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LEARNING BY TEACHING WITH VIDEOS

APRENDENDO ATRAVÉS DO ENSINO COM VÍDEOS

APRENDIENDO MEDIANTE LA ENSEÑANZA CON VIDEOS

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Abstract

In today's world, technology plays an important role, and its influence is evident in almost every domain, and education is no exception. The introduction of new technologies represents a valuable resource in improving the teaching and learning process. Of these resources, video has been used to support student learning. From traditional classrooms to online platforms, videos have become invaluable tools for teachers and students alike, enriching the academic experience.

This work focuses on the LIGHTS project, which began in 2018. This project aims to improve students' mathematical communication: (i) organize and link students' mathematical thinking through communication; (ii) communicate logical and clear mathematical thinking to colleagues, teachers, and others; (iii) analyse and evaluate mathematical thinking and strategies; (iv) use mathematical language to express mathematical ideas correctly. The LIGHTS project involves the use of videos where students take an active role in the video, rather than a passive, contemplative role. Specifically, they produce videos centered around specific mathematics topics. By adopting this strategy, students become more motivated to learn mathematics, avoiding giving up and abandoning curricular units related to mathematics. The LIGHTS project is also a strategy to integrate new students into higher education.

In this paper we will describe how the project was implemented over the last six years and the profile of the participating students (and the curricular units and degrees where this participation took place).

Keywords: active learning, videos, mathematical communication, student engagement.

Resumo

No mundo de hoje, a tecnologia desempenha um papel importante e a sua influência é evidente em quase todos os domínios, e a educação não é exceção. A introdução de novas tecnologias representa um recurso valioso na melhoria do processo de ensino e aprendizagem. Dentre esses recursos, o vídeo tem sido utilizado para apoiar a aprendizagem dos alunos. Das salas de aula tradicionais às plataformas online, os vídeos tornaram-se ferramentas inestimáveis tanto para professores como para alunos, enriquecendo a experiência académica. Este trabalho foca-se no projeto LIGHTS, que teve início em 2018. Este projeto tem como objetivo melhorar a comunicação matemática dos alunos: (i) organizar e ligar o pensamento matemático dos alunos através da comunicação; (ii) comunicar um pensamento matemático lógico e claro a colegas, professores e outros; (iii) analisar e avaliar o pensamento e estratégias matemáticas; (iv) usar a linguagem matemática para expressar ideias matemáticas corretamente. O projeto LIGHTS envolve o uso de vídeos onde os alunos desempenham um papel ativo no vídeo, em vez de um papel passivo e contemplativo. Especificamente, eles produzem vídeos centrados em tópicos matemáticos específicos. Ao adotar esta estratégia, os alunos tornam-se mais motivados para aprender matemática, evitando desistir e abandonar

unidades curriculares relacionadas com a matemática. O projeto LIGHTS é também uma estratégia para integrar novos alunos no ensino superior.

Neste artigo, descreveremos como o projeto foi implementado nos últimos seis anos e o perfil dos alunos participantes (e as unidades curriculares e cursos onde esta participação ocorreu).

Palavras-chave: aprendizagem ativa, vídeos, comunicação matemática, envolvimento dos alunos.

Resumen

En el mundo actual, la tecnología desempeña un papel importante y su influencia es evidente en casi todos los ámbitos, y la educación no es una excepción. La introducción de nuevas tecnologías representa un recurso valioso para mejorar el proceso de enseñanza y aprendizaje. Entre estos recursos, el vídeo se ha utilizado para apoyar el aprendizaje de los estudiantes. Desde las aulas tradicionales hasta las plataformas en línea, los vídeos se han convertido en herramientas inestimables tanto para profesores como para alumnos, enriqueciendo la experiencia académica. Este trabajo se centra en el proyecto LIGHTS, que comenzó en 2018. Este proyecto tiene como objetivo mejorar la comunicación matemática de los estudiantes: (i) organizar y vincular el pensamiento matemático de los estudiantes a través de la comunicación; (ii) comunicar un pensamiento matemático lógico y claro a compañeros, profesores y otros; (iii) analizar y evaluar el pensamiento y las estrategias matemáticas; (iv) usar el lenguaje matemático para expresar ideas matemáticas correctamente. El proyecto LIGHTS implica el uso de vídeos en los que los estudiantes desempeñan un papel activo en lugar de un papel pasivo y contemplativo. Específicamente, producen vídeos centrados en temas matemáticos específicos. Al adoptar esta estrategia, los estudiantes se motivan más para aprender matemáticas, evitando abandonar unidades curriculares relacionadas con las matemáticas. El proyecto LIGHTS también es una estrategia para integrar a nuevos estudiantes en la educación superior. En este artículo, describiremos cómo se implementó el proyecto en los últimos seis años y el perfil de los estudiantes participantes (y las unidades curriculares y cursos donde tuvo lugar esta participación).

Palabras-clave: aprendizaje activo, vídeos, comunicación matemática, compromiso estudiantil.

1 INTRODUCTION

A student's motivation is a key element in the learning process (Pintrich, 1999). Technology plays an important role in our lives, in our world. Education, as an integral part of the world, also has a direct influence on new technologies. It is generally recognized that new technologies are valuable resources in improving the learning process. (Kharatova, 2022). Among these tools, video has been used in recent years to support student learning (Barford & Weston, 1997, Bravo et all, 2011, Gedera & Zalipour, 2018, e Bobkina, Romero & Ortiz, 2020).

1.1 Using videos in Higher Education

The use of videos in higher education classes has become an increasingly common and effective practice. This pedagogical approach brings several benefits to both teachers and students, enriching the teaching-learning process. Videos can be easily integrated into distance learning platforms and virtual learning environments, complementing study materials. Furthermore, there are several benefits to using videos in higher education and these benefits are all related to academic success, for example (Noetel, 2021):

- Videos can be accessed at any time, allowing students to review material at their convenience. This is particularly useful for those who have difficulty keeping up with in-person classes or who require additional revision.
- Videos can make classes more dynamic and interesting, capturing students' attention more effectively than traditional methods. Moving images, sound, and visual effects help keep students engaged.
- Complex concepts can be more easily understood when presented visually. Animations, simulations, and hands-on video demonstrations can illuminate topics that would be difficult to explain with text or speech alone.

- The availability of videos allows students to learn more autonomously. They can pause, rewind and review content as needed, which promotes personalized learning.

Using videos in teaching and learning has some challenges. MacHardy and Pardos (MacHardy & Pardos, 2015) showed that certain videos have minimal impact on student performance. Videos must be effective for students to achieve the desired learning outcomes. So, what are the main requirements that videos must satisfy? Brame states that to get the most out of educational videos, focus on three crucial factors: cognitive load, engagement, and active learning. By addressing these, few clear recommendations can follow (Brame, 2021):

- Keep videos brief and targeted on learning goals.
- Use audio and visual elements to convey appropriate parts of an explanation; consider how to make these elements complementary rather than redundant.
- Use signalling to highlight important ideas or concepts.
- Use a conversational, enthusiastic style to enhance engagement.
- Embed videos in a context of active learning by using guiding questions, interactive elements, or associated homework assignments.

It must be ensured that the video content is clear and well structured, videos must be a complement to the subject content. Before embracing video production, the first decision to be made is which type of video lecture to use. Woodlift (Woodlift, 2015, see also the references in it) describe the following 18 production styles: Talking Head; Presentation Slides with Voice-Over; Picture-in-Picture; Text-Overlay; Khan-Style Tablet Capture; Udacity Style Tablet Capture; Actual Paper/Whiteboard; Screencast; Animation; Classroom Lecture; Recorded Seminar; Interview; Conversation; Live Video; Webcam Capture; Demonstration; On Location and Green Screen. These styles can be mixed and matched in various ways and this variety of choices can be a challenge for video production. The choice should be based on which style best serves the learning outcomes with a careful focus on the information to be transmitted.

1.2 The LIGHTS project

Our purpose is to motivate students to engage with mathematics so that they do not give up and abandon curricular units related to mathematics. we also aim to improve students' mathematical communication:

- organize and link the mathematical thinking through communication
- communicate the logical and clear mathematical thinking to the colleagues, teachers and others;
- analyse and evaluate mathematical thinking and strategies used by others;
- use mathematical language to express mathematical ideas correctly.

Furthermore, we intend to promote better academic inclusion of new students at an engineering school (ISEP), towards 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 take an active role in the video, rather than a passive, contemplative role - they create a video about how to solve a concrete math problem. The creation of digital videos by students can develop effective learning (Kearney & Schuck, 2006). Unlike more traditional teaching tasks, where materials and processes are imposed on students by the teacher, when creating a video, students collaboratively plan, produce, and evaluate their own projects. When adopting active methods, students' autonomy is prioritized, since they are the centre of the teaching/learning process. According to Lima, Anderson and Saalman (2017), active learning practices were included in Engineering Education programs following recommendations from professional Engineering associations such as the European Society for Engineering Education (SEFI), organizations such as UNESCO and national organizations and international accreditation programs such as the Accreditation Board for Engineering and Technology (ABET) and the European Network for Accreditation of Engineering Education (ENAEE). The active learning recommendation of those associations is related to the fact that students are encouraged to actively participate in learning, that is, students should do more than assume the position of listeners, they should also get involved in activities such as reading, discussing, writing, and solving problems. Active learning improves critical thinking, motivation, communication, collaboration, entrepreneurship, and integration into society.

2 METHODOLOGY

To prepare the educational video, students are divided into teams, and each team, guided by the teacher(s), investigates the proposed topic and how to solve the proposed problem. The objective of the video is very specific and has a brief solution of mathematical problems. To prepare the video, students are suggested to use low-cost videos – Low-cost video (Simo et all, 2010) – short videos using free or affordable materials. Students are encouraged to explore creativity combined with mathematical rigor. To communicate with students, provide support material and deliver the final work, the Moodle platform is used. A dedicated space is created on this platform, accessible to everyone involved, to assist in managing the process, delivery of the final work and its logistics.

The videos have a didactic and pedagogical nature, the most effective videos are made available to colleagues through the Moodle platform. Students learn while watching each other's videos. The LIGHTS project began in the 2018/2019 academic year and has been developed in the following courses: LEESEE (Electrical Engineering - Power Systems), LETI (Telecommunications and Informatics Engineering) and LEGG (Geotechnical and Geoenvironmental Engineering) and in the curricular units ALGAN (Linear Algebra and Analytic Geometry) – 5 ECTS and ALGEB (Algebra) - 5 ECTS. The editions where the project was implemented and finalized are presented below. Also, the number of students participating in the project, the curricular unit (U.C.), and the associated degree program are specified.

1st semester 2018/2019:
68 students. Curricular unit: ALGAN. Degree: LEESEE.
1st semester 2019/2020:
84 students. Curricular unit: ALGAN. Degree: LEESEE.
1st semester 2020/2021:
106 students. Curricular unit: ALGAN. Degree: LEESEE.
52 students. Curricular unit: ALGEB. Degree: LETI
1st semester 2021/2022:
99 students. Curricular unit: ALGAN. Degree: LEESEE.
60 students. Curricular unit: ALGEB. Degree: LETI
1st semester 2022/2023:
90 students. Curricular unit: ALGAN. Degree: LEESEE.
65 students. Curricular unit: ALGEB. Degree: LETI
1st semester 2023/2024:
68 students. Curricular unit: ALGEB. Degree: LETI
25 students. Curricular unit: ALGEB. Degree: LEGG

Over the six academic years in which the project was implemented there were two particularities:

1. Academic year 2018/2019 - the first year the project was implemented. The objective was to motivate and encourage students to study Linear Algebra and Analytical Geometry in order to attract students to U.C. with the intention of avoiding abandonment and withdrawal. Students were only required to prepare the video without prior delivery the report. At this academic year this work had a weight of 10% in the final assessment (Caldeira et al., 2020).

2. Academic year, 2020/2021 - a particular year, because of the Covid-19 pandemic. This academic year, ISEP started its academic year, using the following model: Theoretical classes: synchronous and online and theoretical-practical classes: synchronous, and combination of face-to-face and online classes. half of the class was in person in the theoretical-practical class and the other half was at home and online.

   Students had little contact with each other, and the LIGHTS project was a new and innovative way of integrating 1st year engineering degree students in times of pandemic, improving their mathematical communication, making students communicate with each other and with teachers (Caldeira et al., 2023).

To accomplish the proposed work, the students need to undertake the following steps and strategies:

Phase 1: Form the work team with 2 or 3 students;
Phase 2: Provision of the project statement (different for each team);
Phase 3: Analysis, investigation, discussion and resolution of the proposed problem;
Phase 4: Plans discussed with the teacher with particular focus on scientific content;
Phase 5: Submission of the report on the Moodle platform;

Phase 6: Teacher's opinion on the report (in writing);
Phase 7: Preparation of the video;
Phase 8: Submission of the video on the Moodle platform;
Phase 9: Making the most effective videos are available on the Moodle platform so that the videos can be consulted by colleagues;

To guarantee equality between students and the accessibility of opportunities, the production of the video takes place in such a way that students' expenses with this pedagogical practice can be residual or even non-existent. The necessary material: a computer (if necessary, students can use ISEP computers), their own cell phone or, possibly, a filming instrument. The outputs of this work are a report: serves as a script for the video that students will prepare and an educational video: it will help colleagues study specific topics from the curriculum. Before embracing video production, the first decision that the teams had to make is which type of video lecture to use. As previously mentioned, there are some different types of video lectures. Of those already mentioned above (Woodlift, 2015), the teams mostly chose:

- Talking Head;
- Presentation Slides with Voice-Over;
- Picture-in-Picture;
- Style Tablet Capture;
- Classroom Lecture.

3 ASSESSMENT METHODOLOGY

In the first year that the project was implemented, academic year 2018/2019, the learning assessment consisted of two individual written tests, each test had a weight of 45% in the final assessment, and a team work (video creation) with the 10% weight. In this academic year, a report was not requested prior to the production of the video. Consequently, the videos contained mathematical errors. In the following academic year and beyond, students were asked to write a report with the following steps:

- Make a short **Introduction**, explaining the objectives of the work.
- Indicate **The Problem** and briefly describe the **Methodology** used.
- Present the **Results** of the proposed problem.
- End the report indicating the **Bibliographic References** consulted.

In later years, until today, learning assessment is composed of two separate written tests, each contributing 40% to the final grade. Additionally, there is a team project that accounts for 20% of the final grade (elaboration of the report and production of the video). Within the team project, the report constitutes 40% and the video 60% of the project's grade.

The reports are analysed by U.C. professors, who provide a written opinion to each group. Only after this step is completed, the video can be produced.

The evaluation criteria for the report and their corresponding weights are:

- Introduction (10%)
- Proposed problem (5%)
- Methodology (30%)
- Results and interpretation (50%)
- Bibliographic References (5%)

The evaluation criteria for the video and their corresponding weights are:

- Scientific content (50%)
- Pedagogical aspects: "learning by teaching" (35%)
- Technical, aesthetic, and creative aspects (15%)

The grades ranged from 0 to 5, with 0 meaning nothing was done, 1 indicating very weak, 2 for weak, 3 for sufficient, 4 for good, and 5 for very good. The table 1 is used to evaluate both the report and the video.

Table 1

The evaluation criteria, for the report and video

	0 - None; 1 - Very weak; 2 - Weak; 3 - Sufficient; 4 - Good; 5 - Very good							0 - None; 1 - Very weak; 2 - Weak; 3 - Sufficient; 4 - Good; 5 - Very good						
	Report							Vídeo						
	0,1	0,05	0,3	0,5	0,05			0,5	0,35	0,15				
	Introdution (10%)	The problem (5%)	Methodology (30%)	Results and Interpretation (50%)	Bibliographic references (5%)	Comments	Report Grade (40% work final evaluation)	Scientific content (50%)	Pedagogical aspects (35%)	Technical, aesthetic and creative aspectss (15%)	Comments	Report grade (60% work final evaluation	Self-evaluation	Final grade
Team 1														
Team 2														

4 FINAL CONSIDERATIONS

In this work, we presented the LIGHTS project. This project involves the use of videos where students take an active role in the video, rather than a passive, contemplative role. The implementation of the project over the past six years was detailed, including the profile of the participating students and the specific courses and degrees in which they were involved. At the end of each semester, an anonymous survey was carried out to assess student opinion. In general, students enjoyed this experience and felt motivated to learn, highlighting that learning something new by investigating, teamwork, being able to use their colleagues' videos for their individual study and the development of new skills in terms of video editing and production were positive aspects of this initiative. This opinion of the students is in line with the results in the evaluation of the curricular units, observing, in these six academic years, an increase in the pass rate compared to previous years. In previous works we presented studies carried out based on surveys carried out with students (Caldeira et al., 2020 & Caldeira et al., 2023).

The use of videos in higher education classes, when well planned and executed, can transform the learning experience, making it more interactive, accessible and effective.

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