

Whiteboard animation: a potential teaching tool for health science education

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ABSTRACT

Background: Combining visual thinking and storytelling makes whiteboard animation an effective educational tool. However, the impact of whiteboard animation is understudied in health science education. We explored the current literature to identify the application and impact of whiteboard animation for teaching in health science education. **Method:** A comprehensive electronic literature search was conducted on five databases: PubMed, Google Scholar, CINAHL, Web of Science, and Education Research Complete to include full-text research articles published in English between 2013 and 2024. Articles were screened to match inclusion criteria, and data were extracted from the eligible studies. **Results:** After two rounds of screening, six articles were included in the review, all focusing on evaluating the impact of whiteboard animations in dental, medical, and other health science education. All studies reported positive impacts of whiteboard animation on student satisfaction and knowledge acquisition. A correlation between the number of video views and students' longitudinal exam performance was also reported. **Discussion and Conclusion:** The concise and engaging animations explaining concepts in a storytelling manner offer an alternative mode of presenting teaching material, reducing the extrinsic cognitive loads on the learners. Further studies are needed to evaluate the impact of this powerful tool on health science education.

Keywords: education; learning; teaching; teaching method; whiteboard animation

CDHA Research Agenda category: capacity building of the profession

INTRODUCTION

Higher educational institutes worldwide are increasingly interested in improving student engagement by incorporating innovative and engaging teaching tools and resources.¹⁻³ Teaching complex scientific concepts in an engaging manner is one of the major challenges educators face.⁴ Science education delivered solely by lecturing is less effective and a leading cause of students losing interest in science at the undergraduate level.^{5,6} The rapid development of digital instructional tools has enormous potential for instructors to design and develop engaging and effective teaching resources; whiteboard animation can be one of them.^{4,7}

Whiteboard animations

Animated videos are a successful pedagogical tool for explaining concepts and engaging students by combining audio messages with changing graphics.⁴ Animations have a long history in education, impacting learning outcomes.⁸ A meta-analysis by Höffler and Leutner (2007) identified a significant impact of animation, compared to static images, on the learning outcomes of undergraduate and high school students.⁹ Whiteboard animation is a newly developed branch of animation that is rapidly gaining popularity as an educational tool. Whiteboard animation refers to a specific style of animated videos where the content appears to be hand-drawn on a school whiteboard and narrated, typically in a storytelling manner. This technique uses cartoons and line drawings rather than live videos and realistic images. Hand movement showing the process of creating the line drawings or writing the on-screen text is the signature feature of a whiteboard animation (Figure 1).

Whiteboard animations have all the benefits of traditional animations, illustrating an abstract idea, simplicity, and engagement. However, the feature that makes whiteboard animations stand out as an educational tool is their ability to combine visual thinking and storytelling.^{10, 11}

Storytelling is a multimodal teaching approach that simultaneously engages listeners' thinking, emotions, and imagination.¹² However, this powerful tool has consistently been understudied and underutilized in higher education, particularly science education.^{13, 14} Csikar et al. (2018) used storytelling in the classroom as an instructional strategy for teaching human anatomy and physiology at the university level in a quasi-experimental study. Results revealed that storytelling was equally effective in conveying complex scientific information as traditional instructional methods.¹⁵ Whiteboard animations are powered by storytelling. The short animations include explanatory narratives, which are essential for explaining the concepts in animated videos.¹⁶ These animated videos also tend to break down large concepts into a sequence of illustrative moments and use narrative storytelling to explain those moments.¹¹ Depending on the concept being presented, some storytelling in whiteboard animation often includes characters, conflicts, quests, and resolutions.¹¹

Tools to create whiteboard animations

The original theme of whiteboard animation- the white background, hand motion, and voice-over- is inspired by the classroom environment. The founding of YouTube in 2005 was an impetus that inspired people to create and share videos of all kinds, including animations.³ The United Parcel Service (UPS) created some of YouTube's earliest known whiteboard animation videos to explain key concepts to customers.¹⁷ The Royal Society for Arts (RSA) is one of the leaders in creating and popularizing modern-day whiteboard animations.^{17,18} The first whiteboard animations were manually hand-drawn and filmed over the artist's shoulder, a tedious technique still in use. However, in recent years, software has been developed to replicate the style, making whiteboard animation more straightforward. Popular web tools for creating whiteboard animations

include GoAnimate, VideoScribe, Animaker, PowToon, and Rawshorts.¹⁹ Figure 1 shows a screenshot from a simple whiteboard animation created using PowToon.²⁰

Whiteboard animations as a teaching tool

Visual storytelling with whiteboard animations has enormous potential as a teaching tool. Multiple educational theories support such educational videos. According to Dewey's pragmatic view of learning, learning is essentially a social activity resulting from human interactions.^{21,22} Consistent with this view, studies found that the on-screen appearance of avatars, cartoon characters, dialogues, and simulated real-world settings in animated videos serves an important social function in engaging students.^{4,10}

Cognitive Load Theory and the principles derived from the Cognitive Theory of Multimedia Learning also support the impact of animated videos as a teaching tool. According to the Cognitive Load Theory, we have a working memory with a limited capacity that is affected by the underlying nature of the subject matter (intrinsic load) and the way the topic is presented (extrinsic load).^{23,24} The intrinsic load cannot be changed for a given subject matter, but the learning process can be eased by changing how the subject is presented (extrinsic load).^{23,24} Whiteboard animations offer an alternative learning scaffold; therefore, they are expected to reduce the extrinsic load of understanding complex concepts. The Cognitive Theory of Multimedia Learning postulates that receiving information through multiple channels (e.g., auditory and visual) simultaneously helps students process the information to move into long-term memory more effectively by integrating the new knowledge with their existing knowledge.^{25,26} In support of this theory, in a study, participants identified animated videos as 'a refreshing change from conventional teaching', suggesting reduced extrinsic load by the alternative presentation method.⁴

The success of a teaching technology is often guided by Keller's Attention, Relevance, Confidence, and Satisfaction (ARCS) model.²⁷ The characters, storytelling, and pictures used in whiteboard animations aim to gain viewers' attention through perceptual arousal, inquiry arousal, and variability.^{27,28} The study by Liu & Elms, 2019 revealed that animated teaching videos enhanced students' learning experience by improving their self-assessed understanding of the materials, indicating enhanced confidence. The animated videos are often made accessible to students outside the classroom, facilitating flexible and self-paced learning and thus increasing student satisfaction.⁴

Whiteboard animations have a positive effect on retention, engagement, and enjoyment. Li et al. (2019) studied the effectiveness of whiteboard animation for educational purposes at a university in Hong Kong. Animated educational videos made with whiteboard animation techniques were offered to the students as a part of a general education course. The results of the study showed that students who watched the animations before class achieved better grades than those who did not. Over 92% of students found the whiteboard animations helpful in gaining knowledge and clarifying concepts.²⁹ In another study, general adult populations selected as study participants were randomly distributed to one of the four instructional conditions: whiteboard animation, electronic slideshow (sequential images with narration), audio-only, and text-only, to learn concepts of physics. The study reported that whiteboard animations have a better impact on retention, engagement, and enjoyment than other instructional media.⁸

Objective of the review

Despite the potential and positive impact of whiteboard animations, their application in health science education is scarce. This narrative review aims to explore the current literature to

identify the application of whiteboard animation as a teaching tool in health science education. We aim to answer the following questions:

1. What is the nature of the whiteboard animations developed or used for teaching purposes in health science education?
2. How do the whiteboard animations impact students' learning experiences in health science education?

METHODS

A comprehensive electronic literature search was conducted on five databases: PubMed, Google Scholar, CINAHL, Web of Science, and Education Research Complete using the search terms: “Whiteboard animation” AND “Health science education.” Fulltext, non-duplicate literature published in English between 2013 and 2024 were included. Articles were excluded if they were published in a language other than English, were not available in full-text articles, did not include faculty or students from health science education, or did not conduct an evaluation to assess the impact of the whiteboard animation. Review studies, editorials, and perspective articles were also excluded. The inclusion and exclusion criteria of this review are summarized in Table 1.

Two rounds of the review were carried out to screen the articles according to the inclusion and exclusion criteria. The first screening was conducted by title and abstract. A full-text review was conducted in the second round, followed by data extraction. Data was extracted from the eligible studies related to the year of publication, source, and topic of the whiteboard animation used for intervention, study participants, evaluation method, and the evaluation outcome.

RESULTS

Features of the reviewed studies

The initial search identified 48 articles from five databases (PubMed, Google Scholar, CINAHL, Web of Science, and Education Research Complete). After two rounds of screening, six articles were included in this narrative review (Figure 2). Studies were published between 2016 and 2023 in Canada (n=2) and the United States (n=4). Study participants were from medical schools (4 studies), dental schools (1 study), and university students from health professional, biomedical, or science-related fields (1 study).

Nature and source of the whiteboard animations used as a teaching tool in health science education

Several institutions adopted whiteboard animations to explain various scientific concepts, ranging from simple (basic science) to complex (empiric antibiotic selection, biofilm formation by bacteria) (Table 2). Three studies used whiteboard animations commercially available from Osmosis (<https://www.osmosis.org>) as supplementary learning materials for dental and medical students.³⁰⁻³² Osmosis is a web-based collaborative learning platform for medical students that provides open access to a series of whiteboard animations and self-assessment questions.³³

On the other hand, three studies used author-created whiteboard animations as teaching tools.³⁴⁻³⁶ Mcguinness, 2020 created whiteboard animations by hand-drawing the images on a whiteboard and filming the drawing process.³⁵ Larnard et al., 2020, alternatively used screen capture and video editing software to create whiteboard animations for students.³⁶

Impact of the whiteboard animations on students' learning experiences

The included studies conducted quantitative research to evaluate the impact of whiteboard animations on student satisfaction, engagement, and knowledge acquisition (Table 2). Zheng et al., 2023 evaluated dental students' perceptions, video-watching patterns, and the correlation between video-watching and exam performance.³⁵ The whiteboard animations from Osmosis were well received by students. Most study participants reported those videos as valuable for their learning. The results also revealed a positive correlation between the number of video views and students' longitudinal exam performance in two content areas: biochemistry and nutrition.³⁵ Whiteboard animations from Osmosis were also perceived as beneficial and preferred over traditional lectures by medical students.³⁰ However, in a campus-wide study, Hudder et al., 2019 reported that only 50% of the students signed up for an account on the Osmosis platform when it was made available to medical students. The findings of the study revealed a positive experience for students with learning resources on Osmosis; it also identified medical students' lack of time as a barrier to adopting this platform.³¹

Larnard et al., 2020 invited participants to a survey and knowledge test before and after watching the whiteboard animation video on empiric antibiotic selection.³⁶ 100% of the study participants agreed or strongly agreed that the whiteboard animated videos were an effective way to learn the material. A significant improvement in test scores was reported in the knowledge test after watching the video.³⁶ A similar approach by Thomson et al., 2016 showed a significant increase in the test scores of the study participants after watching the whiteboard animation on infertility.³⁴

According to a study conducted by McGuinness (2020), whiteboard animations are effective in explaining complicated ideas.³⁵ The study focused on students' preferences in understanding biofilm formation by bacteria through either whiteboard or 3D animation. The majority of the participants reported that whiteboard animation was easier to comprehend compared to 3D animation.³⁵

DISCUSSION

Our review investigated the current literature on the use and impact of whiteboard animations as a teaching tool in health science education. Our review includes a small number of studies, and though we also found many animated videos aiming to explain health or disease-related topics, many were developed for patient education or were not evaluated for their impact or effectiveness. Although research on whiteboard animations in health science education is scarce, their positive effect on students' learning experiences is evident from the findings of the study.

Half of the studies included in our review used commercially available whiteboard animation videos created by Osmosis;³³ others created their own animations aiming to explain specific topics. Although the sample size for all the studies was large, the focuses of the evaluations were centered around knowledge acquisition and satisfaction only. Qualitative studies and studies exploring student motivation are largely absent. Another weakness of the studies included in this review is the absence of theory-driven application and evaluation of the whiteboard animations and an educational tool.

Although traditional animations have a long history in education, studies focusing on whiteboard animations are minimal.^{8, 37} Our review identifies limited research and potential for future endeavors in establishing whiteboard animation as a teaching tool in health science education. Visual storytelling is the most appealing and unique feature of whiteboard animation. Studies found the successful application of storytelling in conveying complex scientific information.¹⁵ Along these lines, more research is needed on the impact of whiteboard animations in higher education, focusing on their ability to explain complex scientific concepts to reduce extrinsic cognitive loads.

A study exploring the aspects of animation design that enhance student engagement found that character design, dialogues, and voice acting contribute the most towards students' interest, enjoyment, and engagement.⁴ Whiteboard animation uses line-drawn characters, narrative voice-over, storytelling, and human hand-motion. It is crucial to investigate which components of whiteboard animations contribute to enhancing student engagement.

Animated educational videos can impact students differently depending on their demography. Liu & Elms, 2019 reported that although all study participants, regardless of gender and age, found animations useful for their learning, female and younger students valued that animations make learning more enjoyable.⁴ To male students, animations were more 'valuable' in simplifying complex technical concepts.⁴ The same study also found that older students appreciated the flexibility offered by the animated videos to enable self-directed learning.⁴

Evaluating the pedagogical value of whiteboard animations for diverse learners can be another potential research area.

The characters, narratives, tones, and humor used in whiteboard animations can be tailored easily for target learners and audiences, which makes this tool particularly valuable for adult education. Adults learn differently from children. Adult learning theories suggest that adults are goal and relevancy-oriented, intrinsically motivated, and self-directed.^{38,39} Educational videos using the whiteboard animation technique can be effective for adult education, providing self-directed, flexible, and relevancy-oriented learning options. Investigating the impact of whiteboard animations on adult learning can also be an area of potential future research.

Though the majority of the studies in our review do not incorporate the theoretical underpinnings of the reasons whiteboard animations are effective in education, many existing educational theories may explain why students thrive when using this technology. Narrative learning theory suggests that the storytelling of whiteboard animation videos can engage the learner at multiple levels, including cognitive, emotional, and cultural. This creates a dimensional, integrated learning experience that allows them to reconstruct that knowledge into something that is meaningful to them as an individual.⁴⁰ This constructivist approach to learning helps learners critically think about the material they are learning and integrate it with their existing knowledge, belief system, and culture.

The storytelling component of whiteboard animation videos also lends itself to Indigenous ways of knowing and knowledge mobilization. The storytelling nature of whiteboard animation videos can be used to teach in a way that is consistent with Indigenous values and traditions, such as the development of skills through observation.^{41,42} The use of whiteboard animation videos has been shown to help to overcome knowledge mobilization barriers in Indigenous communities and

can improve knowledge translation, particularly when compared with conventional knowledge translation outputs like manuscripts, which are often difficult to access and understand outside of the academic community.⁴³

The multimedia aspect of whiteboard animation videos may also explain why they are more effective as a learning tool when compared with conventional means. The multimedia learning theory postulates that receiving information through both auditory and visual channels (known as dual coding), facilitates the transfer of information from working memory into long-term memory.²⁶ This may explain why the Larnard et al., 2020 and Thomson et al., 2016 studies demonstrate improved test scores following teaching with whiteboard animation videos.^{34,36}

Many digital technologies, like whiteboard animation videos, can also be used to support equity, diversity, and inclusion in the classroom and beyond. The Universal Design for Learning framework strives to make education equitable and accessible by following three principles: 1) engagement, 2) representation, and 3) action and expression.⁴⁴ This inclusive, pedagogical approach is captured by whiteboard animations as the dynamic, multisensory nature of the videos allows students to modify the speed of the videos, replay them, or enable closed captioning. Representation of distinct cultures, genders, and abilities is also readily facilitated by this technology.

One of the major drawbacks of using whiteboard animation videos for education is that creating even short videos can take a significant amount of time and resources. With the recent popularization of artificial intelligence (AI), the production of whiteboard animation videos becomes more streamlined and requires less technical expertise. A number of AI-assisted free or paid online whiteboard animation tools are readily available, including Canva⁴⁵, Mango Animate:

Mango AI⁴⁶, and Powtoon Imagine⁴⁷. AI-based text-generation tools can also be used to create scripts for whiteboard animations.

CONCLUSION

The unique features of whiteboard animation make it a valuable tool for simplifying complex concepts and engaging learners. The application of whiteboard animations is rapidly growing in health science education. Multiple applications of animated educational videos made using the whiteboard animation technique are reported. Besides traditional classroom teaching, the storytelling feature of whiteboard animations can be particularly effective for case presentation and patient education. Further research is needed to carefully evaluate the impact of this powerful tool in improving learning experiences in health science education.

Practice Implications:

- The unique features of whiteboard animation make it a valuable tool for simplifying complex concepts and engaging learners.
- The storytelling feature of whiteboard animations can be particularly effective for case presentations and patient education.

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Figures and Tables

Figure 1: Screenshot of a whiteboard animation explaining genetics. Some of the signature features of whiteboard animation, including human hand motion, white background, and line-drawn character, are shown here. A trial version of PowToon²⁰ was used to create this animation.

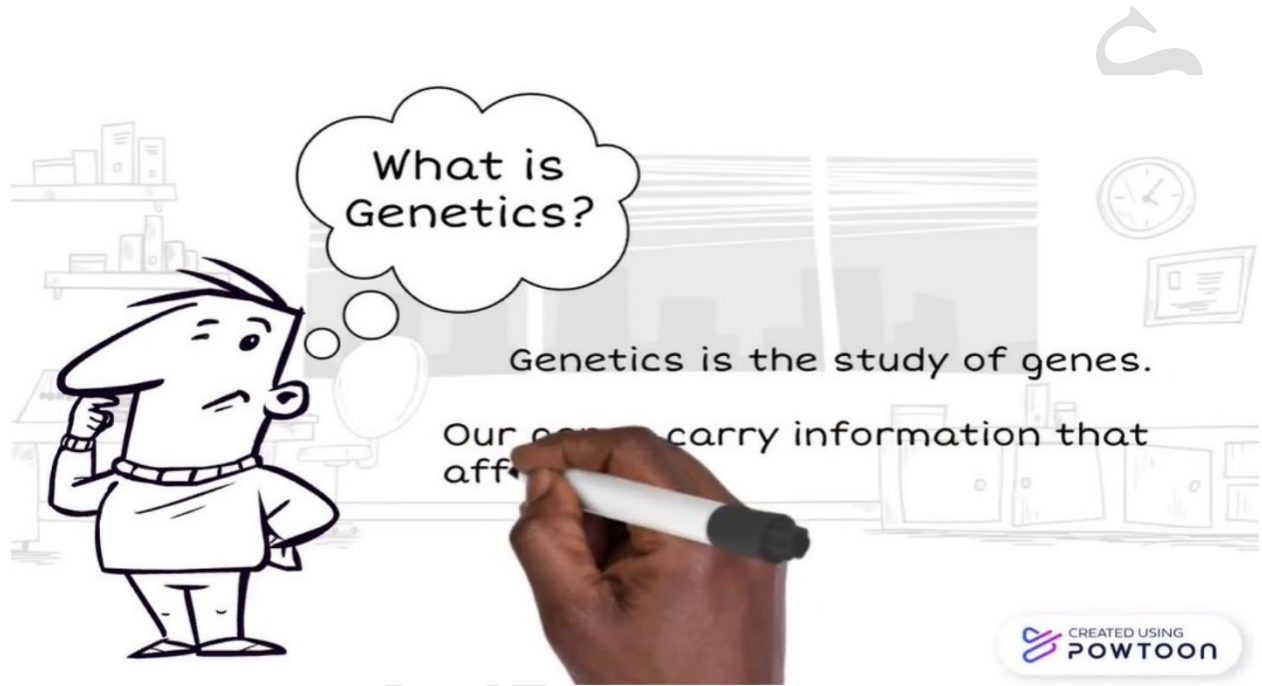


Figure 2: Flow diagram explaining the study selection process

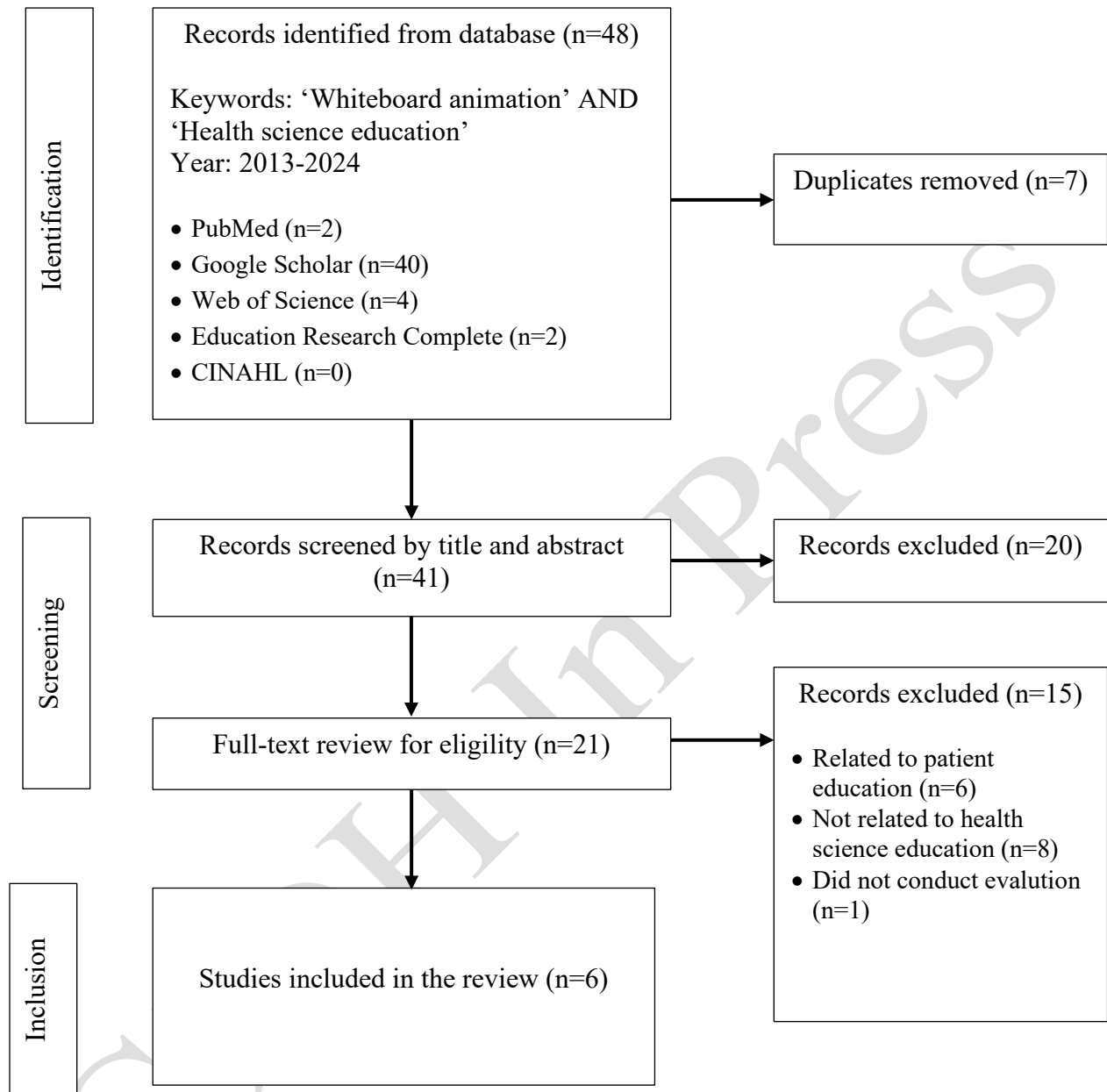


Table 1: Inclusion and exclusion criteria

	Inclusion	Exclusion
Language	English	Non-English
Year of Study	Studies published between 2013-2024	Studies published before 2013
Study focus	Health science education	Non-health science education
	Used for student education	Used for patient education
	Tools to improve education	Tools to improve patient care, clinical practice.
	Studies to assess the impact of whiteboard animation on students' learning experience.	No assessment was performed. Review articles Editorials Perspective articles Full-text not available
Study design	Any	None
Setting	Any	None

Table 2: Extracted data from included literature

Author, Year of Publication, Country	Source of the whiteboard animation video	Topics of the whiteboard animation video	Study Participants	Evaluation Method	Impact of the whiteboard animations on students' learning
Zheng et al., 2023 ³² Canada	A series of commercial whiteboard animation videos created by 'Osmosis' were made available to students as supplementary resources.	Multiple topics related to basic science concepts.	Students of the Doctor of Dental Surgery (DDS) program. (n = 143)	The authors used surveys, platform analytics, and exam scores to evaluate student perceptions, video-watching patterns, and the correlation between video-watching and exam performance.	The whiteboard animations were well received by students. Most study participants reported the videos as valuable for their learning. Regression analyses revealed a statistically significant positive correlation between the number of video views and students' longitudinal exam performance in biochemistry and nutrition.

Author, Year of Publication, Country	Source of the whiteboard animation video	Topics of the whiteboard animation video	Study Participants	Evaluation Method	Impact of the whiteboard animations on students' learning
Thomson, et al., 2016 ³⁴ Canada	The authors created a 15-minute whiteboard animation video with assistance from Information Technology Services at the University.	Infertility	First- and Second-year medical students. (n = 101)	A questionnaire was used for knowledge assessment before and after watching the whiteboard animation video.	Students showed a significant increase in their scores after watching the video. Female respondents had a greater increase in mean score after watching the video than male respondents.
Mcguinness, 2020 ³⁵ United States	Created by the author by hand drawing on a whiteboard and filming that drawing process.	Biofilm formation by bacteria	Students of health professional, biomedical, or science-related fields. (n=500)	A survey was conducted to assess participants' opinions on the comparative impact between whiteboard and 3D animations.	58% of participants responded that the whiteboard animation was easier to understand than the 3D animations.
Larnard, et al., 2020 ³⁶ United States	Created by the authors using Show Me, Screen Capture, and Camtasia.	Empiric antibiotic selection	Fourth-year medical students. (n=37)	Surveys, Knowledge assessment before and after watching the whiteboard animation video.	Significant improvement was found in the knowledge test after watching the video. All participants agreed or strongly agreed that whiteboard animations as a supplementary module were an effective way to learn the material.
Hudder, et al., 2019 ³¹ United States	A series of commercial whiteboard animation videos created by 'Osmosis' were made available to students.	Multiple topics related to basic science concepts.	First- and Second-year medical students. (n=1135)	Engagement metrics were tracked for the 2016-2017 academic year within the Osmosis platform for all students who created an account across the 3 campuses of the Institution.	The adoption of the Osmosis platform varied among medical students. 50% of the students signed up for an account on the Osmosis platform. Although the use of the platform across campuses was uneven, it was most significant when there was overt support by faculty.

Author, Year of Publication, Country	Source of the whiteboard animation video	Topics of the whiteboard animation video	Study Participants	Evaluation Method	Impact of the whiteboard animations on students' learning
Tackett et al., 2021 ³⁰ United States	A series of commercial whiteboard animation videos created by 'Osmosis' were made available to students.	Cardiovascular Systems	First-year medical students. (n=232)	Survey	Most students found whiteboard animation videos helpful for learning and preferred these videos over the traditional lecture format.

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