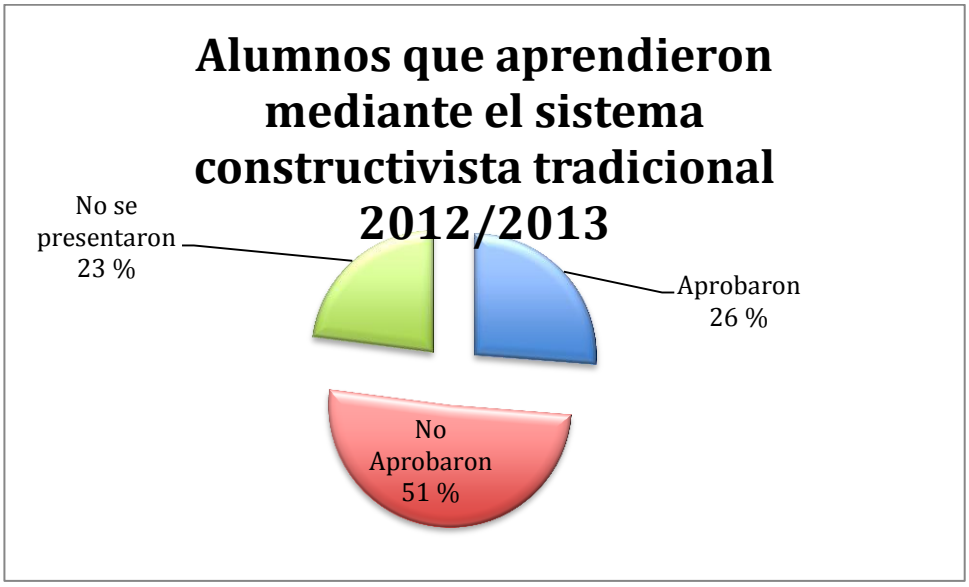


Figure 6. Percentage of evaluation to students who were taught by traditional constructivism cycle 2012/2013. Fuente: Rojas, E. (2012).

In the first half 2013-2014, the corresponding evaluation without linking ICT was:

Aprobaron	***37***
No Aprobaron	*30*
No se presentaron	*8*

Table 6. Number of students who passed the assessment without incorporating ICT in their learning cycle 2013/2014. Fuente: Rojas, E. (2013).

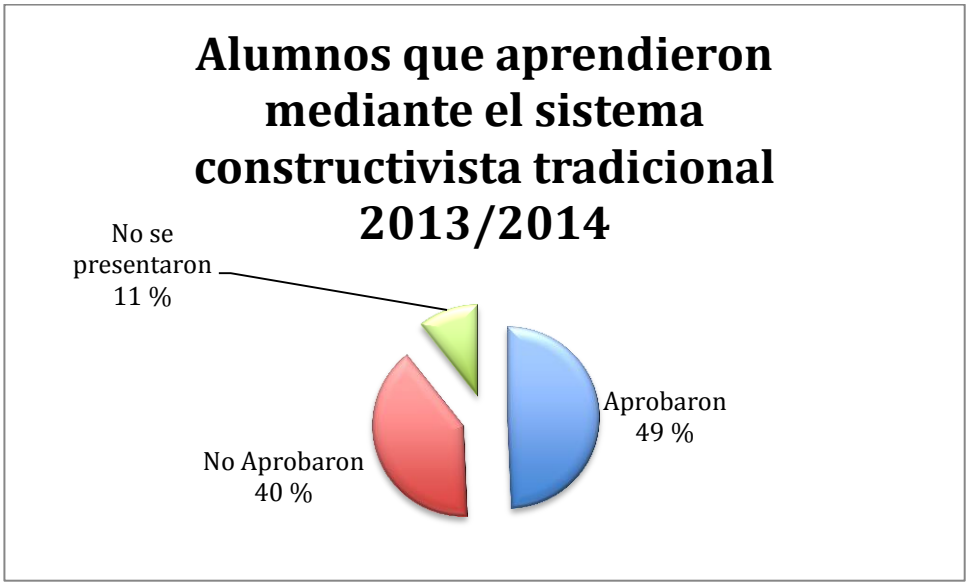


Figure 7. Percentage of evaluation to students who were taught by traditional constructivism cycle 2013/2014. Fuente: Rojas, E. (2013).

Below is a column chart shown.

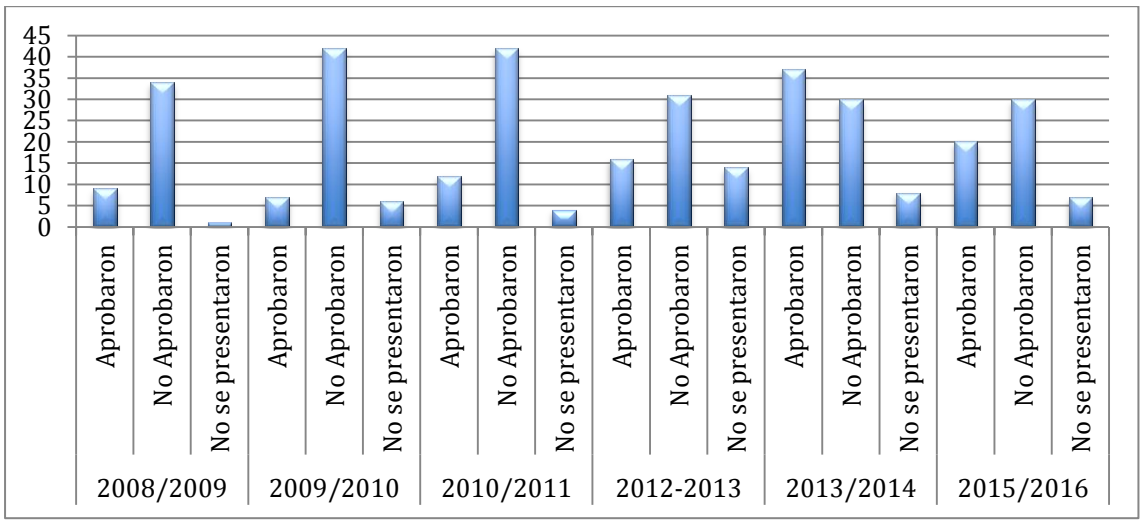


Figure 8. Evaluation of students corresponding to the thematic unity of Limits. Fuente: Rojas, E. (2016).

And the following chart:

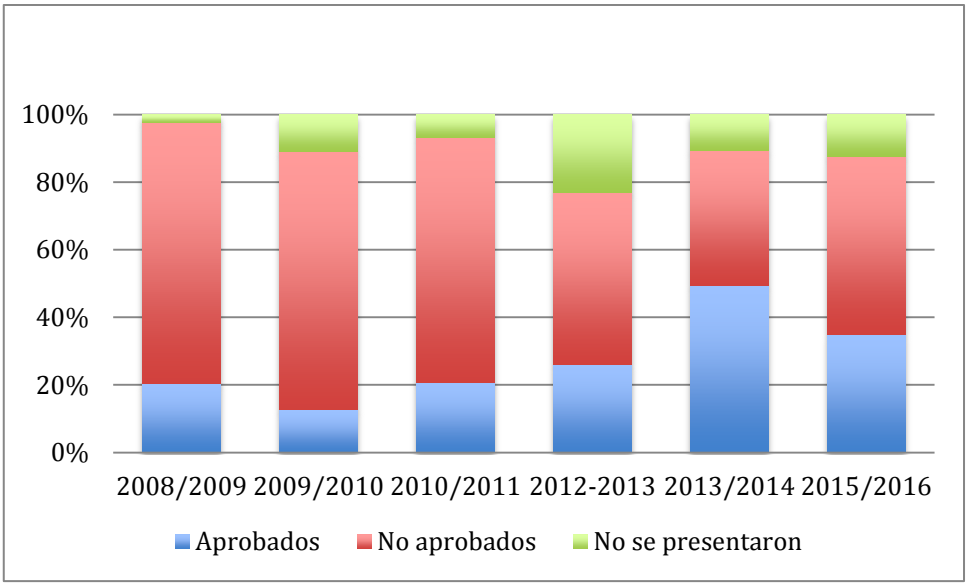
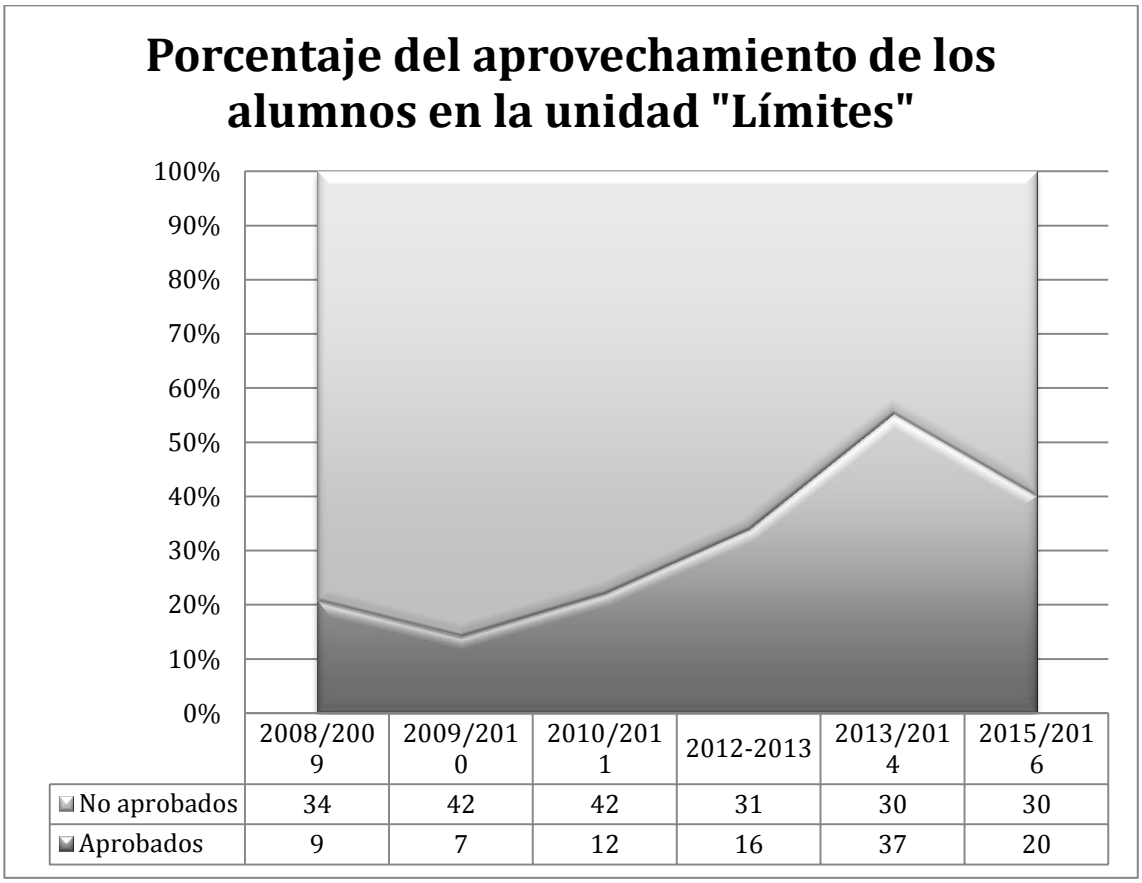


Figure 9. Graph of student assessment globally in stacked column 100 %. Fuente: Rojas, E. (2016).



	2008/2009	2009/2010	2010/2011	2012-2013	2013/2014	2015/2016
No aprobados	34	42	42	31	30	30
Aprobados	9	7	12	16	37	20

Figure 10. Use of students per semester. Fuente: Rojas, E. (2016).

Analysis of results

During the pre-implementation of the proposal period, the percentage of students who demonstrated the ability to solve limits and understand the concept was very limited. More than 70% failed to understand the limits and resolve them, and the lowest percentage was 40% disapproval. Furthermore, this art proved to be much more current technology.

During the semester 2008/2009 there was a percentage of approval on the Limits unit only 21%, while 2% did not report to the relevant assessment, and usually consists of students who drop out of high school to study engineering and architecture another option, or deciding to enter another school. Often the young having to choose a school for a career later decides to join the high schools and half of the semester, when carrying out official inscriptions, you join one of them. Usually in high school social history, necessary to study law, literature, philosophy, education, etc., the subject of differential calculus is not taught. This issue requires further study.

Figure 10 shows that from 2008 to 2013 a rising approval rating was submitted, except for the 2009 period; however, this was insufficient. After a maximum rate of utilization of over 55% was achieved, considering that the absent students are not included in the evaluation for the above reasons.

Constructive traditional teaching, ie which does not use technological means, improved every year. But when the sequences were applied in the period 2015/2016 a fall in the utilization of about 10%, ie, the percentage of utilization reached 40% was introduced, when the assumption was that it would improve student achievement by linking technology classes.

	Sin TIC 2013/2014	Con TIC 2015/2016	SUMA[1]
Promedio	5.64	3.4	4.70
Mediana	6.6	3.15	3.3

Table 7. Comparison of averages and medians of evaluations obtained in 2013/2014 y 2015/2016 Fuente: Rojas, E. (2016).

[1] La SUMA representa las evaluaciones del periodo 2013/2014, más las del periodo 2015 /2016, para obtener los promedios y medianas correspondientes.

This table shows the average that had been keeping in the periods evaluated. There is observed a decrease in both the average and median evaluations in the period 2015/2016, compared with the period before evaluated.

After analyzing the values of the periods 2013/2014 and 2015/2016 obtained in the assessments corresponding to the unit limits the subject of differential calculus, we developed the following table.

	Sin TIC 2013/2014	Con TIC 2015/2016	SUMA
NO aprobaron	30	30	60
Aprobaron	37	20	57
SUMA	67	50	117

Table 8. Matrix actual evaluations. Fuente: Rojas, E. (2016).

The question is: are interrelated learning and technology?

To answer test was used chi-cuadrado[2] (n=117), and draw up the following table of expected values.

	Sin TIC 2013/2014	Con TIC 2015/2016
No aprobaron	34.35897436	25.64102564
Aprobaron	32.64102564	24.35897436

Table 9. Matrix expected assessments. Fuente: Rojas, E. (2016).

[2] The null hypothesis of chi-square test postulated a probability distribution totally specific as the mathematical model of the population that generated the sample. The analysis of such a table assumes that two classifications are independent. That is, from the null hypothesis of independence you want to know if there is sufficient difference between the observed frequencies and the corresponding expected frequencies, so that the null hypothesis is rejected. The chi-square test provides appropriate means to analyze these types of tables.

Specifically where the statistic is $x^{2^*} = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$ con $(n-1)(k-1)$ degrees of freedom.

And then we formulate hypotheses:

Null hypothesis H_o*:* learning limit is independent of the application software.
Alternative hypothesis H_a*:* learning limit is dependent on the application software.
After doing the calculations value it was obtained $P = 0.10314906$ y $Valor\ Prueba\ X^2 = 2.65616654$

Given the $Valor\ de\ P > 0.05$ we can conclude that the null hypothesis is valid H_o, ie learning limit is independent of the application software.
Now, we must ask what some improvement appeared to involve teaching software in the unit limits?
To answer the question we succoured the median value of the sum of both periods, which in this case equals $M = 3.3$, as it is shown in Table 7.

Therefore, we can form the following matrix:

	Sin TIC 2013/2014	Con TIC 2015/2016	SUMA
Valores menores a la Mediana	17	25	42
Valores mayores o iguales a M	50	25	75
SUMA	67	50	117

Table 10. Matrix actual frequencies with respect to the global Medium. Fuente: Rojas, E. (2016).

We apply again the chi-square matrix having the expected frequencies.

	Sin TIC 2013/2014	**Con TIC 2015/2016**
Valores menores a la Mediana	24.05128205	17.94871795
Valores mayores o iguales a M	42.94871795	32.05128205

Table 11. Matrix expected frequencies with respect to the global Mediana. Fuente: Rojas, E. (2016).

And we formulate hypotheses:

Null hypothesis H_o*:* the use of software does not improve the understanding of the limits.

Alternative hypothesis H_a*:* the use of software improves understanding of the limits.

After performing the calculations value is obtained $P = 0.006013091$

and $Valor\ Prueba\ X^2 = 7.54637527$

Given the $Valor\ de\ P < 0.05$ we can conclude that the alternative hypothesis is valid H_a, ie using software improves understanding of the limits.

Conclusion

It is clear that the problems facing the teacher to impart knowledge of this unit and in general, that of all other branches of science of the mathematics is to identify learning styles of young people from high school.

The high school students Nicolaitan are not elected by his teacher, nor they choose him. There is no admission profile for this school that expose the necessary requirements in order to understand a particular subject, in this case differential calculus. However, it is assumed that the student passing the fifth semester (third year) high school and manages the fundamental concepts of algebra and trigonometry, and possessing the skills associated with them, allowing subsequent learning calculation. But the results show otherwise.

Despite the efforts of teachers to innovate and incorporate teaching materials, the results have not been completely satisfactory. However, no effort is wasted if the student shows at least some academic achievement.

In education should spare no resources, nor efforts. Although there was an improvement with the application of teaching sequences and incorporating ICT, this was not as rapid as that of semesters 2012 and earlier.

It would be good to analyze what happened in the 2013/2014 semester, when not taught through ICT. constructive teaching that gave better results than involving technology used in that period. But it is also pertinent to note that the student is responsible for what happens; that is, he must also look for the most suitable mechanism for learning.

Students now belong to a generation where technology is used and constantly moving. Perhaps that is why they incorporated the technology into learning, or maybe not according to the sequences shown herein. However, it is also important to note that the ability of that generation with algebra highlighted compared to previous semesters. In other words, they showed superior qualities to learn mathematics compared to where technology semesters (2015) became involved.

These results are reflected globally according to the study of OCDE (2015):

> Computers are used more in Mexico for teaching mathematics than the average of OECD countries. However, students who said they frequently used computers in his math class on average paid less in PISA assessments than those who said that use them. Overall, in the last ten years there has been no noticeable improvement in student achievement from countries that have invested heavily in ICT for education, with respect to the subjects of reading, mathematics or science. In 2012, in the vast majority of countries, students who used computers moderately in school were, in some ways, better learning outcomes than those who used them rarely; but students who used computers frequently at school did much worse, even after taking into account their social background and demographic environment.

The conclusion of this global study reflects what exposed here.

The question then is whether it is appropriate to continue this type of teaching strategies. This analysis shows that not abuse of technology and it is better to strive to gain experience and skill in algebra, trigonometry and subsequently calculation. May be advisable to give a brief introduction to certain concepts, for example, the limit, incorporating just a little technology but without forgetting the mathematical formalism. Students should learn when to use technology and when to abstain from it, achieving a balance between handling and management of this pencil and paper. That way they can check their own conjectures and

rely on visual aids provided by the software, and achieve change their study habits, their learning strategies and their attitude towards knowledge. According to the philosopher Horace, "Virtus est medium vitiorum utrimque reductum" (SOMA, 2010), ie, none of the efforts made so that students learn significantly in vain.

Undoubtedly technological innovation in education generates a series of changes that help organize thinking differently. Combining traditional methods with appropriate technology allows a new language and cognitive associate the word with the picture.

However, one drawback encountered was that although many students had the technological tools and that these were structured sequences, not really used them. That is, Smartphone and the application had to show but hoped that his companions did the calculations, refraining from experience. Probably they not attract them to use the technology, although many said they gave them lazy and therefore confined to wait and see the results. That is, they not deduced. Clearly, this attitude allows students to acquire a correct interpretation of the concept of limits and not decipher. Other students were surprised at just social networks, for example, WhatsApp and Facebook. It is obvious that these students, despite having the technology at hand, showed no interest in learning the subject.

Therefore, it is recommended that the school be developed Nicolaitan urgently income profile of the student, to ensure that this log with the minimum knowledge needed for training at this level.

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