LEARNING BY TEACHING WITH VIDEOS - AN INTEGRATION STRATEGY TO PROMOTE MATHEMATICAL COMMUNICATION AMONG STUDENTS OF HIGHER EDUCATION

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Abstract. This paper intends to present the LIGHTS (LearnInG by teacHing wiTh videoS) project that aims to promote a better academic inclusion of new students in an engineering school (ISEP), in the sense of their full integration into the new academic life, making use of their mathematical knowledge and communication skills. The pandemic affected face-to-face communication and in-person socialization. We present the students' opinions about the challenge they faced when participating in the LIGHTS project during the Covid-19 pandemic.

Key words: Integration in higher education, LIGHTS project, mathematical communication.

INTRODUCTION

Participating in group work, helping colleagues to complete tasks, and interacting with the teacher are essential to facilitate teaching and learning. This interconnection is achieved in conventional classroom teaching, where students and teachers interact face-to-face, but it is minimal when students are involved in an online learning situation. The Covid-19 pandemic and the related measures and restrictions brought barriers to communication. The communication and interactions between students and teachers and between students and their peers have been directly affected (Aboagye et al., 2020). The challenge was enormous and, from one moment to the next, the educational community found itself in the middle of a tornado. The imposed restrictions to daily life have forced the educational community to quickly adopt different ways of working, learning, and connecting with each other. The pandemic affected face-to-face communication and in-person socialization. Students were jolted from their academic routines, and socialization and communication were affected.

The situation becomes more complex when it comes to 1st year students who are joining higher education. It is very important to promote the integration and socialization of new students coming to higher education (Rezaei, 2018; Vagos & Carvalhais, 2022). Many of these young students are displaced, that is, they are far from home, far from their comfort zone. When a young adult transitions to higher education, he/she starts a new phase in his life - it is a new period full of challenges, both personal and academic. That's why it's important to promote the integration of new students, help students interact with each other and with the teacher, even if the face-to-face contact time is very short. While this crisis has brought unprecedented challenges for both teachers and students, it has brought a wave of inspiring new ideas. New ways had to be found to communicate.

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This paper describes a project that aims to:

- promote the integration of new students, help students interact with each other and with the teacher;
- improve mathematical communication skills;
- cultivate means that lead to academic success.

The paper is structured as follows. The next section contains background material: integration in higher education, mathematical communication skills and low-cost videos as a learning tool. Then, is described the LIGHTS (LearnInG by teacHing wiTh videoS). The results are presented later and finally the conclusions and considerations.

BACKGROUND

In this work there are three fundamental points to consider: integration in higher education; mathematical communication skills and low-cost videos.

Integration in Higher Education

When a young adult transitions to higher education, a new phase in his life begins; it is a new period filled with both personal and academic challenges. In adapting to higher education there is an academic aspect (study, curricular involvement, school performance, etc.) and a social aspect (relationship with teachers, colleagues and other elements of the educational establishment, participation in social activities, etc.), which is why a good integration can positively influence behavior and adaptation to the new context (Caldeira et al., 2016; Almeida et al., 2018). Academic integration can be defined as academic progress, cognitive growth and positive learning experiences (Tinto, 2015). Tinto argued that both personal and institutional strategies are equally responsible for adaptation in academic pursuit among students. In particular, personal strategies include skills, abilities, and previous education, as well as students' goals. Good integration into higher education helps students have better academic lives and not drop out of their studies.

Mathematical communication skills

Mathematical communication skills refer to the students' ability to (Rohid et al, 2019):

- arrange and link their mathematical thinking through communication;
- communicate their logical and clear mathematical thinking to their colleagues, teachers, and others;
- analyze and assess mathematical thinking and strategies used by others;
- use mathematical language to express mathematical ideas correctly.

Writing skills are an important part of communication. Good writing skill allow students to communicate their message with clarity and ease. Throughout our academic life, we are led to think that writing is more important than speech, as stated by Storto (2020). Maulyda et al. (2020) conducted a study focusing on students' mathematical communication skills whose objective was to describe the students' written and oral mathematical communication

skills in solving word problem. They concluded that students' verbal communication skills are better than their written communication skills. As Ribosa and Duran (2022) state, science teaching and learning practices need to enable students with skills to talk about science, so that they can verbally formulate, exchange explanations to communicate and argue scientific ideas.

It is necessary to implement a more frequent and regular oral pedagogy in mathematics classes, which enhances moments in which students express themselves and interact, in order to develop essential skills for adequate oral expression in the formal context of communication in mathematics. For the student, the more he/she talks, the more he/she will gain talent, dexterity and skill in the art of speaking mathematics. It is necessary to develop teaching strategies that provide students with moments of communication to develop their critical and reflective capacity. Furthermore, one of the most important tasks of higher education is to prepare students to work in a changing world and to motivate them to develop skills other than those specific to their fields of study. Abadzi states that:

> Technological achievements and the globalization of labour require complex skills for the workplace. Companies reportedly demand employees ready to "plug and play", who are also creative, communicative, and collaborative. Accordingly, international agencies often advise lower-income governments to de-emphasize "traditional" book learning and use innovative pedagogies to teach the needed skills explicitly (Abadzi, 2015).

Low-cost videos

Technology has changed the teaching and learning scenario. Media, and the use of video in particular, contributed to the change of teaching, learning, studying, communicating, working. The use of video as an educational tool is reinforced when three elements are considered (Brame, 2016):

(1) how to manage cognitive load of the video;

(2) how to maximize student engagement with the video;

(3) how to promote active learning from the video.

The use of low-cost videos in this work it was very important because it is a cheap tool and is relatively easy to handle. Doing a low-cost video, make the students improve their learning by making them more autonomous and contribute to make them more motivated and, consequently, contribute to improve the learning by teaching process. In addition, this task encourage discussion between the teams' elements (Caldeira et al., 2020).

LIGHTS PROJECT

It is widely accepted that the use of new technologies is a supportive tool to improve the effectiveness of learning (Targamadze & Petrauskiene, 2010). Among these tools, video has been used in recent years to support student learning (Barford & Weston, 1997; Bravo et al., 2011). The use of videos engages and helps students retain knowledge, motivates interest in the subject, and illustrates the relevance of many concepts. The LIGHTS project that aims to promote a better academic inclusion of new students in an engineering school (ISEP), in the sense of their full integration into the new academic life, making use of their mathematical

knowledge and communication skills. The LIGHTS project involves the use of videos where students have an active role in the video rather than a passive, contemplative role - students create a video about how to solve a concrete math problem.

The scenario

In September 2020, the School of Engineering of the Polytechnic of Porto (ISEP), started its academic year, using the following model:

- Theoretical classes: synchronous and online.
- Theoretical-practical classes: synchronous, and a combination of in-person and online lectures. Face-to-face classes were interspersed with online and distance classes: half of the class had face-to-face classes and the other half were at home and online.

The question is: *How to encourage formal oral expression, involving mathematical communication, when students are in an online learning situation?*

159 first year students participated in the LIGHTS project, of which 99 are students of the 1st year of the Degree in Electrical Engineering – Power Systems in the subject of Linear Algebra and Analytical Geometry and 60 are students of the Degree in Telecommunications and Informatics Engineering in the subject of Algebra (from now on, Linear Algebra and Analytical Geometry and Algebra are called Linear Algebra).

Project execution

It started by forming teams with two or three students and each team received its task, in this case related to Linear Algebra. For communication with the students, it was used the Moodle e-Learning platform providing supporting material and for the delivery of the final work. A proper space was created in this platform, accessible to all persons involved, to help the management of the process, the delivery of the final work and its logistics. In this experience the following six steps were performed:

Step 1: Form the team;
Step 2: Get the project worksheet (different for each team);
Step 3: The problem (analysis, discussion and resolution);
Step 4: Plans discussed with the teacher with particular focus on the scientific contents;
Step 5: Make the video;
Step 6: Delivery the final work in the Moodle platform.

Part of the Moodle page can be seen in Figure 1, where students can consult the videos. All videos are available, and all students can consult the videos produced by themselves and by their colleagues.

Students study to teach their colleagues, they present in the video the solution to the proposed problem so that their colleagues understand the resolution of the problem and the contents involved - students learn while making the video and while watching each other's videos (Figure 2).

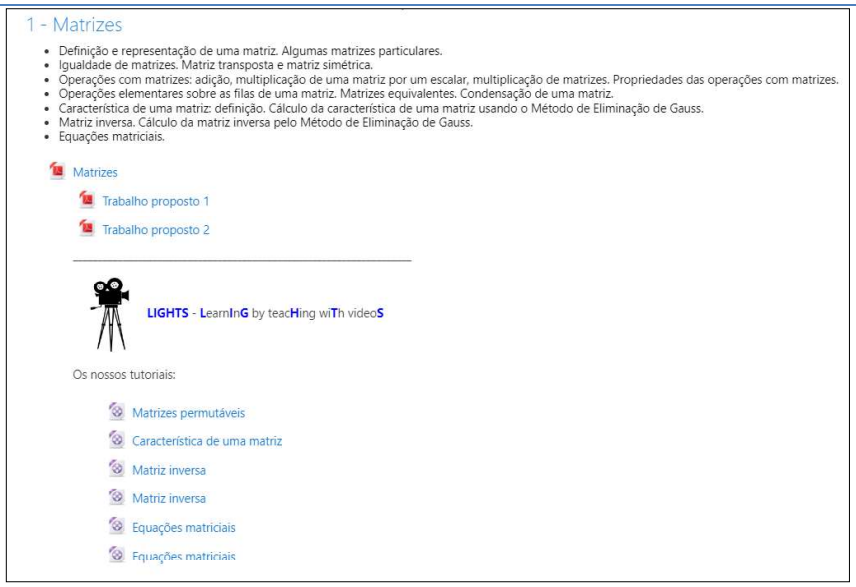

Figure 1: Aspect of Moodle platform (in this case about matrices).

The objective of this video is very specific and has a short resolution of mathematical problems. Students have to create it in a very short period of time (more or less 2 weeks) and with few resources. It is a low-cost educational video (Simo et all, 2010).

Figure 2: Visual aspects of some videos.

At the end of the project, the students' opinions about the challenge they faced were evaluated. A questionnaire where students were asked to give their opinion:

Q1: Despite the constraints due to the pandemic, I was able to integrate into the project and interact with my colleagues;

Q2: I think that learning/teaching through videos is a positive learning process.;

Q3: I was able to get involved in the project and promote my learning.;

Q4: I felt motivated and accompanied by the teachers during the course of the project;

Q5: I felt more motivated and interested in studying the syllabus;

Q6: I felt a greater development of knowledge and skills with the participation in the LIGHTS project;

Q7: I learned by watching my colleagues' videos;

Q8: The LIGHTS project should be applied in other curricular units.

RESULTS

These questions were evaluated using a Likert scale, with 1 being "I completely disagree" and 5 being "I completely agree" (see Figure 3).

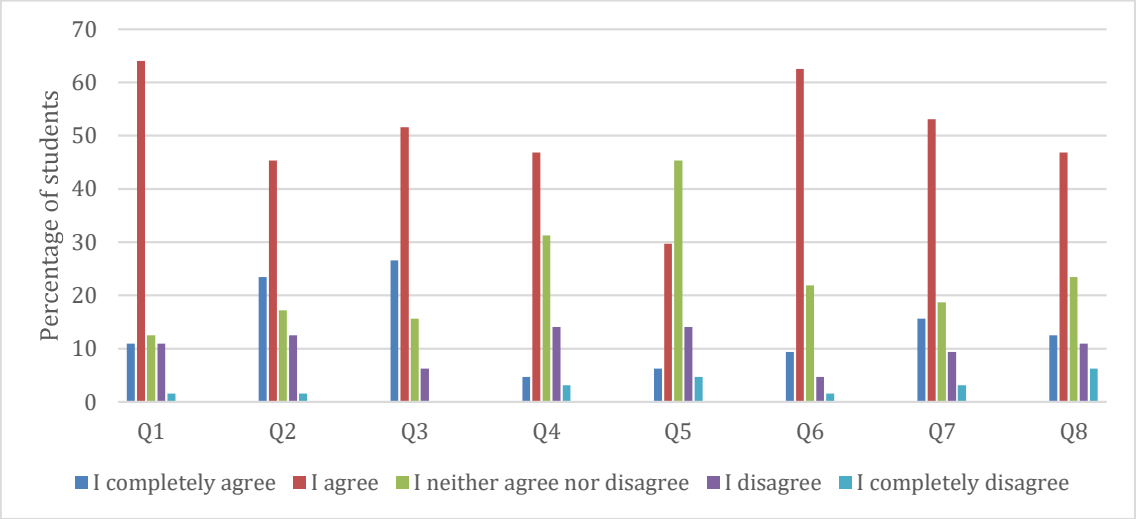

Figure 3: LIGHTS project students 'perceptions.

Sixty-four students answered the questionnaire. The average score was 3.6, considering all the questions, reaching 3.9 in the questions in which the students evaluated the project's objectives and 3.7 in the overall opinion of the project (see Figure 4). We highlight the average of 3.7 obtained when the students were asked about the importance of the project in their integration and in their interaction with their colleagues during the Covid-19 pandemic.

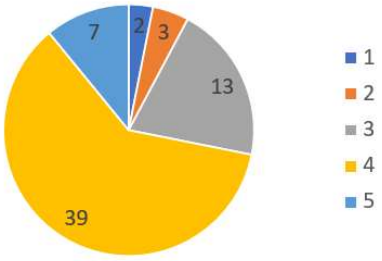

Figure 4: Overall evaluation of the LIGHTS project.

Students were also asked to provide general feedback on the project, as well as identify strengths and weaknesses. As for the strengths, the students highlighted the relevance of the project to learn and consolidate the concepts of Linear Algebra and the innovative way of learning in a team and training the ability to teach. Although most of the students did not mention any weaknesses, one team pointed to the fact that not all members of the group were equally committed.

CONCLUSIONS

The COVID-19 pandemic has created the largest disruption of education systems in history, affecting nearly 1.6 billion learners in more than 190 countries and all continents. Closures of schools and other learning spaces have impacted 94 per cent of the world's student population, up to 99 per cent in low and lower-middle income countries. (United Nations, 2020).

The COVID-19 pandemic has suddenly and abruptly forced schools and education to adapt to a new reality. COVID-19 has thrust digital technology and education into the spotlight. The integration of digital technology into the teaching and learning process has been fundamental, resulting in fundamental changes in education. The use of digital technologies gives teachers the opportunity to design engaging learning opportunities in the courses they teach.

A new and innovative way to integrate 1st year students of degrees of engineering in a pandemic time, improving their mathematical communication, is the LIGHTS project. The students developed videos using the concept of "Low-cost educational video" - they made a video with a specific goal and it was created in a very short period of time, with a few resource. In this way a number of common problems were eliminate: the budget and time decrease. With the LIGHTS project, communication paths were created between students and teachers and between all students.

The results obtained by the participating students were very positive. The students' involvement in the project was notorious. With this type of challenge, students had the opportunity to develop reflective thinking to overcome difficulties and thus develop knowledge and skills. In fact, many skills were developed by the students during the execution of this project. As an example, we can point to the ability to work with others, solve problems and conflicts and also the ability to make public presentations. This project demonstrated that the use of videos has a positive effect on students' motivation in learning, in this case Linear Algebra.

We can conclude that the students recognized the importance of this project not only to develop personal and teamwork skills, but also to consolidate the knowledge of Linear Algebra. In addition, it made the students not give up on the subject, accompanying it throughout the semester. Highlighting the fact that, even in a pandemic, it is possible for students to communicate with each other and with the teacher, interaction between all is possible.

As a final note, this project will be replicated at the University of Minho in Guimarães, Portugal, in Mathematics subjects and Engineering Degrees.

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