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Article

Differences and Similarities between Face-to-Face and YouTube Chemistry Teaching

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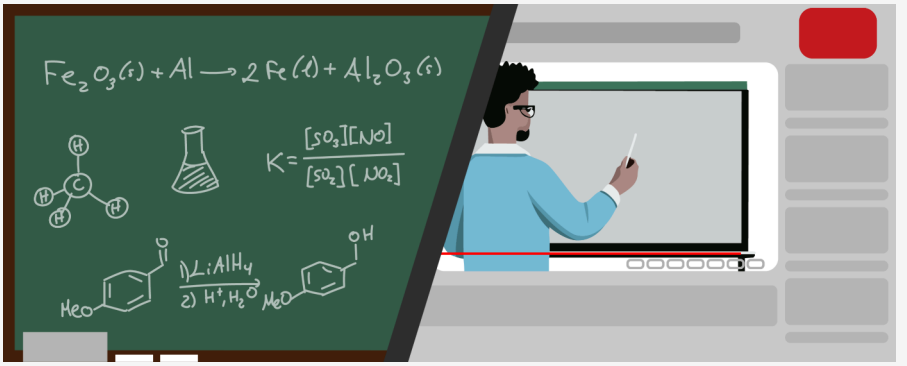

ABSTRACT: This paper explores the digital landscape of YouTube teaching in comparison to traditional face-to-face education. It delineates the distinctions between these two educational paradigms, with a specific focus on two concrete cases: traditional face-to-face teaching at a public university and the distinctive Breaking Vlad channel on YouTube. By conducting this analysis, our goal is to furnish guidance for educators, whether at the elementary or university level, who are contemplating the development of a teaching channel in the field of chemistry. This paper offers insights into the diverse dimensions of education in the digital age, providing a roadmap for educators venturing into the online teaching landscape.

KEYWORDS: *General Public, Public Understanding/Outreach, Distance Learning/Self Instruction, Internet/Web Based Learning, Multimedia-Based Learning*

INTRODUCTION

The use of visual media tools plays a central role in teaching and learning chemistry. Today, students are becoming increasingly adept and more engaged with the Internet and social media. One of the most popular online platforms is YouTube,[1] which greatly facilitates access to and the publication of video lessons across various disciplines. However, length has an impact on student decisions whether or not to watch a video.[2] In the case of chemistry channels, the most popular video lessons tend to be of considerable length, ranging from 5 to 20 min, and typically feature instructors using a blackboard to convey content.[3] It is important to note that this context is specific to Brazil and Portugal, involving 15 channels with a moderate number of viewers.

Certain studies are dedicated to investigating the use of personalized YouTube videos as a virtual substitute for in-person discussions.[4] These videos are tailored to align with the learning objectives of General Chemistry courses and can serve as a practical alternative when scheduling conflicts arise in face-to-face lessons. The most recent situation requiring remote materials was the COVID-19 pandemic in the spring of 2020. During that period, it was advised to regularly solicit feedback through low-stakes assignments to assess student learning and improve their courses while they were online.[5] Feedback from students and the utilization of the recorded videos suggested that creating such content was not only valuable at that moment but also for future remote or in-person courses.[6−8] Additionally, it was found that the videos effectively illustrated important aspects of experimental chemistry and made students feel as if they were actively participating in the experiments themselves.[9]

YouTube can also be used to share videos produced specifically by students centered around a particular topic. Here, students can "learn by performing" as opposed to "learn by listening". Furthermore, these videos serve as valuable study tools not only for the students who created them but also for their classmates and anyone who watches them at any time.[10−14]

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Nonetheless, YouTube lessons can serve as a valuable complement to traditional face-to-face lessons,[15] especially for challenging concepts, by utilizing online recordings featuring globally renowned and engaging lecturers.[16,17] Teachers can integrate this technology into their teaching practices when equipped with the necessary technological tools and are part of a learning community that enhances their self-efficacy beliefs.[18] However, it is not common for teachers to actively create YouTube channels dedicated to chemistry. Alternatively, sometimes they contribute by participating in an editorial board, taking on the role of peer-to-peer-reviewers. An example is CADMIO, a YouTube channel dedicated to inorganic chemistry, where teachers from the Faculty of Chemistry of the Universidad Nacional Autónoma de México actively serve as peer reviewers, ensuring the quality of content covering both introductory and advanced topics.[19]

Given that some teachers may aspire to create channels, it becomes essential to offer guidance on effectively differentiating between face-to-face and video instruction. In this paper we undertake a comparison of face-to-face and YouTube based chemistry teaching. Our aim is to identify the similarities and differences between these two methodologies by contrasting two cases: a Chemistry course at the Universitat Rovira i Virgili, representing traditional face-to-face teaching, and "Breaking Vlad", a YouTube channel which provides a variety of chemistry lessons.

The objective is to compare the personal experiences in these two methodologies and identify connections between them. Additionally, the aim is to provide a set of guidelines or a guide on the issues, problems, and challenges that an "in-person" teacher may encounter when creating their own videos on a YouTube channel.

The Universitat Rovira i Virgili (URV) is a public university primarily focused on in-person education. Specifically, the Faculty of Chemistry offers several undergraduate degrees related to chemistry, including Bachelor's in Chemistry (offered in both Catalan/Spanish and English editions), a Bachelor's in Biochemistry and Molecular Biology, as well as a double degree in Biotechnology and Biochemistry and Molecular Biology. Nuria Ruiz-Morillas (coauthor of this paper) has been a full-time associate professor in these degree programs since 1997.

The Breaking Vlad channel was created by Vladimir Sánchez-Gonzaga (coauthor of this paper) in 2015, initially with the aim of disseminating fundamental chemistry concepts such as "what is an atom" or "differences between atoms and molecules" (Vladimir Sánchez-Gonzaga also holds a PhD in chemistry and has a background as an adjunct professor at URV). However, it quickly garnered increased interest in more advanced topics, leading to substantial channel growth. Eventually, the channel has solidified its position as one of the top three Spanish-speaking chemistry channels for university-level content. With over seven years of teaching on Breaking Vlad Channel, featuring more than 900 videos and accumulating over 180 million views, it becomes evident that traditional academics should consider the significance of this digital realm and place particular emphasis on platforms like YouTube.

TEACHING METHODOLOGIES

Face-to-Face

In traditional face-to-face education, students and teachers meet in physical spaces according to fixed schedules, be it in a classroom, laboratory, or seminar setting. This synchrony promotes the formation of study groups and communities, crucial for collective engagement throughout a trimester, semester, or course. Within this framework, the social dimension of teaching holds significant importance.[20] Various teaching methodologies, including traditional lectures, group activities, cooperative learning, flipped classrooms, and gamification,[21−27] encourage dialogue and interaction among participants, albeit with differing levels of teacher centrality. Moreover, a structured timetable is essential for organizing course content into coherent subjects and topics. To ensure high-quality face-to-face instruction, teachers must go beyond textbook material, adding value through clear explanations, tailored instruction, expansion on relevant topics, interdisciplinary connections, and effective communication. Building a close rapport with students fosters an environment of trust that promotes meaningful learning experiences.[28] In-person teaching allows for a flexible hierarchy of ideas, enabling the integration of foundational concepts as necessary to advance understanding. Teachers must skillfully balance this adaptability with ensuring the timely completion of institutional requirements, which dictates the smooth transition to subsequent courses.

Digital

On YouTube, the typical methodology involves creating concise videos that explain specific aspects of a subject. This platform offers the advantage of utilizing various multimedia elements, including sounds, animations, 3D models, whiteboard teaching, and even text. Another approach is to teach through experiments, ensuring that students do not face any risks associated with chemicals or take an active role in the experimental process.

Richard Mayer's Cognitive Theory of Multimedia Learning is essential for understanding the efficacy of multimedia instruction. According to this theory, a set of characteristics associated with high-quality multimedia learning has been identified to improve viewer comprehension. These characteristics include: Coherence (distinguishing relevant from unnecessary information), Temporal (evaluating simultaneous or asynchronous presentation of audio/text and graphs), Spatial (accessing fully or partially visible representations on screen), Segmenting (examining the logical flow of ideas), Cueing (identifying whether the presenter cues essential content) and Organization (analyzing hierarchical or nonhierarchical listing of topics).[29] This framework serves as a valuable tool for content creators to become more mindful of their decision-making process.

It is worth noting that YouTube reaches a much larger audience than a traditional classroom. However, interaction with students differs significantly, primarily occurring through comments and social media platforms. Assessing student understanding is challenging, relying mainly on engagement metrics. Alternatively, the barrier for entry into teaching on YouTube is remarkably low, requiring only an Internet connection. As a result, quality standards are less regulated compared to traditional education.

YouTube educators might not possess the same social skills that are imperative for in-person teachers, with empathy being a clear example. While empathy is of utmost importance in traditional education, its significance appears diminished in the vast social media platform. Consequently, one might assume that the primary requirement for a YouTube teacher is the ability to convey concepts in a summarized manner. However, research suggests that the charisma of the presenter plays a pivotal role in the success of videos, sometimes outweighing the importance of

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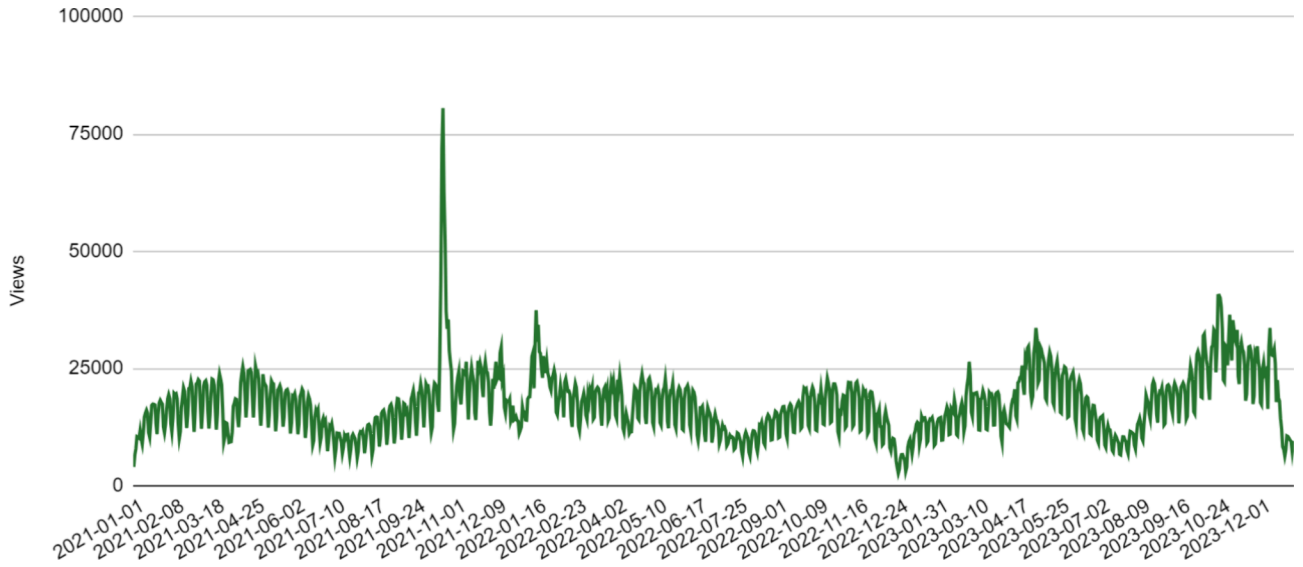

Figure 1. Daily visits in a three year period on the Breaking Vlad channel, January 1, 2021 to January 1, 2024.

content accuracy.[30,31] Furthermore, viewers exhibit greater interest in videos presented by scientists with captivating personalities,[32] and the consistent presence of the same presenter can positively influence the audience.[33] Additionally, analysis of TED talks reveal a disparity in viewership, with talks featuring male presenters garnering more views than those with female presenters.[34] These findings collectively underscore the intricate interplay between presenter characteristics and audience engagement in online educational content.

At this stage, it is evident that face-to-face and YouTube teaching in chemistry have both similarities and differences. Moving forward, we will delve into each aspect individually, comparing and highlighting the connections between these two methodologies. This exploration can also serve as a guide for individuals looking to initiate their teaching journey on YouTube, offering insights into how to effectively conduct master classes on this platform and what pitfalls to avoid.

COMPARISON OF RELEVANT ASPECTS

Schedule and Scope

In contrast to the fixed schedules and mandatory enrollments of traditional face-to-face teaching, digital education offers a more flexible approach, allowing students to access content at their convenience. This freedom of choice means that students engage with course material on their own terms, seeking out specific content as needed, rather than adhering to a predetermined class schedule. Consequently, online educators face the challenge of not only delivering content but also ensuring that it is engaging and captivating enough to hold students' attention. The focus shifts from simply imparting knowledge to actively engaging and captivating the viewer, a dimension that differs significantly from the conventional dynamics of a face-to-face classroom.

Furthermore, the scope of teaching in an online environment expands beyond the limitations of physical classrooms. In contrast to traditional lectures, which are constrained by the capacity of the classroom, online courses have the potential to reach a much broader audience. For instance, a traditional 1 h lecture might accommodate only a limited number of students based on the capacity of the classroom. In contrast, an 8 min video uploaded to platforms like YouTube can be accessed by millions of users worldwide, without the constraints of physical space or time. This digital approach offers a broader, more global perspective on the students' requirements and needs, transcending geographical boundaries and time limitations. However, it also poses challenges, such as the lack of personalized analysis for each student, particularly with regard to evaluating each student individually, a feature that is often integral to traditional teaching methods.

Views/Attendance

Based on the observations made at URV and some Spanish universities, in face-to-face-teaching, attendance can vary, with some activities being compulsory, such as laboratory practices and in-person assessments, while others, like master classes, are typically optional. Despite this, most students tend to attend classes regularly even when not mandated.

Contrary to traditional face-to-face education, where classes are typically scheduled from Monday to Friday between 8:00 a.m. and 8:00 p.m., online teaching offers a more flexible approach. Students can access content at their convenience, breaking away from the constraints of fixed schedules.

Analyzing the viewership profile on YouTube provides valuable insights into student engagement and behavior (Figure 1).

One can observe specific troughs in viewership around the start of April and December, aligning with academic holiday periods, such as Easter and Christmas, respectively. In July, there is a noticeable, sustained decline, corresponding to the summer break, which is a nonschool period in Spain but not in some Latin American countries.

In contrast, the peaks in viewership are most pronounced at the end of April and late November, coinciding with periods of intense examination schedules. Additionally, the spike in mid-October 2021 can be attributed to a video showcasing an experiment that gained widespread attention and rapidly circulated on line.

Upon closer examination in Figure 2, a recurring pattern becomes evident, marked by a sequence of troughs and peaks. Each pair of minima aligns with Fridays and Saturdays when students take a break, while on Sundays, they tend to resume their studies in preparation for exams or homework due on Mondays.

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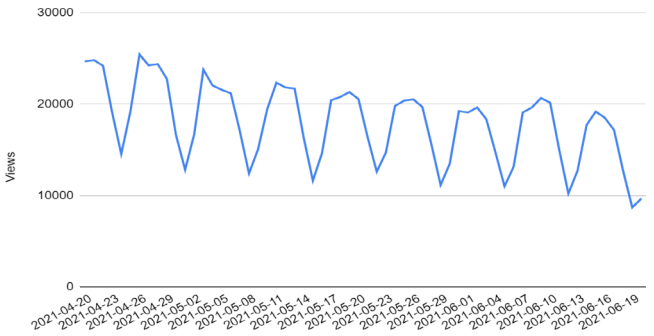

Figure 2. Daily visits from April 20, 2021 to June 20, 2021, Breaking Vlad channel.

Demographics

Compared to the predominantly localized demographic composition of students at URV, where the majority originate from the same city, province, or autonomous community,[35] the audience of a YouTube teaching channel like Breaking Vlad is significantly more diverse due to its international accessibility. While at URV's Faculty of Chemistry, a noteworthy 84.6% of students are from Tarragona,[36] individuals from any country can access the content on YouTube, provided they understand the language, which in this case is Spanish. Consequently, the majority of visits to Breaking Vlad channel are primarily from Spanish-speaking countries (see Figure 3). Notably, the top 5 countries contributing to this viewership include Mexico, Spain, Argentina, Colombia, and Peru as illustrated in Figure 4. Nevertheless, it is worth noting that over the past year, people from countries as far-reaching as Russia, Canada, the United States and Indonesia have visited the channel.

This issue presents a challenge when creating content aligned with specific curriculum plans, as each country follows its own set of guidelines, and the chronological order of topics may not precisely match. Consequently, it is quite challenging to create a playlist that caters to all countries unless it is designed in a very general manner. In this regard, it is often more effective to produce videos of high-interest or difficult content, even if they are disconnected from each other, rather than following a programmed academic schedule.

Age and Gender

Diverging from the traditional in-person education model observed at URV, where the majority of students typically fall within the 18−24 age range and commit to full-time studies, online teaching platforms like YouTube offer a more diverse audience base (Figure 5). YouTube teaching is entirely free and accessible with just a mobile phone, attracting viewers of all ages and socioeconomic conditions. Despite the majority of viewers on Breaking Vlad channel still fall within the 18−24 age bracket, there is a noticeable trend of increasing viewership among older demographics over time. This broad accessibility can significantly influence the creation of content on YouTube by allowing creators to explore a wider variety of themes and levels of difficulty. For instance, identifying real-world examples that have a broad cultural relevance or to fully contextualizing any example to address cultural relevance concerns would be beneficial. By doing so, creators can ensure that their content resonates with a diverse audience and fosters greater engagement. As a result, they have the opportunity to cater to a broader range of demographics and interests.

In the field of science, there is a balanced distribution of students enrolled in university degree programs regardless of gender.[37] Interestingly, this gender balance is also reflected in the distribution of visits on the YouTube channel, indicating that the number of visits from both men and women, including individuals who identify as such, is comparable: 51.5% men, 48.4% women, and 0.1% unidentified (data from Breaking Vlad Channel from February 2021 to February 2022).

How Students Reach the Traditional Classroom and the YouTube Channel

In the context of chemistry face-to-face studies at URV, students become acquainted with the chemistry program through their secondary schools, personal connections, and the self-promotion efforts at URV, including initiatives through mass media. However, the discovery and use of online platforms reveals a different dynamic.

Upon closer examination of Breaking Vlad channel's YouTube statistics, 28.3% of all visits originate from direct searches for specific terms or concepts on YouTube (see Figure 6). Additionally, 22% of all views come from external sources.

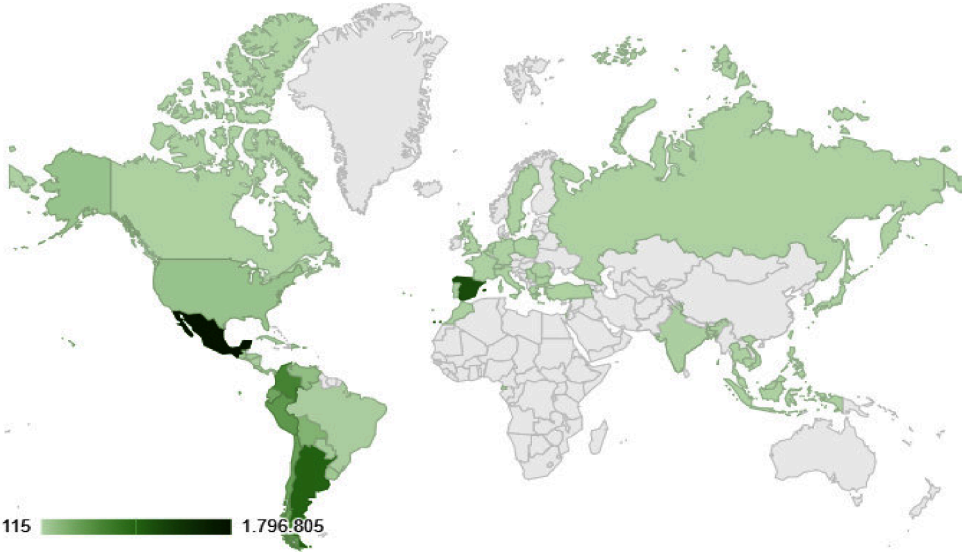

Figure 3. Map showing views by country (February 17, 2021 to February 17, 2022, Breaking Vlad channel).

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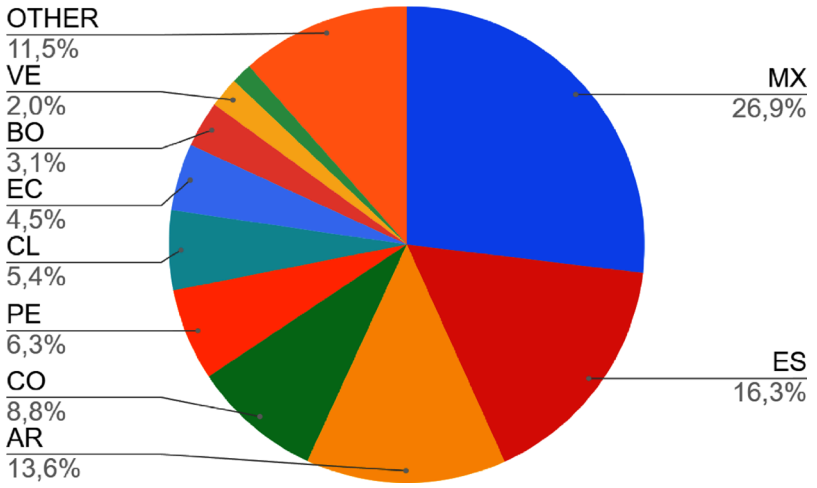

Figure 4. Percentage of views according to geographic area (February 17, 2021 to February 17, 2022, Breaking Vlad channel).

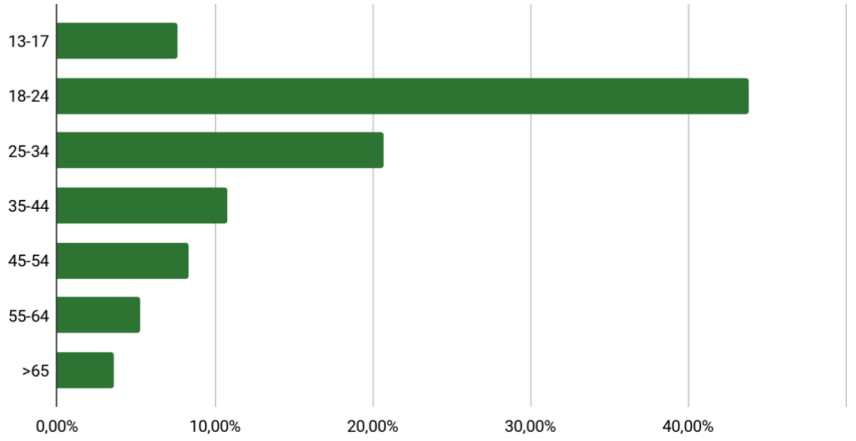

Figure 5. Visits according to age (February 17, 2021 to February 17, 2022, Breaking Vlad channel).

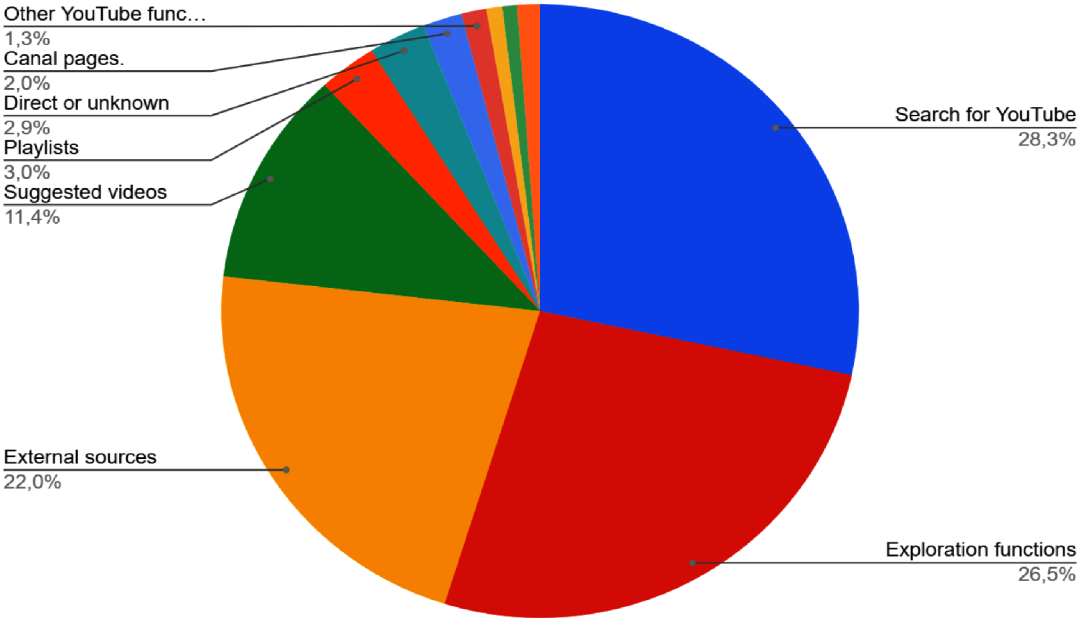

Figure 6. General traffic source diagram (February 17, 2021 to February 17, 2022, Breaking Vlad channel).

Among these, 72.7% of these external sources are attributed to direct term searches on Google (see Figure 7). This implies that 44.3% of total visits directly result from users searching for specific terms, whether on Google or on Youtube. The remaining views typically arise from YouTube recommendations based on related searches or video embeddings on other

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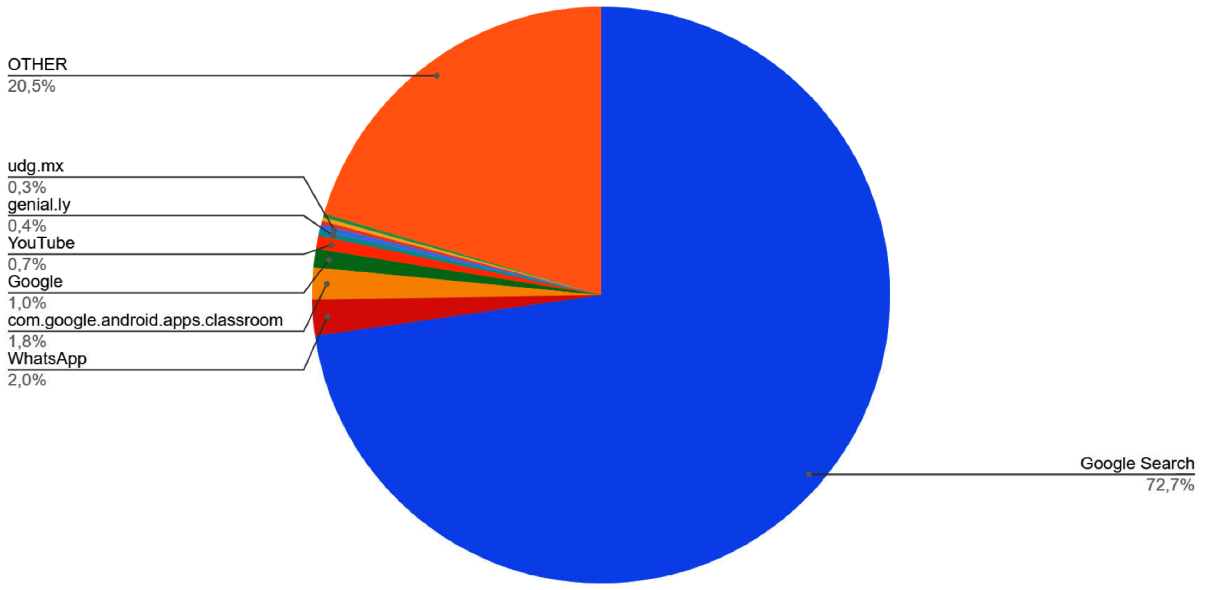

Figure 7. Insight on external traffic sources (February 17, 2021 to February 17, 2022, Breaking Vlad channel).

web pages. This data suggests that optimizing content for search engines and using relevant keywords can significantly impact the visibility and accessibility of a YouTube channel, influencing its overall success and viewership.

Requirements

In the sphere of YouTube teaching, the barriers to entry for educators are notably lower compared to traditional academia. While securing a teaching position at a university often requires extensive qualifications such as a Doctorate and success in competitive public tenders, YouTube offers a more accessible avenue for individuals to share their knowledge and expertise.

On YouTube, there are no prerequisites or formal qualifications necessary to begin teaching. Anyone with access to a camera and an Internet connection can start their own channel and create content on a wide range of subjects. This unrestricted access allows for a diverse array of voices and perspectives to contribute to the educational landscape, democratizing the dissemination of knowledge. However, it is important to note that the absence of prerequisites on YouTube also presents challenges in terms of quality control and credibility.

Credibility

In online teaching, credibility takes on a different form compared to face-to-face instruction. While in traditional settings, a teacher's credentials and teaching experience support their credibility, online educators, regardless of an impressive curriculum, must gradually earn the trust of their audience by consistently generating high-quality content. This ongoing challenge underscores the importance of prioritizing content quality and engaging presentation styles to build credibility over time.

Popularity vs Success

In face-to-face teaching, it is challenging to quantify the popularity of professors. However, success in this context may be linked to the teaching evaluations conducted by the institution. It is reasonable to assume that sometimes, but not always, positive teaching evaluations are correlated with the teacher's popularity, as one of the evaluation aspects includes student satisfaction.

In digital teaching, popularity and success are essentially synonymous, as both concepts are closely related. The most reliable way to gauge student satisfaction with the content is by assessing their return to the virtual classes, leading to increased views and, consequently, higher income.

It is not immediately clear that success and popularity as an in-person academic teacher necessarily translate to success and popularity as a digital teacher. Likewise, it is not self-evident that a teacher from a popular YouTube channel will excel in face-to-face teaching. Achieving success and popularity in one teaching medium is a significant accomplishment, but does not guarantee possessing the specific teaching skills required for the other medium because the demands and dynamics are distinct in each case. Therefore, YouTube teachers should focus on developing specific digital teaching skills and adapting to the unique demands of online education to thrive in the digital teaching space.

Competition

When comparing face-to-face education to YouTube teaching in terms of competition, it is evident that traditional education operates within a regulated framework, where universities compete for student enrolment. In contrast, online teaching introduces a new dimension of competition among educators striving to capture the attention of viewers. In traditional face-to-face education, students follow prescribed study programs and the guidance of assigned professors, whereas on YouTube, a multitude of educators compete for student attention by delivering content on similar subjects. Standing out and excelling as an educator on YouTube requires finding the right balance between capturing viewer's attention and delivering valuable content. Despite its vast reach and accessibility, achieving educational goals on YouTube necessitates continuous analysis of competitor's strategies to optimize content effectiveness and viewership, a task which is not relevant in face-to-face teaching.

Evaluation Methods

YouTube is not explicitly designed for education, and certain essential resources related to face-to-face teaching are missing, such as self-assessment exams, the option to submit assignments,

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and the generation of student progress reports. Creating interactive experimental video content, where students can make choices and participate in meaningful evaluations, is often a challenging or nearly impossible task. Consequently, content on YouTube predominantly leans toward explanation, leaving students responsible for self-directed learning and self-assessment. In this context, the evaluation process primarily resides within their educational institutions if the student is affiliated with one, as it is important to note that some individuals using the videos may not have any institutional affiliation and simply seek to learn the content.

Interaction with the Student beyond the Classroom

YouTube teachers often receive positive feedback from their students. Given its mass appeal, interaction via comments or social networks is quite frequent. In general, the contributions to this type of content are usually favorable, with the comment section often filled with expressions of gratitude and thanks. Such content reflects a significant connection between the teacher and the student, helping students relate more personally and become more engaged with the material. This shift transforms the teacher's image from merely "the teacher" to "the person who educates on YouTube", which can reduce the perceived authority of the teacher and make students more open to learning.

While in face-to-face education, teachers can provide individual attention to each student, learn about their backgrounds, understand their specific needs, and allocate dedicated time to teach one, such personalized interaction is challenging to achieve on YouTube. Although there is interaction through comments, questions about content or requests for clarification, these interventions are often anonymous (or linked to avatars). Furthermore, teachers cannot observe individual student's reactions to the class, whether they are interested, bored, or at what point they become disengaged. Consequently, it is more challenging to discern precisely what needs improvement in the explanations. Hosting live Question and Answer sessions or integrating interactive elements into videos can encourage active participation and enhance the learning experience for viewers.

Remuneration

Teaching on YouTube should be primarily understood as a hobby, form of entertainment, vocation, or voluntary endeavor. While creators of entertainment content on social networks can generate substantial income, those who are dedicated to teaching, generally, earn much less than their counterparts in traditional face-to-face teaching. For example, the monthly income for the Breaking Vlad channel fluctuates between 200 and 1000 euros.

Face-to face teaching typically involves a stable employment contract, whereas on YouTube, educators function as freelancers, and their income hinges on factors such as the number of views and other variables like the date and geographic location of viewers. Consequently, during months with higher viewership, income sees a significant uptick, but it experiences a sharp reduction when viewer engagement wanes, at times falling below half of the usual earnings.

This fluctuation severely constrains the capacity to exclusively focus on producing educational content. In response, many of these educators often need to juggle different income sources. For those who aspire to pursue this profession full time, it necessitates seeking collaborations with brands and institutions interested in sponsoring content and projects.

Based on the experience of the Breaking Vlad channel, even with a channel ranking in the platform's top 3 regarding chemical education for Spanish-speaking audiences and boasting a highly targeted audience, it remains challenging to secure collaborations with companies or organizations. This difficulty primarily stems from the emerging nature of this field and the prevalent misconceptions about its potential advantages. Consequently, this presents a significant impediment to the creation of new content and its continuous improvement, particularly given the limited available investment.

Furthermore, it is noteworthy that in Spain, there are several partial public funding schemes for the elaboration of open educational resources at the primary and secondary school level. However, when it comes to universities, initiatives related to such resources are typically funded internally from university budgets.[38] Understanding these funding dynamics is essential for educators and policymakers seeking to promote the creation and dissemination of open educational resources across all levels of education.

Final Discussion on Teaching Chemistry via YouTube

Over the years, the Breaking Vlad channel has received numerous comments of the following nature:

- *"Señor, yo a usted lo amo. Lo entendí perfectamente"*
- Sir, I love you. I understood it perfectly.
- *"El único que sabe explicar las cosas de forma tan sencilla, te debo todooooo"*
- The only one who can explain things so simply, I owe you everythiiiing"
- *"La mejor explicación del tema, muchas gracias"*
- The best explanation of the topic, thank you very much.
- *"Qué fácil se me hace cuando lo explicas tú"*
- It becomes so easy for me when you explain it.

The key lies not in whether the Breaking Vlad teacher explains better or worse than others. The main factor at play is the student's mindset. When a student actively chooses to seek out a video, it is a voluntary decision, unlike attending a scheduled class which is usually interpreted as an obligation, and this results in a different approach to comprehending the explained content. Furthermore, it often happens that when students search for a video, they are currently studying a particular subject. Consequently, the overall topic is fresh in their minds, and they turn to videos to reinforce or clarify specific aspects.

In face-to-face classes, there is typically a duration of 50 min to 2 h for explaining concepts, ideally with students fully engaged and focused on the professor. This extended time frame permits the teacher to cover multiple concepts per class, work through exercises, solve problems, and employ various teaching resources. However, when transitioning to YouTube, it is crucial to recognize that students are often seeking specific concepts. As a result, video lessons must be brief and concise, with a focus on explaining each term individually.

In this domain, the crux lies in understanding what students seek and providing precisely that. To ascertain the preferences and needs of the audience seeking your content, a meticulous analysis of the statistics offered by YouTube, as discussed in prior sections, is indispensable. Armed with this data, it becomes evident that when creating chemistry teaching videos, it is imperative to consider what your audience is actively searching for.

In contrast to conventional curricular studies, there's no requirement to adhere strictly to a predetermined syllabus, as a substantial portion of traffic results from direct searches for

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specific subjects. These insights can be derived from statistics related to traffic sources.

As such, a pivotal consideration for those embarking on YouTube teaching is mastering the art of capturing the attention of the young audience, particularly students who are in pursuit of specific terms. The goal is to entice each student to choose your particular video over others.

Another aspect worth discussing is the idea that it is better to teach a smaller audience but higher quality than to reach a broader audience and compromise on quality. This premise is controversial because these are not mutually exclusive factors. An emeritus professor, for instance, can create a short, concise video on a well-explained topic and upload it to YouTube. The content can indeed be excellent. However, the number of students who attend the class depends largely on the video's thumbnail and title, as these are the first elements a student encounters during a search. Achieving a well-balanced combination of quality content, an engaging thumbnail, and an enticing title can help excellent content reach a larger audience.

Teaching videos should be perceived as concise tutorials for students. When an individual needs to learn how to do something, such as making a scarf or brewing the perfect cup of coffee, they typically turn to Google. There, they'll come across a series of videos and choose one that appears to offer a straightforward, to-the-point explanation of what they seek to learn. In most cases, people are looking for short, concise videos without unnecessary embellishments, aiming for simplicity and efficiency in conveying the desired knowledge.

Hence, any endeavor to teach chemistry on YouTube should align with these principles.

CONCLUSIONS

Teaching on YouTube brings forth a distinct landscape compared to traditional face-to-face education. In the traditional model, universities engage in fierce competition to attract students, while professors play a central role in the educational process. However, in the digital realm of YouTube, educators find themselves in a different kind of competition, where the battle is for viewers' attention. Striking the right balance between capturing their interest and delivering valuable content becomes a pivotal challenge.

Online teaching through YouTube introduces unique hurdles. The need to create content that is both engaging and concise is paramount, driven by the specific search intentions of the platform's users. Furthermore, educators must adapt their content to cater to the preferences of YouTube's predominantly young audience, who are actively seeking specific terms and information.

One notable departure from traditional education is the flexibility for content customization. Unlike structured curricula in traditional settings, YouTube allows users to select content that aligns with the specific interests and needs, while disregarding what they do not require, even if it is part of a formal education. This flexibility makes YouTube a more adaptable medium for personalized learning in terms of content selection.

Interactivity and feedback are crucial aspects of teaching on YouTube. The platform allows for engagement through comments and social media, providing a means for educators to establish a more personal connection with their students, gather feedback, and enhance the learning experience. However, achieving this level of personal interaction, while not as direct as in face-to-face teaching, poses a challenge for YouTube educators.

Monetization on YouTube poses its own set of challenges. Educators often face income fluctuations, requiring them to seek brand collaborations and sponsorships to sustain their content creation efforts.

The confluence of quality and quantity is a point of contention. Common belief suggests that teaching fewer students yields higher quality, but YouTube demonstrates that quality content can reach a larger audience. Achieving this balance depends on creating compelling, quality content and optimizing elements like thumbnails and titles.

YouTube, in essence, serves as a platform for students seeking concise, to-the-point tutorials. As a result, educators in subjects like chemistry must align their content with these expectations, delivering succinct and valuable information.

In summary, teaching on YouTube presents a unique landscape with its own set of opportunities and challenges. Understanding the specific needs and intentions of the audience is paramount, as is the delivery of high-quality content. Balancing quality and quantity, adapting to customization, and ensuring efficiency are crucial components of success in the domain of online education.

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Notes

The authors declare no competing financial interest.

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