PLATFORM M@T-EDUCATE WITH SUCCESS - A CASE STUDY IN HIGHER EDUCATION

Isabel Araújo[1], Isabel Cabrita[2]

[1]Instituto Politécnico de Viana do Castelo (PORTUGAL)
[2]Universidade de Aveiro (PORTUGAL)
iaraujo@estg.ipvc.pt, icabrita@ua.pt

Abstract

Last decades have witnessed continuous and interrelated changes, namely technological such as the Internet, and socio-economical such as globalization. Both have impacted contemporary society, a global society that has evolved from Information Society to Information and Communication Society and that should ultimately evolve to a true knowledge society. Education nowadays must respond to globalization demands and prepare students for the challenges of today's society which is constantly evolving. Existing technologies (especially online) allow us to manage, in a more expedite way, diversified information and contribute to improve teaching and learning quality namely in mathematics. On the other hand, they have also re-conceptualized the way we perceive teaching and learning.

In this context, we created the "M@t-educate with success" (M@t) Platform, which is still giving its first steps and, thus, lacks a systematic validation which will allow to find out if the main objectives have been achieved. A central research question arises then: Does an adequate exploitation of M@t supporting Mathematics topics learning in Higher Education, contribute to the development of mathematical skills, promoting mobilization of knowledge, skills and attitudes?

We opted for a qualitative research approach, based on the constructivist paradigm, more precisely a case study, since it allows us to study in detail one particular aspect of a problem. We used the techniques of inquiry, observation and document analysis to collect data in order to understand the phenomenon. Several data collection tools were used since a case study will be more reliable if based on several sources.

The study was conducted in the curricular unit of Mathematical Analysis from the degree in Food Engineering 1st year (more specifically with the Integral Calculus Thematic Unit (IC)). Before starting IC classes, students answered a characterization questionnaire and a pre-test was also conducted. That served a dual purpose - diagnostic evaluation and, later, assessment of students' progress, when compared with the results of the post-test, performed shortly after in the IC classes ended and again replicated one month later. In the first class it was clarified the way that IC classes would be held: weekly, the student would carry out a preliminary exploration of the issues to be addressed in the following classes, by solving tasks proposed in the Study Guide (SG) provided in Moodle Platform. Thus, in the classroom, the topics previously explored would be discussed and tasks (of different sort) would be performed to assess the students' ability to apply the knowledge built by an autonomous self-regulated exploitation of M@t. At the end of IC classes a questionnaire was applied to obtain students' opinions regarding the M@t and the teaching methodology adopted.

The study leads to a favorable conclusion concerning the advantages obtained from students which explored the IC contents through M@t with a particular focus on students high involvement level in the classroom and also the development of mathematical skills, encompassing knowledge and other general and specific attitudes. Also we can highlight the development of autonomy and the ability to transfer the knowledge produced. M@t and the adopted methodology seem appropriate, both because it has improved students' attitude in the classroom, and by the increasing students' performance in various proposed tasks, including exams.

Keywords: Learning platforms, Information and Communication Technology, Higher Education, Mathematics, Innovative Environments. Learning.

1 INTRODUCTION

Several changes, including technological, economic and social have impacted contemporary society during last decades. Technologies by causing a new way to be, to communicate, to think and to understand, spurred the creation of a Global Information and Communication society that ideally

would turn into a true Knowledge Society [26] [1]. Educational systems cannot remain indifferent to this society; thus, they must prepare students for new challenges, always renewed, facing and dealing with uncertainty. In fact, what is true today may no longer be so tomorrow [5] [9]. They should also take advantage of technologies that exist today, especially online technologies, which allow users to manage information, in a quicker and diversified way, contributing to improve teaching and learning quality [10] [11] [2]. In particular, virtual learning environments (from free simple platforms to certain specific or licensed platforms for educational purposes) have created new spaces for knowledge construction [10]. This is the case of iMate and Pmate platforms, in the mathematics area [19] [25].

In this context, we projected a qualitative case study to be developed in an environment close to the action-research logic. The object of study is "M@t successfully educating" platform (M@t), which is specifically designed to support Mathematical Analysis courses in a Portuguese Polytechnic Institute. This project pursues the primary purpose of analyzing the (M@t) platform impact on learning Mathematics topics (associated with the Moodle platform, through the Course Unit webpage) on a group of undergraduate students from that Higher Education (HE) institution. More specifically, we want to find out about mathematical skills development level, expressed by students' interest to knowledge building and the development of autonomy and also knowledge transfer into other mathematical situations.

This article focuses on the pilot study conducted within this project (M@t) which is intended to estimate the adequacy of the investigative design outlined and find out possible obstacles to its implementation. On the other hand, it also took an exploratory function of the platform impact on mathematics learning.

2. THEORETICAL FRAMEWORK

Currently, we live in an Information Society supported by data storage and transmission technologies, which, virtually, allow accessing an immense amount of information, anytime and anywhere. Furthermore, such information spreads instantaneously.On the other hand, it is possible to establish communication in a formidable quantity, speed and credibility. We live in a Communication Society. but we wish to evolve to a Knowledge Society, which is the strategic factor of paramount wealth and power [26] [1], transforming the data processed and updated into real knowledge.

Portuguese HE institutions have tried to adapt to the new demands of this "new" society, more competitive and constantly changing, thus avoiding possible discrepancies between "real life" and "school life". Hence, there is the need (and especially at this teaching level) to move to a more dynamic educational model that promotes debate and reflection and which allows the conversion of information into knowledge. To achieve that, the teacher should promote the development of skills related to the selection, use and review of information, being no longer a mere "transmitter". According Warnock [33], the dogmatic teacher will be substituted by the dialogue teacher. The accommodated student will be substituted by the pro-active student, in building his own knowledge in interaction with knowledge and evoking technologies as mediators in this process. In fact, some studies have reported a positive impact of technologies in the teaching and learning processes, as they allow implementing strategies more focused on students [11]. A meaningful construction of knowledge can be promoted. According to Miranda [21], it is cumulative and depends on the particular individual and what he already knows about it. Thus, the student becomes more independent, responsible and able to ask and answer to complex and open-ended tasks which require an involvement in the learning process.

To enhance this process leading to skills acquisition and development of competencies, involving knowledge, attitudes and values, resulting from the interaction of each individual with information and its environment [21], it is essential that the teacher is familiar with theories of learning and that he follows the main principles concerned with the latest theories of education. According to Merrill [22], learning is most effective when the instructional process encourages students to recall, relate, describe, or apply knowledge from the experience already lived, and that can be used as pillars of the new knowledge.

Aware that the academic success also depends on the motivation for learning [30], another major concern of a teacher is to encourage students to know. This theme is not new but the school has not had much success in achieving it [13] [23].

The area of mathematics is flagrant, being failure and dropout a problem of paramount importance, particularly in Portugal, if we look at the study conducted at the Technical Higher Institute [16] and, more recently, the study conducted by researchers at the University of Évora. [32] But it is believed

that information technology, and in particular, learning platforms and LMS - Learning Management Systems can play a major role in the resolution of this problem. With this perspective, some platforms to support learning of mathematics have been developed, such as the one behind the Mathematics Education Project - PMATE [27], [4], [25] at the University of Aveiro and the iMática Project [2].

Also in the School of Technology and Management at the Polytechnic Institute of Viana do Castelo (ESTG/IPVC) some work has been done to overcome this. One example is the project "M@t successfully educating" (M@t) inserted in the Operational Program for Science and Innovation (POCI 2010) under which the (M@t) platform has been developed [6]. This platform[1] seeks to introduce in the process of teaching and learning of mathematics, innovative environments supported by appropriate digital resources. It is intended that on the one hand, it can lead students in the exploration, understanding and application of mathematical concepts, and secondly, it can promote critical analysis of methods used and results obtained. To achieve that, making use of visual components, such as animations and graphical images that help to clarify some concepts, digital guides have been developed, with which the students may (at its own pace and autonomously) dynamically construct their mathematical knowledge, exploring, conjecturing, investigating, discovering, testing concepts, ensuring a more active role in the educational process. The student learns by doing (learning by going) through options, reflections, analysis of actions, options change and evaluation of solutions [18]. M@t supports learning activities and according to Dillenbourg [17] it cannot be considered as a virtual learning environment (VLE), since it does not incorporate spaces that allow for collaborative interaction between teachers and students and among students. More specifically and according to this author, the VLE must have a feature set that will: (1) Auxiliary, extend and improve educational spaces, focusing on subjects in the construction of knowledge; (2) Provide a space for realization of innovative educational practices; (3) Provide a space for research, action and continuous development; (4) Provide for interdisciplinary between individuals from different areas of knowledge; (5) Provide collaborative interaction between the subjects involved; and (6) Promote spaces of knowledge and social skills construction. Corroborating this idea, Santos [29] considers the VLE as rich content spaces that enhance the construction of knowledge through interaction with these spaces.

On the one hand, this platform is not a mere repository for static content, as well as .pdf documents. It also provides Interactive Dynamic Guides with tasks of different nature involving illustrations and animations which force the student to interact and take decisions, always having a feedback of his options. On the other hand, a generic technological system is considered to provide interactive information as a result of data entry involving sustainable modes of feedback, providing the ability to change the user's reasoning [12]. Thus, we can consider this platform as an interactive learning environment, with reasonable levels of interactivity. Thus, and according with [24], this could provide a boost of motivation that includes gradual attention, relevance, confidence and self-satisfaction [20]. In fact, such a platform considers the needs of individual students in order to effectively support them, boosting confidence in the pursuit of their learning activities. What, according to the author, it is essential to keep interesting levels of motivation.

3 METHODOLOGY

In order to come to answer the questions that guide the research, it was considered pertinent to conduct a first phase, a pilot study whose main objectives were, first, assess the adequacy of the outlined investigative design, including all instruments and materials to use, and secondly, to study the feasibility and interest of using the platform, identifying any problems and technical content to address the implementation of the study itself.

3.1 Methodological Options

In this pilot study, and similar to that devised for the study itself, we opted for an exploratory case study in the context of action-research. In fact, we intend to study in detail a particular aspect of a problem [8] and the complexity of understanding the phenomenon involves detailed descriptions, operation processes and discovery of relations, based on the experiences of individual students. It is assumed as exploratory because it seeks to obtain prior information on the target object of study [28]. It provides an overview of a fact, as a basis for in depth investigations [3]. However, to ensure the

[1] http://www.estg.ipvc.pt/mat/

quality of education would not affect students in any way, necessary changes were made, on the basis of repeated cycles of planning, implementation and evaluation [15].

3.2 Participants

The pilot study was developed in the fall semester of the academic year 2010/2011, in the normal academic environment of the Thematic Unit of Infinitesimal Calculus (IC) of the Mathematical Analysis Course, of Food Engineering Degree. A total of 38 students participated is this pilot study (those who participated in theoretical and practical classes).

The characterization was performed using an initial questionnaire. It can be said that a large number of students seem not to know about some "Social Bookmarking" tools (e.g. Delicious, Magnolia) and teaching-learning platforms (e.g. Pmate). Synchronous communication tools are the best known.

Regarding the importance attributed to it, these students found the e-learning platforms "important" (45%) or "very important" (55%), followed by communication tools and services for storing and sharing files. Most did not value Blogs and micro-blogs (76%) or social networks (71%). Concerning the tools of "Social Bookmarking" only 3% of respondents considered then important and 63% answered to not know them.

Most of the students ranked math as "difficult" and considered themselves not be good students and having little relation with it. However, they recognized the importance to their training. With respect to web services and resources in the study of mathematics, the majority reported not using them. However, a great part of the respondents rated them as "important" or "very important" in the study of mathematics. It should be noted that these students did not recognize the importance for social networking and blogs in the study of mathematics.

3.3 Techniques and tools for data analysis

In order to respond to research questions formulated and taking into account the methodological options, we decided to use multiple sources of data collection, which also lends credibility to the study [34].

Inquiry by questionnaire was privileged, as a technique for collecting data, because this type of instrument provides information about a particular phenomenon through questions that reflect attitudes, opinions, perceptions, interests and behaviors of a group of individuals [31]. The first questionnaire was taken at the beginning of the semester and was aimed at the characterization of students. The second, applied at the end of the pilot study, pursued the main objective to know students' opinions about the M@t platform and to evaluate the methodology used in its operation.

For the collection of data during the implementation of the pilot study, we used two additional techniques – observation (direct and participant) and document analysis [7]. Also diverse instruments were used such as the logbook records available on the platform, the answers to the tasks proposed in the Study Guides, the test knowledge assessment, and some emails received from students. The teacher was the researcher, allowing greater interaction with the subjects of study and participating in the study itself, without interfering with student behavior. It was thus possible to understand the reality from the point of view of those who are part of the process [34]. In the logbook, evidence, reflections and measures during the course of action research were recorded.

Documents produced by the students were also collected and analyzed - knowledge assessment, tests, papers submitted in Moodle, e-mails and other pieces of evidence of using the M@t platform. The assessment test, which was previously validated by two experts, was applied in the form of pre-test, post-testing and post-testing II.

3.4 Description of the Study

At the beginning of the semester, students were informed about how the Curricular Unit would be taught and that the course was under scientific investigation. Before this topic was started, students were asked to answer a characterization questionnaire and to make a pre-test, which served a dual purpose – a diagnostic evaluation and later it allowed the evaluation of students' progress, by comparing it with the post-tests results. In the first class, students were elucidated on the functioning of the course: each week, they would have to solve the tasks proposed in the Study Guide, provided in Moodle platform. In the following week class, those subjects already pre-explored by the students would be discussed and tasks of different nature would be carried out to assess their ability to apply

the knowledge, built by autonomous and self-regulated exploiting of M@t. It was also indicated that the practical evaluation of the curricular unit would be subject to timely delivery of responses to all the Study Guides.

During this period a self-regulated exploration of the platform M@t was encouraged, so that students could later take part in the discussion of the main subjects with the whole class, concerning the resolution of the exercises as well as on the use of the Study Guides available on the M@t.

At the end of curricular unit the first post-test was taken and the opinion questionnaire was applied, concerning the M@t platform and the methodology used in the curricular. One month later the (II) post-test was taken.

3.5 Data treatment and presentation

The data of qualitative nature was analyzed through content analysis, guided by categories recursively defined. However, wherever it was possible and necessary, quantified data statistical treatment was taken, using software programs like Excel.

The presentation of data is essentially descriptive, making use of evidence through logbook transcripts and students answers to several applied instruments. The quantifiable data is presented through graphics, making it easier to read.

4 MAIN RESULTS

The study lasted 5 weeks (two practical clases, on Mondays and Tuesdays,and in-lab practical clases on Tuesdays). (It should be noticed that on Tuesdays, students had seven hours of curricular units in the area of mathematics.).

4.1 Platform Subscription

Considering the M@t platform subscription results, we infer that 41 students used the platform, and accessed it 205 times. Therefore, we can conclude that the platform was used by students who were not in the class of the researcher. With a total of 155 visits, students have downloaded the Study Guides and from those 96 digital explored and solved the dynamic guides. After the study has finished, students continued to use the platform, and there was a subsequent 11 thematic accesses. It was thus possible to see that the platform was operating in good condition, which was confirmed by the students during classes.

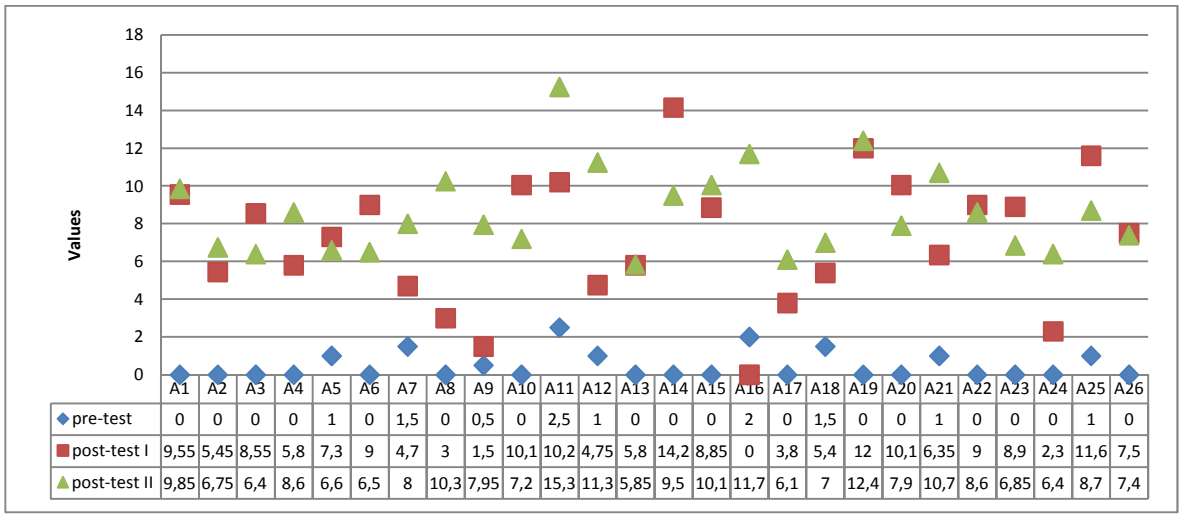
Arising from the use of the platform, the change in attitude of the students was remarkable, becoming more involved in class (showing what they had studied and presenting their difficulties) and more critical and autonomous. Two comments of the students stand out:

- In a class: “This platform helps me to have a more continuous study. It forces me to study more. With this platform I do all the exercises, which did not happen when I had a book. Classes take place rapidly.” [Logbook of the day November 5th, 2010].
- In an email: - “Since this platform appeared, I realized that I have had a more correctly and exciting study, because, first, the language used in the platform is simple and understandable, I can understand, and then have time to go back and to read again what I did not notice the first time. (...) I’m now much more willing to study and got it done with more enthusiasm, I understand better that way (...) I am sorry that the platform has not existed since the beginning of classes, because I think that I would have had more propensity to study! "

Although most students have considered to have little appetence for mathematics, not considering themselves as good students at this scientific field, it was found that with this methodology, based on the use of the platform, students were more engaged, involved with other enthusiasm in tasks proposed in classes, raising questions and challenging the resolutions, having been able to better solve more and more tasks than in previous Thematic Units. It was possible to detect higher maths skills on students. This conclusion reinforces the idea that the M@t platform can be a useful tool in students’ motivation and participation.

4.2 Results obtained in the different stages of evaluation

(Graphic 1) shows the results obtained by students who carried out the three stages of evaluation: pre-test, post-test I and pos-test II. The lower adherence was registered at the last moment of evaluation (post-test II) and that may be coincided with several other assessment tests that students had to perform, and by the fact that this evaluation had not been revealed in advance to have a surprise factor.



	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26
pre-test	0	0	0	0	1	0	1,5	0	0,5	0	2,5	1	0	0	0	2	0	1,5	0	0	1	0	0	0	1	0
post-test I	9,55	5,45	8,55	5,8	7,3	9	4,7	3	1,5	10,1	10,2	4,75	5,8	14,2	8,85	0	3,8	5,4	12	10,1	6,35	9	8,9	2,3	11,6	7,5
post-test II	9,85	6,75	6,4	8,6	6,6	6,5	8	10,3	7,95	7,2	15,3	11,3	5,85	9,5	10,1	11,7	6,1	7	12,4	7,9	10,7	8,6	6,85	6,4	8,7	7,4

Graphic 1: Results of the pre-test, post test I e post-test II.

It is verifiable that, prior to the study, students did not demonstrate knowledge and skills within the theme, and later it was concluded in the post-tests, that students have developed knowledge in this theme. It should be noted that, the zero value which appears in the post-test I (Graph I) corresponds to a student who withdrew from the evaluation because he had not prepared for it. Comparing the averages of scores in the three times of application of the test: 0:46, 7.14 and 8.6, respectively, we verify an increase in the results obtained. The same is true for the minimum grades, pre-test: 0, post-test (I): 1.5 and post-test (II): 5.85. And maximums, pre-test: 2.5, post-test (I): 14.15 and post-test (II): 15.25. One can also highlight that from pre-test to post-test (I) 4% of students got worse and 96% improved their classification, while from post-test (I) to post-test (II) 48% got a lower mark and 62% improved. As far as the average in gains and losses, it was 7.02, 8.14 and 3.67 values, respectively, of pre-test to post-test (I), the pre-test to post-test (II) and post-test (I) to post-test (II). From post-test (I) to post-test (II) the average loss is 2.4 absolute values. For the average earnings for the pre-test to post-test (I), the pre-test to post-test (II) and post-test (I) to post-test (II), there is 35.72%, 41.84% and 23.72 %, respectively. The average loss from post-test (I) to post-test (II) is 19.89%.

Considering that we intend to evaluate the progression in learning and the significance of the results, we applied the Friedman test (nonparametric test for related samples). It was considered as hypothesis H_0: there was no progress in learning. The significance level used was $\alpha = 0.05$. And we considered the $N = 26$ students who completed the test in all forms (pretest, post-test (I) and post-test (II)) and $k = 3$ conditions (evaluation of the test in each modality). Considering the Friedman test statistics (Sidney & Castellan, 1988) $\chi_r^2 = 37$ was obtained, and so we can say with 95% confidence, to reject the hypothesis of no progress in learning. Subsequently, and considering that *H0* hypothesis was rejected, we proceeded to test for multiple comparisons, the overall significance level of 5%, comparing the samples, two by two, to verify which differences can be considered significant. It appears that there are significant differences between pre-test and post-test (I) and between pre-test and post-test (II), although is not significant the difference between post-test (I) and post-test (II).

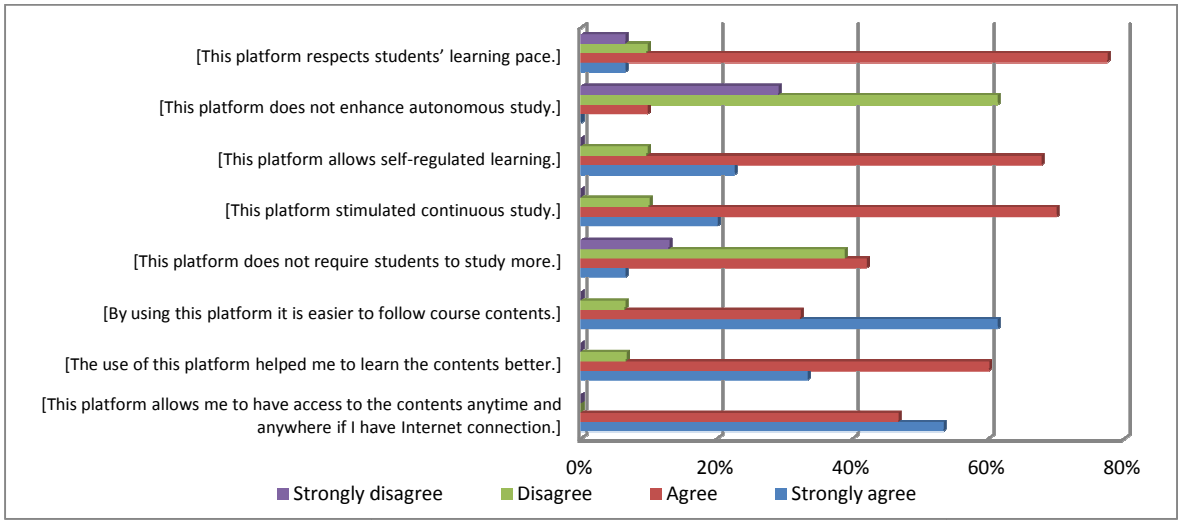
Comparing the results between the post-tests, it appears that the post-test (II) results are better than the post-test (I), which is in agreement with that was found in other studies [14], [25].

4.3 Opinions about the Platform

4.3.1 Platform Global Evaluation

Most students who answered the questionnaire (97%) recognized the usefulness of the platform in supporting self-study. About 90% of students agreed that this platform allows self-regulated learning

and stimulates continuous study. A percentage of approximately 21% strongly agreed with that(Graphic 2).



Graphic 2: *M@t-educar com sucesso* Platform Global Evaluation.

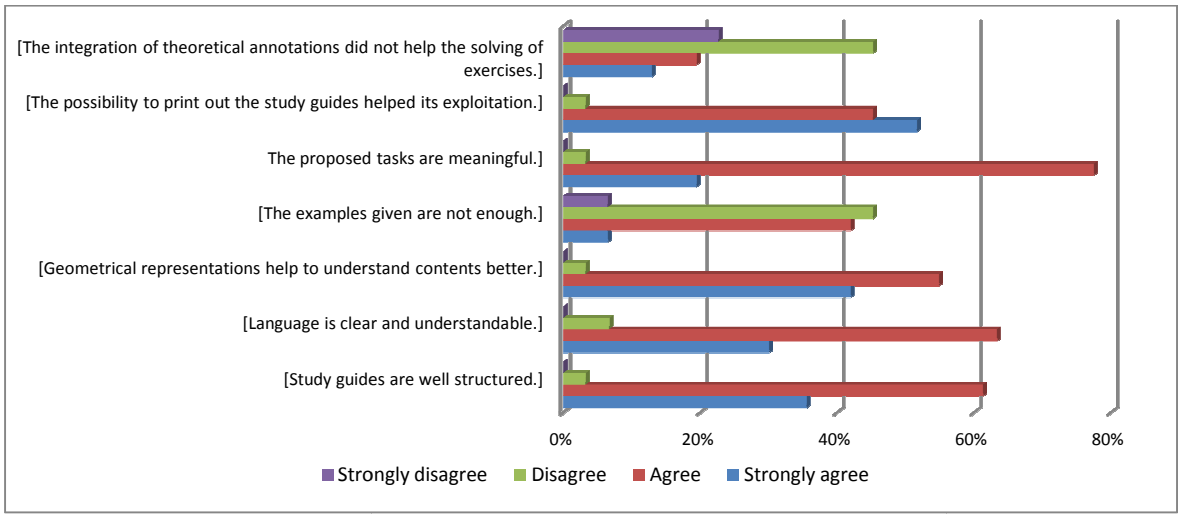
However, the percentage of students who reported to agree that this platform does not require further study (39%) is identical to that of students who reported they disagreed (42%). The majority, (90%) of students, strongly disagreed (29%) or disagreed (61%) that the platform does not facilitate the self-regulated study and agreed (77%) or strongly agreed (6%) that this platform respects the pace of learning of each one. Respectively (60%) and (32%) of the students agreed with the statement "the use of the platform helped to understand the content" and "the use of this platform helped me to better monitor the course contents". Respectively (33%) and (61%) strongly agreed.

SWOT analysis on the platform stands out:

- "I think that this methodology was very helpful in understanding the terms of integrals, it was a way for me to study and prepare myself for classes and should be applied to the entire course";
- "... I consider this platform was a good choice, because I acquired more knowledge and it helped me a lot in the lectures.".

4.3.2 Evaluation of Digital and Dynamic Guides

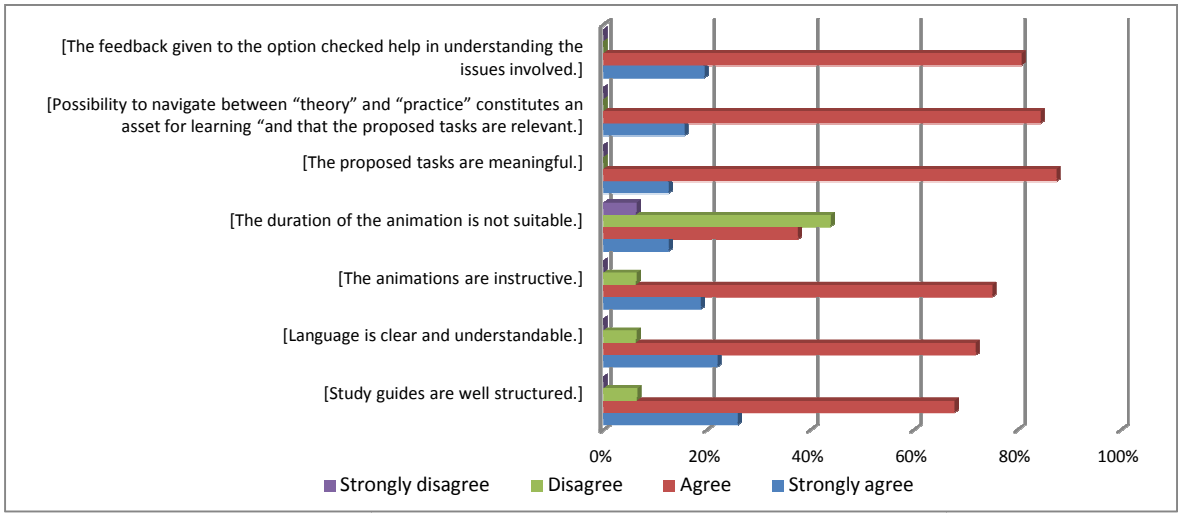
Concerning the digital guides, most students strongly agreed or agreed that the possibility of printing them, simplified its exploitation. The proposed tasks are relevant, the representations helped to better understand the content, the language is clear and understandable and they are well-structured (Graphic 3).



Graphic 3: Digital Guides evaluation.

Also, the majority of students agreed that the integration of theoretical notes over the guides facilitates the resolution of the tasks.

Regarding the dynamic guides, all students agreed or strongly agreed that the feedback given to the option checked help in understanding the issues involved, in which the possibility to navigate between "theory" and "practice" constitutes an asset for learning "and that the proposed tasks are relevant".



Graphic 4: Dynamic Guides evaluation

However, concerning the statement about the duration of the animations be appropriated, the opinions are equally divided between strongly agree or agree and strongly disagree or disagree. Most of the students (about 90%) agree that both guides (digital and dynamic) were well structured and the language was clear and noticeable. Therefore, students acknowledged that the proposed tasks present in the guides were relevant.

5 MAIN CONCLUSIONS

The developed study leads to favorable conclusions about prior exploitation of M@t content. In fact, by changes in student behavior in the classroom, motivation and performance during the approach of the teaching unit, this platform appears to enhance the development of mathematical skills, encompassing knowledge, competences and attitudes such as communication, autonomy, and the ability to transfer knowledge to other mathematical situations similar in nature.

However, the platform itself does not clarify all the students' questions, and in class it was possible to share them and collaboratively discuss and overcome them, through interaction between students and the teacher. In this sense, we can consider that this is one of the limitations of M@t platform, given the small number of examples or response options, and it is even impossible, in each issue, to cover all the possible answers equated by students (right or wrong). Therefore, it was critical the role of the teacher as facilitator and advisor.

This study also allows verifying the validity of instruments and materials used in the study itself, as well as review of the platform implementation strategy and the feasibility of implementing this methodology. According to the experience carried out, data theanalysis points out to the feasibility of the proposed research, the adequacy of design and relevance of this investigative study. Thus, this may be a contribution to the discussion of measures to combat mathematics failure at school in (HE).

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