EDUCATION

Dissemination videos can enhance education in STEM disciplines

By Invited Researcher September 9, 2024 0 comments Print

***Authors**: **Rubén Lijó**, Global Training Coordinator at Hitachi Energy, Posdoctoral Researcher at Instituto para el Desarrollo Tecnológico y la Innovación en Comunicaciones (IDeTIC) / Universidad de Las Palmas de Gran Canaria; **Eduardo Quevedo**, Institute for Applied Microelectronics (IUMA) / Universidad de Las Palmas de Gran Canaria; and **José Juan Castro**, Department of Psychology, Sociology and Social Work / Universidad de Las Palmas de Gran Canaria.*

Teaching in Science, Technology, Engineering and Mathematics (STEM) disciplines presents certain common challenges due to the **high complexity of their body of knowledge** and an **elevated presence of abstract concepts** that hinder learning. In addition, it has been documented that there is a specific difficulty in establishing connections between the concepts learned and previous knowledge in these fields; a reality that is aggravated by a tendency to teach the subjects as independent silos, without strengthening their interrelationships and without contextualizing them in the overall picture of the disciplines.

This situation predisposes students to consider that the study of STEM disciplines implies a very high level of difficulty; and this perception is strongly linked to the **high dropout rates and the scarcity of scientific vocations**.

However, there are resources that teachers can take into consideration to **mitigate many of these challenges**. One of them is **science dissemination**, particularly in audiovisual format.

Source: Freepik

The benefits of dissemination videos

Teachers can make use of the audiovisual format in multiple classroom dynamics and for different purposes.

Videos can be used as an introductory resource to **stimulate interest in a topic**, which the teacher can then expand on with explanations. The use of an attractive format, a pleasant pace and an attention-grabbing communicative style can be particularly beneficial for students to become interested in the topic and show a greater willingness to listen to the teacher and learn more.

Videos can also be used to **dive deeper into complex and abstract issues**, where visualization may be relevant. For example, abstract mathematical concepts or physical phenomena such as electromagnetism can benefit from dynamic, three-dimensional visualization through animations embedded in videos. In this way, students do not have to imagine a concept they do not know from sketches drawn statically on the blackboard, but can directly visualize the concepts in a more intuitive way.

https://mappingignorance.org/2024/09/09/dissemination-videos-can-enhance-education-in-stem-disciplines/

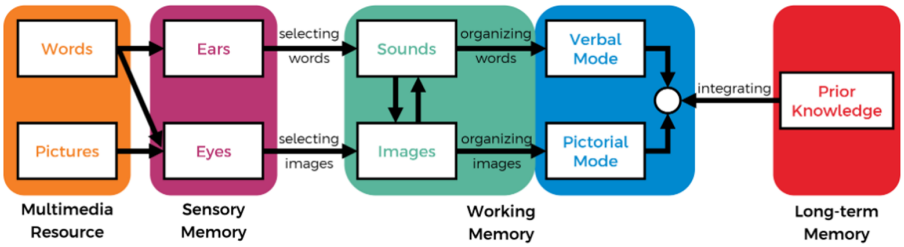
In addition, videos can be paused and replayed as many times as necessary, so they can also be used as **review material to promote independent learning**. They are also a powerful ally in the application of **active learning methodologies**, such as the flipped classroom, in which students can familiarize themselves with the video content before class and then work on it in the classroom.

However, it is not always easy for teachers to find the time, resources and skills to create their own videos. This is when **popular science dissemination videos widely available on the Internet can become the best ally**. Not only is there a wide variety of videos on various STEM topics, but also their format has proven to be suitable for this educational purpose. Normally, dissemination videos have animations and visual resources to support the explanations, have an adequate rhythm and, in addition, the voice and communicative style is usually close, dynamic, and optimized to capture attention.

The appropriate use of these types of resources has the potential to increase students' motivation and interest in STEM disciplines, increase their academic performance, and improve long-term conceptual retention and deep learning.

Double channel: the power of watching and listening

The rationale for these benefits is well explained by the Cognitive Theory of Multimedia Learning. This theory is based on three fundamental principles: information can be received and processed in **verbal or visual mode** (dual channel); we have a **limited capacity to process** a given amount of information at a given time, conditioned by our working memory; and **effective learning must be active**, meaning that we must make a particular effort to integrate new information into our previous body of knowledge.



Source: Ruben Lijo (2024). Implications of using dissemination videos as a didactic resource in STEM education. PhD Thesis, Universidad de La Laguna. Repositorio Institucional de la Universidad de La Laguna. Available at: https://riull.ull.es/xmlui/handle/915/38547

Considering the above, we can **optimize the capacity of our working memory** if we receive complementary information in our verbal and visual mode, and this is precisely how videos work. Through a proper balance of explanations in words and visual explanations we can greatly improve our learning capacity at any given time.

Thus, by taking advantage of this dual channel of information reception and processing, popularization videos can help us in the learning process. This optimization of working memory contributes to a **reduction in the cognitive load** associated with the difficulty in understanding the concepts of the subject matter learned (called intrinsic cognitive load).

Strategies for video integration

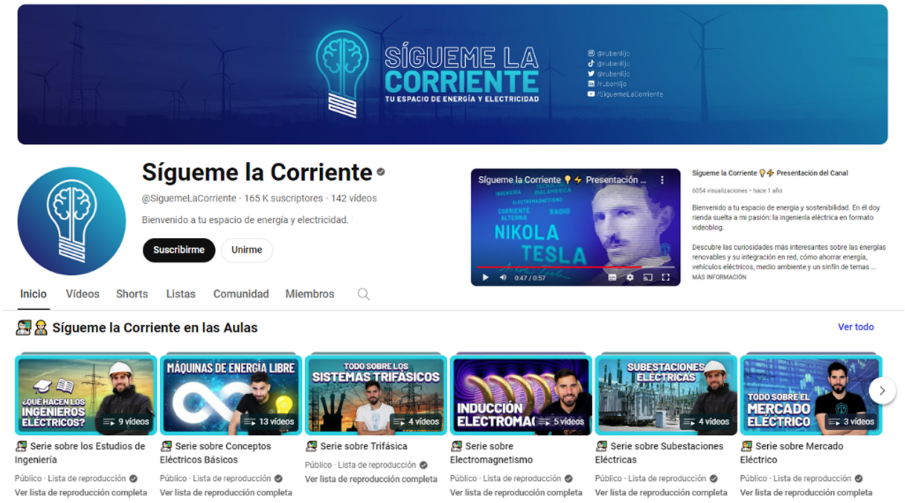
In addition to the above, dissemination videos can offer further benefits in the learning process. These benefits will be given by the strategies we employ in the integration of videos, and are related to the reduction of other cognitive loads: extraneous cognitive load and germane cognitive load. Let's understand them separately.

On the one hand, **extraneous cognitive load** is related to the context in which we learn. A context of noise or distractions will increase this type of cognitive load, for example. In the recent emergency remote learning scenario due to the COVID-19 pandemic, many students suffered an increase in this cognitive load due to having to adapt to home study and online teaching. Videos can be a good tool to mitigate these impacts, as they can be **replayed as many times as needed**, adapting to each student's individual learning pace. Informative videos also tend to use a **pace and language optimized for** information **comprehension** and attention capture, helping to minimize distractions.

On the other hand, the **germane cognitive load** is that related to our ability to integrate new information into long-term memory, relating it to our previous body of knowledge. An appropriate strategy of **integrating videos that complement each other**, and scale in level, could be adequate to reinforce the interrelationships between the concepts of the subject matter and the integration of new information. In addition, videos that include **practical examples and contextualize their contents** in the overall picture of the discipline are very useful to reduce this type of cognitive load.

Sígueme la Corriente: 8 years of STEM education and dissemination

These principles have been put into practice on the YouTube channel Sígueme la Corriente since 2017, with promising results. In addition, the subsequent outbreak of the COVID-19 pandemic caused an increased demand for videos compatible with teaching, and this motivated a series of studies with which to optimize the channel for a **dual use towards dissemination and education** in science and technology.



Source: Sígueme la Corriente Channel

This optimization involves the **curricular alignment of the topics** raised in the videos, as well as an **increase in the number of animations** to favor conceptual learning, and special attention to the duration of the videos, improving the **efficiency of the explanations**. Thus, we would have purely disseminatrion videos such as "How is energy produced in the Matrix movies?" or "What happens to your body when you are electrocuted?", and videos with an educational purpose such as "What are three-phase circuits?" or "How to create electricity with magnetism?".

This study was divided into three phases: an initial pre-experimental phase, a second phase with the integration of the channel in real classroom environments, and the comparative evaluation of the use of dissemination and educational videos over six years of channel operation.

https://mappingignorance.org/2024/09/09/dissemination-videos-can-enhance-education-in-stem-disciplines/

In the first phase, the **audience's perception of the educational value of the channel** was evaluated when content optimized for educational integration had not yet been created. A series of parameters were defined to measure the suitability of videos for educational purposes, relating to the content of the videos, the quality of the explanations, the visualization of the conceptual explanations and the format of the videos. Through the participation of 912 people, a positive perception of these metrics was evidenced, as well as the existence of an educational use of the channel of a similar order of magnitude to the use for entertainment (72.7% of the participants, compared to 87.2%). A great success, considering that the channel did not have an educational purpose at the time.

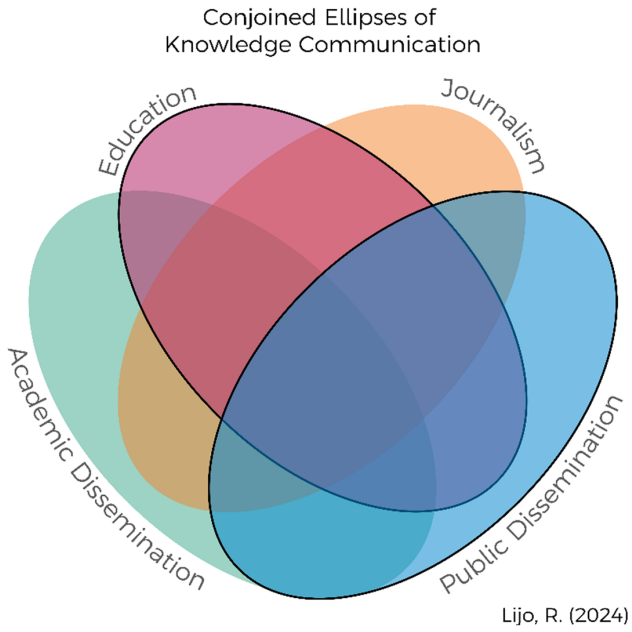
With these promising data, the second phase of the channel's development was tackled: the launching of a **new content section with a dual informative-educational purpose**. In this context, through a collaboration agreement with the Universitat Politècnica de Catalunya, a series of videos was created for the conceptual reinforcement of the principles of electromagnetism and three-phase circuits. These videos were part of a study in which their integration in the Degree in Electrical Engineering was evaluated over three years: 2019, 2020 and 2021. In addition, this temporal range allowed us to evaluate its impact as a mitigating tool for the negative effects of the pandemic in the educational environment.

It was evidenced how this video-based learning strategy contributed to mitigate the impact of emergency remote learning. Its support for conceptual learning also led to improved academic performance in theory exams, and also contributed significantly to increased motivation and interest in the subject.

Following this successful experience, the channel continued to generate dual-purpose videos for dissemination and education in parallel to its outreach activity. In a final study, the **comparative performance** of both types of videos was evaluated, showing that the dual-purpose videos outperformed the entertainment videos in all the metrics evaluated: views, audience retention, comments, likes, etc. In addition, a significant association was observed between video duration and audience retention time, with educational purpose videos being more sensitive to duration.

These studies demonstrate the **potential of informative videos in the field of education**. It is a bidirectional path, through which educators and content creators can benefit. On the one hand, educators can access a greater number of appropriate teaching resources with benefits for their teaching activity. On the other hand, disseminators can use their activity to reach a larger target audience and a complementary social purpose.

https://mappingignorance.org/2024/09/09/dissemination-videos-can-enhance-education-in-stem-disciplines/



Source: Ruben Lijo (2024). Implications of using dissemination videos as a didactic resource in STEM education. PhD Thesis, Universidad de La Laguna. Repositorio Institucional de la Universidad de La Laguna. Available at: https://riull.ull.es/xmlui/handle/915/38547

References:

Ruben Lijo (2024). Implications of using dissemination videos as a didactic resource in STEM education. PhD Thesis, Universidad de La Laguna. *Repositorio Institucional de la Universidad de La Laguna*. Available at: https://riull.ull.es/xmlui/handle/915/38547

Ruben Lijo, Eduardo Quevedo, José Juan Castro and Ricard Horta (2022). Assessing Users' Perception on the Current and Potential Educational Value of an Electrical Engineering YouTube Channel. In *IEEE Access*, vol. 10, pp. 8948-8959, doi: https://doi.org/10.1109/ACCESS.2021.3139305

Ruben Lijo, Eduardo Quevedo and José Juan Castro (2023). Qualitative Assessment of the Educational Use of an Electrical Engineering YouTube Channel. *2023 IEEE World Engineering Education Conference (EDUNINE)*, Bogota, Colombia, pp. 1-6, doi: https://doi.org/10.1109/EDUNINE57531.2023.10102890

Ruben Lijo, Eduardo Quevedo, José Juan Castro and Ricard Horta (2023). Impact of Electrical Engineering Didactic Videos During Emergency Remote Learning. In *IEEE Access*, vol. 11, pp. 19622-19634, doi: https://doi.org/10.1109/ACCESS.2023.3248299

Ruben Lijo, José Juan Castro, Eduardo Quevedo (2024). Comparing educational and dissemination videos in a STEM YouTube channel: A six-year data analysis. *Heliyon*, vol. 10 (3), doi: https://doi.org/10.1016/j.heliyon.2024.e24856