Review Article

Online Illustrations for Students' Self-Learning: A Review using Dentistry as an Example

Thai Yeng[1*], Anthony J O'Sullivan[2] and Boaz Shulruf[1]

[1]*Faculty of Medicine, Medical Education, University of New South Wales, Australia*
[2]*St George and Sutherland Clinical Hospital, University of New South Wales, Australia*

Abstract

Introduction

With the growth of available video and multimedia resources, there is a need to revisit the relevance of illustrations in contemporary dental education. Knowing whether online illustrations help students self-learn will provide information for educators on whether illustrative materials are self-explanatory in the study topic of interest.

Materials and methods

This literature review followed the "Preferred Reporting Items for Systematic Reviews and Meta-Analysis" (PRISMA) guidelines. Scopus was the selected database as it includes Medline, Embase and Compendex coverage of studies published to July 2020. The search strategy consisted of a string of important keywords: 1) Type of activity "Learning": (learn OR educat OR stud); 2) Medium of learning "Online": (e-learning OR online OR virtual OR internet); 3) Field of study "Dentistry": (dental OR dentistry); and 4) Type of material "Visual": (visual OR photo OR image OR illustrat OR manual skills).

Results

Three studies met the inclusion criteria. Two studies were conducted as questionnaire-based surveys and one was carried out as a focus group discussion. Evidence suggests students found online illustrative materials important, helpful and they enhance confidence in their learning.

Conclusion

Visual learning is important in education and based on these review findings, students found online illustrations useful. This allows us to reaffirm the importance of including pictures and illustrations during our learning course.

Introduction

Background

Effective teaching is critical for student learning, especially in professional specialist fields such as dentistry [1]. Developing appropriate learning activities varies across sectors; while groups of medical and nursing students might be introduced to a patient scenario during a ward round, dentistry training is based more on building a one-to-one relationship between student and patient [2]. An international survey among health educationalists in dentistry showed that a variety of learning tools, such as virtual reality with haptic devices, virtual learning environments (web-based platforms), telecommunications (teledentistry) and rich media (video, audio), etc., are widely used at universities [3]. Videography can also be a useful tool for teaching diagnosis and management of rare diseases that students are unlikely to see during training [4]; for illustrating dental laboratory steps [5]; for demonstrating clinical procedures and treatment of real patients [4]; or for videoconferencing courses that do not require audience participation in practical exercises [6]. Unfortunately, such video content is rarely subject to any formal review and leads to concerns regarding the reliability, degree of accuracy and scientific validity of video content [7]. For example, some dentistry videos are too simplistic, some only show the first part of a procedure, and others do not clarify key learning objectives [4]. Being a popular source of information, one study assessed 120 YouTube videos aimed at dentistry training. It reported that none of the assessed videos accurately reflected the nine important points highlighted in the International Association of Dental Traumatology (IADT) guidelines for managing dental injuries [8].

In dentistry, photographs form an important record and are often used in clinical education to help ensure all students have a broad, case-based training that complements their experiences in the clinic [2]. Photographic images are used to record important details during initial dental examinations and treatment planning for patients facing aesthetic dentistry, implant dentistry, oral surgery, endodontics, orthodontics, or periodontics [9], for example. In addition, high-quality photographic documentation taken throughout dental treatment [10] provide documentary evidence, and crucial legal records for some clinical cases [9]. In terms of helping students meet the professional competence levels for training of health specialists [4], a study looking at dental students' preferences towards various teaching strategies reported that students preferred the use of visual aids in the form of clinic and laboratory pictures (or illustrations) [11]. Illustrations, be it a single picture or a series of photos [12] depicting the flow of clinical procedures, offer opportunities for dental students to learn more effectively [13] by helping to clarify a topic and making it easier to understand [11].

A set of guidelines for educators considering text-accompanying illustrations has been proposed [14] and includes the following 10 recommendations:

a. Select pictures that overlap with text content

b. Easy-to-follow texts that readily elicit visual imagery are unlikely to yield more cognitive benefits from the inclusion of pictures

c. Basic reading skills are prerequisite for positive effects of pictures to emerge

d. In light of the desired learning outcomes, choose pictures for their function: representational (to make the text more concrete), organizational (to make the text more coherent), interpretational (to make the text more comprehensible), or

transformational (to make the text more memorable)

e. In general, the more complex the text, the more likely pictures will be helpful

f. Computer software that uses integrated displays may be more effective than those using split displays where pictures and text appear in separate locations on the screen

g. Consider students' individual learning styles (for example, "imager" cognitive styles versus "verbalizer" styles)

h. Realize that illustrations or pictures are not necessarily perfect, nor easy for students to comprehend or remember and will be useless if the learner does not perceive the illustrated content as intended

i. Illustrations are designed to improve a reader's recall of text information; and

j. The illustrations should direct students to do something with the pictures, such as constructing pictorial representation.

This review only searched for studies focusing on illustrative materials such as pictures and photos; it did not include any specific video, virtual, multi-media, or three-dimensional learning resources. Although videography serves as a useful learning resource, in some situations, it may not be available for teaching purposes since some patients may not consent to be videoed when they are experiencing acute dental pain, severe facial swelling, are extremely anxious, and/or dental phobic. With the growth of video and multimedia resources available, there is an urgent need to revisit the relevance of online illustrations in contemporary dental education because video materials is not always available. Understanding the extent to which online illustrations help students self-learn will assist educators to select illustrative materials that make a specific topic more self-explanatory. This review searched for studies focusing on the use of illustrative materials, such as pictures and photos, in dentistry training.

Research question

Using dentistry as an example, to what extent do online illustrations enhance students' self-learning?

Methodology

This literature review followed the "Preferred Reporting Items for Systematic Reviews and Meta-Analysis" (PRISMA) guidelines [15]. The database used for the study was Scopus. Scopus was selected because it holds 4600 indexed health science titles including the entire databases of Medline, Embase and Compendex [16]. No time limit was set for the search of studies prior to July 2020.

Search criteria

The search strategy comprised the creation of a string of important keywords: 1) Type of activity "Learning": (learn* OR educat* OR stud*); 2) Medium of learning "Online": (e-learning OR online OR virtual OR internet); 3) Field of study "Dentistry": (dental* OR dentistry*); and 4) Type of material "Visual": (visual* OR photo* OR image* OR illustrat* OR manual skills*). The use of * was used in the search for enhancing inclusion words: for example, photo* may include photography, photograph, photos, etc.

Selection procedure

The lead author identified all titles and abstracts. After screening the abstracts and titles, inappropriate articles were removed based on the eligibility criteria. The first and second authors reviewed the remaining full-text versions. Disagreements between authors were reviewed by the third author and resolved by consensus. The results of the screening process are shown in (Figure 1).

Eligibility criteria

To be included in this review, studies must have been published as peer-reviewed journal articles or conference papers in English, with all quantitative and/or qualitative analyzes fully reported. Studies must also involve dental students. No geographical limitations were imposed. Studies were excluded if they were unpublished theses, not in English, or were dissertations or commentary articles, and no analysis of data was undertaken or reported. In addition, studies that included three-dimensional (3D) images, web-based practical courses, virtual 3D reality simulations, manual dexterity training, simulation training videos, haptic drilling simulations practical/clinical course videos, or teledentistry were excluded. Any participants that are classified as non- dental personnel (medical doctors), oral therapists and/or dental hygienists were excluded.

Data extraction

A data extraction template was designed to extract the following: (a) location; (b) date; (c) study type; (d) access to visual resources; (e) learning experience with visual resources; (f) role in clinical education; and (g) educational implications of visual learning in dentistry. The data from each study were independently extracted by the three reviewers.

Results

Three studies met the inclusion criteria, and all were published in the European Journal of Dental Education.

Study characteristics

Two studies were conducted as questionnaire-based surveys and one study was carried out as a focus group discussion.

Synopsis

The findings of whether online illustrations enhance self-learning for dental students are summarized in (Table 1).

Summary of findings

Access to visual resources

Having access to illustrated online resources, such as photos of specific clinical dental or laboratory procedures, allowed students to better understand the learning materials [4,17,18].

Learning experience with visual resources

Students' reported the importance and helpfulness of online illustrations in their learning of clinical dentistry; for example, photos of patients' cases or step-by-step procedures [4,17,18].

Role in clinical education

Online illustrative materials were regarded by students' as an adjunct to supplement conventional formal learning contents offered at each dental school [4,17,18].

Educational implication on visual learning

Online illustrative materials were expected to improve the quality of learning [17], enhance clinical confidence, and cultivate learning experience for students [4]. The flexibility to determine where, when, and how to access visual learning resources was reported as beneficial for students' dental education [18].

Discussion

This review aimed to explore the literature on ways online illustrations enhances students' self-learning, using dentistry education as an example to explore visual tools. Compared to videos, online illustrative materials more easily complement educators' teaching resources as photographs are often taken routinely in dentistry; for example, for evaluative [19], diagnostic [20,21], documentary and legal evidence [9]. As a valuable educational resource, they help students to see more clearly the procedures necessary to carry out clinical treatments. Three studies were identified in this review that reported illustrative materials being used in clinical dental teaching. In an era where many dental institutions already use videos and virtual imaging resources for teaching, this review highlights important evidence to support the value of online illustrations as a relevant learning tool for dental students. The results suggest students prefer courses with pictures over those without illustrations and reaffirms the importance of including pictures and illustrations in our courses.

Online learning allows students to self-learn anywhere, at any time [23,24], and the students perceiving that online courses are easy to access will help make the course more enjoyable for them [25]. In addition to illustrative materials stimulating thinking and improving learning, the effective use of visual aids relieves a monotonous learning environment and helps students develop and increase personal understanding of the topics. Students find visual images most useful and relevant when they are directly related to the course content [11]. Overall, they promote better self-learning for students. Online illustrative materials are regarded as effective learning tools if they help to make the lesson clearer or easier to understand [11] and students highlighted the importance of photographic clinical sequences for explaining the complexities of simple to advance treatments [4,17,18]. These might include class 1 dental restorations, direct pulp capping, root canal treatment, crown preparation, and impression taking for removable partial dentures, etc. For effective self-learning, clear, sequential online illustrations that capture each step/stage are essential. For example, students will see how to perform an emergency root canal treatment on an anterior tooth using the step-by-step images, including the access cavity, instrumentation techniques and medicaments used.

Table 1: A summary that provides an overview of the main points from the literature review.

| Publications	Locations, date, and study type	Summary of findings	Educational implications of visual learning	Reference
Integrated learning in dentistry: baseline data and first evaluation at the Dental School of Basel	Switzerland 2008 Questionnaires	**Access to visual resources** 94% of respondents positively prefer access to online learning materials as they offer better visualization. **Learning experience with visual resources** 96% of respondents positively agree that visualization of learning contents is important. **Role in clinical education** Significant correlation is found between the aspects 'flexibility regarding location' and 'visualization of learning content'. There are no significant differences between different student years concerning the aspects of 'visualization of learning content'.	Students expect the quality of their studies to improve with regularly updated learning materials.	[17]
Learning clinical procedures through internet visual resources: A qualitative study amongst undergraduate students	Hong Kong 2015 Questionnaires	**Access to visual resources** The manufacturer's manual was quoted as one source for learning clinical procedures because it displays detailed illustrations for carrying out procedures. **Learning experience with visual resources** Participants reported visual illustrations such as 'step-by-step' procedures with clear photos were useful. Some students mentioned that visual resources were useful in learning certain simple clinical procedures that were meant to be self-learned, and in learning advanced procedures that were not required at undergraduate level. The main reported advantages of visual resources included the visual impact and inclusion of real patient cases. **Role in clinical education** Visual resources were mainly regarded by students 'as a supplementary learning source, to reinforce the mainstream clinical learning'.	Visual resources were generally viewed as enhancing students' clinical confidence, enriching their learning experience, and serving as an important supplement to formal learning.	[4]
Students' evaluation of online course materials in fixed prosthodontics: a case study	United States of America 2001 Questionnaires	**Access to visual resources** 100% of survey respondents reported they had access to and used the online materials. The online materials included the syllabus, handouts, and lecture materials. For example, photographs, detailed descriptions and photos of laboratory instruments and procedures. **Learning experience with visual resources** Most students reported using the online materials to be either helpful (16%) or very helpful (80%). **Role in clinical education** When asked how these online materials should be used, more than half responded that the online materials should be a mandatory supplement to the traditional lecture format.	Students reported the most helpful aspects of having online materials were the convenience of access and the ability to view materials at their own pace.	[18]
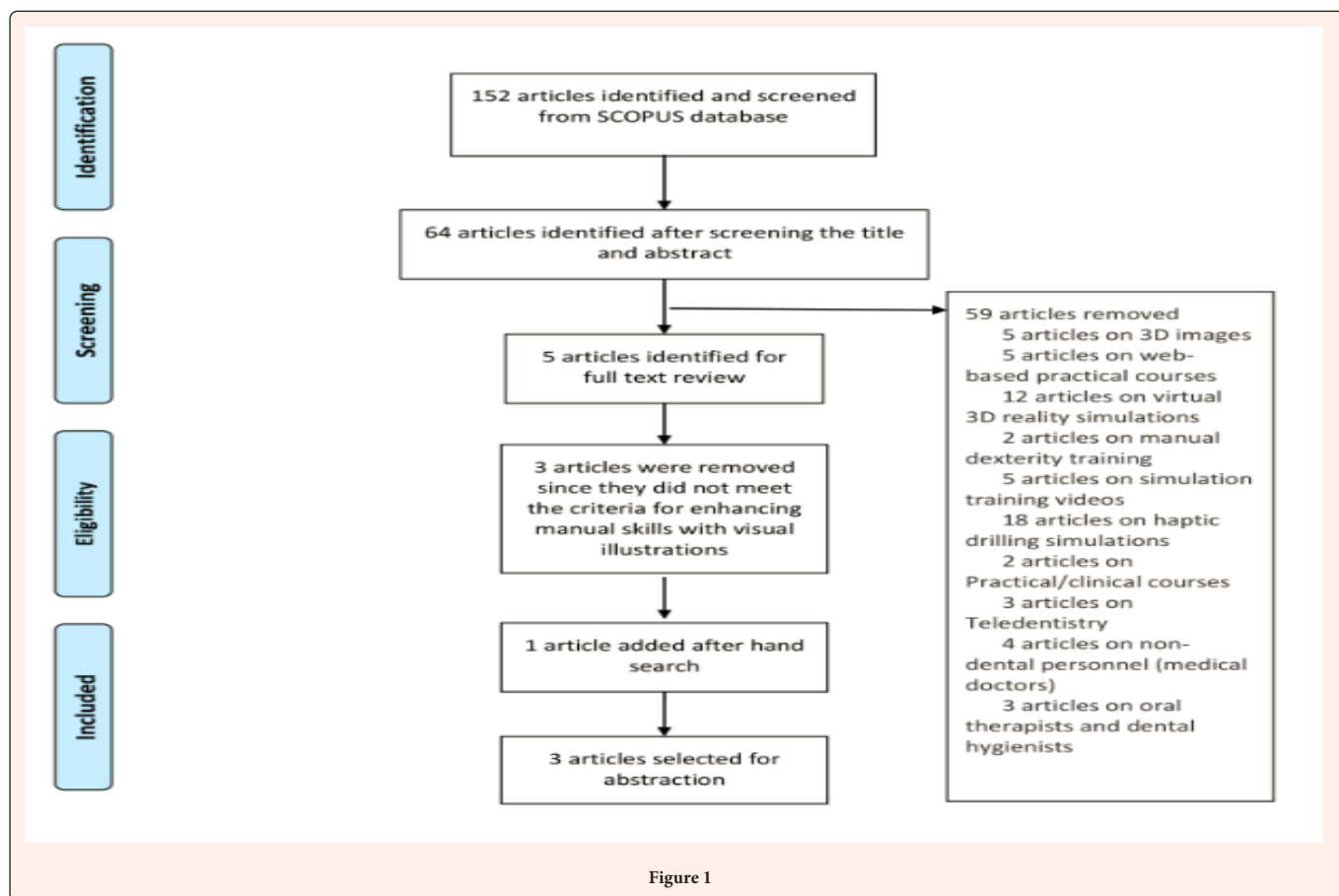
Figure 1

This review supports the educational literature in suggesting that using visual elements in teaching results in enhanced learning [26]. Dental students affirmed that online illustrative materials were adjuncts that positively support mainstream dental teaching [4,17,18]; that is, as text supplements, not as text substitutes [5,27]. As educators are regarded as learning facilitators, it is their role to create an environment that makes students' access to learning material as uncomplicated as possible [28]. According to students, the inclusion of observable images enhances in their teaching material enhances their clinical skills and confidence [4,17,18]. For example, in dental traumatology, it is difficult for students to gain adequate clinical experience in diagnosing and managing patients presenting with traumatic dental injuries not only because the occurrence of such injuries is unpredictable and relatively unlikely in private practice, but also because there are many different types of injury [22]. Clinical pictures or photos are of great benefit to students' self-learning on this topic and supplement a potential lack of TDI experience.

It must be noted that the reviewed studies have limitations, such as small sample size, as well as selection and information bias. Small sample size may make it difficult to determine if a particular outcome is of significance. For example, in one of the reviewed studies, the student sample (n=18) happened to be the dental school's smallest cohort of fourth-year students [17]. Selection bias also occurs wherever the selection of people, groups, or data for analysis is not randomized. If different studies lack standardization and utilize different methodologies-questionnaire-based research [17,18] versus focus group discussion [4] – outcome data should be interpreted with caution. A lack of accurate measurements of key study variables can create information bias, another distortion in the measure of association. For example, open-ended questions in questionnaires are often difficult to assess and are subject to interpretation [4], and close-ended questions may not offer the researcher the opportunity to follow up on ideas or to clarify issues [17]. As such, these limitations may fail to explain the underlying reasons for the outcome of students' perception of online illustrations enhancing their dentistry learning experience.

Limitations of the review

It must be noted that this review only searched for studies focusing the use of illustrative materials in dental teaching such as pictures and did not feature any specific studies featuring video, virtual, multi-media, or three-dimensional learning resources. With only a limited number of papers identified, this review identified an important lack of information on use of online illustration in dental education for enhancing student engagement, critical thinking, and manual skill learning. Also, no mention was made as to whether the questionnaires of the included studies have been validated or had their reliability (Cronbach's alpha) assessed. Since this review only focused on dental students acquiring knowledge and competence in performing clinical procedures through online illustrations, it would be beneficial to investigate whether other allied health education, such as nursing or medicine, have similar finding. Currently, the authors are investigating medical students' perceptions and attitudes towards learning with online illustrations.

Conclusion

Visual learning is an important aspect of education and based on our review findings, students find online illustrations useful. This allows us to reaffirm the importance of including pictures and illustrations in course notes. Since there are few studies on the use of illustrative material in dental education per se, further research is indicated in this area.

Acknowledgement:

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