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ORIGINAL ARTICLE

YouTube™ as a supplemental learning source for undergraduate dental students

ABSTRACT

Aim: *The objective of this study was to investigate, through a survey, the use of YouTube™ by dental students. Subsequently, the educational value of YouTube™ videos on 3 hot topics in endodontics was evaluated.*
Methodology: *The 3-, 4-, 5-, and 6-year dental students from the University of Parma were invited to complete an online questionnaire consisting of 20 multiple-choice questions regarding their use of YouTube™. Subsequently, YouTube™ videos were searched for the following topics: "root canal filling with single-cone technique and calcium silicate cements (CSCs)", "regenerative endodontics" and "guided endodontics". Data of interest were extracted from each video, and a specific scoring system was applied to evaluate scientific soundness, quality, and educational value.*
Results: *Although only a minority of students responded that they accessed the YouTube™ platform primarily for study purposes, 93.3% of dental students watched videos for educational pursuit, particularly for the disciplines of Restorative Dentistry, Prosthodontics, and Endodontics. Among the videos on Endodontics, the most viewed were those on access cavity opening.*
Analysis of 64 selected videos revealed that the majority were uploaded by private users and came from the United States. The average number of views was 6535, 3592,5 and 1143, respectively for videos on root canal filling with single-cone technique and CSCs, regenerative endodontics and guided endodontics. 46% of the videos on root canal filling with single-cone technique and CSCs had significant commercial bias. 71.8% of the videos were judged to be useful or highly useful for the students.
Conclusions: *YouTube™ videos currently represent an important auxiliary learning source for dental students, however there are currently no control mechanisms to verify the soundness of the information conveyed.*

Giovanni Mergoni*
Benedetta Ghezzi
Andrea Salvaterra Toffoli
Maddalena Manfredi

Department of Medicine & Surgery, Dentistry Center, University of Parma, Parma, Italy

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Corresponding Author
Giovanni Mergoni | Department of Medicine & Surgery, Dentistry Center, University of Parma, Parma | Italy
Tel: +390521 906718 Email: giovanni.mergoni@unipr.it

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Introduction

The way students learn evolves over time, in response to the sources available and accessible to them (1) and adapting to the surrounding environment conditions, as the recent pandemic has shown (2). In addition to traditional learning tools, such as written notes and textbooks, students are increasingly using e-learning tools, including online educational videos (3). Video, combining visual and verbal elements, has the potential to be a more effective way to deliver instructional material than text or static images alone (4). According to a surveys conducted in the United States, videos uploaded to YouTube™ are the most widely used non-curricular resource by dental students (5) . Youtube™, launched in 2005 and owned by Google, is the currently largest Internet video-sharing website and it is the second most visited website in the world (6). Dental students benefit from several advantages when using YouTube™ for educational videos: 24/7 access, ability to view the content an unlimited number of times, the opportunity to interact with other users in the comments section, and exposure to similar videos recommended by the algorithm. By using YouTube™ as an educational source, students can practice self-directed learning, a skill they will need for lifelong continuing education (7). Despite these positive aspects, there are also drawbacks, in particular concerning the quality and reliability of videos. While YouTube™ has established guidelines for content related to spam, deceptive practices, sensitive content, violent and dangerous content, regulated goods, and copyright, there is no specific mechanism to guarantee the scientific accuracy and clinical relevance of medical education videos, including dentistry. This lack of control can lead to the dissemination of misleading or biased information, potentially impacting the learning of dental students, especially among students with underdeveloped critical thinking skills.
The quality of YouTube™ videos for student learning has been previously investigated for selected topics, including root canal preparation (8), access cavity preparation (9), pulpotomy and pulp cupping (10), with contrasting results.
The aim of this study was to investigate the use of YouTube™ by dental students from a Northern Italian dental school, with particular reference to endodontics, and to assess the quality of videos on three hot topics in endodontics.

Materials and methods

Survey
Between November 2023 and January 2024, 101 students attending the 3th, 4th, 5th, and 6th years of the Dental School at the University of Parma were invited to participate to a survey on their use of the YouTube™ platform through a Google Forms. The survey was approved by the local research ethics board (protocol number 22180/2024). Students were informed about the purpose of the survey, that their responses would be anonymous, and that their participation would not affect their academic evaluation.
The questionnaire consisted of the following 20 multiple-choice questions.

1. Have you ever used the YouTube™ platform?
2. How long have you been visiting the YouTube™ website?
3. How often do you visit the YouTube™ website?
4. Since you have been a university student, have you ever used YouTube™ for training or study purposes?
5. How many professors use videos uploaded to YouTube™ in their classes?
6. What is your primary use of YouTube™?
7. Do you find that videos on dental clinical procedures on YouTube are a useful tool for students?
8. How often do you refer to a video on YouTube to prepare for an exam?
9. In which of the dental subjects do you feel that YouTube™ videos can be most helpful?
10. Would you recommend YouTube™ videos to your classmates as a tool to supplement the teaching material?

11. Do the teachers of the Dentistry Course recommend or advise watching videos on YouTube™ to learn more about topics?
12. How do you rate the average level of evidence-based videos you have watched for study purposes?
13. Are the YouTube™ videos consistent with what is explained in class?
14. Would you like your teachers to upload educational videos to YouTube™?
15. Would you find it useful to watch videos on YouTube™ prior to perform a clinical procedure that you have never done before?
16. Have you already taken or are you taking the endodontics course at your university?
17. How often have you searched for videos on endodontics on YouTube™?
18. Would you recommend to your colleagues watching videos on YouTube™ for endodontic procedures for better learning and a better approach to the clinical side of the subject?
19. For what topics related to endodontics have you visited YouTube™?
20. What do you think is the level of evidence-based videos on endodontics that you have seen on YouTube™?

The results were obtained directly from Google Forms, maintaining anonymity, and analysed using Microsoft Excel 15.13.3 (Microsoft Corporation, Redmond, WA, USA) and Prism 4.01 (GraphPad software, San Diego, CA, USA). Answers were reported as percentages.

Assessment of endodontic YouTube™ videos

We selected the following three endodontic hot topics:

-root canal obturation with single cone technique and calcium silicate cements (CSCs);

-regenerative endodontics;

-guided endodontics.

These topics were chosen because a previous study showed that they were scarcely addressed in Italian dental schools (11). We hypothesized that students might be interested in further exploring these topics on their own searching on YouTube™.

The following queries were used: "bioceramic sealer", "single cone obturation", "single cone technique", "single cone bioceramic obturation", "one cone technique", "hydraulic condensation technique", "Endosequence BC sealer", "bioceramic obturation", "regenerative endodontics", "endodontic regeneration", "endodontic revascularization", "endodontic revitalization", "guided endodontics", "dynamic navigation in endodontics". Queries where constructed based on tags found in pertinent videos. The search was carried out using an incognito window with cache clearing and an unregistered browser to prevent the algorithm from selecting videos based on history. The default settings were maintained without any filter, and the videos were sorted by relevance. Considering that more than 90% of Internet users only consult the first 3 pages of search engines (12), the first 20 videos were considered for each query. After removing duplicates, the following exclusion criteria were applied to select the videos to be included:

1. videos not in English;
2. videos not dealing with the topic of interest;
3. videos on other endodontic procedures;
4. videos without written or verbal explanations;
5. videos shorter than 3 minutes.

An account was created to store the included videos. The following data were extracted for each video: video duration (minutes), number of views, days since upload, number of likes and dislikes, type of user who uploaded the video (private, company or academic institution), country. The view ratio (number of views / days since upload) was calculated (13).

To evaluate the educational value of each video, a specific 5-item scoring system, was used (Table 1). Each item will be assigned a value of 0 (item not adequately addressed in the video) and 1 (item adequately addressed in the video). A total score was assigned to each video adding the score assigned to each item. In addition, a modified version of the Global Quality Score (Table 2) was used to assess reliability and educational quality of the videos. This

evaluation tool, although non-validated, has been commonly used for the assessment of the content quality of online resources as it rates the quality and usefulness of online resources with a 1 to 5 scale (10, 14, 15).
The evaluation was performed independently by 2 raters previously calibrated for each item. In case of disagreement, a third rater was involved.
Categorical data are presented as number and percentages. Continuous data are presented as median and interquartile range (IQR) because at the Shapiro-Wilks test they shoved a non-normal distribution.
The collected data was compared between the three topics. Chi-2 test or Fischer exact test were used to compare categorical data in a 3x2 contingency table, followed by a 2x2 test with Bonferroni correction when significance was found.
Continuous data were compared with the non–parametric test of Kruskal-Wakllis followed by a Mann-Whitney U test with Bonferroni correction when significant. Data were analyzed using Stata v. 12.0 (College Station, TX).

Results

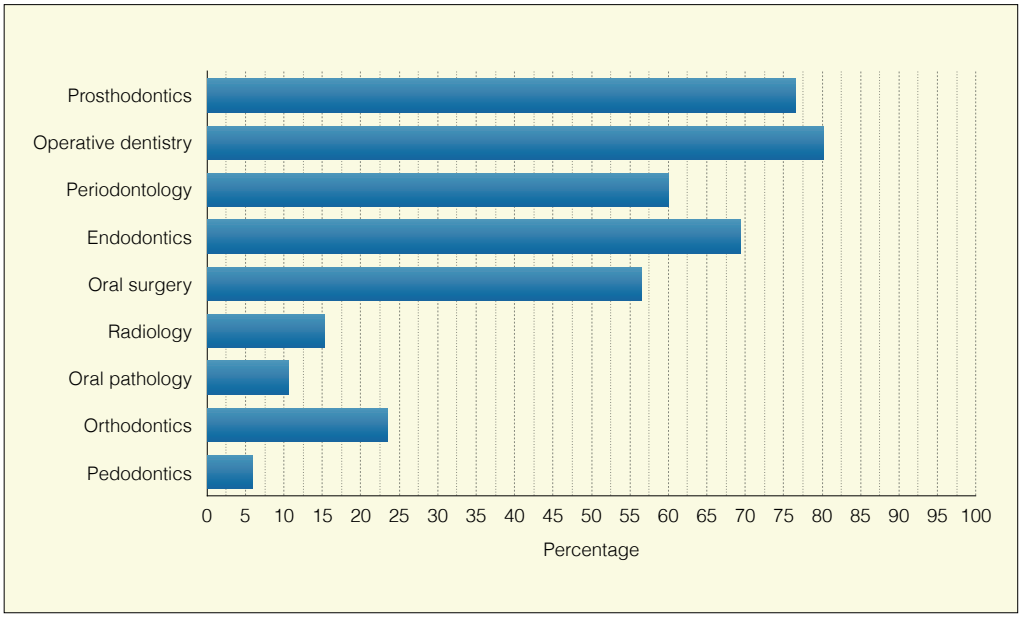
Out of 101 students, 89 (88.1%) responded to the questionnaire. All students had used YouTube™ at least once, and 82% had been using it for more than five years. Regarding usage frequency, 34.8% of students used YouTube™ weekly and 38.2% visited it daily. Although entertainment was the primary reason for using YouTube™ (74.2%), almost all students (93.3%) had used the platform for study purposes at least once. Additionally, 69.7% reported using YouTube™ often or very often to prepare for exams. Figure 1 illustrates responses to the question, "In which dental subjects do you feel that YouTube™ videos are most helpful?"
Further key results were:
- 80.9% of respondents believed that the level of evidence-based videos they watched for study purposes was average;
- 60.7% thought the content of YouTube™ videos was consistent with what was explained in class;
- 96.6% stated they would find it useful to

Table 1

Scoring system used to assess the educational value of the videos

Item	Score=0	Score=1
1 Global scientific soundness	The information conveyed is not aligned with current scientific knowledge	The information conveyed is aligned with current scientific knowledge
2 Commercial bias	The information conveyed has primarily commercial purposes	The information conveyed has not primarily commercial purposes (simply referencing market products does not automatically determine a commercial bias)
3 Quality of the clinical procedures	Clinical procedures are not shown OR the clinical procedures shown do not comply with current quality standards OR clinical procedures are not exhaustively described	The clinical procedures shown comply with current quality standards AND clinical procedures are exhaustively described
4 Audio and image quality	The image quality is poor OR text is not legible OR and the audio speech is not comprehensible	The image quality of the images is good AND text is legible AND and the audio speech is comprehensible
5 Comparison with other techniques	No reference is made to other techniques for the same purpose	The advantages and disadvantages of the technique are highlighted by comparing it to other techniques with the same purpose

Figure 1
Summary of the answers to the question "In which of the dental subjects do you feel that YouTubeTM videos can be most helpful?"



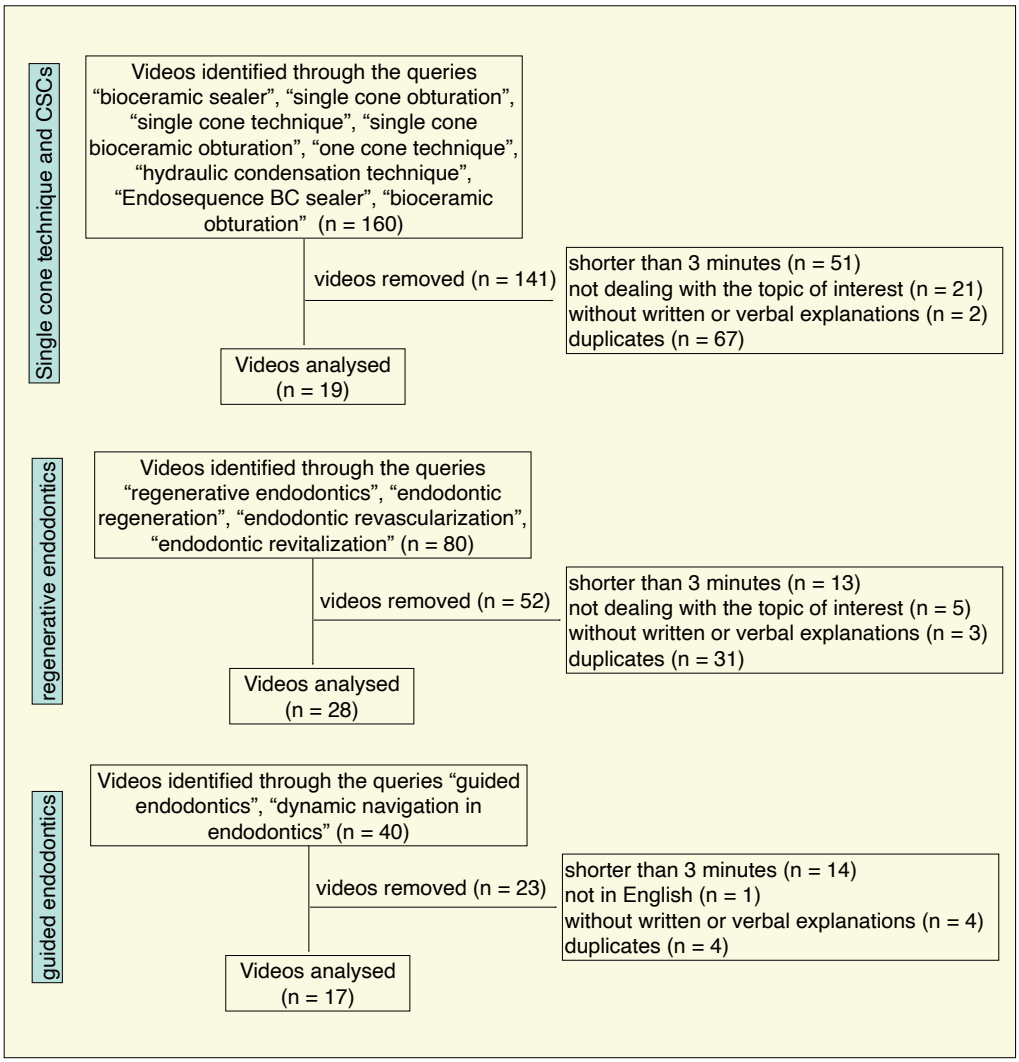


Figure 2
Flowchart of video selection.

Table 2

Modified version of the Global Quality Score

Score	Explanation
1	The video is of poor quality and content; the most important information does not appear. No or almost no utility for the students.
2	The video is of poor quality and content; some information appears, but some of the most relevant topics do not appear. Low utility for the students.
3	Moderate quality and fair fluency of content; some important information is adequately discussed, but others are less so. Average utility for the students.
4	Good quality and content; most of the relevant information is discussed, but some important topics are not. Useful for the students.
5	Excellent quality and content. Highly useful for the students.

watch videos before performing a clinical procedure for the first time.
The most-watched topics on YouTube™ included access cavity opening (75.8%), root canal shaping (64.5%) and root canal obturation (64.5%). Only 12.4% of students would not recommend using YouTube™ for endodontic procedures. Answers to questions regarding teacher usage were:
- 50.6% of students said a few teachers used YouTube™ videos in their lessons;
- 43.8% said some teachers used them;
- 61.8% reported that teachers sometimes recommended watching YouTube™ videos to learn more about topics;
- 31.5% said teachers never recommended them.
Despite this, 85.4% of students wanted teachers to upload educational content to YouTube™, 86.5% found the platform useful for learning, and 91% would recommend it to their classmates as a supplementary learning tool.

Video analysis

The video selection process is shown in Figure 2, and the main characteristics of the selected videos are summarized in Table 3. The longest video, titled "Pulp Revitalization-regeneration. Which one?", was uploaded on August 1st, 2021, by Dr. Hussain Al-Huwaizi from Iraq. It received 637 views. The top-viewed video, "Basic Hydraulic Condensation Technique", uploaded on September 27, 2013 by Dr. Allen Ali Nasseh (US), received 44,487 views and the most likes (n=765). A video titled "Can We Regenerate Our Teeth?" posted on the official channel of Meducator, a McMaster University's open-access, peer-reviewed undergraduate health sciences journal, had the highest view ratio of 97.7. Most of the videos (45 out of 64, 70.3%) were uploaded by private users and only two videos, both on "regenerative endodontics", were uploaded by academic institutions. There were significant differences in the number of views, likes, and view ratios across topics.
Key results of post hoc analysis revealed that:
-videos on "guided endodontics" had significantly fewer views and likes compared to other topics;
-videos on "single cone technique and CSCs" had a higher view ratio than those on "guided endodontics".
- a significantly higher percentage of videos on the "single cone technique and CSCs" topic were uploaded by companies (47.4%) compared to "regenerative endodontics" (14.3%).
Videos were uploaded from 12 countries, with the largest contributors being United States (26.6%), United Kingdom (18.7%), and India (18.7%). The country of origin could not be determined for two videos.
The average total score, based on a 5-item scoring system, was the same across all three topics (3.8/5). However, there were significant differences between topics for two specific items. Videos on "single cone technique and CSCs" were more likely to have primarily commercial purposes compared to "regenerative endodontics" videos and videos on "regenerative endodontics" were more likely to show clinical procedures that did not comply with current quality standards compared to "single cone technique and CSCs" videos. No videos scored 1 or 2 on the modified Global Quality Score (Table 5). Most were rated as useful for students, and there were no significant differences in usefulness among the topics.

Table 3

Characteristics of the selected videos

	single cone technique and CSC (n=19)	regenerative endodontics (n=28)	guided endodontics (n=17)	P
video lenght (s)	532 (287-830)	626,5 (276,5-1336)	657 s (470-2301)	0,511
Days since upload	1.096 (800-1747)	1.198 (794,5-1714)	827 (335-1228)	0,184
Number of views	6.535 (3138-16807)	3592,5 (1901-8961,5)	1.143 (424-1917)*†	0,001
Number of likes	175 (54-255)	127,5 (38,5-239)	16 (11-48)*†	<0,001
view rate	6,5 (3,0-9,8)	3,2 (1,2-5,6)	2.3 (0,9-4,5)*	0,046

*All data are reported as median (IQR) - *= Significant vs single cone technique - †= Significant vs regenerative endodontics*

Table 4

Results of the 5-items educational value scoring system

	Single cone technique and CSC (n=19)	Regenerative endodontics (n=28)	Guided endodontics (n=17)	P
1 Global scientific soundness	100%	100%	100%	1
2 Commercial bias	68%	100%*	88%	0,006
3 Quality of the clinical procedures	84%	46%*	76%	0,034
4 Audio and graphical quality	89%	89%	76%	0,968
5 Comparison with other techniques	47%	50%	41%	0,903

*The numbers refer to the percentages of score 1 assignments. *=significant vs single cone technique.*

Discussion

Endodontics, as a specialty, is one of the dental disciplines that causes the most stress among students (16). This is due to its inherent complexities and the technical precision required for successful outcomes. Additionally, it is the only dental discipline where many procedural interventions are performed "in the dark," because once the operator enters the root canal system, he cannot "see" and "do" simultaneously (17). Furthermore, what little the operator can see within the pulp chamber is even less visible to a student observing the treatment, unless an operating microscope connected to a monitor is used. For these reasons, videos of endodontic pro-

Table 5

Results of modified Global Quality Score

Score	Single cone technique and CSC (n=19)	Regenerative endodontics (n=31)	Guided endodontics (n=17)	P
1	0%	0%	0%	NA
2	0%	0%	0%	NA
3	21%	32%	29%	0,503
4	53%	57%	41%	
5	26%	11%	29%	

The numbers refer to the percentages of score assignments. NA=not available.

cedures could be highly effective for learning. The widespread accessibility of video platforms has made it easy and immediate to access a vast array of learning resources. However, this has also quickly raised the issue of misinformation, because of the dissemination of online videos where the content is not subjected to rigorous review (18). In this context, the present study aimed, for the first time, to explore how dental students from an Italian dental school utilize YouTube™, specifically in the field of endodontics, and to evaluate the quality of videos related to three emergent topics in endodontics.

Our survey corroborated results from other studies investigating the use of YouTube™ by dental students (19-21). While YouTube™ was primarily used for entertainment, nearly all respondents reported using it for educational purposes, finding it particularly useful for operative dentistry, prosthodontics, and endodontics. A similar trend was observed among students from five American universities (New York University, University of Texas Health Science Center, Tufts Health Sciences, Roseman University of Health Sciences, and Western University of Health Sciences), where a comparable survey was conducted (20). These disciplines are often introduced early in the undergraduate curriculum, when students have limited clinical experience. To compensate, students frequently turned to online videos for supplementary learning. Interestingly, although students recognized that online videos might not meet high-quality standards or fully align with their formal education, they still considered them useful for gaining indirect experience before performing clinical procedures. However, it is important to note that while students widely used YouTube™, its integration into formal teaching remained limited. Only a minority of teachers supplemented their lessons with YouTube™ videos or recommend specific content to students. One suggestion from students, which the authors endorse, is that teachers should create and upload educational videos to YouTube™ to complement their lessons. While this would require efforts, including obtaining necessary permissions to avoid privacy violations, the potential benefits are significant (22). First, this would ensure that the content is high-quality and consistent with the curriculum and clinical environment of the school. Additionally, any uncertainties about the video content could be directly addressed with the teacher, fostering interactive learning. Furthermore, the video repository could expand over time, providing up-to-date resources for future students. While several dental schools have already established official YouTube™ channels, many institutions have yet to capitalize on this valuable opportunity. To bridge this gap, it would be advantageous for institutional bodies

to actively promote and financially support the development of high-quality YouTube™ channels.

In the second part of our study, we evaluated the educational value of YouTube™ videos. We considered three current hot topics in endodontics: "single cone technique and CSCs," "regenerative endodontics," and "guided endodontics". These three topics were selected due to their innovative nature, high clinical relevance, and their potential to shape future clinical practices (23). However, like many innovations, they have not yet been fully integrated into undergraduate curricula (11) which may lead students to seek additional information through online platforms. The single cone obturation technique, though long established, has gained renewed attention with the introduction of bioceramic cements. These materials offer several advantages over traditional cements, such as improved biocompatibility, superior sealing ability, and strong antibacterial effects (24). Regenerative endodontics presents an alternative to conventional apexification techniques for treating pulp necrosis in immature teeth. This biologically-based treatment promotes not only the resolution of symptoms but also continued root development, reducing the risk of root fracture (25). Guided endodontics, which adapts technologies from implant surgery, is particularly useful for locating severely calcified canals and performing precise endodontic surgery. This technique relies on physical templates or dynamic navigation systems based on three-dimensional imaging (26).

Videos on the single cone technique and CSCs garnered more views, likes, and higher view rates compared to the other two topics. This popularity may be attributed to the technique's simplicity, speed, and the growing interest in bioceramic cements. Moreover, root canal filling is a routine procedure, attracting a wide audience. In contrast, the other two topics, while clinically significant, are applicable to a narrower range of cases, which may explain the lower engagement. Notably, videos on the single cone technique and CSCs showed differences from the other two categories in terms of two variables: the percentage of videos uploaded by commercial entities and the percentage of videos that received a score of 0 for item 2 in our scoring system. A score of 0 was given when the primary intent of the video appeared to be commercial rather than educational. The bioceramic cement market has seen a surge in commercial interest, leading manufacturers to promote their products aggressively through various channels, including YouTube™.

As YouTube™ is widely used by both dental students and practitioners (20, 27), it is unsurprising that companies leverage this platform for promotional purposes. While commercial bias did not necessarily affect the overall scientific accuracy of the videos (item 1), it is important for viewers to be aware of this bias and exercise critical judgment when interpreting the content. For videos on "regenerative endodontics," over half received a score of 0 for item 3, which evaluates the quality of clinical procedures. Upon further investigation, we found that most of these videos originated from the US and UK, contrary to our initial assumption that lower-quality videos might come from regions with less developed dental standards. According to item 5 of our scoring system, watching a single video is typically insufficient for gaining a comprehensive understanding of a particular technique. Viewers are encouraged to watch multiple videos on alternative approaches to develop a more balanced perspective on the pros and cons of different methods. The modified Global Quality Score did not reveal any significant differences in quality among the three topics. Overall, the videos were of good quality, though some key aspects were omitted, even when most of the essential information was covered.

Our findings contrasted with those of other studies that assessed the quality of YouTubeTM videos on different endodontic topics. Falakaloğlu et al., evaluating 108 videos on root canal preparation, assigned a "poor quality" score to 63% of the videos (8). Kodonas et al.'s assessment of videos on pulpotomy and pulp capping was even more negative. According to their

analysis, most videos (85%) were classified as "poor" or "generally poor" in educational quality (10). Kaval et al. analyzed 60 videos on regenerative endodontic treatment procedures and assigned a lower average GQS score compared to our study (2.8±1.3 vs. 3.8±0.7) (28).
These discrepancies can be attributed not only to the different video selections but also to the inherent subjectivity of the scoring system used. Results more similar to ours were reported by Jamleh et al., who assessed the educational value of YouTubeTM videos on endodontic access cavity preparation. They found that most videos (70.7%) received a rating of "moderate to good" usefulness (9). On the other hand, our results are strongly consistent with the opinions of the interviewed students, who reported that YouTubeTM videos generally provided a valuable educational resource.
Most authors agree that, albeit the use of non-curricular resources like YouTube™ is beneficial for reinforcing learned concepts, exploring specialized topics, and fostering self-directed learning (29), these sources lack rigorous oversight. Consequently, they can disseminate inaccurate or incomplete information, which poses risks to the professional development of future dentists (8-10, 30). Addressing this issue is challenging. Effective educators must equip students with critical thinking skills, enabling them to discern valuable content from misinformation. Given the increasing reliance on non-curricular sources, it is imperative that educators prioritize the development of these skills in their students.

Conclusions

YouTube™ videos currently represent an important auxiliary learning source for dental students. However, due to the lack of content oversight, there is a risk of misleading or biased information being disseminated. To mitigate this potential threat to dental student learning, educators should curate a selection of reliable videos to share with students or recommend specific channels/broadcasters known for their accuracy and quality.

Clinical Relevance

Given the widespread student use of freely available video content for learning and the risk of exposure to misleading information, teachers should instruct students in the critical appraisal of contemporary media resources.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be considered as a potential conflict of interest.

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