



Fostering Adaptive Expertise in Tomorrow's Prescribers

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Dear Editor,

A goal of undergraduate medical education is to equip students to meet societal needs through providing safe healthcare cost-efficiently. This objective becomes increasingly challenging with the rapidly changing landscape of healthcare delivery worldwide. It is thus, unavoidable that healthcare professionals are life-long learners with the ability to constantly acquire new knowledge, and utilise the existing one flexibly. The requirement of adaptability is specifically applicable to therapeutics and prescribing context. With the ever-increasing influx of new drugs and new treatment modalities, there are changes in the status of existing medications and a requirement for physicians to keep updated with latest developments. The challenges of aging population, together with increasing chronicity and multi-morbidity of illnesses pose additional demands on practitioners (1). With the advent of artificial intelligence, it is probable that simple and straightforward clinical scenarios might not need expert consultation. Such patients will most likely be issued an automated prescription as per the national guidelines or local protocols, which are supervised by a nurse or pharmacist prescriber at best. Future clinicians are likely to be challenged with relatively atypical cases and complex situations, that demand expert judgement and innovative solutions. Recently, COVID-19 pandemic has disrupted the routine style of healthcare delivery, and accelerated the move to remote consultations (2). Medical education has been impacted and several setups have involved undergraduate students to take an active role in patient care, including early graduation of senior medical students (3). The pandemic may be considered a classical example when health systems leaders, public health experts and clinicians from diverse disciplines have come together to wrestle a complex emergency. In order to meet such challenging situations, undergraduate medical education needs to prepare physicians for effective

clinical decision making in times of volatility, ambiguity and complexity. Adaptive expertise has been described as the capacity to modify approaches to solve problems creatively, enabling individuals to thrive in a changing environment (4). This paper presents how research on “adaptive expertise” can inform pharmacology teaching in medical curricula, placing emphasis on training clinicians who are adaptive prescribers.

Traditionally, medical science including pharmacology and therapeutics has predominantly been a fact-based and content overloaded discipline. Acquisition and application of knowledge has been considered the foundation of medical expertise and clinical decision making. Educational experiences during medical school are designed and delivered to build the extensive knowledge base. However, recent conceptualisations of expertise have evolved to include ways in which practitioners generate new solutions in actual practice through the flexible use of knowledge. It is imperative to distinguish between adaptive versus routine expertise. Adaptive experts respond to novel situations more effectively and innovatively, while routine experts continue improving task efficiency (5). The former apply their knowledge creatively, to recognise the dynamic nature of the medical situation, and thereby establish context-aware goals. It is noteworthy that adaptive expertise is not an inevitable consequence of experience, but is actually an outcome of processes and habits that must be practised early in training and regularly refined throughout one's career. A solid conceptual understanding of the discipline is mandatory to foster the ability to define new problems and develop appropriate solutions. In context of safe and effective prescribing ability, it implies expanding pharmacology beyond biomedical, into the clinical scenario. Integrating the biomedical science closely with clinical knowledge during instruction results in the formation of explanatory links within the knowledge network; this is

known to aid in future therapeutic decision-making during complex situations. Pharmacology and drug-related information when contextualised with the clinical picture facilitate formation of necessary connections, which can potentially assist in retrieval of knowledge in future situations. Although an integrated curriculum design is being followed in many medical schools, integration at the level of the individual teaching session is often ignored (6). There is scope for intervention at the level of individual classrooms to achieve cognitive integration of clinical and biomedical knowledge within the mind of the learner. It is considered that a lack of awareness of the context-specificity of knowledge is a prominent limitation in routine expertise (4). Basic sciences have suffered dilution in the undergraduate medical curricula over the past few decades, and concerns regarding the consequences of reduced pharmacology teaching such as prescribing errors by junior doctors, have been expressed in the past (7). Taking cues from theories of adaptive expertise, it should be a worthwhile exercise for faculty to expand sciences into the clinical years, to enable students to consolidate knowledge base as dictated by patient needs and context. These might be an ideal opportunity for clinicians and pharmacologists to co-facilitate case-based teaching workshops for medical students, to enable coherent mental models and rich conceptual knowledge. Using serial concept mapping in group and collaborative learning is an identified tool to foster critical thinking and clinical reasoning in earlier reviews (8). Concept map is a pictorial assembly of specific topics that assist in understanding of a subject and integration of elementary and applied sciences. Although, there are reports of positive student perceptions regarding the use of concept mapping in pharmacology education in undergraduate medical curriculum, their effectiveness in improving performance in assessments is doubtful (9).

Educationalists from a range of disciplines appear to be in agreement that adaptive expertise is built over and above subject expertise; however, there is significant debate over the additional attributes needed and ways to foster these through curricular interventions. Bohle Carbonell et al. (4) suggest that these attributes can be divided into metacognitive skills and cognitive skills and abilities, including “flexibility, ability to innovate, continuous learning, seeking out challenges, and creativity”. Neuroscience research has revealed that certain brain patterns necessary for the creative production of ideas are activated when acquired expert knowledge is flexibly and playfully linked with the current environment (10). The organization and coordination of the knowledge appears more important than the quantity for expert performance. Parallels have been drawn between innovation, improvisation, creativ-

ity, and adaptive expertise since each of these constructs is characterized by flexibility, continuous learning, and challenge seeking (11). These behaviours need to be supported and nurtured, while decreasing the focus on summative performance. Mylopoulos⁶ proposed a version of active learning that incorporates “guided discovery” and “productive failure”, where students are given the opportunity to “discover” new content on their own through struggle or failure. They further suggest addition of “meaningful variation” around conceptual knowledge to prepare students for transfer of learning in future complex encounters. Teachers can support the development of deeper conceptual knowledge by prompting students with “why” and “how” questions in both formal assessments, and at bedside informal conversations. Addition of “what if” questions can incorporate meaningful variation and lead to broadening the understanding. Multiple choice questions with single best answers must be carefully crafted to serve the purpose through inclusion of competitive options as close distractors. These question types, even when answered incorrectly, shift the emphasis from surface learning to deeper connections between concepts, cementing the cognitive domains needed for future learning⁶. Formative assessments can be employed to ask students to make therapeutic decisions and justify their choice-correct or otherwise; these assessments for learning would serve as learning opportunities that consolidate mechanisms that underpin a clinical concept.

Research from cognitive psychology states that novelty in the form of unfamiliar tasks should be introduced at irregular intervals especially in the advance years of the course to facilitate adaptive expertise (4). These may take the form of practice tests and quizzes to stimulate retrieval, which is considered more effective than re-reading. Retrieval practice is known to reconstruct and restructure existing knowledge, as well as free up mental resources for future learning. However, students need constant encouragement, since forgetting is frustrating and recall from memory is effortful. Activities and questions should not only stimulate learners to explore the topic, but also encourage errors, since this allows individuals to try out alternative methods and hence, gain a better understanding of the subject in the process (12). Feedback opportunities can be built in the timetable to correct conceptual errors and make the struggle fruitful. There is scope for simulation-based learning to be harnessed to afford a risk-free and supportive environment, where learners can be forced to switch from automatic to problem-solving mode through creating complex problems. Along with affording curricular opportunities for problem solving tasks, educationalists have argued that autonomy may also be an en-

abler towards development of adaptive expertise. Autonomy in this context implies the degree to which students are allowed to decide how to accomplish tasks or work out solution strategies. Providing independence does increase the risk of errors, but this is considered a favourable outcome as discussed above (12). However, the need for reflection on errors is key, as is the requirement of a supportive environment. Cutrer et al. (13) emphasised the role of critical thinking in mastering adaptive expertise, since it can challenge existing assumptions in order to reconstruct the problem. Metacognition and self-regulated learning can aid adaptability, as experts consciously strive to keep knowledge active and fluid rather than automated (11). Adaptive experts ensure that the knowledge structures remain accessible and updated, as well as self-monitor their understanding and performance through reflection. The course assessment thus, should incorporate assessment of the conceptual knowledge and meta-cognitive capacities such as self-regulated learning and reflective abilities. The curriculum design must include these learning outcomes with appropriate exemplars to make the value of these explicit to the learners.

This paper hopes to advance conversations on instructional approaches to ensure that future generation of prescribers are well equipped to define new problems, and work out strategic solutions. Research on adaptive expertise lends useful insights into understanding cognitive processes involved in training individuals for future volatile situations. The paper initiates the discussion on teaching and learning strategies in pharmacology education that could be instrumental in developing adaptive expertise. These are supported with underlying principles and convincing evidence from pedagogical research. The principles are complimentary and are applicable at the broader course level as well as the individual sessions. As evident, there are no elaborate recommendations, but rather a reorientation to already existing tools to reinforce cognitive integration, productive struggle and formative support. Certain forms of instruction to sustain and encourage adaptive expertise have been discussed, but a lot remains unexplored. There is a need for basic science educators and clinicians to join hands and develop curricular content that incorporates nurturing of adaptive expertise. It is time that subject experts begin to think beyond their individual specialities to explore innovative ways to challenge students, and support them during the struggle, and not just focus on excellence in the particular discipline. More research is needed to study how pharmacology teaching can be enhanced and delivered to future proof our students.

Footnotes

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