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Adaptive Learning in Medical Education: The Final Piece of Technology Enhanced Learning?

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ABSTRACT

Technology enhanced learning (TEL) is now common practice in the field of medical education. One of the primary examples of its use is that of high fidelity simulation and computerised mannequins. Further examples include online learning modules, electronic portfolios, virtual patient interactions, massive open online courses and the flipped classroom movement. The rise of TEL has occurred primarily due to the ease of internet access enabling the retrieval and sharing of information in an instant. Furthermore, the compact nature of internet ready devices such as smartphones and laptops has meant that access to information can occur anytime and anywhere. From an educational perspective however, the current utilisation of TEL has been hindered by its lack of understanding of learners' needs. This is concerning, particularly as evidence highlights that during medical training, each individual learner has their own learning requirements and often achieves competency at different rates. In view of this, there has been interest in ensuring TEL is more learner aware and that the learning process should be more personalised. Adaptive learning can aim to achieve this by ensuring content is delivered according to the needs of the learner. This commentary highlights the move towards adaptive learning and the benefits of such an intervention.

BACKGROUND

Technology enhanced learning (TEL) now plays a significant role in the field of medical education. Examples being the flipped classroom approach where video based information is delivered to learners prior to class with class time spent problem solving[1], Problem or Team Based Learning sessions where portable devices allow for the instant retrieval and sharing of information among peers and faculty[2]; high fidelity simulation and computerised mannequins[3]; and in assessment practices where exams are delivered via computer based instruction[4].

Easy access to the internet via portable connected devices allows doctors to gain clinical information instantly, either in the ward or clinic environment. Platforms such as UpToDate (http://www.uptodate.com/) and eMedicine (http://emedicine.medscape.com/) can provide expert knowledge and there is increasing use of app based access to medical journals. Doctors also rely on technology to further their learning through the use of online knowledge based modules[5]. This concept takes the learning process further with the inclusion of assessment, providing learners with instant feedback. This is particularly beneficial as feedback from more formal examinations is often limited[6].

Technology based high fidelity simulation has allowed learners to take part in clinical scenarios in a safe learning environment and gain knowledge and skills to better equip them when dealing with real life patients. Simulation can help to provide instant feedback and allow for the repetition of clinical situations in order to better ensure competency is reached[3].

Technology has also allowed for documentation of a learner's progress during training courtesy of online portfolios[7]. Here, trainees and specialists can capture their competency across the domain of knowledge, skills and attitudes in relation to a particular area. They can also take part in reflective based writing of cases which were managed well and those more difficult to manage situations. The introduction of revalidation in the UK and the American Board of Medical Specialties (ABMS) Portfolio Program in the US means that demonstrating competency is now a formal requirement and electronic portfolios are an obvious choice for record keeping as well as distribution of an individual's performance to date[8].

ADAPTIVE LEARNING (AL)

Whilst the use of technology has been positive in many aspects of medical education, one of the primary concerns from a learning point of view is its current lack of recognition of a learner's needs. At present TEL is delivered in a standard fashion to reach a large cohort of learners regardless of individual knowledge, understanding or skills. This is problematic as it is well recognised that learners during training have different levels of understanding and subsequent knowledge gaps. Whilst some may achieve competency

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relatively quickly, others may struggle to do so. Variation in rates of competency achievement is well recognised but is not easily solved when teaching materials are delivered on a mass scale. From a teacher perspective, engaging with learners one on one and recognising each individual's strengths and weaknesses is simply not possible during large scale lectures and seminars where often due to time constraints, information is delivered in a passive fashion[9]. It is important to appreciate that more needs to be done to achieve the true potential of technology enhanced learning. In our view, TEL should be leveraged to address real life teaching and learning problems such as learner diversity and engagement. With these points in mind, TEL can be conceived as a means to enhance faculty-learner interactions, as well as learner-content interactions[10]. By ensuring that content is learner specific, a personalised and adaptive learning environment can help individuals better meet their competency requirements.

At the most basic level, adaptive learning is a process that provides an individualised learning experience with technologies designed to determine a learner's strengths and weaknesses. Once an individual's strengths are recognised, the computer based technology can modify the learning material to ensure that there is greater focus on an individual's limitations. One example comes from The University of New South Wales, which offered a massive open online course (MOOC), "Learning to Teach Online". In this course, there were thousands of learners with just two core teachers and hence educational support on an individual basis was impossible. This situation was addressed by having learners engage with assessment and reflective activities that generated personalized learning content based on their responses and self-reflection information. From an exam and course participation perspective, research by the Educational Growth Advisors on the use of AL has demonstrated an 18 percent increase in pass rates and 47 percent decrease in withdrawal from educational courses[11].

Adaptation is however not just limited to the content for learners based on their particular learning requirements. Other forms of adaptation include: an adaptive system interface where learner preferences are met with respect to navigation and structure of the course content, the discovery and assembly of content from multiple sources – such as learning repositories available via the web and discussion forums to connect peers and faculty with each other, based on a specific understanding of each individual learner and their requirements[12].

In the medical field, there has been little in the way of formal research into adaptive learning uses, yet this is likely to change as time progresses. Elsevier currently utilises an adaptive learning platform powered by Cerego to assist health science users. Dr Jan Plass at NYU, commented that "Cerego ensures a continuous update on research theories allied to learning and information processing. Performance is predicted per user to determine what they already know and what they need to know, helping to ensure an understanding of higher level tasks[13]". McGraw Hill Education has also entered the AL domain and partnered with technology company Area9, founded by Dr Ulrik Christensen, one of the pioneers in this area[14] . More recently, the NEJM launched an adaptive learning process, in recognition of the fact that frequent updates in the medical field conflict with clinicians' limited time. The resource focuses on clinical scenarios which aim to mirror real life occurrences with the knowledge + learning system designed to aid preparation for internal medicine exams[15].

Published work by Kellman in relation to AL, centres on the repeat delivery of specific knowledge items or categories if mistakes are made. There is also use of "interleaving", where information is delivered in an alternating or mixed fashion to better ensure learning gains whilst "mastery criteria" ensure specific learning objectives are reached before a learner can be deemed competent[16]. These techniques have been trialled during delivery of the dermatology histopathology curriculum at UCLA with significant improvements in pre and post-test scoring ($P < 0.0001$). In the future, there is also hope for the utilisation of AL in relation to more procedural and high fidelity simulation based tasks. Figure 1 illustrates 2 examples of Adaptive Learning.

- **Preparation for examinations** - > attempts gastroenterology specific questions - > AL system recognises optimum knowledge of extra manifestations of inflammatory bowel disease but poor knowledge of treatment escalation - > computerised delivery of treatment escalation occurs to ensure an understanding of this poorly understood aspect

- **Preparation for real life working** - > attempts module on management of acute conditions as part of continuing professional development (CPD) - > AL system recognises optimum knowledge of the features of sepsis but poor knowledge of antibiotic prescribing in relation to infection - > computerised delivery of information on antibiotic prescribing occurs to ensure an understanding of this poorly understood aspect

Fig 1. Medical student or doctor in training potential AL examples

CLOSING REMARKS

In this commentary, we have sought to show that TEL has failed to an extent to deliver value added learning and that the adoption of more learner specific, adaptive learning systems could address this issue by solving real life teaching and learning problems specific to knowledge deficiencies and user engagement. Adaptive learning could generate personalized learning content to improve mastery of learning and connect learners and faculty to one another based on educational needs. Faculty could then engage with their learners at a much deeper level recognising learner deficiencies and facilitating

the learning process[17].

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