Case Study

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Virtual Teaching Environment in Chemistry Laboratories (AQuí): Expanding Teaching on YouTube

Ambiente Virtual de Ensino em Laboratórios de Química (AQuí): Expandindo o Ensino no YouTube

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Abstract

Digital information and communication technology tools have been used as allies in teaching. Chemistry teaching sometimes requires practical activities in laboratories to elucidate the content better, and using videos aimed at this approach can help in the teaching-learning process. This descriptive, qualitative and quantitative study aims to describe the production of manual videos to handle equipment in chemistry laboratories and analyze the scope of the material produced and made available on the "Projeto AQuí" channel on YouTube. Undergraduate students' teaching material was prepared, following the pre-production, production, and post-production steps described in this work. Through the indicators obtained by Google Analytics, it was possible to verify the impact of the material produced. Through the comments left voluntarily on the page, it was possible to perceive viewers' satisfaction with the material. Based on the metrics analyzed, the "Projeto AQuí" channel on YouTube fulfills its proposal to disseminate material on laboratory operations, with a national and international reach.

Keywords: DICT. Technology in education.Video. Laboratory equipment.

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Resumo

As ferramentas de tecnologia digitais da informação e comunicação vem sendo utilizadas como aliadas no ensino. O ensino de química por vezes necessita de atividades práticas em laboratórios para melhor elucidar o conteúdo, e utilizar vídeos voltados para esta abordagem podem auxiliar no processo de ensino aprendizagem. Este estudo, de caráter descritivo, qualitativo e quantitativo, tem por objetivo descrever a confecção de vídeos-manuais voltados ao manuseio de equipamentos em laboratórios de química, e analisar o alcance e a satisfação do material produzido e disponibilizado no canal "Projeto AQuí" no YouTube. O material didático foi elaborado por alunos de graduação, seguindo os passos de pré-produção, produção e pós produção descritos neste trabalho. Através dos indicadores obtidos pelo YouTube Analytics, foi possível verificar o alcance do material produzido, e através dos comentários deixados voluntariamente na página foi possível perceber a satisfação dos espectadores com o material. Com base nas métricas analisadas, o canal "Projeto AQuí" no YouTube cumpre sua proposta de divulgação de material sobre operações laboratoriais, com um alcance nacional e internacional, sendo utilizado por instituições de ensino técnico e de ensino superior.

***Palavras-chave**: TDIC. Material didático. Tecnologia na educação. Vídeo. Equipamentos de laboratório.*

1. Introduction

In the last decades it is possible to observe a growing use of Digital Information and Communication Technologies (DICT) as allies in the teaching-learning process. Its use goes beyond technological support, the breadth and diversity of resources allow to enhance teaching work, so that learning is meaningful for students (LEITE, 2019). In this context, knowledge goes beyond the classrooms of educational institutions, and the construction of knowledge can happen in a more open, integrated, interesting and multisensory way (ARANHA et al., 2019).

The benefits can be applied in the most diverse areas of knowledge. Chassot (2018) reports that the use of technologies is a good resource for the development of learning in general, including in chemistry, and that it should be used exploring its investigative potential, valuing the relationship between the construction of scientific knowledge and reality.

The use of DICTs as a complementary resource for teaching chemistry has been reported by several authors, whether in the use of remote laboratories (SILVA et al., 2020), of virtual laboratories (FEHLBERG, VARGAS and ANDREATTA-DA-COSTA, 2016) , in the use of virtual environments, online games and applications for smartphones (DIONÍZIO et al., 2019), in the reproduction of videos in the classroom (SILVA, LEITE and LEITE, 2016; ROCHA, MARTINS and COSTA, 2019), or even the production of videos aimed at teaching chemistry (SANTOS and NANTES-CARDOSO, 2021; BARROS et al., 2020; WATANABE, BALDORIA and AMARAL, 2018). In the aforementioned research, the authors claim that the use is beneficial for students, who can bring them closer to the content by making it tangible and interesting.

Chemistry teaching sometimes requires abstract thinking, and practical and experimental activities are considered essential pedagogical resources to help the acquisition of scientific knowledge (AMAURO, SOUZA and MORI, 2015). This methodology allows the direct handling of materials and equipment in the laboratory, and through the teacher's mediation, they are encouraged to visualize, argue and question the experiments, thus assuming an active role in the construction of their learning (GUIMARÃES, 2009).

However, some students present difficulties in relation to conduct and learning within the laboratories. Barros and collaborators (2020 p. 84) attribute these difficulties to several factors, among them "the lack of contact with the laboratory environment, with the activities developed in this space, with various materials and reagents present in this place and the lack of knowledge about disposal of chemical waste".

Virtual resources can be used to support the training of academics who need to use chemistry laboratories, and also an effective alternative when there are structural, financial or other obstacles that make it impossible to handle equipment and materials in practice. Although these tools do not replace real laboratories, they can be used as a complement to a theoretical class to enrich learning situations, contribute to the construction of knowledge, acquire a greater degree of meaning and also stimulate the student's interest in the subject (ROCHA , MARTINS and COSTA, 2019).

Among those cited, we highlight the use of videos as facilitating tools for teaching chemistry. In addition to effective and easily accessible tools to diversify the didactic routine, audiovisual resources can show actions and interactions and "stimulate the senses, making visible the diversity of elements that permeates the student's imagination when entering a certain content" (PEREIRA et al. MAGALINI, 2017, p.125). In addition, the videos can be used as supports for carrying out experiments, complementing the class script executed in practice. (ARANHA et al., 2019)

When using videos aimed at teaching safety standards in chemistry laboratories and in experimental activities in the initial training of undergraduates, Barros et al. knowledge on the subject of study. They also emphasized the advantage of being able to visualize the handling of equipment, even when it is lacking in the institution.

Videos for learning chemistry were also evaluated by Silva, Leite and Leite (2016), who pointed out the direct contact that students have with this media as beneficial, and their understanding that videos are more than a form of leisure, a learning tool, and that should be used more often in the classroom.

In a work developed in a technical education class, the students had access to videos on the assembly of the equipment and to a virtual laboratory before the practical activities in the laboratory. After the activity, when answering a questionnaire, they were satisfied with the activity, considering the activity interesting, and that with prior access to the online material, it was easier to understand the assembly of the equipment during the practical activity (FEHLBERG, VARGAS AND ANDREATTA- DA-COSTA, 2016).

Although the use of videos as a teaching tool does not configure a new methodology by itself, they can bring a different dynamic to the classroom, after all, audiovisual language permeates the sociocultural environment of most university students. Currently, the biggest video streaming platform is YouTube. It is used by people of all ages, however, its predominant audience is between 18 and 44 years of age, with the smartphone being the main equipment used for access. Brazil is the third country that most consumes its content, and 64.7% of Brazilians over 18 years old have access to this platform (WE ARE SOCIAL, 2021).

Widespread worldwide, YouTube is a platform that allows users to create and publish their own content, and also encourages interaction with users who consume this content, through comments and rating the watched video ("liked" and "disliked" button). Originally, YouTube was not created with educational intentions, but when they realized this potential, some users started to use it for this purpose (JUNGES and GATTI, 2019).

A channel on the YouTube platform created with this intention is "Projeto Aquí". The project "Virtual Teaching Environment in Chemistry Laboratories" (AQuí) is a teaching project, developed at the Federal University of Pampa (UNIPAMPA) Itaqui campus, and started its activities in 2015, with the aim of demystifying the use of chemistry laboratories, addressing the use of glassware, equipment, safety in the laboratory and other matters related to the area. All didactic material is produced by the students, and made available in the form of manuals and video-manuals on the project's website, and from November 2017 the videos were also made available on the project's YouTube channel.

Considering the ability to permeate students' culture due to their familiarity with audiovisual and the advantages that videos can bring, and also the current pandemic scenario, with the growing need for quality online teaching material, this work proposed to carry out a report on the construction of video manuals on laboratory operations, aimed at chemistry laboratories, and analyze the scope and satisfaction of this didactic material available on the YouTube channel "Projeto AQuí".

2. Methodology

This research was developed as an experience report, due to its characteristic of a well-defined study and with analysis within the inserted context (VENTURA, 2007). The methodology was chosen in order to elucidate in detail the making and dissemination of the videos produced by the project "Virtual Environment of Teaching in Chemistry Laboratories" (AQuí), and also to bring the interaction of the users of the YouTube platform with the material available on the project channel. .

A survey of the equipment and glassware available in the chemistry laboratories of the Federal University of Pampa (UNIPAMPA), Campus Itaqui was carried out to select the subjects that would be addressed in the videos. The videos produced were called video-manuals because they present an approach aimed at instruction in the handling of materials. The making of the video manuals was categorized into three stages, namely: pre-production, production and post-production. Pre-production is the most laborious of the stages and consisted of studying the equipment to be covered in the video-manual, followed by peer correction, technical correction and script writing. The video-manuals produced were published on the AQuí project website and on the "AQuí Project" channel on YouTube.

Undergraduate and graduate students from different UNIPAMPA courses, from the Itaqui and Uruguaiana campuses participated in the preparation of the material. A term was presented to these students, clarifying the objective, the stages of the research, the themes to be worked on and the expected results and the students spontaneously agreed to give their image for the realization and dissemination of this work.

The research was also developed with a qualitative and quantitative approach, with the intention of better understanding the objects of analysis (MUSSI et al., 2019). The analysis and interpretation of the comments expressed in the channel was carried out qualitatively, in a descriptive and interpretive way, categorized according to Bardin's Content Analysis (2002). The research also includes quantitative attributes, by presenting the reach and interactions of users of the YouTube platform with the "Projeto AQuí" channel. The collection of user reach and impressions data was obtained through YouTube Analytics, which allows the analysis of the number of views per period, the profile and frequency of viewers, as well as user reactions to the material. The following variables were also considered: form of traffic, search for available teaching material, device used to reproduce the videos, age group of spectators and place of reproduction. This database whose information was compiled is in the public domain.

3. Results and Discussion

3.1. The construction process of the teaching material

To start making the video-manual, each student received an object of study, mostly laboratory equipment. In addition to the equipment, the study also addressed the topic of laboratory glassware and safety in the laboratory. The distribution was made so that each student received equipment that had never been handled, in this research this subject was called primary user, as this was his first contact with the equipment. We believe that in this way it is possible to minimize the interference of defects in the use of the equipment, in addition to the fact that their doubts about the handling and use of the equipment under study could be closer to that of a student when entering a laboratory for the first time. .

Each student prepared a manual for using the equipment, in a step-by-step format, illustrating each stage of use through photographs. To make this, the student sought information from the equipment's instruction manual, websites, leaflets and other informative materials made available by the manufacturers. Students were instructed to use simple, easy-to-understand language and to describe the steps in as much detail as possible.

After collecting the information, the students handled the equipment, under the supervision of laboratory technicians. The technical staff sought not to interfere in the process of knowing and discovering the operation of the equipment, they only observed the construction in order to preserve the safety of students as users of the laboratories, without effectively interfering in the process of making the material.

After the description of the necessary steps for handling was completed, a second student, also a primary user, used the material made, performing the actions described, to test the effectiveness and clarity of the information contained, and made the necessary adjustments together with the student who prepared the manual. At this point, the debate among students is encouraged on the best way to expose the information, so that it remains accurate, detailed and in facilitating language.

Once the peer correction was completed, the elaborate manual moved on to the technical correction. At this stage, the technical staff is concerned with the fidelity of the information, and if they are complete, however, it interferes as little as possible with the language in which the information is exposed. This material is then available on the project website, and can be used as an auxiliary resource for handling the equipment in the laboratory. However, in order to explain the information contained therein in a more didactic and accessible way, we opted for the construction of videos demonstrating the use of this equipment. Moore and Kearsley (2007) state that video is a good medium for teaching any type of procedure, as it allows and favors the sequence of actions, using filming and/or editing resources.

By using this resource to show equipment and other materials present in a chemistry laboratory, it is possible to stimulate multiple senses, and make more palpable what sometimes happens only in the students' imagination, when it is not possible to use a physical laboratory, for example.

However, recording videos is a laborious step, and requires planning. As the last step of pre-production, we adopted the creation of scripts. The scripts were designed so that all the necessary information was passed on within a maximum time of 5 minutes. In some specific cases, this time was slightly extrapolated, due to the complexity of the object of study. Studies point out the students' preference for short videos, and that the student's attention in educational videos is fixed for an average time of 3 to 5 minutes, and can extend up to 8 minutes (NAGUMO, TELES and SILVA, 2020; BAHIA and SILVA, 2017).

The scripts were based on the manuals prepared, however, at this moment, the shooting sequence and the subtitles that will compose the video are thought, being organized in the following order of information: a) scene number, to organize the videos for editing; b) way of framing in which the recording should

take place (most commonly used examples: "general shot", with recording in an open scenario, "zoom", to capture the details of the equipment, "slow motion", to capture details of the actions, " high angle", to frame the equipment with the footage from top to bottom); c) description of the action to be performed, with enough information for the actor to know exactly what to do in the scene; and d) a preview of the subtitles that will compose the video in the final edit.

This step requires many hours of planning, but its importance is verified on the day of recording, since a failure in this planning can result in the rescheduling of the activity, or in some cases even in the re-recording. A well-prepared script gives security, quality and clarity to the content being worked on. It must contain the description of the scenes, description of the lines and/or actions and bring the definition of scenarios and soundtracks (SANTOS and NANTES-CARDOSO, 2021).

For the production of the video, it was necessary to distribute specific roles for each member of the team, consisting of an actor, who handled the equipment; a camera operator, responsible for filming and framing the scenes; a director, who coordinated the action of the other members based on the pre-established script, mainly the actors; an assistant director, responsible for noting the sequence of the videos filmed in the filming follow-up form, marking the scenes and assisting the director; and by a stagehand, responsible for organizing the scenery, costumes and laboratory equipment used.

The production stage began with the preparation of the location and scenery by the stage set. The videos were recorded in the laboratories of UNIPAMPA campus Itaqui. Canvas posters with the university's logo were used to compose the background of the videos, aiming, in addition to identifying the institution, to reduce background interference, which could divert attention from the study equipment. Then, the equipment and other accessories were organized for the composition of the scenario, reserving space for the positioning of the actor. Regarding the costumes, the actors always wore lab coats and the personal protective equipment necessary for handling the equipment. The lighting of the scenario proved to be an important factor, because as we did not have lighting equipment, the recordings were made during the day, to make the best use of ambient lighting.

When framing the scenes, the cameraman should look for the best angle considering, in addition to the ambient light, the actor's action (so that the hands or body do not cover the action), and still reserve a space in the frame for later addition. of the subtitles. For the filming, between 2015 and 2018, a Sony HDR-CX 130 camera was used. In 2019, the recordings were made with a smartphone.

At the time of filming, it was up to the director to organize the order of the scenes to be recorded, and they did not always follow the logical sequence of use of the equipment, as it was more effective to film all scenes in "general plan", for later camera repositioning and scenery to shoot scenes in "zoom" mode, and "high angle".

Considering this alternation in the recording order, before starting the action of each scene, a sheet of paper (informally known as "clapperboard") was placed in front of the camera containing information about the video to be recorded (name of equipment, date of footage, scene and shot number) to assist in the organization and subsequent editing process. For this purpose, the assistant director also used a spreadsheet, where the information contained in the "clapperboard" was transcribed, the action taken, and if the action was carried out as planned or if there was any recording error, in addition to additional observations. for the editing step.

During the recording of the different manual videos, there was a rotation between the collaborators (students and technicians) and the functions performed, in this way the students participating in the project acted in all stages of production. The use of audiovisual resources, with the student as the protagonist is described as beneficial to the student, as it allows the development of multiple perceptive attitudes, creativity, communication, interaction and content fixation (WATANABE, BALDORIA E AMARAL, 2018). The

role of actor in the videos has always been performed by a student, as we believe that students can identify more when watching the videos and seeing their peers as protagonists. We believe that this experience can help to make the production of video-manuals meaningful for students, and that the material, in addition to the quality of the information, can serve as a learning tool both for the students who participate in the process, and for the public to which the students participate. videos are intended.

After the recording process was completed, the videos were edited with the Windows Movie Maker software. In the editing process, all the original audio was removed and replaced by songs made available by the audio library of the YouTube platform, respecting the policies defined for each song by the respective copyright holders. The videos were subtitled, describing the steps necessary for handling the equipment, which were being performed in each scene. We tried to use a large font for the subtitles to facilitate viewing, since most of the access to content by YouTube users is done through the smartphone (WE ARE SOCIAL, 2021).

Opening images were added to the videos containing the name of the equipment presented in the video, and at the end, the name of all the participants, in addition to other important information, such as the source of the information contained in the video, the project registration number, thanks the institution and the project website to search for information about other equipment. The images were produced by the project participants, and in the videos in which images from other sources were used to better elucidate the content, the search was carried out in an image database respecting the copyright of use.

A YouTube channel was created for the dissemination of the didactic material made, following the steps of registration and feeding available on the platform. The channel entitled "Projeto AQuí", is available through the address: https://www.youtube.com/channel/UCmhnIqPPd2mXLU0aMfkY7Vg. The videos were also made available on the AQuí project website: http://aqui.itaqui.unipampa.edu.br.

3.1. Media impact analysis

In the period between November 2017 and July 2021, the channel "Projeto AQuí" produced and made available on YouTube 30 videos on the use of laboratory equipment and glassware. These videos were viewed over 82,000 times, this represents approximately 2,000 hours of content displayed. Currently, the channel has 421 subscribers, with an average reproduction of 2,300 monthly views.

The type of device most used to search the channel was the smartphone, responsible for 54% of the viewing time of the videos, followed by computers (43%), tablets (1.3%), smartTV (1.1%) and other devices (0.6%). The majority access by smartphone is not exclusive to the "Projeto AQuí" channel. The data expressed by the We Are Social survey (2021) indicate that 70% of YouTube accesses are made through smartphones.

Most viewers of the "Projeto Aquí" channel fall into the age group between 18 and 34 years old (74.9%). We believe that using YouTube as a tool for the dissemination of technical-scientific material, the project is reaching the target audience, as according to the last Higher Education Census, carried out in 2019, most undergraduates are aged between 19 and 19. 30 years (INEP, 2021). In a questionnaire applied by Nagumo, Teles and Silva (2020), 87% of the students interviewed stated that they use YouTube to reinforce or learn some content that they could not fully understand in college.

The geographic reach of the content produced by the "Projeto Aquí" channel has crossed borders. The largest number of hits comes from Brazil (77.8%), but the audience was also registered in other countries, such as Portugal (5%), Mexico (1.8%), Spain (1.2%), other Latin American countries (together they add up to 4.2%), countries on the African continent (together they add up to 3.1%) and even in other locations.

Although with reach abroad, it is observed that it was restricted to countries that speak Portuguese or Spanish. The subtitles tool with automatic translation was not activated once by the users. It should

be noted that the titles of the videos shown on the channel are the names of the equipment presented, and that most of these do not have many orthographic differences between the Portuguese and Spanish languages. We believe that language can be a barrier to expanding the dissemination of videos to other countries, because although the YouTube platform provides the automatic translation tool, it can only be activated while the video is being shown, and not during the search.

Of the ten most watched videos, eight address the handling of laboratory equipment, one video addresses the use of personal protective equipment, procedure gloves, and one video deals with a laboratory operation, demonstrating the adjustment of the meniscus for the preparation of solutions and measurement reading. The videos with the highest views were "Alcoómetro Gay-Lussac and Cartier", with over 19,000 views, "How to remove the gloves", with nearly 17,000 views, "Menisco" with over 9,000 views, "Water Distiller" with just over 8 thousand views and "Silica Desiccator" with almost 6 thousand views.

We observed that although the videos have reached a significant number of views, users do not often express their satisfaction or not with the material, through the options "liked" and "disliked", typical of the platform, as well as not making many comments. During the period, 1302 tags were received as "I liked", 52 tags as "I did not like" and 95 comments.

Of the comments on the channel, 43% were doubts from users regarding the use of the equipment, or even doubts about technical specificities. There were still many praises (40% of the comments) and some criticisms (4% of the comments). We also received suggestions for new videos (4% of comments). There were also comments in which students reported the reason that brought them to the video, or their educational institution (4% of comments). We also received comments from people who identified themselves as teachers (5% of the comments) and who reported that they would recommend the page to their students, or even requesting permission to use the videos in the classroom.

Among the comments received, some drew attention during the analysis for reporting the satisfaction of users with the material available, among them we highlight the following: "I loved the video! "to" being able to understand things in the laboratory."; "Perfect! Now I understand how it works."; "Very very good!! A very cool contribution to enrich our work in the classroom. Congratulations on your dedication and whim!"; "Thanks for the video. It cleared my doubts!".; "Perfect. It helped a lot! Especially at this time of remote study, you can get an idea of the use of the equipment. Congratulations!". The criticism received was in relation to the background music used in a video, and there was also criticism for the lack of temperature conversion calculations when using the alcoholometer.

The constant evaluation of viewers' satisfaction is important to verify that the material produced arouses interest and meets their needs, to maintain the interest of subscribers, and to grow the channel (MURIEL-TORRADO and GONÇALVES, 2017). All comments were marked as "liked" and answered by the project team, and criticisms and topic suggestions will be evaluated for future videos.

The sharing service was used 2,500 times, with the Whatsapp application being the most used (56.4%), the second most used action was "copying the video link to the clipboard" (24.9%). followed by the social network Facebook (6.6%), by e-mail (0.9%), and by other forms of sharing.

The action of sharing the videos allows users to forward the video link through their social networks and embed it on other websites. It can be interpreted as an approval action, as something in the video motivated viewers to forward the video to third parties, and for this to occur, a few clicks are needed, while to express yourself with the "like" and "dislike" buttons ", only one click is required. It should be noted that in order to express yourself through the comments and the "like" and "dislike" buttons, it is necessary to log in, that is, it is necessary to register on YouTube and access the platform through it. However, to make shares it is not necessary to login.

The possibility of "copying the link to the clipboard" is one of the advantages of using the YouTube platform, as it makes it possible to incorporate the video link on other platforms, such as websites, blogs, virtual learning environments (VLE) and other media. Through the Google Analytics tool, which presents the list of domains that incorporated a link containing the content of the channel, it was possible to observe that the material was incorporated into different domains, and of these, those used with educational intentions, such as Google Classroom, and 27 websites from different educational institutions, 11 from Federal Universities, 5 from Federal Institutes of Education, 4 from foreign educational websites and blogs, 4 from national educational websites and blogs, 2 from State Universities and 1 from a Private University.

The incorporation of videos from the "Projeto AQuí" channel in institutional domains of different universities and other educational sites suggests the approval of professors to the content of the videos, since they are using them as an educational resource. The use of videos as a teaching tool is widely disseminated in higher education as an auxiliary tool in the teaching and learning process. In their research, Santos and Nantes-Cardoso (2021, p.12463) report that "teachers see that videos have high pedagogical potential and that they should be used properly to compose the learning scenario they propose". These teachers reported an improvement in the students' understanding of the content. However, they also report some resistance and fears when using this technology. According to Reis, Leite and Leão (2021), it is necessary to invest in training programs that enable teachers to make better use of video, aiming at a real use of the educational potential of this resource.

External sites that incorporated video links account for 5.4% of views. Most of the videos were watched on the YouTube platform itself (94.3%), while the project's website was responsible for only 0.3% of the reproductions. These data demonstrate that although the project has a website for organizing and publicizing the material, its reach is insignificant when compared to the power of reach and dissemination of YouTube.

We observed that the main audience of the channel comes from non-subscribers (98.7%). Most of the views occurred when the internet user performed a search on search engines (33.8%), but most of the views (47.4%) occurred because users searched for exactly one of the terms in the titles of the videos in their search. directly on the YouTube platform. This shows that users are using YouTube as a source of research for technical-scientific content, since the names used for the titles of the videos are specific, and only bring the name and brand of the laboratory equipment.

The impression rate, which is the ratio of times the Internet user reached the content through the video thumbnail displayed on the platform, is 10%. This also demonstrates that videos are not watched at random, due to a flashy cover of the content, or through clickbait. It can be considered as another indication that the material is intentionally visualized, as a source of specific technical information about laboratory equipment.

Among the videos on the channel, one in particular drew attention due to the metric of views presented. The video "How to remove the gloves" was posted in November 2017, and by the end of January 2020 it had been viewed 4,000 times, an average of 150 views per month. However, during the month of March 2020 the video had more than 10 thousand views, reaching peaks of 650 views daily. Currently this video is the second most watched on the channel.

It is believed that the increase in demand for this video is related to the COVID-19 pandemic, which had the first case reported in the country at the end of February 2020, and with this, there was a need to adopt care and health measures to avoid contagion. The video in question addresses how to remove procedure gloves, avoiding user contact with the outside of the glove (contaminated). The increase in demand for this video in this specific period suggests that YouTube users are using the platform to seek scientific knowledge.

In general, the channel's videos had an increase in views after the beginning of the pandemic, the daily average until February 2020 was 50 views per day, rising to an average of 270 views per day in March 2020 and from April 2020 maintains an average of 113 views per day. Of the 27 educational institutions that copied the video link and incorporated it into their domains, 16 took this action during the pandemic.

Goés and Cassiano (2020) report that teachers and educational institutions had to adapt to a new system, requiring the use of TDIC as positive strategies for this period of social withdrawal. They also explain the challenges during this period, which are many, while enabling discoveries, renewals and resignifications. Mazzafera et al. (2021) report that there have been changes in study habits in higher education students during this pandemic period, with an increase in connection time and readjustment of study spaces (physical and online) and that some of these habits should remain even in a post-pandemic moment.

4. Conclusions

The steps for the construction of the video-manuals were used to produce 30 videos on handling equipment and materials commonly used in chemistry laboratories. The video manuals were published on the AQuí project website and on its YouTube platform channel.

The choice of platform for dissemination proved to be adequate because the majority of the channel's audience is of university age, in addition, it was possible to track that the videos were incorporated into other sites for educational purposes, both nationally and abroad.

The comments left by viewers on the channel also demonstrated their acceptance of the material. However, new tools are needed that can better evaluate user feedback regarding the understanding of the teaching material available on the platform. It is intended in future studies to develop strategies for incorporating the evaluation of teaching material by undergraduates and university professors who make use of chemistry laboratories in higher education.

Biodados

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