Where is evidence-based instructional design in medical education curriculum development?

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If you are interested in developing evidence-based educational materials, you should be aware of Richard E Mayer's work on the principles of instructional design, which are nicely summarised in this edition of the journal.[1] Over his career, Mayer has developed and empirically tested theories of multimedia learning, while elaborating principles and guidelines on how to design and develop instructional materials.[2] His work is also an excellent complement to the recent paper by van Merriënboer and Sweller[3] on cognitive load theory, and together these articles highlight the increasing interest in applying the science of educational psychology to medical education curriculum materials.

As the science of learning advances, are we in fact being guided by the instructional design research evidence when we are creating educational events and curricula? In considering this question, it is important to consider both the micro- and macro-level issues. Micro-level issues include the internal and external validity of the design, development and evaluation of specific instructional events (e.g. a lecture or e-learning module). Macro-level issues encompass elements of the programme and curriculum design as a whole (e.g. undergraduate and postgraduate training programmes, continuing medical education).

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Mayer's work has substantial implications at the micro level in terms of understanding the internal validity of a specific instructional event. He has repeatedly demonstrated that applying the principles of multimedia instructional design and cognitive load theory result in impressive effects on retention and transfer tests under laboratory-type experimental conditions with non-health professions learners. To date, though, there has been little replication or extension of the findings in medical education settings. For example, Cook *et al.*[4] found very few studies that reported on the instructional design principles used to guide the development of interventions in their systematic review and meta-analysis of Internet-based learning. Similarly, Ruiz *et al.*[5] found a paucity of comparative studies testing theories of multimedia learning in their review of the use of computer animations in medical education. Given the possible interactions between educational interventions, learners and topics, confirming Mayer's findings in medical education settings will be important.

It is also sometimes unclear where Mayer's principles for a specific learning event fit within the broader, macro-level context of an entire, multi-year medical school programme. This suggests it is important to reflect on other instructional design models and theories, such as van Merriënboer and Kirschner's four-component method,[6] and to consider the implications of research and best practices from other bodies of knowledge, such as the workplace learning and training literature.[7] Moreover, despite the work of Mayer, van Merriënboer, Sweller, Clark and others, a 'know–do' gap exists between the science of instructional design and its implementation within medical education settings. Why is this?

A 'know–do' gap exists between the science of instructional design and its implementation within medical education

We need to remember that education, like medicine, is both a science and an art. Somewhat analogous to the principles of evidence-based medicine, the art lies in knowing when and how to apply the science of learning principles. Although these scientific principles are helpful guides that should inform our practice, there are probably no shortcuts to determining how best to apply them in a particular instructional context. At the end of the day, a skilled, evidence-informed educator has to know something about the topic, the audience and how people learn in order to design and deliver an effective learning event. Although there are many outstanding education 'artists', many medical teachers lack the opportunity, time or

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incentive to develop the expertise required to effectively apply the science of instruction. The majority of medical school lectures or grand rounds presentations run contrary to best practices in instructional design, often consisting of PowerPoint slides with redundant text, 'death by bullet points' and – where graphics are used at all – trivial, seductive augmentation that probably reduces learning.

The majority of medical school lectures run contrary to best practices in instructional design

As an enterprise, medical education faces many challenges in the implementation of evidence-informed instructional design. At the micro level, there is a lack of expertise in the science of learning, and institutions under-fund quality curriculum content development, evaluation and improvement. At the macro level of curriculum and programme design, one would like to see the integration of more opportunities for deliberate and mixed practice with expert feedback.[8] However, pragmatic and logistical barriers such as limited faculty time, packed learner schedules and patient unavailability often preclude the optimal intensity of clinical practice opportunities and expert feedback. It remains to be seen whether technologies such as virtual patients and simulations will adequately help resolve some of these challenges through the provision of deliberate practice, although none of them are likely to represent a panacea.[9,10]

Why should we bother trying to overcome these barriers to both internal validity and generalisability? As medical care becomes more complex, doctors will need to learn even more than they did in the past. Or, perhaps more likely, they will need to learn different skills and will require high degrees of adaptability as new technologies emerge and alter the landscape of clinical care. Developments in mobile and Internet technologies have resulted in much improved access to reference and performance support materials in educational and point-of-care settings. These developments will continue to shift the focus of medical education away from fact-based learning towards an emphasis on concepts and strategies, including, for example, more effective use of information-search strategies and job aids that can help students to preserve scarce cognitive resources for reasoning and patient engagement. Transfer (information retrieval in a new context) is difficult; decision support can support but not replace the doctor. Instructional science and cognitive load theory should inform best practices in the design and use of decision support and job aids in medical education and practice.

Transfer is difficult; decision support can support but not replace the doctor

Applying the science of learning and instructional design to medical education is necessary, but not sufficient. Although we need to replicate studies of the internal validity of instructional design principles across different topics, learners and settings, we cannot ignore the pragmatic and cultural issues. Science must be buttressed by policy and economics (e.g. by institutional support for curriculum development) to see real gains, and the work of Mayer and others can provide a valuable road-map. As in other domains of medicine, it is essential to overcome barriers that hinder the translation of research into action.

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