



## Story of Experience: Calculus in Comics

Lavoisier Almeida dos Santos<sup>1</sup>  <https://orcid.org/0000-0002-0914-7442>  
<sup>1</sup> Universidade de Brasília

### ABSTRACT

Calculus in comics? It's possible? It is notorious that in classes taught exclusively in traditional and expositive forms the student is dispersed and not stimulated to learn. In this way, research is growing in the study of the change of the student's behavior in relation to her learning process. Considering this aspect, the present work aims to report how it is possible to use comics in a compulsory discipline class, Calculus, of the course of Engineering of the University of Brasília of the Gama campus, in an attempt to bring the student closer to the content, motivate the learning environment and make the classroom environment closer and more attractive to the student. At the end of the didactic sequence, a questionnaire was applied so that the student could evaluate the experience. In the evaluation carried out by the students it was concluded that the universe of the strips in the teaching of Calculus made the study more significant, relaxed and effective.

### KEYWORDS

Comics. Calculus. Significant learning.

Corresponding to Author  
<sup>1</sup> Tatiane da Silva Evangeista  
 E-mail: [tatilista@gmail.com](mailto:tatilista@gmail.com)  
 Universidade de Brasília  
 Brasília, GO, Brasil  
 CV Lattes  
<http://lattes.cnpq.br/9553853568740488>

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## Relato de Experiência: Cálculo em Quadrinhos

### RESUMO

Cálculo em quadrinhos? É possível? É notório que em aulas ministradas exclusivamente nas formas tradicionais e expositivas o discente se disperse e não fique estimulado a aprender. Dessa forma, cresce pesquisas no estudo da mudança do comportamento do aluno em relação ao seu processo de aprendizagem. Considerando esse aspecto, o presente trabalho tem o objetivo de relatar como é possível usar histórias em quadrinhos em uma turma de disciplina obrigatória, Cálculo, do curso de Engenharias da Universidade de Brasília do campus Gama, na tentativa de aproximar o aluno do conteúdo, motivar o aprendizado e tornar o ambiente da sala de aula mais próximo e mais atrativo ao estudante. No final da sequência didática, foi aplicado um questionário para que o estudante pudesse avaliar a experiência. Na avaliação realizada pelos discentes concluiu-se que o universo das tirinhas, no ensino de Cálculo tornou o estudo mais significativo, descontraído e eficaz.

### PALAVRAS-CHAVE

Histórias em quadrinhos. Cálculo. Aprendizagem significativa.

## Relato de experience: calculo en historietas

### RESUMEN

¿Calculo en historietas? ¿Es posible? No es notoriamente que se haya dispersado y no se haya estimulado en el aprendizaje. En este sentido, la investigación es creciente en el estudio del cambio del comportamiento del comportamiento en relación con su proceso de aprendizaje. En el presente trabajo, el presente trabajo tiene el objetivo de relatar como es posible el uso de los comics en una clase de clasificación de ejercicios, desde el curso de ingeniería de la Universidad de Brasilia del campus de la universidad, en un intento de traer al estudiante adolescente a la satisfacción, motivar el aprendizaje y hacer que el entorno de estudio sea cada vez más atractivo y más atractivo para el estudiante. En el extremo de las clases, los cuestionamientos se aplicaron para que el estudiante pudiera evaluar la experiencia. La evaluación realizada por los estudiantes que el universo de los comics en la enseñanza de cálculo hizo el estudio más significado, relaxed y eficaz.

### PALABRAS CLAVE

Historietas. Calculo. Aprendizaje significado.

## 1 Introduction

What is your learning style? This was the question that the author asked the first day of class to a class composed of 130 students of the course of Engineering, in the discipline of Calculus, Faculty of Gama (FGA), University of Brasilia (UnB), to guide the answer some issues were divided into three blocks.

The first block contained the following questions: Are you always wearing a headset? Do you like to listen to music or leave the TV on while you study? Can you remember what was said in class, even if it was spoken weeks ago?

The second block addressed the following questions: Do you like to scribble your notebook while you attend classes? Do you usually get impatient and restless in your desk during class? Do you prefer real practice and some class activities? Do you chew gum, smoke, drink or snack while you study?

Finally, the last block of questions contained: Do you enjoy reading? Do you pay more attention to what is written on the board than what the teacher is saying? Do you enjoy writing notes during class? The best way to remember is to imagine the situation? Like to write for a visual review?

The result was 18%, 39% and 43%, respectively, in the first, second and third blocks. That is, the predominance of learning is visual (43%) and kinetic (39%), analyzing this percentile with the high failure rate in the discipline of Calculus, in which Mello (2001) justifies these values for the following reasons: students and teachers that believe that failure and rejection are normal, the lack of previous knowledge that should have been acquired by students at previous levels of education, the lack of motivation of students, the large number of new concepts brought about the discipline and the shortage of alternative teaching methodologies.

In view of this situation, the idea of using comics (HQs) as a support tool in the teaching of Calculus arose, because it was observed that the best use of the class would be to trace the path of learning through visual and tactile means, that the comics can provide. Besides, who does not like to read a comic book?

Thus, the objective of this article is to report the experience of the use of the HQs as a didactic resource for the teaching and learning of the discipline of Differential and Integral Calculus of several variables for the Engineering courses of the University of Brasília (UnB), Gama campus.

Initially, we will make a brief theoretical reference of the concept of comics and meaningful learning. Next, we report the characteristics of the students involved in the Engineering course, in which the work was developed and the experience report. Finally, we will show the results obtained and the conclusions.

## 2 Comic Books and Meaningful Learning

In this section, two lines of research are presented that provide theoretical sustainability to the work: comics and meaningful learning.

From a more general point of view, a comics or comic strips are narratives made with sequential designs, usually in the horizontal sense, with short dialogue texts (balloons) and some descriptions of the situation. The essential aspects of a comics are: balloons, onomatopoeia, layout, reminders and gutter or drain.

The use of HQs in education is recognized by the National Education Guidelines and Bases Law (LDB) (BRASIL, 1996). According to Vergueiro (2004), there are several reasons for their use in teaching, such as: words and images, together, teach more efficiently; the comics help in the development of the reading habit; the comic language forces the reader to think and imagine; comics can be used at any school level and with any theme, etc. In the literature, there are several works using the comics in primary and secondary education, but at university level are few.

Therefore, we highlight the works of Oliveira (2010) and Felix (2016) that report experiences in the classroom for academics. Both propose the production of comics by students. It is worth noting that in Felix's work (2016), in addition to proposing the making of comics, using the students' drawing skills, some technological resources were also presented, which facilitated the creation, making it possible to make associations with mathematical contents and with the resolution of problems. The main objective was the production of comics for solving mathematical problems related to students' daily situations.

In this perspective, the comics in this article, which will be presented in the next sections, are humorous comics that have been proposed by students to identify, analyze and use the mathematical content in the plot of the comic strip for then use it to solve mathematical problems, a fact that reinforces the sketch of significant learning considerations.

Among the several definitions of meaningful learning, we highlight the one presented by Ausubel (2002), which states that meaningful learning is the process that is characterized by the association between previous knowledge and new knowledge, and that this interaction is non-literal and not arbitrary. In this procedure, new knowledge acquires meaning for the subject and prior knowledge acquires new meanings or greater cognitive stability.

If this junction is not carried out, there will be a mechanical learning, based on tasks composed of purely arbitrary associations, which require the student to reproduce the concept that was "transmitted" to them, without associating them with previously acquired knowledge. Again, according to Ausubel (2002), the conditions for meaningful learning are: material and learning must present logical meaning and availability of content of psychological significance. In this perspective, the strips can thus favor the passage from the logical to the psychological, becoming one of the justifications for the elaboration of our proposal. In this way, we understand that classroom HQs should emphasize problematic situations that favor the apprehension of new concepts, accentuating the logic of contents, also identifying their relations with other disciplines and with other mathematical notions that

are related in some way to study subjects. The interpretation and understanding of mathematical ideas, in our view, can be facilitated when, instead of presenting them as perfect and finished truth, we highlight the ideas that can lead the students to build relationships necessary to apprehend the concepts under study. Thus, we believe that engaging students in structured activities, such as those based on strips, enables exploration and discovery in a research process that helps students make connections between new and old information. In view of the theoretical structuring organized up to this point, in the next section will be reported the experience of the use of comics in the discipline of Calculus.

### 3 Characteristics of the Students of Calculation Discipline of the FGA

The experience was developed at Faculdade do Gama (FGA), which is an extension of the University of Brasilia (UnB), in the administrative region of Gama, the federal capital. It hosts five courses in the area of engineering: aerospace, automotive, electronics, energy and software.

The FGA is part of the expansion project of the federal universities, 'Reuni'. It came into operation in the second half of 2008. The students are admitted in three ways:

a) Vestibular (S.A.T.): Normally the opening notice of registration is launched in April. The exam is held in June. For those who pass the entrance exam, classes begin in the second semester of the year. There are 280 places.

b) PAS (Serial Assessment Program): SBP occurs in three stages, the first test being done during the first year of high school, the second evaluation during the second year of high school and the third test during the third year from high school. Those who pass, begin classes in the first semester of the year. There are 140 places.

c) SiSU (Unified Selection System): Through the ENEM, the candidate competes for 140 places for FGA courses and those who pass the exam begin classes in the first semester of the year.

In general, every semester there are 280 students. Each Class of FGA Calculus is composed on average by 120 students. These students enter the first year of the course with great difficulty in basic concepts of Elementary Mathematics.

It is worth mentioning that the menu of Calculus 3 taught in the use of the HQs in this research deals with the calculation content of several variables, such as: partial derivatives, double integrals, triple integrals, line integrals, surface integrals, etc.

It is worth mentioning that the use of this methodology was approved by the Research Ethics Committee of the Faculty of Health of UnB, under the protocol CAEE 72644517.7.0000.0030.

### 4 Experience Description

The idea of the HQs arose from the author's dissatisfaction with student performance in the discipline of Calculus 3, when teaching in the second half of 2016, whose content

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addresses concepts of Differential and Integral Calculus for several variables. The table below shows the performance of approval, disapproval and lockdown in the discipline in the mentioned year. The lockout rate of 30% was an alert to the teacher, because it was clear that the students were discouraged with the discipline taught in a traditional way - teacher in the frame with lectures, exercises and face-to-face assessments.

**Table 1** Student performance on 2/2016- before use HQs

Students	Approval	Disapproval	Lockdown
119	58%	12%	30%

Source: Author, field research.

In the first half of 2017, the use of comics began in the discipline of Calculus 3 taught by the author. The comics approach was organized in four stages.

In the first stage, we offered a group of four to five graduate students' self-made comic strips, on average four comic strips. These strips dealt with distinct contents of Calculations (some with theoretical contexts and others with practical applications). For each of the comics, the graduates resolved the questions in groups. In this initial moment, we tried to situate this didactic tool as a complement to the classes in the resolution of exercises and fixation of theory. After the activities were done, the teacher discussed all the strips with the class.

In the second stage, which occurred in a non-face-to-face way, the students were proposed to construct comics of their own fist. In this non-face-to-face activity, the students chose the theme for the elaboration of the strips and did this group activity of four to five students. It was scheduled one day for students to deliver this activity in writing.

In the third stage, in the classroom, were analyzed the comics made by the students. In groups, the students explored the strips of each group in the class. In this stage, strips dealing with different contents were explored. In the end, the teacher discussed all the comics with the class.

In the fourth step, a questionnaire was applied, composed of four questions to evaluate the students' perception of the use of the HQs in the discipline of Calculus, in the engineering courses of the FGA. This research presented questions where the students answered how much they agreed with the affirmatives, through a Likert scale (Rensis Likert, American psychologist who conceived in 1932 a methodology to measure the attitude of his patients and today this is used in scientific research methodologies).

A total of 341 students took part in these activities, between the semesters 1st/2017, 2nd/2017 and 1st/2018. It is emphasized that the essential objective of this work is the presentation of the reports of didactic experiences, using the HQs in the teaching and learning process of Calculus. Thus, another study on a statistical analysis, both descriptive and inferential, will remain as a perspective.

Next, we present two strips developed in this work with different themes.

**Figure 1:** The Variable Change Theorem in polar coordinates

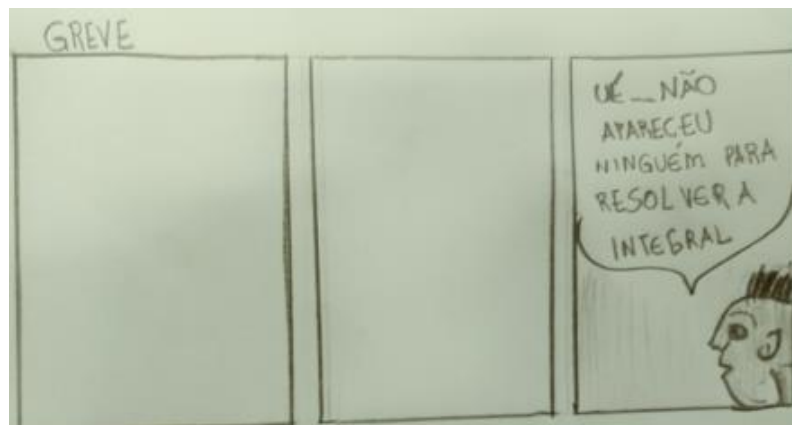


Source: Author, field research.

Translating comics of Figure 1: Love Triangle

- Love, I have something to say that might disturb our polar relationship.
- Oh, really? What is it?
- The Jacobian is between us!!

**Figure 2:** Integrals



Source: Author, field research.

Translating comics of Figure 2: Love Triangle

- Hey, nobody showed up to solve the integral?

The students had a lot of fun with the strips presented above. The first comic strip addressed the use of the Variable Change Theorem in polar coordinates for the double integral calculation. Most of the students concluded that the pivot of love triangulation (the Jacobian) is fundamental to the resolution of exercises that uses this theorem as theoretical support. It was a relevant activity, because the students always forgot to determine the Jacobian in the solution of problem and after this strip, they never forgot it again. The second comic strip reinforced how difficult it is to solve an integral (in the study in question, it

approached double and triple integrals) and also motivated the students the importance of the commitment in the discipline.

In both strips, students were able to identify, analyze and use the mathematical contents covered in a clear, fun, efficient and meaningful way.

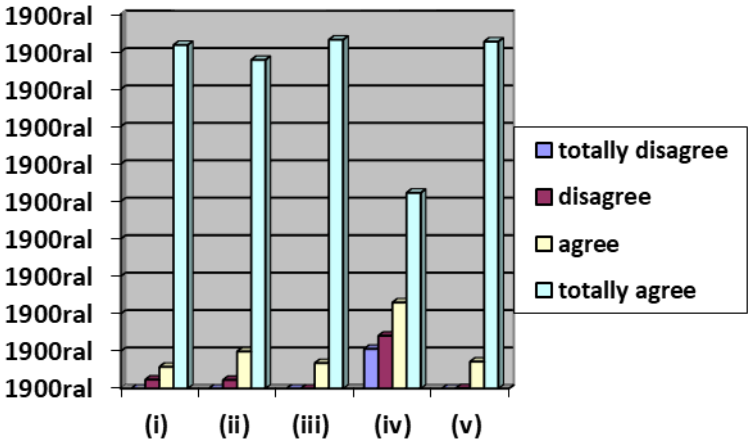
**5 Outcome and Analysis**

With the purpose of collecting information, regarding the use of the universe of comics in the teaching of Calculus, students who participated in this activity, on average 100 students per semester, answered a short questionnaire (voluntarily) that addressed the following questions:

- (i) The methodology applied in the discipline of Calculus 3 contributes significantly to its general academic training;
- (ii) The use of this methodology stimulated the commitment to the discipline as assiduity and attention to doubts;
- (iii) The use of comics should be used in other disciplines;
- (iv) Did you like to make the comics?
- (v) Did you appreciate the comics provided by the teacher?

Also provided in the questionnaire was a space for open response for students who wanted to leave some testimony if they considered it necessary. Thus, the scale dimensions ranged from 1 (totally disagree) to 4 (totally agree).

**Graph 1:** Questionnaire response



Source: Author, field research.



Based on the results of the scales, it can be analyzed that the great majority of the students considered that the applied methodology contributes significantly to the learning (92%) and that its use motivated attendance and comprehension in the discipline (88%). The use of comics in other subjects was recommended by 93% of the students. A curious fact, the students liked the comic strips provided by the teacher (93%) rather than making their own comics (51%). In the spaces for testimonials it was possible to verify the voluntary opinions of some students:

- a) "I really enjoyed studying Calculus using HQs, a pity that I cannot draw" (Student 1).
- b) "How fun it is to learn in a fun way" (Student 2).
- c) "Pity that the teacher does not use the comics in all classes (Student 3), etc.

Regarding the Student 3 commentary, these activities were proposed in the form of auxiliary and complementary to the classes, being impracticable to practice them daily due to the extensive content of the discipline and the time released for application of this methodology. Thus, the consolidated data of the research allows us to conclude that, in relation to the main object of the research, the use of HQs in the discipline of Calculus, improved the approval rate of students and also, the frequency of students increased in the classroom, the which allows us to conclude that there was a greater interest in the participation of these, which possibly reflected an improvement in the results obtained in terms of approval in the discipline, after the implementation of the use of the HQs, as can be seen in Table 2 compared to Table 1 .

**Table 2:** Student statistics in the Calculus 3- after use HQs

Semester	Students	Approval	Disapproval	Lock down
1º/2017	128	61%	34%	5%
2º/2017	123	70%	27%	3%
1º/2018	90	83%	14%	3%

Source: Author, field research.

An important highlight in the research is in relation to the final averages in the subject and the attendance/interest of the students in the classroom, which reinforces the idea that in their perception, the breakdown of the traditional classroom paradigm worked positively.

**Conclusion**

With the results obtained in the present work, it was possible to observe that, both the students and the teacher, the use of comics, in the teaching and learning process of the Calculus discipline, provided moments of relaxation, arousing students interest, which enabled a better learning of this subject. The presented approach made it easier for the student to create associations and generalizations of these activities with related algebraic contents. We can affirm that the use of the strips has a great potential to work with problem solving and

revision of mathematical contents, through the illustrated situations, allowing the student to develop the critical sense, in view of the presented theme, to develop the logical reasoning, when diagnosing the comic messages, stimulating research and associations with other disciplines.

Therefore, it is believed that the use of comics, inserted in mathematics classes, allows students to be more interested in and motivated to learn it, through the relaxed way that approaches different concepts, contributing to the improvement in teaching and learning of mathematics. The observation of students' behavior towards the proposed problems, and also their commitment to finding solutions, corroborates Dewey's (1959) statement that learning occurs effectively only in cases where there is a real problem if resolved. In mathematics teaching, the real practices provide an environment in which the content no longer has a strictly abstract character and is seen as routine, applicable on a daily basis and easily accessible. Thus, this methodology fulfilled its pedagogical objective and hopes that this report may also motivate teachers from various courses to re-elaborate and re-signify their classes.

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