

MOTIVATION FOR LEARNING MATHEMATICS IN HIGHER EDUCATION THROUGH THE “ M@T-EDUCATE WITH SUCCESS” PLATFORM

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Abstract

According to several authors, motivation is a major determinant of academic success and quality of school education. However, the lack of motivation among students is a current problem leading to school failure manifested in particular through early school dropout, or low exam scores. This happens especially in mathematics, and students dropout in courses that integrate subjects in this area in its curriculum, jeopardizes the future of a number of essential areas to the development of mankind.

The attitudes and teaching practices of teachers are essential in the motivational process of students. It is therefore urgent that there is a change in the way of educating and teaching to enhance students' motivation to learn and like Mathematics.

In this context, we developed a study focused on the influence of the online “M@t - educate with success” platform (pM@t) in particular, in enhancing undergraduates' level of motivation for learning and liking Mathematics.

We chose an essentially qualitative research approach, based on a constructivist paradigm, and used case study design. The empirical study focused on the thematic unity of Integral Calculus Course of Infinitesimal Calculation from the Degree in Management of a Portuguese Polytechnic School. Students, during that thematic unit, explored the contents in pM@t and tried to solve the weekly tasks proposed, before those contents were lectured in class. In these sessions, the contents and solutions were discussed after they had been pre-explored by students and other tasks from a different nature were also performed in order to assess students' ability to mobilize the knowledge built and skills developed through the independent and self-regulated exploration of pM@t. Data was collected through the techniques of inquiry, observation and document analysis, supported by various tools. Content analysis techniques were applied.

The main results highlight the influence of prior exploration of pM@t on student motivation for learning mathematics and in particular, integral calculus. This was translated, in particular, in students' interest in the resolution of the proposed tasks and a greater interaction in the classroom, which was positively reflected in the assessment results.

Keywords: Virtual Learning Environments, “M@t-educate with success” Platform, Higher Education, Mathematics Learning, Motivation.

1 INTRODUCTION

The relevance of mathematics in personal and professional everyday life is a reality recognized worldwide [1]. Besides having applicability in various scientific and technological fields it also underpins the development of science and technology [2]. On the other hand, it contributes to the development of individuals, stimulating thinking and communication skills important to everyday social life, serving the needs of all citizens [2].

As such, there are several courses of mathematics that are part of the curricula of numerous higher education courses. However, the motivation of students and, consequently, school failure this area of knowledge is a fact in the context of this level, sometimes leading to school drop-outs [3], [4], [5], [6], [7].

According to several authors [8], [9], [10], [11], [12] motivation is a major determinant of the success and quality of school learning. Therefore, it is urgent to reflect on pedagogical practices that are

fundamental to the motivational process of the students and rethink teaching practices to enhance students' motivation to learn and like Mathematics [4], [12].

Several studies [9], [13], [14], suggest that technologies allow you to create individual environments, customised, tailored to each one, enabling students to experiment and develop their own learning, hence promoting student interest in mathematics.

In order to contribute with innovative ways to increase school success in mathematics, we created a platform to support the learning of mathematics - M@t-educate with Sucess (pM@t) [15], which needs to be evaluated, being this the aim of this study.

In this context, we developed a study focused on the influence of pM@t particularly, the level of students' motivation in higher education for learning and enjoying mathematics, which is presented in this article.

Initially we aim to contextualise and justify theoretically and methodologically the study. Then we present the main results and the main conclusions.

2 THEORETICAL FRAMEWORK

Mathematics is an area of knowledge which involves several dimensions such as cultural, social, training and politics. The cultural level is associated with a heritage of humanity and a way of thinking and access knowledge, contributing to the exercise of citizenship [2]. The social level contributes to the integral development of citizens who should be able to participate actively and critically in society and become competent in the design and troubleshooting of your everyday life tasks. Concerning the training level, it is mandatory in the school curriculum of various levels of education worldwide [5], [16], occupying a privileged position at schools. Politically, some measures to its development have been taken by many countries [17].

It is no surprise that in order to meet the demands of an increasingly competitive society, at European level, it has been strengthened training in mathematics, alongside the scientific and technological training, in order to make students competent, proactive citizens, creative and autonomous [17].

Thus, in Portugal, as in many countries, mathematics plays an increasingly important role in terms of selection of candidates for a number of higher education courses, particularly in science, economics, engineering, teacher training, management, technology and health. On the other hand, it strengthened the presence of Mathematics related subjects on many different other higher education courses [18]. Alongside these measures, higher education should allow students to become capable of meeting the demands of an ever-changing society, developing core competencies [17].

However, the failure in mathematics continues to be a constant concern and is considered by many students as an obstacle that prevents them from pursuing and achieving their goals [2].

Under the program "Promotion of school success and fight against dropout and failure in Higher Education" a project entitled "Students and their journeys in Higher Education: success and failure, factors and processes, promoting good practice" was developed, which involved several institutions of higher education [19]. Three analytical aspects were identified that, while different, complement each other: the structural (external variables to the higher education system, the social framework of this system and its agents); institutional (integration of students in the social and academic systems of institutions) and individual (particular characteristics of each).

Regarding this third individual strand, various authors address the phenomena of failure and dropout in higher education focusing the explanation on variables such as motivation, vocation and skills such as autonomy, self-regulation and mathematical thinking [19], [20] [21], [22].

According to [23], "motivation is a set of variables that activate and direct behaviour in a certain direction in order to achieve an objective." To Bzuneck [24: 9], "motivation or the reason, is what moves a person or puts it into action or does change course." Therefore, motivation can be understood as a process that instigates a conduct, which supports a progressive activity, which directs this activity to a sense [25].

Thus, motivation must always be present in the educational process, as several authors argue [26], [27], [28]. According to Matos [27: 41] "motivation is essential in the learning process. The quality of learning is not only related to the ability to learn, but also to the level of motivation we have to learn".

Roth and Radford even claim that “an integral part of the learning activity is for students to Recognize the object / motive in their own actions” [26: 16].

On the other hand, cyclically, [28] considers that learning depends on motivation, but this is directly related to the choice of tasks, the effort, the watch, reflect and be persistent - to engage in their own learning. The teacher has an important role here by encouraging the student to be an active part in their own learning process and thus develop motivation for learning. [12]

According to other literature, technologies have been recognized by several authors as a resource to consider in teaching practices, allowing students, the very motivational way, engage in their own learning. Online technologies can promote greater involvement of students with the contents [14] enhancing a greater commitment in carrying out mathematical activities.

According to [9: 154], “it is important to integrate ICT and online platforms as a resource in learning as it enables students to be engage in self-directed and more active learning, within a shorter period of time.” They also argue that online technologies can promote greater involvement of students with the contents [9], which provides the construction of new knowledge, showing the relationship between motivation and learning. Note that, in studies conducted by the authors, most students expressed interest in autonomously learning some subjects, resorting to the use of computers, and acknowledged that they helped them to study. Thus, the authors argue that computers should be used, recognizing the use of technology as an asset in teaching and learning processes.

In fact, digital technologies provide tools that enhance the resolution of tasks and provide access to real-world data, involving students and motivating them to study mathematics. If students are able to use them to perform mathematical operations, learning in science, technology and engineering in schools and colleges can be improved [29].

Thus defend themselves educational contexts more focused on student learning, to arouse their interest in the study and, in a way, that encourage them to understand the world they live in. Such environments promote more independent and more active citizens, able to use the information with a critical sense and to make choices, which enhances the formation of free citizens, happy and skills to compete on a global scale, making use of reason itself [30].

In this perspective, the School of Technology and Management of the Polytechnic Institute of Viana do Castelo, the platform “M@t – educate for success” was developed under the project “Educating with Success”, inserted in Operational Programme for Science and Innovation (POCI 2010), in order to contribute to the fight against school failure in mathematics which was the subject of this study.

3 METHODOLOGY

In order to study the potential of pM@T platform, we developed a study whose main objective was evaluating the influence of previous exploration of this platform, before the formal approach in the classroom, the integral calculus theme, the development of motivation in learning mathematics, translated by interest in the proposed tasks and for a greater commitment in the classroom.

3.1 Methodological options

Given the purposes of the study, it is inevitable a thorough study of the use of pM@t, by the students, in a real context in order to better monitor their attitudes. Given the complexity of the subject matter and the aim of better understanding it, we opted for an essentially qualitative approach of research [31] based on a constructivist paradigm [32]. Moreover, we intend to study the influence of this platform in student motivation for learning mathematics, namely, the integral calculus, translated by interest in the proposed tasks and greater interaction in the classroom, so we opted for case study strategy [33], [34], since it allows to study, in a detailed manner, a particular phenomenon real context using multiple sources of evidence (qualitative and quantitative).

3.2 Population

The empirical study took place in Integral Calculus theme of the course of Infinitesimal Calculus class taught by the teacher / researcher at the 1st year of the Degree in Management of a higher education institution in the second semester of the school year 2010/2011 in normal academic environment. 19 students attending the class teacher / researcher were considered.

The demographic questionnaire conducted at the beginning allowed to find that most students had chosen this course as their 1st option. We also find that they had a laptop and had accessed to the internet from their room. However, most did not know about learning platforms and assumed not knowing its importance. With regard to mathematics, the majority did not consider themselves good students and have little interest for that area. However, they considered it important or very important for their training.

3.3 Data collection tools

In this study, several techniques of data collection were used, supported by various instruments, consolidating the phenomenon under study and thus giving it credibility. [33] Furthermore, the collection and organization of data from multiple sources was held to just study in a systematic way in order to obtain sufficient and relevant information [33], [34].

We privileged the inquiry by questionnaire, for providing information about a particular phenomenon, through questions that reflect attitudes, beliefs, perceptions, interests and behavior of a set of individuals. Two types of questionnaires were applied: at the beginning of the semester - in order to characterize the students and end of the study - with the main objective to know the opinion of the students about the pM@t.

Also we used the techniques of observation and document analysis [35]. Other diverse instruments were used such as: records available in pM@t, logbook records, responses to the proposed tasks in the Scripts study and test evaluation of learning that was applied to the pre-test mode, post-test and I post-test II.

3.4 Description of the study

In class before the target thematic research unit - Integral Calculus – students answered a characterization questionnaire and were requested the resolution, individually, of a pre-test, which served a dual purpose - diagnostic evaluation and subsequently allowed to evaluate the evolution of students, by comparing with the results of the post-tests.

During the period in which they were discussing the issue, weekly, a screenplay study was made available in Moodle, so that the students could explore content not yet addressed by the teacher and try out the resolution of the proposed tasks there that later would be discussed at Class level. Four study screenplays were performed:

- GE_I - Full notion defined and undefined integral, immediate integration and almost immediate and full implementation of the calculation of areas of plane figures;
- GE_II - immediate and almost immediate integration considering exponential and logarithmic functions, direct and inverse trigonometric functions and integration by substitution;
- GE_III - integration by parts and integration of rational functions;
- GE_IV - other applications of definite integrals, as line lengths, areas of surfaces of revolution, volumes of solids of revolution and improper integrals.

In class, in addition to discussing the content already pre-exploited by students as well as the resolutions of the previously proposed tasks, held up other tasks varied. At the end of the last class of each week, we applied a weekly self-evaluation questionnaire.

At the end of the thematic unit, there was the post-test (I) and an opinion questionnaire on pM@t on the methodology used. A month later, took place the post-test (II).

3.5 Data analysis

The considerable amount of data collected through examination techniques, observation and document collection, supported by various instruments [33], was subject to different treatments, with recourse to the predominantly qualitative analysis.

Quantitative data was analysed by means of statistical analysis, using initially descriptive statistics.

Qualitative data was analysed by means of content analysis [35] according to oriented categories which were defined recursively, and two categories were considered:

- Platform features - involves ease of access, diversity and quality of information, clarity of language, the adequacy of the organization and the existence of feedback and
- The platform's impact on student learning - includes the resolution of the tasks, the development of self-learning, construction of knowledge and increase the interest in studying mathematics.

4 RESULTS

Only two students did not access the platform - one because logged in by using a colleague credentials and the other because he gave up attending the class. The number of accesses by students ranged from 10 (a student) and 2 (three students), departing from the expected, it was predictable that every student perform at least one session per week, which accounted for 4 sessions per student. However, they were performed on average 4.4 sessions, with 42% of 4 sessions performed. This situation is related to students' interest in learning the infinitesimal calculus theme, since they could access once the platform and then try to answer the respective script study. It should be noted that students could perform the tasks of study guides without access to pM@t, since they were also available on Moodle. Therefore, it may be argued that they recognized advantages of using the platform because when exploring it, they could access a set of information that potentially helped in the resolution of the proposed tasks. Moreover, it was found that 21% of students in the class used the platform after completion of the study.

During the four weeks on the experimental phase itself, it was found that four students have not undergone any study script, a student submitted the GE_I another underwent two (GE_I and GE_III) and the remaining underwent all. The screenplay with higher volume of deliveries was the GE_I supposedly because the first tasks did not require little previous knowledge of mathematics. Despite the delivery of study guides be mandatory, and students deliver without performing the tasks proposed, it was considered appropriate to examine whether students were interested in solving the tasks (trying to solve any task) or merely put questions (were classified in this category the ones that did not perform any task and / or only had doubts). As it can be seen in Table 1, most students did not just deliver the guidelines, even though its resolution had no effect on the final classification. The commitment of the students who delivered study guides was notorious, trying to perform the proposed tasks, even before the issues discussed there be worked out and discussed in class.

Table 1: Students' attitudes regarding the proposed tasks in the study guides (%).

	GE_I	GE_II	GE_III	GE_IV
Tried to solve the tasks	79	63	53	53
They limited themselves to put questions or simply did not perform the task	0	5	11	11

Students, even with difficulties, sought to solve the tasks proposed in the study guides. Evidence is shown in (Figure 1), illustrating their interest in this subject, which is associated with the motivation for study.

The notes in the logbook throughout the study also point in this direction. In the second week of school, in class prior to the start of Integral Calculus theme, the teacher / researcher noted the following: "The students show up very worried and discouraged referring not having prior knowlodge, they will not succeed, as some said, they never had derivatives or mathematics." (Logbook, 15/03/2011).

The following week, it was possible to assess students' difficulties, because "... they were very concerned to participate. It was found that they had difficulties in relation to the concept of definite integral" (logbook, 21/03/2011). However, they sought to monitor the activities – "In general, though students found it hard, showed interest and followed their assignments in class." (Logbook, 22/03/2011). After a week, the commitment of students was lower, with the investigator considered that students were unmotivated, as can be read in the following research note: "Taking into account that the accession of students to Study guides was lower, at the beginning of the class I sought to sensitize students to the importance of deliver the tasks proposed. This time it was possible to confirm the motivation of these students" (Logbook, 28/03/2011).

1) a) $\int_{-2}^3 e^{-\frac{x}{2}} dx$
Obs: não sei que regra (de derivação) devo utilizar

b) $\int_{\frac{\pi}{2}}^{\frac{3\pi}{4}} \sin x dx = [-\cos x]_{\frac{\pi}{2}}^{\frac{3\pi}{4}} = -\cos\left(\frac{3\pi}{4}\right) - \cos\left(\frac{\pi}{2}\right)$
 $= -\cos\left(\frac{3\pi}{4}\right) - 0 = -\cos\left(\frac{3\pi}{4}\right)$

d) $\int \frac{\cos x}{\sqrt{1-\sin^2 x}} dx = \int \cos x dx \int \frac{1}{\sqrt{1-\sin^2 x}} dx$
Obs: não consigo desenvolver

2) a) $\int_0^1 (3\sin x + 2x^5 - 0) dx + \int_{-1}^0 (3\sin x + 2x^5) dx$
 $= \left[-3\cos x + \frac{1}{3}x^6\right]_0^1 + \left[3\cos x - \frac{1}{3}x^6\right]_{-1}^0$

b) $\frac{5}{2} - x = \frac{1}{x} \Leftrightarrow 1 = \left(\frac{5}{2} - x\right)x \Leftrightarrow 1 = \frac{5}{2}x - x^2$
 $\Leftrightarrow -x^2 + \frac{5}{2}x - 1 = 0 \Leftrightarrow x = \quad \vee \quad x =$
Obs: não sei como dividir o gráfico de forma a que me possibilite resolver o exercício.

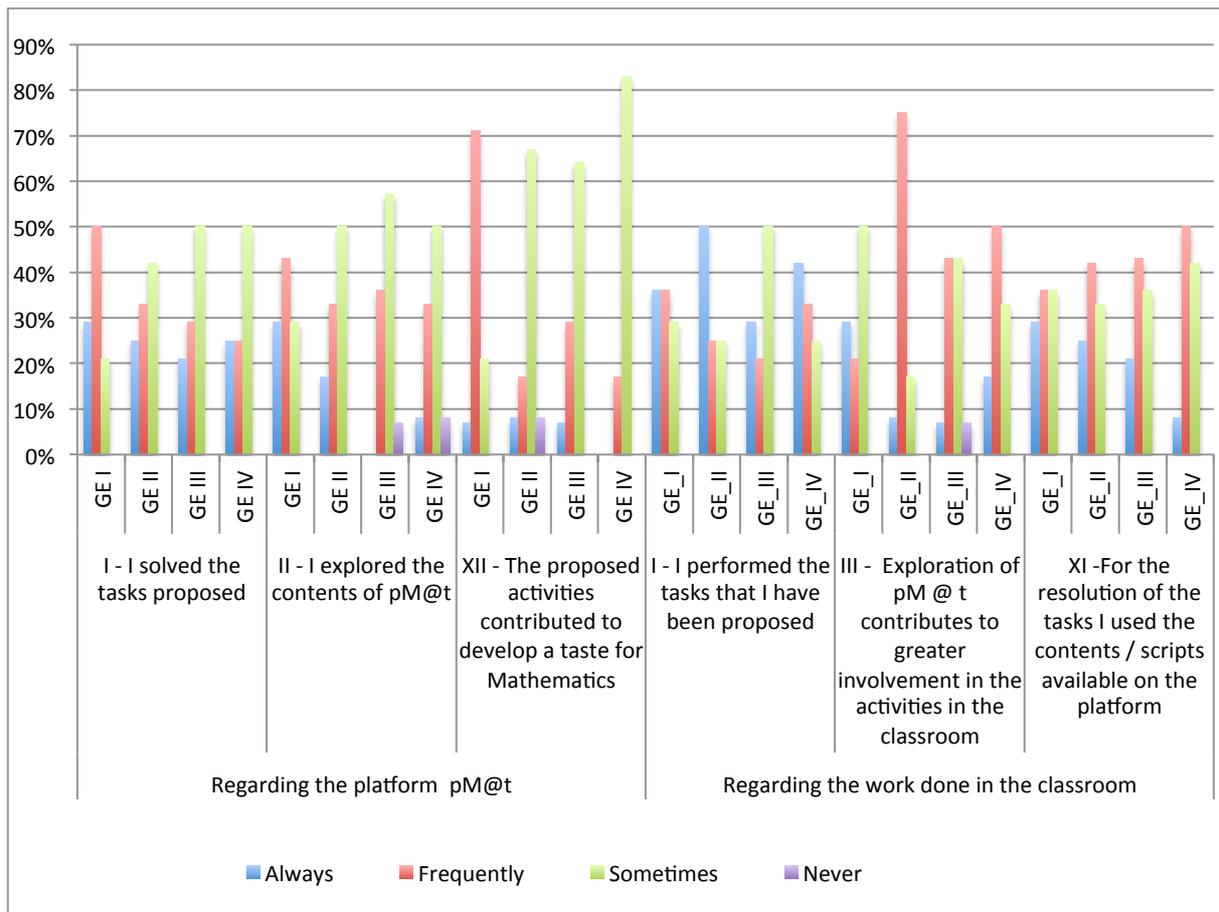
Figure 1: Student's answer to the tasks proposed in GE_II.

The following week the students were involved in more activities. According to the records of the investigator, "It was found that students had explored the method of integration by parts, and most of them understood the method by which it was known the tracking of students in solving the tasks of page 9 of Script Digital Part II." (Logbook, 04/04/2011).

In the last week of the pilot study, "students were asked to resolve the remaining tasks on page 10 of the Digital Script IV and it was notorious the commitment of students given that the majority tried to solve them autonomously." (Logbook, 12/04/2011).

Through the records displayed chronologically, it turns out that the students changed their attitude. In the first weeks, although showing some interest, strove to solve the tasks they were proposed, mentioning lack of prior knowledge. However, in the following weeks, they sought to solve the required task and, in some cases, this situation is no longer the exception becoming the attitude of most students. It was found that students were more motivated by participating more actively in the classroom.

The analysis of the responses to the weekly self-assessment questionnaire, on issues relating to the platform, it turns out that 50% or more of respondents indicated having performed the tasks proposed Always or often; they indicated that almost all have explored, although with varying degrees of frequency, the contents of pM@t; the proposed activities contributed to develop a taste for mathematics, Always or often or sometimes (Graphic 1) and that most students considered that always or often the exploitation of pM@t contributed to greater involvement in the activities in the room class. In the guidelines II and IV these values were 83% and 67%, respectively.

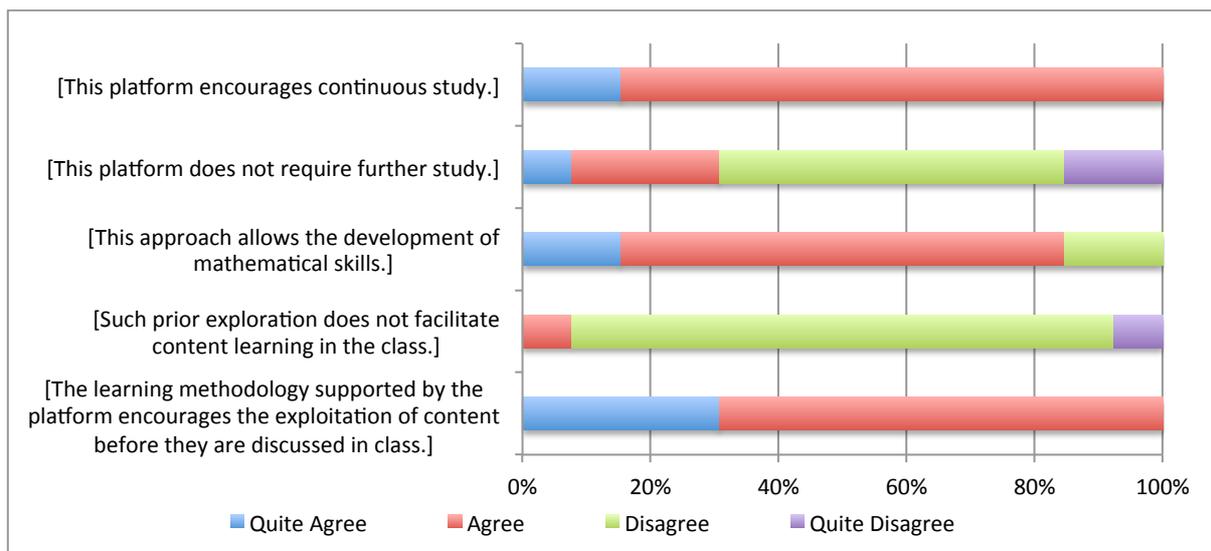


Graphic 1. Influence of pM@t in students' learning

The analysis of these results leads to the conclusion that this methodology, based on prior exploitation of content by pM@t, can be a contribution to stimulate interest in mathematics in particular for its study. It is therefore important, again, to point out that most students recognized that this methodology, integrating the use of the platform and forcing them to a first contact with the contents supported in pM@t outside the classroom, helped to better understand the contents and facilitated the involvement of students in the activities proposed. This fact is not unrelated to the development of interest in this theme and consequently the promotion of motivation of the study of mathematics, particularly of this unit.

As for the test results, calculated in the three stages of evaluation, it was found that all evaluated students had a better grade in the post-tests. It could include a change in attitude of most students. In the pre-test, most students did not try to solve any task, which did not occur in subsequent times. The last time they were given the test, it was found that students, even though it was a diagnostic test for the subsequent issue, sought to solve it, showing interest in properly performing the tasks proposed.

Analysing the opinion questionnaire on pM@t about the influence of the platform on student learning, the overall view that encourages lifelong learning, and 15% chose Quite Agree (Graphic 2). Regarding the statement "This platform does not require further study," the opinions diverged more. However, 54% of respondents chose to disagree and 15% by Quite Disagree.



Graphic 2. Students' opinions on pM@t

As for the methodology, it turns out that most students (85%) disagree that the prior exploitation of content (before being discussed in the classroom) does not facilitate the monitoring of actual classes. However, the opinions of other students are divided equally between quite agree and quite disagree. All of the students selected Agree that "learning methodology supported by the platform encourages exploration of the contents before they are exploited in class." But with regard to the statement "This approach allows the development of mathematical skills", although most have chosen to Agree (70%), 15% ex-aequo chose to agree or quite disagree.

The SWOT analysis in relation to this dimension, taking two categories - Characterization of pM@t and Impact of pM@t on student learning - and respective subcategories, most opinions were associated with the second category and, within this, the subcategory with more units of meaning is related to the promotion of knowledge building, then the related subcategory to promoting problem solving / issues. Moreover, in another category, the subcategory with more meaningful units is related to the ease of access to the platform, then the subcategories related to the diversity and quality of information and clarity of language. However, the analysis carried out indicates a positive perception regarding the platform, both in terms of information, whether as an added value to student learning. Further, there are two references to the sub related increase in interest. Noteworthy is one of the quotes that says that, "the platform enhances learning." In this sense, it can be said that, overall, the platform stimulates learning, which is no stranger to building the capacity of interest in this subject.

5 CONCLUSIONS

On average, students made more than one access per week. The volume of deliveries of study guides was higher in the first week. The performance of students in the scripts of study was not constant throughout the pilot study. However, one cannot ignore the increase of complexity of the proposed tasks and the increased workload inherent in the course of the semester.

At the level of the classroom, at first, the students were little participatory and could not solve the tasks but, throughout the study, began to be more participatory and to perform better on tasks they were proposed. This was reflected in the marks obtained in tests measuring knowledge (pre-test, post-test I, post-test II). Although, initially, students had a little participatory attitude in class at the end of the empirical study period were more attentive and motivated, it was possible to verify a greater interest in learning. Furthermore, students expressed interest in the methodology adopted when implementing the empirical study and have shown concern not continuing to use this methodology in subsequent issues. On the other hand, there was internalization of the need for independent study, leading students to take more responsibility for their learning.

Lastly, analysing the contributions of the students about the strengths and weaknesses of the platform with regard to interest in mathematics, in particular, it was found that most recognize the potential pM@t. They consider that this platform enhances learning, helping them in the study and facilitates

the understanding of the contents dealt with in class, recognizing it as a facilitator and promoter of learning, motivating them to study.

In short, from the analysis performed, it can be seen that the Management students who participated in the study recognized that the methodology adopted, based on exploitation of content by pM@t before being discussed in the classroom, facilitated monitoring of activities carried out in regular classes and expressed interest in this methodology. Therefore, it can be considered that this methodology helps to reduce school failure in the courses of Mathematics, which also involves motivating students for the learning of mathematics and making them more autonomous and critical citizens.

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