ORIGINAL ARTICLE

GIFs vs Pictures in 'How to Use a Slit Lamp' Teaching: Comparing Medical Student Perception

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Background: Videos have been shown to improve learning outcomes, satisfaction and grab learners' attention for medical education. The aim of this study was to look at whether replacing static images with short, looped videos (home-made GIFs) in a presentation on 'How to Use a Slit Lamp' aided learning and engagement for medical students.

Method: In this mixed-method crossover study two presentations were created, one with GIFs and one with images showing how to use a slit lamp. Forty medical students participated with 20 watching each presentation. Students were assessed quantitatively by a 13-task slit lamp assessment immediately after watching the presentation. Students then crossed over and watched the other presentation. They were asked to complete a qualitative survey and participate in a short group discussion regarding their perceptions of enjoyment, learning, engagement and clarity of each presentation. Thematic analysis was conducted on the responses.

Results: Our results indicated that all students performed better or the same when watching the GIF presentation versus image presentation for the 13-task assessment. The students unanimously agreed that the presentation with GIFs was more engaging and increased their learning compared to the presentation with images alone.

Conclusion: Incorporating GIFs into presentations is a quick and cheap method that increases short term recall, is engaging and aids learning.

Keywords: Ophthalmology, Medical education, Undergraduate

صور GIF مقابل الصور في تدريس "كيفية استخدام المصباح الشقي": مقارنة تصورات طلاب الطب

الخلفية: ثبت أن مقاطع الفيديو تعمل على تحسين نتائج التعلم والرضا وجذب انتباه المتعلمين للتعليم الطبي. كان الهدف من هذه الدراسة هو النظر في ما إذا كان استبدال الصور الثابتة بمقاطع فيديو قصيرة ومتكررة (صور GIF محلية الصنع) في عرض تقديمي حول "كيفية استخدام المصباح الشقي" يساعد في التعلم والمشاركة لطلاب الطب.

الطريقة: في هذه الدراسة المتقاطعة ذات الأساليب المختلطة، تم إنشاء عرضين تقديميين، أحدهما يحتوي على صور GIF والآخر يحتوي على صور توضح كيفية استخدام المصباح الشقي. شارك في المؤتمر 40 طالبًا من طلاب الطب، وشاهد 20 منهم كل عرض تقديمي. تم تقييم الطلاب كميًا من خلال تقييم المصباح الشقي المكون من 13 مهمة مباشرة بعد مشاهدة العرض التقديمي. ثم عبر الطلاب وشاهدوا العرض التقديمي الآخر. وقد طُلب منهم إكمال استبيان نوعي والمشاركة في مناقشة جماعية قصيرة بشأن تصوراتهم حول الاستمتاع والتعلم والمشاركة والوضوح في كل عرض تقديمي. تم إجراء التحليل المواضيعي على الردود.

النتائج: أشارت نتائجنا إلى أن أداء جميع الطلاب كان أفضل أو متماثلًا عند مشاهدة العرض التقديمي بتنسيق GIF مقارنة بعرض الصور في التقييم المكون من 13 مهمة. اتفق الطلاب بالإجماع على أن العرض التقديمي باستخدام صور GIF كان أكثر جاذبية وزاد من تعلمهم مقارنةً بالعرض التقديمي باستخدام الصور وحدها.

الاستنتاج: يعد دمج صور GIF في العروض التقديمية طريقة سريعة ورخيصة تزيد من التذكر على المدى القصير، كما أنها جذابة وتساعد على التعلم.

الكلمات المفتاحية: طب العيون، التعليم الطبي، المرحلة الجامعية

GIFs بمقابلہ تصویریں 'سلٹ لیمپ کا استعمال کیسے کریں' کی تعلیم: میڈیکل اسٹوڈنٹ کے تاثرات کا موازنہ

پس منظر: سیکھنے کے نتائج، اطمینان اور طبی تعلیم کے لیے سیکھنے والوں کی توجہ حاصل کرنے کے لیے ویڈیوز دکھائے گئے ہیں۔ اس مطالعے کا مقصد یہ دیکھنا تھا کہ آیا میڈیکل کے طلباء کے لیے 'سلٹ لیمپ کا استعمال کیسے کریں' پر ایک پریزنٹیشن میں جامد تصاویر کو مختصر، لوپڈ ویڈیوز (گھریلو ساختہ GIFs) سے بدلنا ہے یا نہیں؟

طریقہ: اس مخلوط طریقے کے کراس اوور اسٹڈی میں دو پریزنٹیشنز تخلیق کی گئیں، ایک GIFs کے ساتھ اور ایک تصویروں کے ساتھ جس میں دکھایا گیا ہے کہ سلٹ لیمپ کو کیسے استعمال کیا جائے۔ 40 میڈیکل طلباء نے حصہ لیا جس میں 20 نے ہر پریزنٹیشن کو دیکھا۔ پریزنٹیشن دیکھنے کے فوراً بعد 13 ٹاسک سلٹ لیمپ اسسمنٹ کے ذریعے طلبہ کا مقداری اندازہ لگایا گیا۔ اس کے بعد طلباء نے پار کیا اور دوسری پریزنٹیشن دیکھی۔ ان سے کہا گیا کہ وہ ایک معیاری سروے مکمل کریں اور لطف اندوزی، سیکھنے، مشغولیت اور ہر پریزنٹیشن کی وضاحت کے بارے میں ایک مختصر گروپ ڈسکشن میں حصہ لیں۔ جوابات پر موضوعاتی تجزیہ کیا گیا۔

نتائج: ہمارے نتائج نے اشارہ کیا کہ تمام طلباء نے 13-ٹاسک اسسمنٹ کے لیے GIF پریزنٹیشن بمقابلہ تصویری پیشکش دیکھتے وقت بہتر یا یکساں کارکردگی کا مظاہرہ کیا۔ طلباء نے متفقہ طور پر اس بات پر اتفاق کیا کہ GIFs کے ساتھ پریزنٹیشن زیادہ دلفریب تھی اور صرف تصاویر والی پریزنٹیشن کے مقابلے ان کی تعلیم میں اضافہ ہوا۔

نتیجہ: پریزنٹیشنز میں GIFs کو شامل کرنا ایک تیز اور سستا طریقہ ہے جو قلیل مدتی یاد کو بڑھاتا ہے، دلکش ہے اور سیکھنے میں مدد کرتا ہے۔

مطلوبہ الفاظ: امراض چشم، طبی تعلیم، انڈرگریجویٹ

مقایسه گیف با تصاویر در آموزش "چگونگی استفاده از اسلیت لامپ ": مقایسه درک دانشجویان پزشکی

زمینه و هدف: نشان داده شده که ویدئوهای آموزشی، نتایج یادگیری، رضایت و جلب توجه فراگیران را برای آموزش پزشکی بهبود می بخشد. هدف از این مطالعه بررسی این موضوع بود که آیا جایگزینی تصاویر ثابت با ویدیوهای کوتاه و حلقه‌دار (گیف های خانگی) در ارائه‌ای در مورد «نحوه استفاده از اسلیت لامپ » به یادگیری و تعامل دانشجویان پزشکی کمک می‌کند یا خیر.

روش: در این مطالعه ترکیبی متقاطع، دو شکل ارائه به نمایش درآمد، یکی با گیف و دیگری با تصاویری که نحوه استفاده از اسلیت لامپ را نشان می‌داد. چهل دانشجوی پزشکی با 20 بار تماشا برای هر مدل ارائه، شرکت کردند. دانشجویان بلافاصله پس از تماشای هر مدل ارائه، به صورت کمی ارزیابی شدند. سپس دانشجویان از کنار آن مدل عبور و ارائه دیگر را تماشا کردند. از آنها خواسته شد تا یک نظرسنجی کیفی را تکمیل کنند و در یک بحث گروهی کوتاه در مورد درک خود از لذت، یادگیری، مشارکت و وضوح هر ارائه شرکت کنند. تحلیل موضوعی بر روی پاسخ ها انجام شد.

یافته ها: نتایج نشان داد که همه دانشجویان هنگام تماشای ارائه گیف در مقایسه با ارائه تصویر برای ارزیابی 13 وظیفه‌ای بهتر یا یکسان عمل کردند. دانشجویان به اتفاق آرا موافق بودند که ارائه با گیف جذاب تر بود و یادگیری آنها را در مقایسه با ارائه ی تنها با تصاویر، افزایش داد.

نتیجه گیری: گنجاندن فایل های گیف در ارائه ها روشی سریع و ارزان است که یادآوری کوتاه مدت را افزایش می دهد، جذاب است و به یادگیری کمک می کند.

واژه های کلیدی: چشم پزشکی، آموزش پزشکی، دوره کارشناسی

INTRODUCTION

Video has been shown to improve learning outcomes as well as satisfaction (1). Additionally, it can grab the learner's attention, increase memory of content, focus concentration and foster deeper learning (2). When compared against written materials, videos are more effective for teaching (3). Short, looped videos can be incorporated into PowerPoint presentations as an alternative to pictures. Particular file formats are easier to incorporate than others such as Graphic Interchange Format (GIF).

GIF is a file type created in 1987 and was one of the first image files to be widely used on the internet (4). Animated GIFs have gained increasing popularity in social media. These short, looped videos are easy to create and can be embedded straight into presentations without requiring a codec unlike video files; MPEG® (Motion Picture Experts Group), AVI® (Microsoft) and Quicktime® (Apple) (5).

We decided to see if using short, looped videos in the GIF format incorporated into a presentation aided learning, enjoyment and clarity of learning compared to the same presentation using static pictures for teaching how to use a slit lamp. To our knowledge there is no literature that has looked at GIFs incorporated into presentations as a resource for medical teaching.

METHODS

The study design was a mixed-methods crossover using both quantitative and qualitative data. A 5-minute presentation on how to use a slit lamp was created and pictures were used within the presentation to highlight instructions and aid in the various anatomy of a slit lamp (figure 1).

Figure 1. Photograph of Slit Lamp

The presentation covered 13 instructional tasks on 'How to Use a Slit Lamp'. The same presentation was duplicated, and the pictures were replaced with GIFs. The GIFs were 2-3 seconds in length exampling an instructional task. The GIFs and pictures had been created by the medical education department for the sole purpose of the study. The presentations were pre-recorded with the same narration.

Inclusion criteria included medical students at two London medical schools rotating through their one-week ophthalmology attachment. Exclusion criteria was any student with prior knowledge or experience with slit lamps. The students were randomised into two groups of 5 to watch either the presentation with animated GIFs (presentation 1) or the presentation with pictures (presentation 2). Randomisation was by assigning each participant a number. Numbers were placed in a hat and then chosen by an independent member of staff not involved in the study. The first 5 numbers watched presentation 1 and the second 5 numbers presentation 2. The randomisation occurred immediately prior to watching the videos. After the presentation each student was evaluated using a slit lamp and assessed on the 13 tasks covered in the presentation.

After the slit lamp assessment, the two groups crossed-over and immediately watched the presentation that they had not seen prior to the assessment. The students were kept in separate rooms to prevent any contamination. Students were instructed not to discuss the nature of their presentations or assessment. Communication orally or via mobile phone was inhibited. At this point the students had watched both presentations and an anonymised, qualitative survey; assessing student perceptions was taken from each student to answer on their smartphone using the Slido® app. After each question students had the option to free text why they answered how they did. Following completion of the survey the students stayed for an open group discussion about the two presentations in their groups of 5.

The primary outcome was to ascertain whether students subjectively felt animated GIFs embedded in presentations were more engaging, enjoyable, and better for their learning. The secondary outcome was to assess whether videos within presentations improved learning through recall on immediate assessment post-presentation and was determined by the 13-task assessment on 'How to Use a Slit Lamp'.

Informed consent was taken from each participant and the project was approved by the Moorfields medical education department. The tenets of Declaration of Helsinki were upheld.

Data Analysis

Free text comments were encouraged after each question on the perception survey recorded by the Slido® app. The open discussion was overseen by CA and recorded notes were taken. CA and CG performed an inductive thematic analysis following Braun and Clarke's six step method of both the open discussion and free text comments firstly by identifying important text segments followed by creating codes, categories and finally themes (6). Statistical analysis was done using two-sided unpaired Student's *t* test, probability values

of less than 0.05 were considered statistically significant.

RESULTS

During February 2021 a total of 40 medical students, 32 from one medical school and 8 from another participated in the study. There were 16 male and 24 female students with an average age of 20.88 SD+/- 0.76.

Quantitative Analysis

The total correct average of the 13-task assessment for Group 1: GIF was 73%, compared to 63% for Group 2: Images. Group 1: GIF, equalled or outscored Group 2: Images, in all 13 tasks. Figure 2 shows a breakdown of the 13-task assessment in percentage by each group. The largest differences were adjusting the height of the table 90% vs 70% (p=0.06), positioning the patient 85% vs 65% (p=0.08), adjusting the eyepiece and refraction 75% v 50% (p=0.05) and adjusting the slit lamp up, down, left and right with the joystick 70% vs 50% (p=0.10). The highest score attained was switching on the slit lamp which was 100% in both groups. The lowest score attained was switching to the blue filter which was 35% in both groups.

Qualitative Analysis

Question 1: Which presentation did you enjoy more?

Thematic analysis highlighted that the GIF presentation increased engagement and focus compared to the static image presentation. Students found that videos helped to hold their attention whilst watching the presentation. It also found that tasks were easier to conceptualise and follow as you could see the moving parts in real time. The static images only provided snapshots of what was desired. Figure 3 shows that all the students enjoyed the presentation with GIFs more than the presentation with static pictures.

"More interesting and helps to see the equipment in use rather than just pictures. It's also easy to lose focus on the picture presentation."

Question 2: Which presentation enhanced your learning more?

Thematic analysis again identified that students felt the presentation with GIFs enhanced engagement and focus .The videos allowed visualisation of learning how to use a slit lamp by seeing words put into actions. The students also felt that the explanations made more sense with the GIFs showing the moving parts compared to seeing a static image with arrows to certain dials on the slit lamp. In addition, they felt that recall was improved, and that knowledge was better absorbed when watching the GIF presentation. Figure 4 shows that all the students felt that the presentation with GIFs enhanced their learning more than the presentation with static pictures.

"Videos can explain things better than verbally, felt as if I was watching someone use the slit lamp in front of me."

Question 3: Which presentation was clearer for how to use a slit lamp?

Students felt that GIFs helped with reinforcement of learning

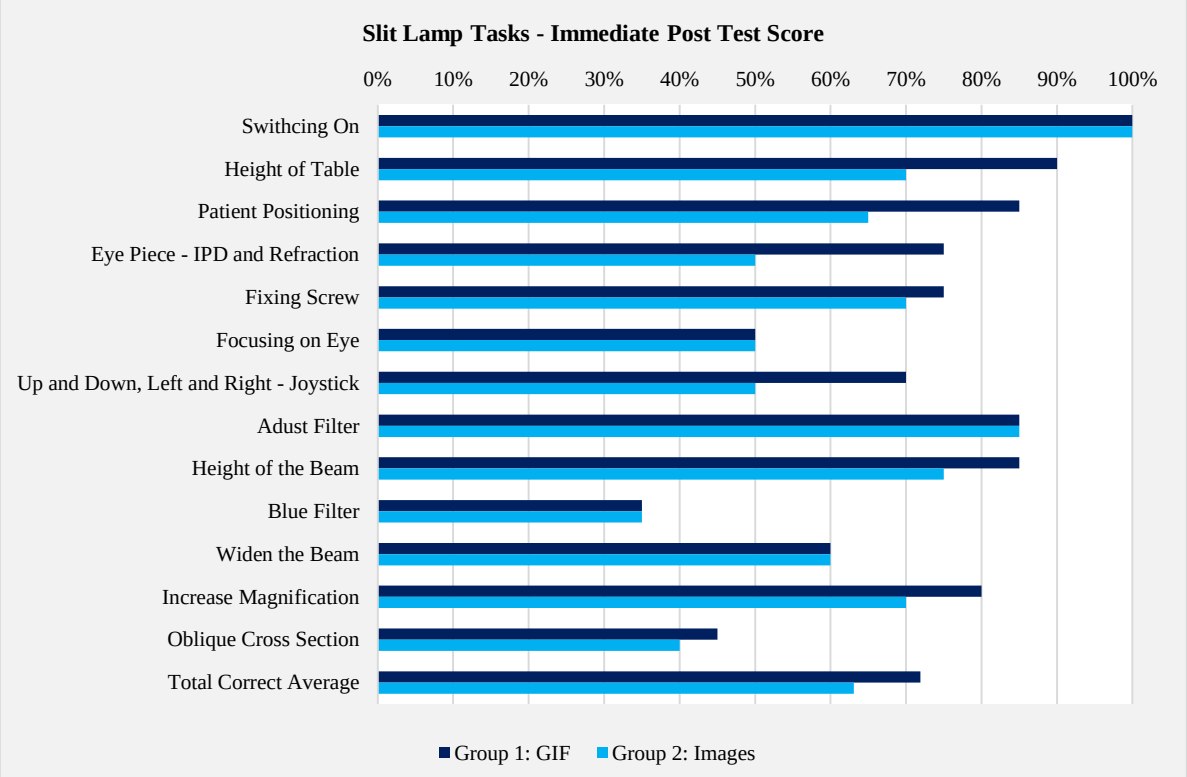

Figure 2. Slit lamp tasks assessment percentage correct after watching either the presentation with GIFs (group 1) or presentation with images (group 2)

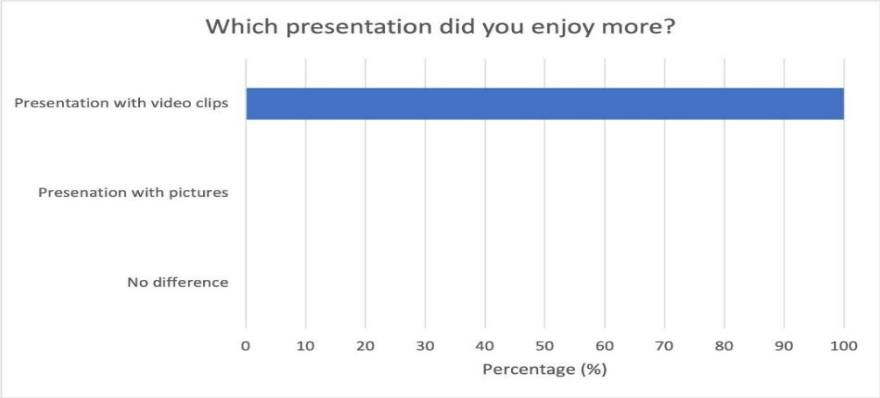

Figure 3. Comparison of enjoyment between presentations

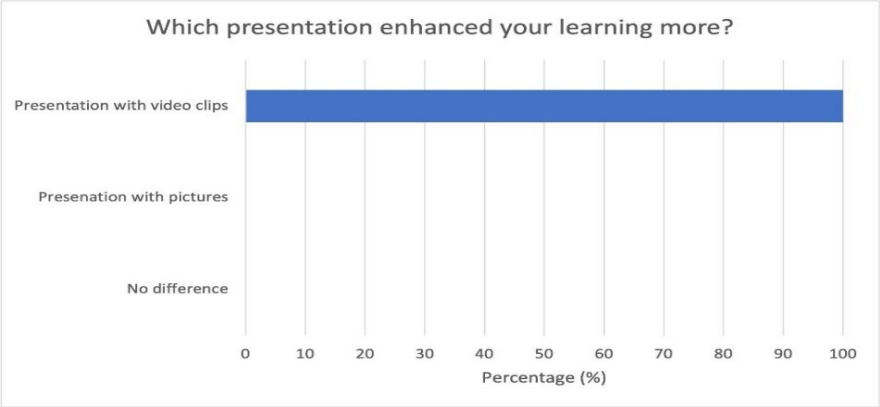

Figure 4. Comparison of enhancement of learning between presentations

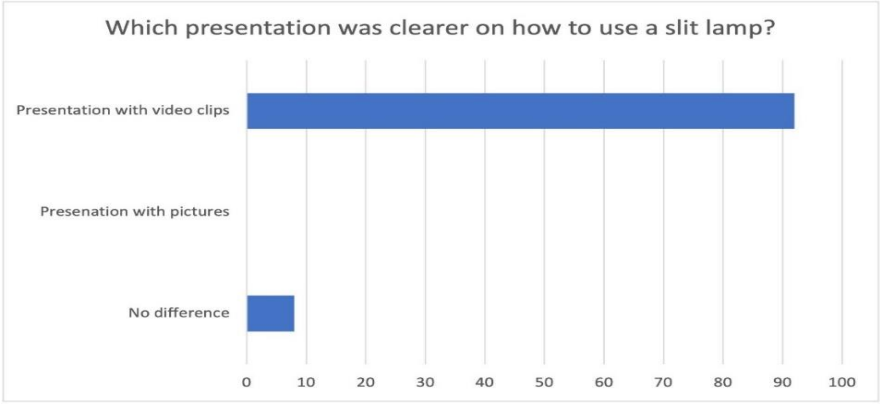

Figure 5. Comparison of clarity between presentations

and recall. Videos showed in better detail the intricacies of the slit lamp. On the contrary, pictures with arrows could be ambiguous and left room for interpretation with regards to instructions given. Seeing the videos in real-time allowed students to conceptualise with easier identification of certain buttons and dial. Videos that zoomed in and out of looking at different functional dials gave a more holistic view of the slit lamp. Figure 5 shows that most students felt that the presentation with GIFs was clearer on how to use a slit lamp. *"When giving directions it may not always be clear what the instructions mean. When we see it being carried it becomes apparent what we ought to do."*

Question 4: Which presentation was more engaging?
Thematic analysis highlighted four recurring themes; engagement and focus, conceptualisation, ambiguity and recall. The videos were found to be more stimulating and enjoyable which helped students hold their attention for longer. The videos were clearer and enabled the verbal instruction and action to coalesce better than the static picture presentation. Having videos show exactly what to do on the slit lamp gave less room for interpretation and were more memorable. Students also felt that they were more likely to lose interest when watching the static picture presentation and were less engaged. Figure 6 shows that all the students found that the presentation with GIFs was more engaging compared to static pictures alone.
"Being able to understand how the equipment functions through real life coverage makes it less abstract."

Question 5: I now feel confident on how to use a slit lamp.
Overall students perceived greater familiarity in how to use a slit lamp but lacked confidence as this had not yet been actively practiced. They felt their knowledge was far greater on how to use a slit lamp and that the video presentation was better for learning and recall. They suggested further training through face-to-face clinical skills sessions as most students felt that the best way to learn was through active use of the slit lamp. One criticism of the presentation with videos was that on some slides several videos were playing at once thus it was difficult to follow, watch multiple videos and listen all at once. Figure 7 shows the confidence of the cohort.
"As a medical student, I don't feel confident, but I now feel more familiar with the equipment."

DISCUSSION

Students unanimously found the presentation with videos to be more enjoyable, engaging and increased learning compared to the presentation with static images. In particular, the GIF presentation improved focus on the topic and students felt that they could conceptualise what task was being performed. Indeed, recall was subjectively also felt to be improved in the video group. Previous research has shown the benefit of video and audio combined. It is known that a person usually retains only 10-15% of what is read, 10-20% of what is heard and 20-30% of what is seen but when audio and video materials are presented side by side the

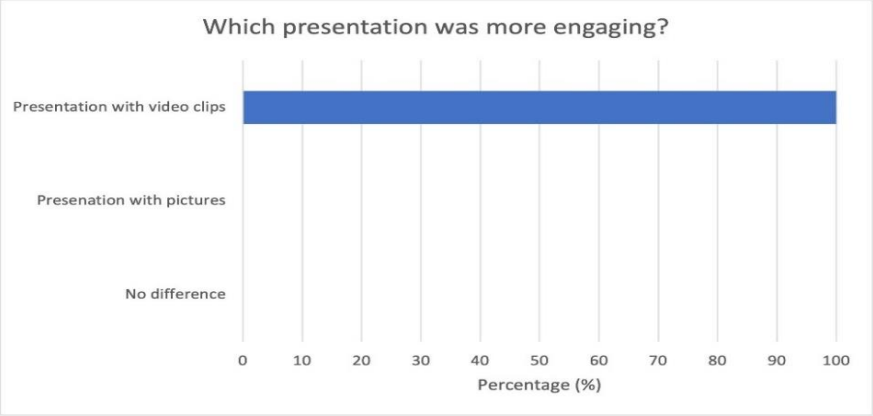

Figure 6. Comparison of the level of engagement between presentations

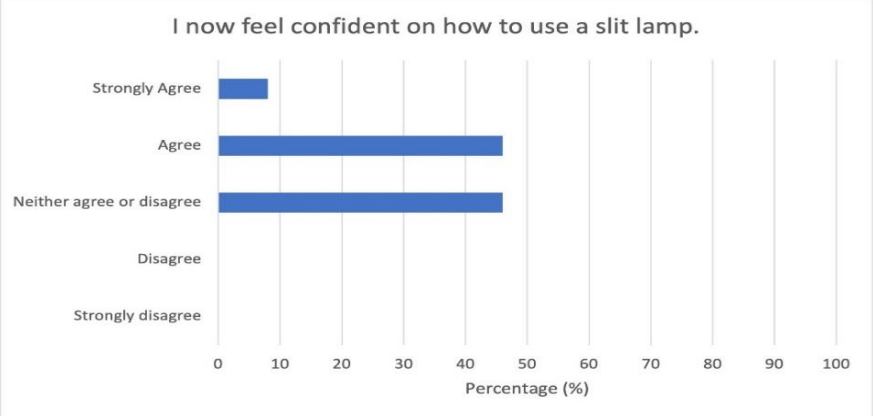

Figure 7. Likert scale of confidence of the cohort on how to use a slit lamp

retention of knowledge increases to 40-50% (7). Mayer's Multimedia Learning Theory provides a strong theoretical foundation for our findings. This theory posits that people learn more deeply from words and pictures than from words alone, which aligns with our students' preference for GIF-based presentations (8).

One student stated that there were too many videos on the screen at once. This is in keeping with the cognitive load theory that too much information, in this case the videos, can impact on working memory and learning (9). Having too much information on the screen could be distracting and detract from the main messages. Van Merriënboer and Sweller have explored how to optimise cognitive load in complex learning environments like medical training (10). Their work could provide insights into how to best structure GIF-based presentations to maximise learning without overwhelming students. Future studies could investigate the optimal number and duration of GIFs in presentations for maximum learning benefit.

Our findings align with and extend previous research on the use of dynamic visuals in medical education. Dong and Goh emphasize the importance of short, focused video content for maintaining student engagement, which aligns with our use of brief, looped GIFs (11). In surgical education, Ahmet et al. found that video-based instruction, particularly shorter videos, was generally superior to traditional methods for teaching technical skills (12). This supports our use of GIFs for demonstrating slit lamp operation. A meta-analysis by Höffler and Leutner found a medium-sized advantage for animations over static pictures, especially when animations realistically demonstrated movements to be learned (13). This aligns with our GIFs directly showing slit lamp operation movements. These studies, along with our results, suggest that GIF-based learning could be valuable across various domains in medical education, particularly for teaching practical skills where direct demonstration of movements is crucial.

In performing the 13-task assessment those students watching the GIF presentation scored higher or equal to the students watching the picture presentation, but only adjusting the eyepiece and refraction was statistically significant ($p=0.05$). Video modelling is well suited for motor learning as it can deliver information concerning how to perform a skill in a practical way (14). Videos can build on Bandura's social learning theory showing the effectiveness of observational learning (15). This theory posits that individuals can learn new behaviours by observing others perform them, a process particularly relevant to the acquisition of clinical skills. The GIF presentations in our study effectively served as a form of video modelling, allowing students to observe the correct use of a slit lamp repeatedly.

In sport Rekik et al showed that viewing videos of tactical actions of basketball was more effective than viewing a series of simultaneous static images (16). For specific tasks when observing a skilled model on video performing a judo technique there was better recall, performances and better motivation levels compared to static pictures (17). The name given to learning actions through video modelling examples is known as 'the human movement effect' (18). While our study focused on ophthalmology, the potential applications of GIF-based learning in medical education are broad. Future research could explore the effectiveness of GIFs in teaching clinical skills across various medical specialties, from surgery to emergency medicine. Studies in clinical education have shown the positive perceptions of OSCE clinical videos for learning (19). However, these videos are time consuming and may require expensive kit and editing software.

When comparing GIFs to other multimedia tools in medical education, such as virtual reality or augmented reality, GIFs offer a cost-effective alternative. They can be easily created and integrated into existing presentation formats, making them accessible for educators with limited resources.

LIMITATION

There are some limitations to our study. Firstly, the open discussion after both presentations was undertaken by only one mediator who took notes. Secondly, the study only recorded post-test scores immediately after the event evaluating for short term recall only. The sample size of 40 was small and continuing the study for a longer period with an increased number of students would have yielded better statistical analysis and further themes that may not have been identified. Finally, despite asking students not to use their smartphones the students were not watched at all times as the assessments were being undertaken. It is possible students could have communicated about the study. Collecting mobile phones before the study and returning them on completion would have prevented potential contamination bias.

CONCLUSION

Students subjectively felt animated GIFs embedded in presentations to be more engaging, enjoyable, and better for their learning. In addition, videos within presentations could increase recall over a presentation with static pictures on immediate assessment post-presentation, on 'how to use a slit lamp'. The advantages are that GIFs are fast and easy to create. They allow a simple, inexpensive way to incorporate into presentations to help engage and teach audiences.

Ethical considerations

Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc. have been completely observed by the authors.

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REFERENCES

1. Woolfitt Z. The effective use of video in higher education. Lectoraat Teaching, Learning and Technology. 2015; Inholland University of Applied Sciences. Rotterdam. Retrieved from: www.inholland.nl/media/10230/the-effective-use-of-video-in-higher-education-woolfitt-october- 2015.pdf
2. Berk R. A. Multimedia teaching with video clips: TV, movies, YouTube, and mtvU in the college classroom. International Journal of Technology in Teaching and Learning 2009; 5(1):1-21.
3. Furnham A, De Siena S, Gunter B. Children's and adults' recall of children's news stories in both print and audio-visual presentation modalities. Applied Cognitive Psychology 2002; 16(2): 191- 210.
4. Ash J. Sensation, Networks, and the GIF: Toward an Allotropic Account of Affect. Networked Affect.The MIT Press; Cambridge, MA, USA: 2015;119-34.
5. Chun-Shan Y, Jonathan K, Michael L. Creating Animated GIF Files for Electronic Presentations Using Photoshop. American Journal of Roentgenology 2007; 188(5): W485-W490.
6. Clarke V, Braun V. Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. The Psychologist 2013; 26(2): 120-23.
7. Prinz A, Bolz M, Findl O. Advantage of three dimensional animated teaching over traditional surgical videos for teaching ophthalmic surgery: a randomised study
8. British Journal of Ophthalmology 2005;89:1495-99.
9. Sweller J, Van Merrienboer J.J, Paas F.G. Cognitive architecture and instructional design. Educ. Psychol. Rev. 1998; 10: 251-96.
10. Mayer R. E. Multimedia learning. 2001; Cambridge University Press.
11. Van Merriënboer JJ, Sweller J. Cognitive load theory in health professional education: design principles and strategies. Med Educ. 2010 Jan;44(1):85-93.
12. Dong C, Goh PS. Twelve tips for the effective use of videos in medical education. Med Teach. 2015 Feb;37(2):140-5.
13. Ahmet A, Gamze K, Rustem M, Sezen KA. Is Video-Based Education an Effective Method in Surgical Education? A Systematic Review. J Surg Educ. 2018;75(5):1150-58.
14. Höffler T. N, Leutner D. Instructional animation versus static pictures: A meta-analysis. Learning and Instruction 2007; 17(6): 722-38.
15. Hoogerheide V, Van Wermeskerken M, Loyens S.M, Van Gog T. Learning from video modeling examples: Content kept equal, adults are more effective models than peers. Learn. Instr. 2016; 44: 22-30.
16. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Psychol. Rev. 1977; 84: 191-215.
17. Rekik G, Khacharem A, Belkhir Y, Bali N, Jarraya M. The instructional benefits of dynamic visualizations in the acquisition of basketball tactical actions. J. Comput. Assist. Learn. 2019; 35: 74-81.
18. H'mida C, Degrenne O, Souissi N, Rekik G, Trabelsi K, Jarraya M, et al. Learning a Motor Skill from Video and Static Pictures in Physical Education Students–Effects on Technical Performances, Motivation and Cognitive Load. Int. J. Environ. Res. Public Health 2020; 17: 9067.
19. Paas F, Sweller J. An evolutionary upgrade of cognitive load theory: Using the human motor system and collaboration to support the learning of complex cognitive tasks. Educ. Psychol. Rev. 2012; 24: 27-45.
20. Jang HW, Kim KJ. Use of online clinical videos for clinical skills training for medical students: benefits and challenges. BMC Med Educ. 2014; 14:56.