



Original Article

Determining the impact of pre-lecture educational video on comprehension of a difficult gross anatomy lecture



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المخلص

أهداف البحث: يعتبر الطلاب محاضرات التشريح صعبة لاحتوائها على معلومات معقدة تتطلب التصور الثلاثي الأبعاد للفهم. وبدون التحضير المسبق لموضوع المحاضرة، يمكن أن يكون فهم الموضوع تحدياً معرفياً من خلال المحاضرة فقط. لذا تهدف هذه الدراسة للبحث في تأثير النشاط القلبي على شكل مشاهدة فيديو على استيعاب الطلاب للمحاضرة.

طرق البحث: أجريت هذه الدراسة التجريبية على ٢٥٤ من طلبة السنة الأولى طب للعام الأكاديمي ٢٠١٧/١٦ و٢٠١٨/١٧، الذين لم يتعرضوا مسبقاً لموضوع المحاضرة قيد البحث. تم تقسيم الطلبة من كل دفعة إلى مجموعتين، وتم عرض مواد فيديو مختلفة لكل مجموعة. طلب من المجموعة أ مشاهدة فيلم حركي، بينما شاهدت المجموعة ب فيديو تعليمي متعلق بموضوع المحاضرة. بعد ١٥ دقيقة، حضرت المجموعتان محاضرة عن تشريح القلب، التي تم إعطاؤها من قبل استاذ تشريح مؤهل. بعد انتهاء المحاضرة، تم قياس استيعاب الطلاب للمحاضرة من خلال اختبار بعدي باستخدام عشرة أسئلة متعددة الخيارات.

النتائج: أظهرت نتائج الاختبار ارتفاع واضح في نتائج المجموعة ب بالمقارنة مع المجموعة أ من الطلاب.

الاستنتاجات: أظهرت هذه الدراسة أن نشاط ما قبل المحاضرة نجح في تثبيت بعض المعرفة السابقة للطلبة قبل المحاضرات. الأمر الذي يتماشى مع نظرية الحمل المعرفي التي تصف انخفاض الحمل المعرفي للمتعلمين بواسطة تحفيز المعرفة السابقة.

الكلمات المفتاحية: الحمل المعرفي؛ محاضرة تشريح الجسم؛ نشاط ما قبل المحاضرة؛ المعرفة السابقة؛ نشاط عرض الفيديو

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Abstract

Objective: Students commonly perceive gross anatomy lectures as difficult because they contain complex information that requires three-dimensional visualisation in order to be understood. Without prior preparation, a gross anatomy topic expounded via lecture can be cognitively challenging. Hence, this study aimed to investigate the impact of a pre-lecture activity in the form of viewing a video on students' lecture comprehension.

Method: A quasi-experimental study was conducted using 254 first-year medical students with no prior exposure to the lecture topic during the 2016/17 and 2017/18 academic sessions. The students from each batch were divided into two groups and exposed to different video material. Group A watched an action movie, while Group B watched an educational video related to the lecture topic. After 15 min, both groups attended a lecture on the gross anatomy of the heart, which was delivered by a qualified anatomist. At the end of the lecture, their understanding of the material was measured through a post-lecture test using ten vetted multiple choice true/false questions.

Results: Group B's test scores were found to be significantly higher than Group A's ($p > 0.001$, t -stats [df] = -4.21 [252]).

Conclusion: This study concluded that the pre-lecture activity had successfully provided the students with some prior knowledge of the subject before they attended the lecture sessions. This finding was aligned with cognitive load theory, which describes a reduction in learners' cognitive load when prior knowledge is stimulated.

Keywords: Cognitive load; Gross anatomy lecture; Pre-lecture activity; Prior knowledge; Video-viewing activity

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Introduction

Gross anatomy is a cognitively challenging medical subject that requires learners to have good three-dimensional (3D) visualisation and visuospatial ability to comprehend anatomical structures.^{1–4} Faculty members have long faced a great challenge when teaching gross anatomy,^{5,6} a subject which medical students often perceive as dull and content-driven.⁷ The fact that many medical students and recent graduates are clinically incompetent due to their lack of anatomical knowledge has caused an uproar among the anatomy lecturer community.^{8,9} Motivated by the urge to make anatomy teaching more effective, anatomy lecturers are assiduous about simplifying their instructional materials and instilling interest in learning anatomy. They have introduced various innovative approaches and invented high technology tools to facilitate anatomy instruction.^{10–15} Nevertheless, none of these methods have been proven superior.¹⁶ Hence, various teaching methods are used in the instruction of modern anatomy to supplement each other, including lecturing.^{9,16,17}

As the most feasible and cost-effective teaching method, lecturing remains indispensable for teaching large groups, especially in developing countries.^{18,19} Rather than being seen as an implicit “spoon-feeding” style of teaching, modern lecturers in medical education aim to provide some prior knowledge to the students to prepare them for subsequent knowledge integration and application in a more student-centred learning environment.²⁰ However, teaching a difficult and content-driven subject through lectures can undoubtedly impose cognitive overload on students if the lectures are not prepared well^{19,21}; thus, it is pertinent to find a way of designing an interactive lecture session.^{21,22} There are many published guidelines on producing engaging and interactive lectures.^{19,23,24} Most of these guidelines emphasise intra-lecture activities that address the problem of declining attention,^{25–27} but not many emphasise prior preparation before the lecture. In fact, lecturers often ignore students’ prior preparation, which tends to be self-regulated and controlled autonomously by the students. Despite the emergence of flipped classrooms, blended learning, and massive open online courses (MOOCs), through which pre-lecture activities are often covered automatically before students enter formal classes,^{28–30} there is a lack of evidence regarding the impact of a structured pre-lecture activity on students’ learning performances, particularly when it comes to knowledge acquisition and comprehension.³⁰ Likewise, the applicability and feasibility of conducting pre-lecture activities have been poorly explored in the context of anatomy lectures.

In order to impart some control and monitoring of students’ prior preparation before the lecture, a structured pre-lecture activity can be conducted. However, to ensure its efficiency, a pre-lecture activity should be designed in a way that can successfully instil prior knowledge.³¹ There are many ways to conduct a pre-lecture activity: either through the online provision of learning materials via e-learning platforms or activities (e.g. games, video viewing, and quizzes) during a face-to-face meeting prior to class.^{32,33} Regardless of how the pre-lecture activity is conducted, it is pertinent to ensure that this activity falls under the radar of lecturers’ monitoring if it is conducted through an online platform, nor should it consume much of the formal class time if it is conducted prior to the lecture session.³⁴ It is more important that the activity caters to differences in students’ learning styles and pacing.³¹ Together, these elements fortify the fact that students can then proceed to the lecture session with successfully instilled ‘prior knowledge’.

Accordingly, this study aimed to investigate the impact of a pre-lecture activity (i.e. viewing a pre-lecture educational video) on students’ comprehension of a gross anatomy lecture. We purposely selected pre-lecture educational video-viewing, as this activity can be easily monitored and does not consume much time. Since the subject of anatomy was used as the content medium for the lecture and the selected anatomy topic was of a high difficulty level,³⁵ we anticipated that our lecture session would impose a high cognitive load on the students. We hypothesised that pre-lecture video-viewing would be able to reduce their cognitive load by instilling some prior knowledge in them. This strategy would allow students to utilise the previously learned prior knowledge during the lecture, thus promoting knowledge acquisition through increased ability to understand the lecture content. Therefore, we hypothesised that fewer cognitive resources would be allocated to the 3D visualisation of the learned anatomical structures.

Materials and Methods

Study design, population, sampling method, and subjects

We conducted a quasi-experimental study in which we compared the level of understanding of the lecture content between two groups of students who were exposed to different pre-lecture video materials. Our target population consisted solely of medical students from the Universiti Sains Malaysia (USM); however, we could only apply the convenience sampling method by selecting 254 newly registered first-year medical students for the 2016/2017 and 2018/2017 academic sessions. Since the study took place during orientation week for both batches of students, bias from previous exposure to anatomy topics and frequent exposure to lectures were eliminated. Participation was on a voluntary basis, and verbal consent was obtained prior to the study.

Research group

The consenting participants were divided into two groups: Groups A and B. Group A was exposed to a movie that was

not related to the lecture content, whereas Group B was asked to watch an educational video related to the lecture content. The video-viewing sessions were conducted 15 min prior to the lecture session.

Research tools

The movie used in this study, 'The Warrior's Way', was purposely selected because its plot opens with a swordsman on an assassination mission. The first 15 min of the movie contain nerve-wracking scenes that can attract and sustain students' focus. This element was important, as it ensured that the Group A students would not be mentally prepared for the lectures.

On the other hand, the educational video was about the anatomy of a human heart. This video contained crystal-clear animated 3D diagrams of the heart coupled with verbal explanation and appropriate labels. An analogy was used to describe the shape of the heart valve, and clinical applications were introduced at the end of the video. Since the video only took 5 min to watch, it was replayed three times to ensure a similar duration of exposure to pre-lecture video-viewing between the two groups.

The lecture topic selected for this study was the 'gross anatomy of the heart'. This topic was selected because content experts have rated it as one of the most difficult anatomy topics.³⁵ The lecture materials were prepared using the PowerPoint software by a qualified anatomist who utilised the lecturing strategies of the Cognitive Load Theory-based Lecture Model (CLT-bLM^{19,21}). This effort was crucial to ensure efficient delivery of the difficult topic through the elimination of extraneous distraction.

The students' comprehension of the lecture topics was measured using ten vetted multiple choice true-false questions (MTFQs). The MTFQ was selected as the assessment tool because they allow for objective marking and do not consume much time. Both the lecture and MTFQs were prepared according to the learning outcomes provided.

The intervention and data collection

The research intervention began with the process of group allocation, whereby the students were divided into two groups. Both groups were separated in different lecture halls and exposed to the video materials for 15 min. Students in Group A watched the action movie, while students in Group B watched the educational video about the anatomy of a human heart. Once the video-viewing session ended, both groups assembled in a lecture hall for the lecture session.

A lecture on the gross anatomy of the human heart was then delivered by a qualified anatomist with more than ten years of experience teaching anatomy. The lecture's delivery aligned with the CLT-bLM lecturing strategies. The lecture ended after 30 min, followed by an assessment session. All students underwent the post-lecture assessment by answering the ten MTFQs.

Data analysis

Data analysis was performed using SPSS version 23. The data were entered, checked for data entry error and

missing values, explored, and cleaned. To avoid biased estimates during data analysis, missing values were imputed with an observed median value for cases of less than 50% missing value.³⁶ Prior to running the statistical test, assumption for the independent t-test was checked, and the level of significance (α) was set at 0.05 with a confidence interval of 95%. Cohen effect size was calculated using the Effect Size Calculator for T-Test³⁷ to investigate the actual impact of the intervention on the test scores.

Results

Our analysis revealed that the Group B students, who were exposed to the educational video, in the 2016/2017 academic session outperformed their peers in Group A in the post-lecture test. The difference in the test scores was highly significant, and the Cohen effect size was large, indicating that the students' results were due to the impact of the video materials allotted to them. Nevertheless, there was no significant difference in the post-lecture test scores between the two groups for the 2017/2018 academic session. Despite the insignificance in this difference, Group B's scores were higher than Group A's, and the Cohen effect size was very small, which indicated that the difference was minimal. When combined, the overall result showed that Group B had significantly higher post-lecture test scores compared to Group A with a medium Cohen effect size. Hence, it can be concluded that the pre-lecture educational video-viewing had a positive impact on the students' lecture comprehension. The results are summarised in Table 1.

Table 1: Difference in post-lecture test scores between the study groups.

Groups	Score Mean (SD)	t-stats (df)	p- value	95% CI		Cohen effect size (d)
				Lower	Upper	
Academic session 2016/17						
Group A (n = 61)	48.13 (14.95)	(119)	<0.001	-16.64	-6.71	0.85
Group B (n = 60)	59.80 (12.45)					
Academic session 2017/18						
Group A (n = 68)	57.23 (8.56)	(131)	0.359	-4.43	1.62	0.16
Group B (n = 65)	58.64 (9.11)					
Overall						
Group A (n = 129)	52.93 (12.80)	(252)	<0.001	-9.20	-3.34	0.53
Group B (n = 125)	59.20 (10.81)					

Independent-t-test was used to determine the means difference between the study groups. Significance level was set at 0.05. SD = Standard deviation; df = Degree of freedom; CI = Confidence interval. Cohen effect size was calculated using the Effect Size Calculator for T-Test.³⁷ Cohen effect size thresholds: Small = 0.20; medium = 0.50 and large = 0.8, very large = 1.13.³⁸

Discussion

Our study revealed a significant positive impact of a pre-lecture activity in the form of video-viewing on students' comprehension of a difficult anatomy lecture. This finding aligned with previous studies, which have reported improvement in students' learning performances after undergoing pre-lecture activities.^{38–40} Moravec et al.³⁹ reported a significant increment in students' task performance after exposure to two different forms of pre-lecture activities: a narrated PowerPoint video and a pre-class worksheet. The study reported that both pre-lecture activities were equally effective for obtaining the targeted achievement.³⁸ Likewise, a study by Stull et al.⁴⁰ reported that students' academic achievement related positively to a pre-lecture activity in the form of online quizzes, but not with pre-lecture students' initiated inquiry with the teachers, either online or in-person.³⁹ This study proved the importance of supplying a structured pre-lecture activity in promoting students' understanding of lecture content. A case study by Seery and Donnelly⁴¹ revealed that a structured pre-lecture activity could equalise the increment of learning performance during a lecture between students who had prior knowledge of the topic and those who did not. The findings of this study suggested that the use of a well-prepared educational video containing crystal-clear 3D animated diagrams, attentive visual cues, and clear verbal explanations with highlighted text might have contributed to our positive result.

An educational video is a convenient and effective tool to convey information and work example to learners.^{41–43} Tilli and Suhonen,⁴² described the effectiveness of educational video-assisted learning used to replace routine learning tasks in an introductory physics course for engineering students. They reported that video-assisted learning significantly improved the students' final examination grades and motivation to learn.⁴¹ Interestingly, they found that students who failed the course never attempted to watch the video materials provided to them.⁴¹ The effectiveness of video-assisted learning is not limited to formal institutionalised contexts; this method has been proven to be effective in providing knowledge about concussion injury to hockey players as an injury prevention measure.⁴² A systematic review of educational video viewing for surgical education highlighted the positive impact of this learning method on knowledge acquisition, learning duration, surgical learning time, acquisition of surgical skills, and students' satisfaction with their learning.⁴⁴

Evidence of the positive effectiveness of educational video-assisted learning notwithstanding, selection of video materials for teaching and learning purposes should be meticulously undertaken to ensure its efficiency in promoting students' learning.⁴⁵ For instance, video material with annotation software was noted to result in surface learning approaches and test anxiety on examination grades despite having positive correlations with students' exam grades.⁴⁶ Hence, the selection of instructional material for a pre-lecture activity is crucial for enhancing students' understanding.

In this study, the aim of the pre-lecture video was not only to reduce the amount of lecturing time spent on explanations of complex anatomical structures but also to instil or stimulate some 'prior knowledge' before the lecture session. We postulated that prior knowledge would be successfully

instilled during the pre-lecture video-viewing session and evidenced by high test performances. From a cognitive science perspective, successfully instilled prior knowledge indicated that the learners' working memory successfully processed the information received during pre-lecture video viewing into a schema (i.e. an organised knowledge structure) and transferred to long-term memory for permanent storage.^{47,48} During the lecture session, the stored schema, which reflects prior knowledge, was probably retrieved from the long-term memory and incorporated with the newly developed schema (i.e. new information received during the lecture) in the working memory for information processing.⁴⁹ This schema integration process could take various forms, such as schema assimilation (i.e. prior knowledge and newly received information were incorporated to assimilate the whole knowledge⁴⁹; schema elaboration (i.e. prior knowledge and newly received information were at the same level and combined to produce a higher level schema⁵⁰; and schema accommodation (i.e. prior knowledge was integrated with newly received information concerning different content.⁵¹ These phenomena explained the higher test scores of the students who attended the pre-lecture educational video-viewing session compared to those who watched the entertainment movie.

Although it could be argued that the students' ability to understand the lecture content was multifactorial, the learners' cognitive function should be the central tenet of the explanation. When learning difficult material, a high intrinsic load is imposed on the learner, which is a type of cognitive load with a high number of contributing elements (i.e. information) and interactions among these elements (i.e. integration of information⁵²). With high intrinsic load imposed during learning, learners need to use more working memory resources to convert new information received during the learning session into a schema.⁵³ Unfortunately, the working memory processing capacity is limited, and it can only construct a limited number of schemas at a time.⁵⁴ If a learner receives multiple pieces of information simultaneously, his or her working memory might not be able to process the information if capacity is exceeded.⁵⁵ Therefore, the information is 'drained out' from the memory system, and the learner is said to be experiencing cognitive overload.⁵⁵

In our study, we postulated that there would be a reduction in cognitive load during the lecture for students who viewed the pre-lecture educational video. This hypothesis was aligned with Seery and Donnelly's⁴¹ finding that the provision of pre-lecture resources could successfully reduce students' cognitive load. We further hypothesised that the learning points contained in the educational video would be successfully converted into schema by the students' working memory and transferred to the long-term memory for storage. The schema retrieval and integration process (i.e. utilisation of prior knowledge during the lecture) indeed helped to conserve working memory resources during the lecture, as no mental effort was used to comprehend prior knowledge.^{56,57} Students might have used the 'freed' working memory resources to process new information received during the lecture through schema assimilation, integration, and elaboration.

Furthermore, we postulated that the video-viewing activity itself would facilitate students' lecture comprehension.

In alignment with the principles of Cognitive Theory of Multimedia Learning (CTML), the educational video used in this study contained 3D coloured animated diagrams coupled with verbal explanations and highlighted text. The instructional design theory of CTML describes learning occurrence when multimedia instructional material is designed in a manner that follows human cognitive function.⁵⁸ This theory is based on a strong foundation of working memory research conducted over the past three decades that demonstrated through various empirical studies that CTML-based instructions result in efficient learning.^{59–64} The triarchic framework of CTML describes three types (Essential, extraneous and generative processing).⁵⁸ The essential processing is the cognitive effort required to encode relevant words and pictures from a multimedia presentation into sensory and working memory.⁶⁵ The extraneous processing is a cognitive effort invested in processing unrelated extraneous information that could result in high cognitive load.^{58,65} The generative processing is cognitive effort invested in making sense of the acoustic and iconic representations of materials and is influenced by motivation.^{58,65}

Prior to the intervention, the educational video was selected carefully to ensure its effectiveness. Through our observation, the video utilised several principles of CTML. Among these were the contiguity, signalling, segmenting, modality, coherence, and voice principles. In this video, the diagrams and their related textual material were presented simultaneously (i.e. ‘temporal contiguity principle’) on the same screen (i.e. ‘spatial contiguity principle’^{66,67}). The video material was easy to understand because the presentation of diagrams and textual materials was coupled with visual and auditory cues (i.e. ‘signalling principle’⁶⁸) and organised in learner-paced segments (‘segmenting principle’⁶⁹). The animated diagrams were explained verbally (‘modality principle’⁷⁰) and spoken by a friendly human voice rather than a machine (‘voice principle’⁷¹). Many well-designed studies have empirically proven that these principles are effective.^{58,66,68,71,72} Hence, we postulated that there would be successful prior knowledge construction in students who were exposed to the pre-lecture educational video, and this prior knowledge was successfully utilised for their comprehension of the lecture content.

Nevertheless, this study had several limitations. First, it was a quasi-experimental study conducted as one of the activities during orientation week. Hence, randomisation and stratified random group allocation were not possible due to time limitation. We have to assume that factors influencing students’ cognitive ability were similar among the participants as they were all first-year medical students who had achieved a certain standard of qualification during their university entry assessment. However, we postulated that the use of non-randomised subjects could be a factor contributing to the insignificant result for the 2017/2018 cohort. Students’ baseline knowledge, which, ideally, should be measured prior to educational video-viewing, was not measured for the same reason. Hence, we suggest that future investigations of the impact of pre-class video-viewing on students’ learning performance should be explored in a better-designed research environment. The outcomes of future studies should not be limited to students’ cognitive performance; rather, they should include the other two

learning components—psychomotor and affective learning. Lastly, future studies should also explore the pre-post difference with elements that reflect learning improvement.

Conclusion

From this study, it was evident that instillation and stimulation of prior knowledge were important for the comprehension of learning material during a teaching and learning session. In the lecture context, prior knowledge was instilled and stimulated through a pre-lecture activity that can be conducted in various forms. Nevertheless, the type and content of the activities should be appropriately designed to ensure their effectiveness for prior knowledge construction. The utilisation of educational theories (i.e. CLT and CTML) during the preparation of pre-lecture activities would enhance the effectiveness of these activities, thereby increasing the comprehensibility of lecture content.

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Conflict of interest

The authors have no conflict of interest to declare. The study comprised one of the activities in the orientation week for first-year medical students.

Ethical approval

The activities conducted in this study were part of the orientation week programme for first-year medical students. Hence, ethics committee approval was not sought. However, consent for publication of this study was obtained in advance.

Authors’ contributions

SNHH planned and managed the study and is the principal author of this manuscript. She conceived and designed the study, conducted data collection, analysed the results, and wrote the initial and final drafts of the article. AALS contributed to this study’s data collection process. SAS contributed to the data collection process of this study. JAMM contributed significantly to the data collection process of this study. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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