Discover Education

Perspective

Reviving the lecture: using visually dynamic approaches to teach physiological concepts

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Abstract
The educational benefit of the traditional didactic lecture to learners in Higher Education is hotly debated. Given increasing student numbers, existing technical set ups and many logistical concerns, lectures remain the norm in many Higher Education Institutions (HEIs). In this personal view piece, we discuss the benefits, opportunities, and challenges of incorporating dynamic teaching approaches, including "draw-alongs" and animations into undergraduate lectures, typically with large class sizes, to create more engaging and interactive lectures for learners.

1 Introduction

The effectiveness of the traditional lecture (a teacher-centred didactic delivery of a subject to a group of students) as an educational tool in Higher Education (HE) is regularly discussed and examined throughout the literature [1–5]. There have been some passionate arguments in favour of retaining traditional lectures on the grounds that they can provide structure and context for a subject [1–3]. However, there is also evidence that traditional lecture formats are a less effective teaching method of knowledge exchange compared to active learning techniques [6], with low levels of student lecture attendance cited as a contributing factor [2].

Despite emerging bodies of evidence that traditional didactic lectures are ineffective as an educational tool, they remain the predominant method of teaching large numbers of students in Higher Education Institutions (HEIs). Lectures are an efficient way of delivering information to large groups of students, which is an important notion given the demands for increasing class sizes and increased workloads at many HEIs. Consequently, the didactic lecture is unlikely to be replaced anytime soon. Therefore, the development of innovative and engaging teaching methods to increase the effectiveness of lecture-based teaching is of great importance.

Bioscience and medical curricula typically encompass a wide array of scientific topics, and physiology is a key theme which must be understood by all students in order to grasp the fundamental workings of the human body. Despite the dynamic nature of physiology as a subject, didactic lecture presentations typically employ static images taken from textbooks or websites to convey concepts such as movement of fluids or ions, neural pathways, or the complex interaction of different organ systems, accompanied by bullet points of text.

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Research has shown enhanced knowledge retention in students who observe instructors actively draw diagrams to convey scientific concepts compared with students who observed static images of the same concept [7]. Here we demonstrate two approaches to developing visually dynamic, interactive lecture-based content using the patella reflex arc as a worked example.

2 Why use visually dynamic approaches to teach physiological concepts?

The use of animations to supplement learning of academically challenging concepts is not new. Mayer and Andersson [8, 9] demonstrated that engineering students who received visual animation concurrently with verbal narration on the workings of a pump or brake scored significantly better on retention tests than students who received narration alone. This work led Mayer to develop principles of multimedia learning based on cognitive theory (i.e., the theory that people process both verbal and visual information separately in the brain, that both of these processes are saturable and integration of these two forms of information leads to greater memory retention [10]). More recently, Issa and colleagues [11] used this principle to redesign learning materials to incorporate visual animations with narration for the teaching of physiological concepts (specifically, cardiovascular shock). Redesigning these learning materials led to significantly enhanced memory retention in a post-delivery test compared with traditional (e.g., bullet point slides) materials. Moreover, students who viewed a dynamic lecture, comprised of a lecturer actively drawing during the lecture to explain concepts underlying renal physiology scored significantly higher on tests than those students who had watched a lecture covering the same content, in which the lecturer spoke over static images [12].

The benefits of a multimedia-based approach to lectures should come as little surprise. Various studies have demonstrated that a significant number of students on healthcare related courses utilise social media websites such as YouTube to supplement their knowledge [13–18]. When trying to understand why medical students utilise online videos to supplement learning, O'Malley and colleagues provide the following student quote: "Videos with animations are particularly helpful for my understanding of phys[iology] because I can "see" certain processes happen rather than just looking at a picture" [17]. Furthermore, Saadeh and colleagues found more than a third of students reported that related online content was more useful than university taught materials [15].

The use of videos in teaching has been shown to improve student learning in Higher Education settings [18]. But how can educators incorporate such visual animations and drawings into both their in-person and online lectures? Here we highlight two methods utilised independently by the authors that integrate dynamic visual elements into their teaching using both freehand drawn diagrams and the use of Microsoft PowerPoint to animate images, using the patella reflex arc as a worked example.

3 The patella reflex arc as a relevant example

The monosynaptic patella reflex arc is a basic physiological concept which is commonly taught at undergraduate level. Anecdotal evidence from our own practice suggests that students struggle to understand the physiological processes underlying this reflex. Therefore, we independently sought to incorporate more visually dynamic teaching approaches into our undergraduate lectures to help students understand the patella reflex arc.

4 "Draw-alongs"

A "draw-along" is defined in our practice as the educator annotating a blank template sheet and using a projector or web camera to enable students to view this in real time during a teaching session (Fig. 1). To implement this, in practice, a template sheet was uploaded onto the central repository for students to view online and either print or draw, should they wish to, prior to the lecture. Then, during the lecture, the educator annotates the blank template sheet while the students are invited to observe or "draw-along" with the educator in real time. Once completed, the resource that has been generated can act as an aide mémoire for revision and consolidating knowledge post lecture.

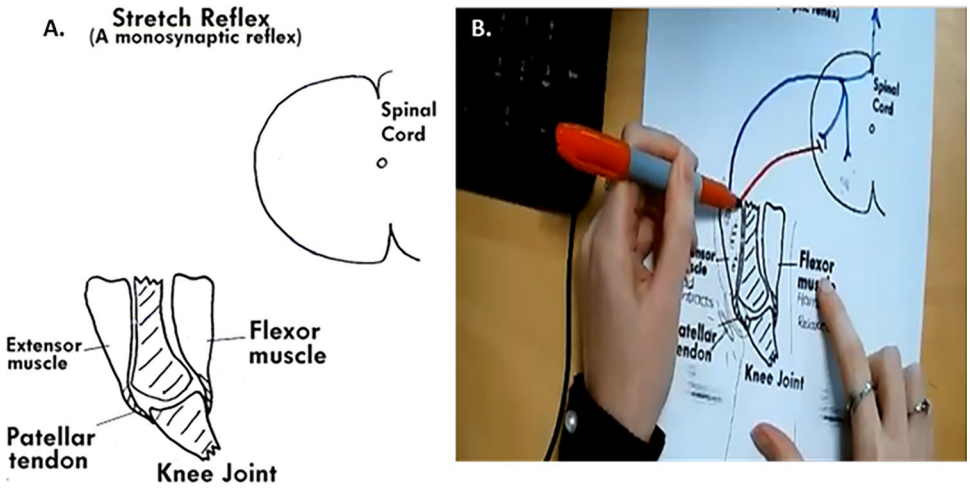

Fig. 1 "Draw-along" resource to demonstrate the patella reflex. **A** Blank template sheet. **B** Screenshot of live annotation of the blank template resource during an online lecture

5 PowerPoint animations

For educators who are not confident in utilising live draw-alongs, Microsoft PowerPoint and the array of online image databases can offer a useful alternative. Various websites now offer free-to-use images and icons for use in educational lectures (e.g., www.biorender.com, https://smart.servier.com). Such icons can be exported for use in Microsoft PowerPoint and then animated to produce moving images. Supplementary Video 1 https://figshare.com/articles/media/Supp_Fig_1_mp4/21590979 , DOI https://doi.org/10.6084/m9.figshare.21590979) demonstrates this approach to describe the actions of the patella reflex arc as delivered to undergraduate medical students. As with the draw-along example, both animations would be delivered with overlayed narration to describe the physiological concepts in a step-by-step approach.

6 What the future holds

Pedagogical research demonstrates the effectiveness of using animations and live drawings to aid retention of complex scientific principles. The move to a more blended teaching approach, in which some lectures are delivered in person and some remotely online will necessitate a teaching style that can engage students both in the classroom and elsewhere. Moreover, an approach that works for both modes of delivery is of vital importance for educators, who with significant workloads, often do not have time to develop multiple learning resources for use over different delivery modalities. The benefits of the approach we have described here are twofold: firstly, the approach to either a live draw-along or the use of animated multimedia icons can be incorporated into both in person and online deliveries. Secondly, the two complementary approaches provide models which can be used by educators who are more or less confident with their own abilities to "live draw".

Whilst the visual animations and draw along provide students with a visual representation of the concepts they are learning; instructor narration is vitally important. This is of particular importance for students with visual impairments, for whom such teaching techniques may not be as accessible.

Incorporating visually dynamic teaching approaches into lectures requires resource, in terms of staff time and knowledge as well as technical resource and methodological know how. Teaching staff require training and confidence in the use of digital technologies to create innovative teaching approaches for students. The approaches demonstrated here do require some technical knowledge (particularly for the PowerPoint animations), which can be developed through practice (an instructional video can be found here: http://tiny.cc/u5a9wz), but both techniques seldom require further technology that is not otherwise provided in most HEIs (Microsoft PowerPoint, digital projector). Crucially, such techniques can be implemented across both in-person and online teaching modalities, meaning resources need not be reformatted for different teaching approaches.

The techniques described here utilise a worked example of a physiological process (the patella reflex arc). However, these approaches are not constrained to this discipline and could equally be applied to others in the life sciences. Complex biochemical interactions, genetics and anatomy are all dynamic processes that could benefit from more visually dynamic teaching approaches.

In summary, the visually dynamic teaching approaches highlighted above enable educators to create more engaging educational resources for learners. Educational experiences, perceived value for money and attendance rates are all important factors in HE, which could be improved by enhanced teaching methods.

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Declarations

Competing interests No conflicts of interest, financial or otherwise, are declared by the authors.

References

1. Furedi, F. 2013. In Praise of the University Lecture and its Place in Academic Scholarship." *The Guardian*, Higher Education Network Blog. 2013. http://www.theguardian.com/higher-education-network/blog/2013/dec/10/in-praise-of-academic-lecture. Accessed 23 October
2. Schmidt HG, Wagener SL, Smeets GACM, Keemink LM, van der Molen HT. On the use and misuse of lectures in higher education. Health Prof Educ. 2015;1(1):12–8. https://doi.org/10.1016/j.hpe.2015.11.010.
3. French S, Kennedy G. Reassessing the value of university lectures. Teach High Educ. 2016. https://doi.org/10.1080/13562517.2016.1273213.
4. Roberts D. Higher education lectures: from passive to active learning via imagery? Act Learn High Educ. 2019;20(1):63–77.
5. Lester S, Crawford-Lee M. Learning from digital adaptations to the pandemic: enhancing work-based higher education. High Educ Skills Work-Based Learn. 2022. https://doi.org/10.1108/HESWBL-01-2022-0008.
6. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, Wenderoth MP. Active learning increases student performance in science, engineering, and mathematics. Proc Natl Acad Sci. 2014;111(23):8410–5. https://doi.org/10.1073/pnas.1319030111.
7. Fiorella L, Mayer RE. Effects of observing the instructor draw diagrams on learning from multimedia messages. J Educ Psychol. 2016;108(4):528–46. https://doi.org/10.1037/edu0000065.
8. Mayer RE, Anderson RB. Animations need narrations: an experimental test of a dual-coding hypothesis. J Educ Psychol. 1991;83(4):484–90. https://doi.org/10.1037/0022-0663.83.4.484.
9. Mayer RE, Anderson RB. The instructive animation: helping students build connections between words and pictures in multimedia learning. J Educ Psychol. 1992;84:444–52.
10. Mayer RE. Cognitive theory and the design of multimedia instruction: an example of the two-way street between cognition and instruction. New Dir Teach Learn. 2002;89:55–71.
11. Issa N, Schuller M, Santacaterina S, et al. Applying multimedia design principles enhances learning in medical education. Med Educ. 2011;45(8):818–26. https://doi.org/10.1111/j.1365-2923.2011.03988.x.
12 Fiorella L, Stull AT, Kuhlmann S, Mayer RE. Instructor presence in video lectures: the role of dynamic drawings, eye contact, and instructor visibility. J Educ Psychol. 2019. https://doi.org/10.1037/edu0000325.
13. Jaffar AA. YouTube: an emerging tool in anatomy education. Anat Sci Educ. 2012;5(3):158–64. https://doi.org/10.1002/ase.1268.
14. Mustafa AG, Taha NR, Alshboul OA, Alsalem M, Malki MI. Using YouTube to learn anatomy: perspectives of Jordanian medical students. Biomed Res Int. 2020;3(2020):6861416. https://doi.org/10.1155/2020/6861416.
15. Saadeh K, Henderson V, Paramasivam SJ, Jeevaratnam K. To what extent do preclinical veterinary students in the UK utilize online resources to study physiology. Adv Physiol Educ. 2021;45(1):160–71. https://doi.org/10.1152/advan.00215.2020.
16. Rapp AK, Healy MG, Charlton ME, Keith JN, Rosenbaum ME, Kapadia MR. YouTube is the most frequently used educational video source for surgical preparation. J Surg Educ. 2016;73(6):1072–6. https://doi.org/10.1016/j.jsurg.2016.04.024.
17. O'Malley D, Barry DS, Rae MG. How much do preclinical medical students utilize the internet to study physiology? Adv Physiol Educ. 2019;43(3):383–91. https://doi.org/10.1152/advan.00070.2019.
18. Noetel M, Griffith S, Delaney O, Sanders T, Parker P, del Pozo Cruz B, Lonsdale C. Video improves learning in higher education: a systematic review. Rev Educ Res. 2021;91(2):204–36.