

Online Teaching Tool for Sinus Surgery: Trends toward Mobile and Global Education

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Abstract

Objective. Online resources may provide an ideal forum for expert presentation of surgical techniques. The purpose of this study was to investigate utilization patterns of a sinus surgery website, SinusVideos.com, to gain insight into the needs of viewers.

Study Design. Retrospective analysis.

Setting. Surgical teaching website.

Subjects and Methods. The website's anonymized analytic database was queried from 2009 to 2014. Quantified data included user demographics, geographic location, viewing device, page visits, and time spent on the website.

Results. A total of 428,691 website pages were viewed during the study period. Growth in viewership was observed each successive year since the site was launched. The mean time spent viewing webpages was 96.1 seconds for desktop computer users, 98.0 for tablet users, and 103.8 for mobile users. The percentage of mobile devices used to view the site increased significantly between 2009 and 2014 (2.1% vs 25.4%, respectively; $P < .0001$). The website's viewership expanded globally, with a significant increase in site views from outside North America over this same period (18.4% vs 51.7%, $P < .0001$).

Conclusion. The observed increase in global participation and mobile device usage may reflect new areas of growth for surgical education.

Keywords

distance learning, self-evaluation, medical education, surgical education, otolaryngology education, online education, e-learning, mobile technologies, sinus surgery, sinus videos, surgical procedures

Traditionally, surgical trainees learned via an “apprenticeship model,” which was based on acquiring technical and clinical decision-making skills in the setting of an operating room. Education came primarily from firsthand experience, supplemented by didactics and textbook learning. Until the 1980s, this apprenticeship model remained largely unchanged.¹ With evolution of duty hour restrictions and the move to more minimally invasive surgical approaches, however, surgical training has begun to include more learner-centered models of education.² Thus, the apprenticeship model of learning has been augmented by the introduction of new educational modalities and innovative technologies.^{3,4} These new resources may be utilized beyond the duration of formal surgical residency and fellowship training.

Innovative technologies serve to supplement learner-centered education models by allowing students to participate in self-regulated learning (SRL). SRL is a constructive process wherein students autonomously monitor and control their behavior to attain learning goals.⁵ Rather than taking a passive stance, as with teacher-guided learning, students are expected to become accountable for their own education. Students who successfully participate in SRL are motivated and have a sense of self-efficacy that they can succeed at learning a specific skill; they also effectively use learning

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strategies, such as resource management (eg, finding useful teaching resources, seeking help, managing time).⁵ Turan et al found that SRL correlated with higher objective structured clinical examination scores.⁵ According to the literature on SRL, most students need to be instructed and supported while developing their ability to self-assess the efficacy of their learning.⁶ For physicians, SRL begins during undergraduate education and enables greater success during medical school.⁷ In clinical practice, SRL is necessary for physicians, as they gradually accept increased responsibility for their continual medical education during formal training and after it is completed.

Electronic learning (e-learning) may serve as a medical education resource by augmenting SRL. E-learning can be defined as the use of Internet technologies to enhance knowledge and performance.⁸ While textbooks and journal articles remain a traditional part of surgical education during and after training, they are now accessed from smartphones, tablets, and computers at a continuously increasing rate.⁹ Mobile devices are also being utilized on the medical wards for clinical purposes. Trainees regularly utilize the Internet to query search engines, access medical apps, and view videos of procedures.¹⁰ Transmission of digital video over the Internet allows surgical trainees to gain experience in real time without being present in the room in which the procedure is being performed.¹¹ Expert-level sites are now available that provide high-quality instructive videos for surgical trainees. One such example is SinusVideos.com, a website that publishes video footage of endoscopic sinus surgery, ranging from basic to advanced procedures. The edited videos are narrated by expert sinus surgeons, and relevant literature is provided alongside the videos for reference. This website therefore provides a platform for the presentation of surgical procedures for a variety of trainees, as well as those in clinical practice.

While the growth of the Internet and the diversification of viewing devices are well known, there are sparse data on how these changes affect otolaryngology or how we should think about online teaching resources for surgeons, patients, or the public. Basic data about a successful video content website as presented here serve as an initial pilot study on how these resources are utilized. The purpose of this study was to investigate the utilization patterns of SinusVideos.com during its first 5 years of usage to gain insight into the contemporary pattern of e-learning for surgery in general and sinus surgery techniques in particular for a broad audience.

Methods

Website Description

SinusVideos.com hosts videos of sinus surgery that are recorded in the operating room, edited for highlights, and narrated. The videos are assigned to ≥ 1 of 19 available categories based on their anatomic region and/or technique. Examples of video categories include maxillary sinus, cerebrospinal leak repair, basic sinus surgery, and balloon

sinuplasty. The website is strictly educational in purpose and receives no outside funding or commercial support. It was launched by the senior author (R.M.) and his fellows in October 2009, and it continues to be maintained by them. It generates no income, and none of the authors receive any financial resources from its operation. The study was approved for exemption by the Massachusetts Eye and Ear Infirmary Institutional Review Board (protocol 15-064H).

Website Analysis

The website's anonymized analytic database was queried via Google Analytics for the first 5 years since its launch (October 2009 to December 2014). For the purposes of this study, the analysis was limited to sessions, which can be defined as a visit to the website wherein multiple pages are viewed.¹² A session terminates following ≥ 30 minutes of inactivity. Visits to the website where only a single page was viewed were excluded to remove accidental visits from the study. Quantified data included user location, viewing device, page visits, and duration spent on the website.

Google Analytics records all visits to a website based on a single time zone regardless of the location from which the website was accessed.¹³ For the purposes of this study, the hour and day analysis was limited to the United States in eastern standard time. All other figures and graphs were generated according to the total international audience. Viewing devices were categorized into 3 groups: desktop, tablet, and mobile. Desktop included both laptop and desktop computers. Tablet tracking in Google Analytics did not exist until late 2011.¹⁴ Mobile tracking included all other devices.

Statistical Analysis

Descriptive analysis was performed to characterize user analytics. Proportions were compared with 2-tailed chi-square test. Significance was defined as an alpha threshold < 0.05 .

Results

Website Usage

SinusVideos.com currently hosts 99 videos of sinus surgery; the number of videos has increased over time. The average video duration is 156.1 seconds. A total of 428,691 webpages were viewed over 59,284 sessions during the 5-year study period. On average, 7.2 pages were visited per session. Users spent an average of 97.3 seconds viewing each page. A growth in viewership was observed each successive year since the site was launched in 2009 (**Figure 1**). Mobile device usage increased significantly between 2009 and 2014, from 19 to 4065 sessions per year ($P < .0001$). Desktop computer usage peaked in 2012 with 11,118 sessions, then declined in 2013 and 2014, with 10,455 and 9,540 sessions, respectively ($P < .0001$). The 5 most-viewed videos were "Basic Endoscopic Sinus Surgery" (22,722 views), "Endoscopic Sinus Surgery Basics, Part 1 of 2" (11,509 views), "Balloon Frontal Sinuplasty" (10,997 views), "Fungal Ball in the Sphenoid Sinus" (10,334

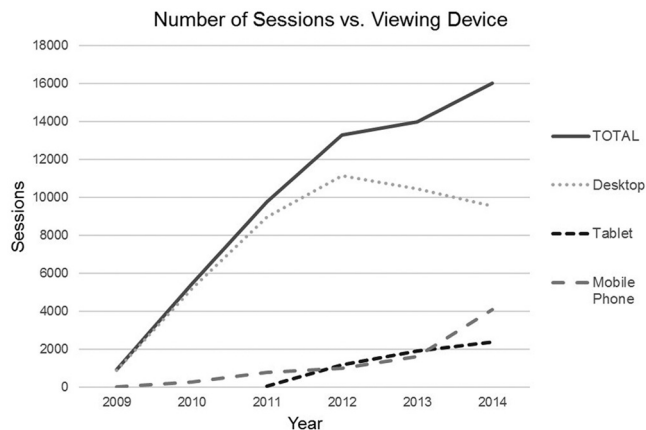


Figure 1. Number of sessions on SinusVideo.com per year according to viewing device. Over the 5-year study period (2009-2014), viewership with tablet and mobile devices increased, while use of desktop computers peaked in 2012 before decreasing.

views), and “Endoscopic Sinus Surgery Basics, Part 2 of 2” (8644 views).

User Activity

During the 5-year study period, the average session duration was 636.1 seconds for desktop usage, 609.2 for tablets, and 404.4 for mobile. The mean number of pages visited per session was 7.6 for desktop, 7.2 for tablet users, and 4.9 for mobile. The mean time spent viewing webpages was 96.1 seconds for desktop computer users, 98.0 for tablet users, and 103.8 for mobile users (Figure 2). Mobile users spent a longer time viewing individual videos than tablet or desktop users. Desktop and tablet users accessed more videos per session than those using mobile devices.

Location Trends

Viewership increased annually on all 5 continents during the 5-year study period (Figure 3). There was a significant increase in sessions outside North America between 2009 and 2014 (18.4% in 2009 vs 51.7% in 2014, $P < .0001$). When ranked according to country viewership, the United States (47.4%) had the most views (Table 1). The United States was followed by India (7.2%), United Kingdom (2.9%), Turkey (2.4%), and Canada (2.2%). Over the 5-year study period, viewers from 185 countries accessed the website.

Day and Hour Metrics in the United States

During the 5-year study period, 199,822 webpages were viewed over 28,089 sessions in the United States. Mobile and tablet sessions constituted 11.8% and 10.1%, respectively, of the total traffic in the United States. Mean total usage for the week was at its highest on Tuesday and lowest on Friday, Saturday, and Sunday. Total usage increased steadily from the early morning at 0400 until a peak at 2100 eastern standard time. Desktop usage increased at a greater rate than tablet and mobile during business hours and then

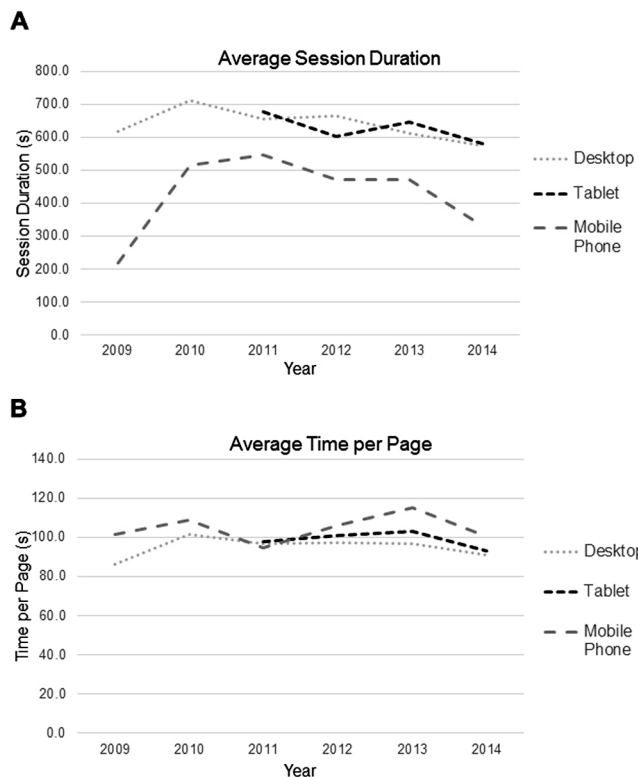


Figure 2. User activity by device type. Mean session duration has remained longer for those using a desktop computer or tablet to view the website (A); however, the mean time spent viewing individual pages is greatest for mobile phone users (B).

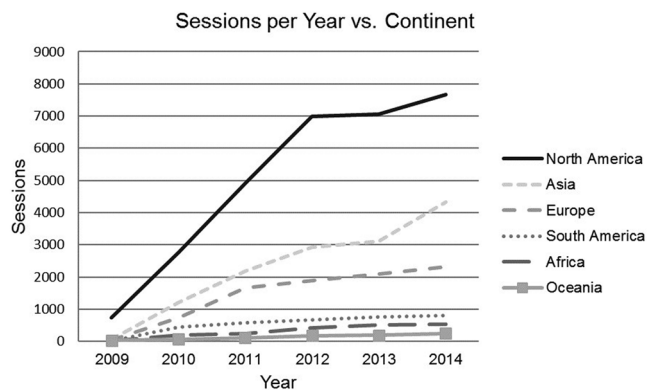


Figure 3. Sessions per year grouped by continent. A significant increase in viewership from outside North America was observed between 2009 and 2014 (18.4 vs 51.7%).

declined slightly between 1500 to 1800. Mobile usage increased significantly between 0400 and 0900 and then remained relatively constant during the hours of 0900 and 1800. Mobile usage peaked at 2200.

Discussion

Reviewing the utilization patterns for the first 5 years of the website SinusVideos.com gives insight into the evolving role of e-learning in the field of otolaryngology in general and

Table 1. Top 10 Countries with the Highest Number of Sessions Viewed per Year on SinusVideos.com.^a

Rank	Country	Sessions per Year, n (%) ^b		
		2009-2010 ^c	2014	2009-2014
1	United States	2417 (55.7)	7122 (44.5)	28,087 (47.4)
2	India	354 (8.2)	1467 (9.2)	4248 (7.2)
3	United Kingdom	105 (2.4)	446 (2.8)	1693 (2.9)
4	Turkey	78 (1.8)	317 (2.0)	1408 (2.4)
5	Canada	99 (2.3)	327 (2.1)	1284 (2.2)
6	Brazil	50 (1.2)	266 (1.7)	1256 (2.1)
7	Vietnam	12 (0.3)	556 (3.5)	1151 (1.9)
8	Mexico	47 (1.1)	210 (1.3)	744 (1.3)
9	Russia	97 (2.2)	153 (1.0)	671 (1.1)
10	Australia	49 (1.1)	205 (1.3)	669 (1.1)

^aCountries are ranked in descending order by total sessions, 2009-2014.

^bPercentage is based on total sessions.

^cIncludes the first 12 months of data (October 1, 2009 to September 30, 2010).

sinus surgery specifically. A marked growth in viewership has been observed each successive year since the site was launched in 2009. Individuals who access the website on their desktop computers were found to view more videos per session than those using a tablet or phone. Mobile users, however, spent a longer time viewing individual videos. These findings may reflect differences in time to load and navigate videos among the various viewing platforms, particularly in countries where viewers rely primarily on cellular data for Internet use.¹⁵ While this study did not investigate the roles of different classes of viewers (eg, surgical trainees, practicing surgeons, or the general public), it did demonstrate a strong and consistent growth in the utilization of this type of education resource across a broad viewership.

Studies have shown that medical trainees respond well to novel teaching methods emphasizing multimedia and technology.^{16,17} A recent study showed that 95% of general surgery trainees surveyed used surgical videos for preparation, with YouTube as the most commonly viewed site.¹⁸ In a survey of members of the American Academy of Facial Plastic and Reconstructive Surgeons, 64% of respondents had used surgical videos at least once to learn a new technique, 84% of whom put that technique into practice.¹⁹

Our study showed continuously increasing usage of tablets and mobile devices. Desktop usage increased from 2009 to 2012 but then declined in 2013 and 2014. Meanwhile, total usage increased continuously over all 5 years. This finding is consistent with survey data showing that the majority of residents and faculty use smartphones, tablets, or both in clinical practice.^{20,21} Peak usage of SinusVideos.com occurred on weekdays during hours when people are most commonly working in the United States.

Comparison with other websites is challenging given the unique nature of each teaching or video website and the reality that unsuccessful sites close over time or are not found with search engines, whereas popular sites are more easily found over time. The massive and popular video content site

YouTube.com had >22 billion viewers in the first 6 months of 2017.²² The top 5 countries for visits to YouTube.com are the United States, Russia, Brazil, the United Kingdom, and India,²² as compared with the top 5 countries for SinusVideos.com—the United States, India, the United Kingdom, Turkey, and Canada. On YouTube.com, average viewing time per page was just under 2 minutes,²² consistent with our findings in this study.

Online usage data collected in this study can be used to improve educational content development for surgical websites. The observed increase in usage of mobile devices to view videos reflects societal trends and behavior. Although most users viewed 5 to 8 pages on the website, the average time spent viewing videos was <2 minutes. These viewing habits suggest the importance of brevity for such online educational content. They also indicate that the length of many videos currently on the website could be modified to highlight key steps of the procedures in a shorter period.

The widespread dissemination of surgical videos has had a global impact in medicine. In addition to the increase in viewership within the United States observed in our study, there was a significant growth in site views from outside North America. India had the second-largest number of sessions of all countries, followed by the United Kingdom, Turkey, Canada, Brazil, and Vietnam. These findings reflect the increasing availability and utilization of online education shared by physicians in low-, middle-, and high-income countries.^{15,23} The growth in international viewership may facilitate the spread of surgical education materials in resource-limited regions of the world.²⁴

The Internet removes geographic boundaries, thereby allowing for the global sharing of knowledge and research collaboration. This model has resulted in rapid incorporation of web-based educational tools into surgical training and practice.³ One of the results of this new educational format can be seen in the standardization of surgical training both nationally and abroad. Implementation of new Internet-

based educational tools, however, necessitates a formal assessment of such tools. A potential downside to the increase in global viewership is the potential implication for patient safety. Viewing an online video of a surgical procedure may give providers a false sense of security in their ability to perform the procedure. Online education should therefore always be supplemented by in-person training. Future studies are needed that utilize survey data to investigate the perceived utility of online videos for sinus surgery.

An additional limitation associated with SRL and online education is that learners find it difficult to accurately self-assess their current skill levels.² Learners are capable, however, of accurately identifying when their skills do not improve during computer-based video training.⁴ To address this challenge, online instruction needs to be supplemented with interaction with a live instructor. Teleconferencing is helping to break down some potential barriers by providing assistance to students in real time.^{2,5} Ideally, in-person training should be made available to online learners to assist them in the SRL process.

A major weakness of this study design is that it did not specifically query the affiliations or roles of the viewers; it is therefore not possible to determine if viewers were students, surgical trainees, attending surgeons, other clinicians, patients, or the general public. Further study is needed to determine the educational needs and utilization patterns of each specific user base (ie, surgical trainees, attending surgeons, patients, the public). In addition, the study analysis was limited to only those visits to the website wherein multiple pages were viewed. This method avoided inclusion of accidental visits to the site but also excluded intentional visits to the website wherein only a single page was viewed. For example, returning visitors who have the link to a video saved and only view that single video would be excluded. In addition, Google Analytics did not begin differentiating mobile and tablet data until November 2011.¹⁴ Prior to that time, tablet and smartphone traffic were grouped as mobile.

Conclusion

There has been a steady growth in the viewership of online videos related to the performance of sinus surgery. The observed increase in global participation and mobile device usage may reflect new areas of interest for surgical education.

Author Contributions

George K. Koch, study design and conduct; collection, analysis, and interpretation of the data; and writing/approval of the manuscript; **Rosh K. V. Sethi**, study design and conduct; collection, analysis, and interpretation of the data; writing/approval of the manuscript; **Elliott D. Kozin**, study design and conduct; collection, analysis, and interpretation of the data; and writing/approval of the manuscript; **Regan W. Bergmark**, analysis and interpretation of the data; and writing and approval of the manuscript; **Stacey T. Gray**, study design and conduct; analysis, and interpretation of the data; and writing and approval of the manuscript; **Ralph Metson**, study design and conduct; collection, analysis, and interpretation of the data; and writing/approval of the manuscript.

Disclosures

Competing interests: The website investigated in this article, SinusVideos.com, is developed and maintained by the senior author (R.M.) and contributed to by his fellows and colleagues. The site does not receive any outside funding, nor does it generate any income from its operation.

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