Adult learning theories: Implications for learning and teaching in medical education: AMEE Guide No. 83

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DAVID C. M. TAYLOR[1] & HOSSAM HAMDY[2]
[1]University of Liverpool, UK, [2]University of Sharjah, United Arab Emirates

Abstract

There are many theories that explain how adults learn and each has its own merits. This Guide explains and explores the more commonly used ones and how they can be used to enhance student and faculty learning. The Guide presents a model that combines many of the theories into a flow diagram which can be followed by anyone planning learning. The schema can be used at curriculum planning level, or at the level of individual learning. At each stage of the model, the Guide identifies the responsibilities of both learner and educator. The role of the institution is to ensure that the time and resources are available to allow effective learning to happen. The Guide is designed for those new to education, in the hope that it can unravel the difficulties in understanding and applying the common learning theories, whilst also creating opportunities for debate as to the best way they should be used.

Introduction

The more we read, the more we realise that there are many different ways of explaining how adults learn (Merriam et al. 2007). None of the individual theories fully explain what is happening when an aspiring health professional is engaged in learning. In this Guide, it will become clear that the authors hold a broadly constructivist view. Constructivists, like Vygotsky (1997), consider that learning is the process of constructing new knowledge on the foundations of what you already know. We will explain a constructivist schema, which we feel has an evidence base and forms a theoretical basis to help curriculum development, learning and teaching strategies, student assessment and programme evaluation.

Malcolm Knowles (1988) considered that adults learn in different ways from children. He introduced the term "andragogy" to differentiate adult learning from pedagogy; this differentiation now seems to be artificial. Many of the principles of andragogy can be applied equally to children's learning. It is probably more appropriate to think in terms of a learning continuum, which stretches throughout life, with different emphases, problems and strategies at different times.

In this Guide, we will indicate what we feel are the main types of learning theories, show briefly the way in which the theories have developed from each other, and then show how, and when, different theories can be applied to maximise learning.

When we consider medical education in particular it is important to remember that in some programmes the learners have already completed a university degree, and in others the students come straight from high or secondary school. Medical

Practice points

- Becoming a member of a healthcare profession not only demands the acquisition of knowledge and skills, but also involves a process of growing into the professional community.
- Although people learn in different ways, we all run through a process of working out what the possible explanations are and sorting them into probable and less probable, on the basis of reflecting on feedback, our existing experience and knowledge.
- Through understanding the ways in which people learn we can plan the most effective ways in which we can help them to learn.
- The model presented here gives a scheme and a checklist that we can use to increase our effectiveness in organising curricula, delivering education and assessing the outcomes.

education also includes postgraduate studies and continuing professional development. Each of our students will have their own individual constraints, experiences and preferences. The educator's task is to provide an environment and the resources in which each learner can flourish.

Categories of adult learning theories

Our task is complicated by the observation that the theories of learning flow partly from psychological theories of learning

Correspondence: David C. M. Taylor, School of Medicine, University of Liverpool, Cedar House, Liverpool L69 3GE, UK. Tel: +44 151 794 8747; fax: +44 151 795 4369; email: dcmt@liv.ac.uk

and partly from pragmatic observation. It is also important to remember that "learning" includes the acquisition of three domains: knowledge, skills and attitudes; any theories should ideally account for learning in each of these three domains.

In broad terms, theories of adult learning can be grouped into, or related to, several categories. There is quite a lot of overlap between the theories and the categories of theories, and here we give a simplified overview:

(a) **Instrumental learning theories:** These focus on individual experience, and include the behaviourist and cognitive learning theories.

(i) Behavioural theories are the basis of many competency based curricula and training programmes (Thorndike 1911; Skinner 1954). A stimulus in the environment leads to a change in behaviour. Applying these theories usually results in learning that promotes standardisation of the outcome. This leads to the main issue with behavioural theories – namely who determines the outcomes and how they are measured?

(ii) Cognitive learning theories focus learning in the mental and psychological processes of the mind, not on behaviour. They are concerned with perception and the processing of information (Piaget 1952; Bruner 1966; Ausubel 1968; Gagne et al. 1992).

(iii) Experiential learning has influenced adult education by making educators responsible for creating, facilitating access to and organising experiences in order to facilitate learning; both Bruner's (1966) discovery learning and Piaget's (1952) theory of cognitive development support this approach. Experiential learning has been criticised for focusing essentially on developing individual knowledge and limiting the social context (Hart 1992). Its application in medical education is relevant because it focuses on developing competences and practising skills in specific context (behaviour in practice: Yardley et al. 2012).

(b) **Humanistic theories:** These theories promote individual development and are more learner-centred. The goal is to produce individuals who have the potential for self-actualisation, and who are self-directed and internally motivated.

(i) Knowles (1988) supported this theory by popularising the concept of "andragogy". Although it explains the motivation to learn, its main limitation is the exclusion of context and the social mechanism of constructing meaning and knowledge. We now know that context and social factors are crucial in professional education (Durning & Artino 2011).

(ii) Self-directed learning suggests that adults can plan, conduct, and evaluate their own learning. It has often been described as the goal of adult education emphasising autonomy and individual freedom in learning. Although it is axiomatic to adult learning, there are doubts about the extent to which self-directed learning, rather than directed self-learning is truly achievable (Norman 1999;Hoban et al. 2005). A limitation of the concept is failure to take into consideration

the social context of learning. It has also implicitly underestimated the value of other forms of learning such as collaborative learning.

(c) **Transformative learning theory:** Transformative learning theory explores the way in which critical reflection can be used to challenge the learner's beliefs and assumptions (Mezirow 1978, 1990, 1995) The process of perspective transformation includes

(i) A disorienting dilemma which is the catalyst/trigger to review own views/perspectives – "knowing that you don't know"

(ii) The context, which includes personal, professional and social factors

(iii) Critical reflection. Mezirow (1990) identifies different forms of reflection in transformation of meanings, structures, context, process and premise. Premise reflection involves the critical re-examination of long held presuppositions (Brookfield 2000).

(d) **Social theories of learning:** The two elements that are crucial to social theories of learning are context and community (Choi & Hannafin 1995; Durning & Artino 2011). These concepts have been developed by Etienne Wenger (Lave & Wenger 1991; Wenger 1998), who emphasises the importance of "communities of practice" in guiding and encouraging the learner. Land and colleagues consider the way that learners enter the community of practice (Land et al. 2008). The way in which a learner's experience is shaped by their context and community is developed by situativity theory and is discussed by Durning & Artino (2011). Situated cognition theories are based on three main assumptions:

(i) Learning and thinking are social activities

(ii) Thinking and learning are structured by the tools available in specific situations

(iii) Thinking is influenced by the setting in which learning takes place (Wilson 1993).

(e) **Motivational models:** Any theoretical model that attempts to explain and relates adult learning to an educational theory must have two critical elements – motivation and reflection. One such theory is self-determination theory (Ryan & Deci 2000; ten Cate et al. 2011; Kusurkar & ten Cate 2013). The theory recognises the importance of intrinsic motivation, and considers that three basic needs must be fulfilled to sustain it: Autonomy, Competence, and a feeling of belonging – or "Relatedness".

(i) One of the issues about learning is that a low expectation of success will result in poor motivation to learn, unless the perceived value of success is overwhelming. This is partly explained by Maslow's theory of needs (Maslow 1954; Peters 1966), but it probably does not capture the balance between the different competing drives of hopes and expectation of learning as opposed to the time and effort needed to engage with the process. The expectancy valence

theory (Weiner 1992) incorporates the "value" of success and expectancy of success.

$$\text{Motivation to learn} = \text{Expectancy of success} \\ \times \text{Value of success.}$$

(ii)   The Chain of Response model concerns participation by adults in learning projects (Cross 1981). In this model three internal motivating factors are inter-related: self-evaluation, attitude of the learner about education and the importance of goals and expectations. The main external barriers to motivation are life events and transitions, opportunities, and barriers to learning or obtaining information.

(f)   **Reflective models:** The reflection-change models consider that reflection leads to action and then change. Reflective learning (Schön 1983, 1987) has important relevance to medical education, and more widely in society (Archer 2012). The role of deliberate practice (Duvivier et al. 2011), using reflection and feedback as tools to develop both knowledge and skills is starting to provide very valuable insights for educators helping students develop autonomous learning.

Even this brief consideration of types of theory applicable to adult learning will lead one to realise that they each have their strengths, and are each incomplete without the others. Before addressing a model that attempts to draw the theories together, we need to consider how we arrived at where we are.

Historical aspects of adult learning theories

In the late seventeenth century, the pervading view was that all knowledge derives from experience. Although he personally did not use the term, John Locke (Locke 1690) considered that the mind was a *tabula rasa* or "blank slate" at birth and that all acquired knowledge was derived from experience of the senses. These ideas were reworked and developed until the early twentieth century when Edward Thorndike derived his laws (Thorndike 1911), principally the law of effect – which stated that learning occurred if it had a positive effect on the individual, and the law of exercise – which meant that repetition strengthened the learning.

This was further developed by behaviourists, such as Skinner (1954) who demonstrated that some forms of learning could be demonstrated by a simple stimulus-response paradigm, so that a reward could be used to ensure an appropriate response to a stimulus. Skinner showed that there were three elements that strengthened learning, namely frequency (the number of times a stimulus was presented), contiguity (the time delay between the response and the reward) and contingency (the continued link between the stimulus and the reward). Chomsky (1975) considers that the type of experiments favoured by behaviourists do not explain the acquisition of higher order skills, such as the learning of language. Chomsky argued that our brains are programmed to acquire higher order skills, which we develop and modify by experience. While some were looking at the potential neural

mechanisms that underlie the acquisition of learning, others were considering the factors that can make it more effective.

Piaget, a cognitive constructivist, considered the different types of knowledge that could be acquired at different stages in a young person's life (Piaget, 1952). This stream of thought continues to the present day in the work of people like William Perry (1999) who studied the way in which college students change from dualism (ideas are either true or false; teacher is always right) to multiplicity (truth depends on context; teacher is not necessarily the arbiter).

Social constructivists, like Vygotsky (1978) focus on the way that the learning community supports learning. A key idea in social constructivism is that of the Zone of Proximal Development, whereby a learner can only acquire new knowledge if they can link it in with existing knowledge. Conversations between learners/teachers articulating what is already known can extend the zone of proximal development by putting new ideas in the context of current understanding. This strand of thought has been taken forward in social learning theories by Bandura (1977), and in a remarkable way by Wenger in the concept of learning communities or "Communities of Practice" (Wenger 1998).

Andragogy and pedagogy: Knowles views and related learning models

Towards the end of the twentieth century, there was a body of research that suggested that adults learn differently from children and that "andragogy" was a better term for this process than "pedagogy". The key difference between adults and children is said to be that adults are differently motivated to learn. Although the arguments no longer seem quite so clear, the line described by Knowles (Knowles et al. 2005) was that adult learners differ from child learners in six respects:

(1)   The need to know (*Why do I need to know this?*)
(2)   The learners' self-concept (*I am responsible for my own decisions*)
(3)   The role of the learners' experiences (*I have experiences which I value, and you should respect*)
(4)   Readiness to learn (*I need to learn because my circumstances are changing*)
(5)   Orientation to learning (*Learning will help me deal with the situation in which I find myself*)
(6)   Motivation (*I learn because I want to*)

These observations, in association with David Kolb's experiential learning model ((Kolb 1984), see Figure 1) have allowed the consideration of learning and teaching strategies appropriate for adult learners.

In Kolb's scheme, the learner has a concrete experience, upon which they reflect. Through their reflection they are able to formulate abstract concepts, and make appropriate generalisations. They then consolidate their understanding by testing the implications of their knowledge in new situations. This then provides them with a concrete experience, and the cycle continues. Learners with different learning preferences will
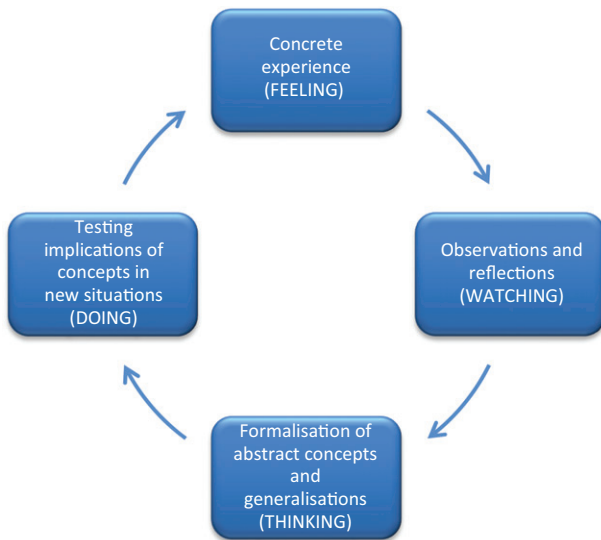
Figure 1. The Kolb Cycle after (Kolb 1984).

have strengths in different quadrants of the (Kolb) cycle. In Kolb's terminology "Activists" feel and do, "Reflectors" feel and watch, "Theorists" watch and think and "Pragmatists" think and do. From the educator's point of view it is important to design learning activities that allow the cycle to be followed, engaging each of the quadrants. Although it is often quoted, and easily understood, the learning style inventory developed from the Kolb cycle has poor reliability and validity (Coffield et al. 2004).

Of particular importance to those who follow a broadly constructivist line (but lacking in the original model), will be the prior experience/knowledge of the individual, and the dissonance between this and the concrete experience that is provided as the learning opportunity. When we see something new, attend a lecture, or talk with a patient, we compare what we are seeing with what we already know, and reflect upon the difference (***reflection in action***, (Schön 1983)). This enables us to formulate abstract concepts that make sense of the new data. In turn this will lead us to propose tests of our knowledge, through direct experimentation or through debate and discussion. This is a familiar process to all acquainted with the scientific/clinical method; however at least one key element is missing, and this is **reflection *on* action**. It is crucial that the learner thinks about the processes they have used, and the extent to which they were rigorous or appropriate in the use of the material; this is fundamental to learning.

The next issue is the way in which new knowledge becomes integrated into the existing knowledge base. Proponents of the transformative learning approach consider that meaningful learning occurs when connections are made between new and existing information (Regan-Smith et al. 1994). Norman & Schmidt (1992) suggest that there are three main elements to this process: elaboration, refinement and finally restructuring. Elaboration is linking in new knowledge with what we already know. It is important, however, that the linkages are precise rather than general (Stein et al. 1984). Refinement is the act of sifting and sorting through

the information to retain those elements that make sense. Finally, restructuring is the development of new knowledge maps (schemata) which arguably allow one to become an expert or demonstrate expertise (Norman et al. 2006).

Learning outcomes and scaffolding from Bloom's taxonomy to Miller's pyramid

The processes of acquiring new knowledge, relating it to what is already known and developing new understanding is complicated and difficult but educators can help the learners by providing advance organisers (Ausubel 1968). There are two types of advance organisers: models and metaphors, which we will consider later, and scaffolding.

Scaffolding refers to the structural things that teachers do to guide learners through the teaching and learning material. They are necessary because the sheer volume and complexity of knowledge to be acquired often leaves the learner standing on the threshold (in a state of liminality), rather than stepping into the world of learning.

It is easy to underestimate the problem of liminality. It is described well by Ray Land (Land et al. 2008; Meyer et al. 2010), but it refers to the sense of discomfort we feel when we do not quite understand the rules or the context of a new situation. We need someone to lead us over the threshold, introduce us to the new ideas, and probably explain some of the language (Bernstein 2000). As we start to build our knowledge and understanding, we need to have some idea of where things fit, how they fit together, and some idea of how the individual pieces are part of a greater whole. "Scaffolding" provides that perspective. Scaffolding includes programme level organisers, which are dependent on both the content and the context in which it is being learned. Programme organisers include the syllabus, lectures, planned experiential learning and reading lists. Most commonly, these days scaffolding includes providing learners with a list of intended learning outcomes. It is important to remember that it also includes the induction that students receive when they enter the programme or a new clinical environment.

Learning outcomes can be further refined using Bloom's taxonomy (Bloom et al. 1956), which has been revised by several authors, including Anderson (Anderson & Kratwohl 2001). In Figure 2, Bloom's taxonomy is shown in the pyramid itself, and Anderson's development of it in the side panels.

Anderson's modifications indicate a belief that "creating" is a higher attribute than "evaluating", but they are also important in emphasising that the learner does things with knowledge. Learning outcomes, therefore, should be associated with verbs, rather than lists of things to learn. The difficulty with the model is highlighted by the differences between Bloom and Anderson's model. In reality, the elements of the pyramid are arranged in a cycle. Evaluation leads to developing a new idea which is then applied, analysed, evaluated and so on.

Bloom's original work led to several variants. In medical education, the most frequently encountered is Miller's pyramid
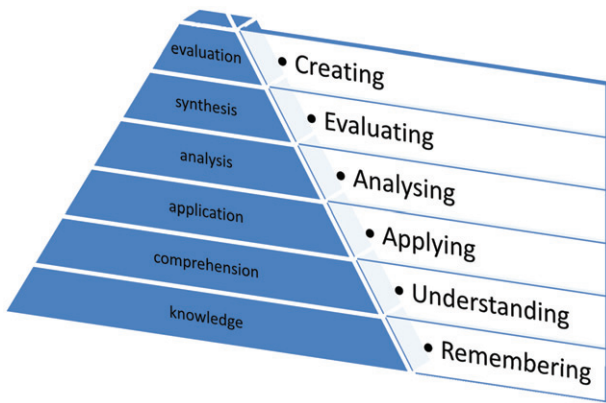
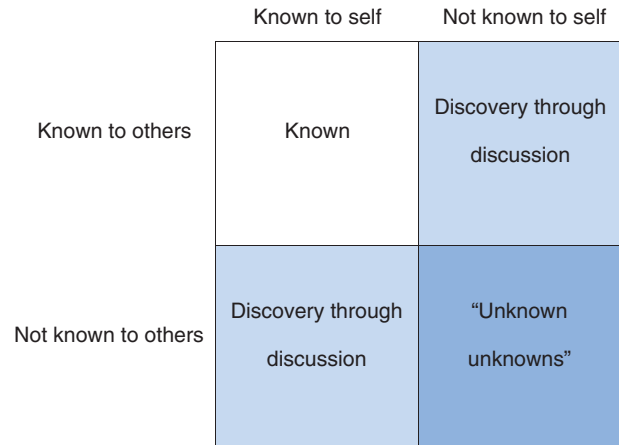**Figure 2.** Bloom's taxonomy, after Atherton (2011).
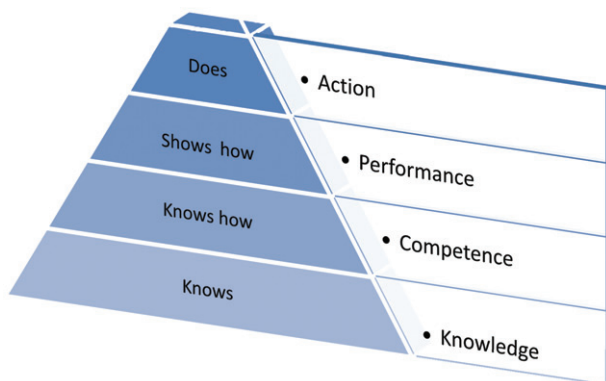
Figure 3. Miller's pyramid after Miller (1990).

Figure 4. The Johari Window after Luft & Ingham (1955).

(Miller, 1990; Figure 3), which can be used as a guide for planning and assessing within a curriculum. The pyramid is important, because in training students for the healthcare professions it is essential to remember that the outcome of training is intended to be a graduate who can take their place in the workforce (Action). Knowledge is the foundation of the pyramid – but not the pyramid itself.

Guided discovery learning and students' learning strategies

In a structured learning environment new knowledge is sufficiently similar to the existing knowledge to allow its relevance to be perceived. A more challenging condition applies in real life, when the relevance of information is often far from apparent. The variants of this situation are described by the Johari Window (Figure 4), named after its originators Joseph Luft and Harry Ingram in the 1950s (Luft & Ingham 1955).

Two things are immediately apparent from this construction – namely that discussion between individuals will increase the amount of practical knowledge, and that some things remain a mystery until we talk to someone else with a different range of knowledge or understanding. It follows that the more diverse a learning group's membership is, the more likely the individuals within the group are to learn. There will always be "unknown

unknowns", but teachers can help students move into those areas through a careful choice of task, resources and, of course, patients. Before we look at the ways in which we can assist learning, there are two other considerations; both of which relate to the way that the learner thinks about knowledge.

Newble, Entwistle and their colleagues, in a number of studies (Newble & Clarke 1986; Newble & Entwistle 1986), have shown that there are several different learning styles, and that learners have different learning preferences. There is a real and active debate about whether learning styles are fixed or flexible, and the extent to which they are determined by the context (Coffield et al. 2004). It does seem clear that some learners prefer to work towards a deep understanding of what they are learning; others prefer to acquire the facts, a term known as surface learning. A moment's reflection will show that each can be an appropriate strategy. Sometimes deep understanding is needed, and sometimes it is enough to know "the facts" – the surface. It is important to know normal blood gas values or electrolyte levels and this surface learning triggers appropriate clinical action. However, to sort out a patient with acidosis requires a deeper understanding of how the various physiological systems interact. The ability to be strategic about the sort of learning we engage in is important. But it can be affected by the assessment system. So, if an assessment system tests for recall of facts, then the successful learner will employ surface learning. If the system rewards deep thought, understanding and reasoning, then the successful learner will aim for that. There is a difference of opinion about whether "strategic" is a third learning style or not (Newble & Entwistle 1986; Biggs et al. 2001). Recognising the different styles is important, as (most) lectures will appeal more to surface learners and extended project work will appeal more to deep learners. Some subject material actually needs to be known and rapidly recalled (blood gas values, electrolyte levels), while other material needs to be deeply understood to allow appropriate interventions (coping with acid base disturbances, or circulatory shock).

In a series of studies on American students in their college years, Perry (1999) noted that students change in their

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approach to learning as they progress through their college years. Typically students develop from an approach based on "duality", with a clear view that the teacher will tell them the difference between right and wrong, towards "multiplicity", where they recognise that context is important, and that they, their colleagues and the environment are valuable sources of knowledge and experience. Together with this change in focus comes a greater confidence with coping with uncertainty. This work was based on a relatively able, affluent and homogenous population of undergraduates and was subsequently extended by Perry's colleagues to a wider cross section of society. They (Belenky et al., 1997) uncovered a group of "silent" learners, who did not recognise their own rights to question or construct knowledge. Belenky and colleagues also extended the scale beyond receiving and understanding knowledge, to being co-constructors of knowledge (Belenky et al. 1997).

Some recent work by Maudsley (2005) shows that medical students develop in the way they learn, but that the progression is not always from duality to multiplicity. There are two explanations for this paradox, one is that the learners tend towards more strategic learning styles in order to cope with the demands of the assessment system; the alternative explanation is rather more complex and relates to the business of becoming a new member of the profession.

The process of learning new things is not just about acquiring knowledge (surface learning), it includes being able to make sense of it, and hopefully making use of it. But being able to do these things means that you have to acquire an understanding of where things fit. A novice stands at the threshold, not quite knowing what to expect, and sometimes not even knowing what they are supposed to be looking at. This is a state of liminality, and the learner needs to have some threshold concepts so that they can move further (Land et al. 2008; Meyer et al. 2010). Frequently the difficulty is in the vocabulary or the way that language is used (Bernstein 2000), but it can also be troublesome concepts (Meyer & Land 2006), or just becoming part of the "team" and assuming a new identity (Wenger 1998). The role of the teacher is to help the learner over the threshold, and, as discussed above, help them until it starts to make sense. If we follow Wenger's arguments (Wenger 1998) then we will see that the whole community has a role in leading the novice over the threshold, and helping them to take their place in the community of practice, that is, in this case, the healthcare profession.

How adults learn: a multi-theories model

It will be clear by now that there are several different theories about, and approaches to, learning. In the section that follows we introduce a model that encapsulates them and can be used to structure, plan and deliver successful learning experiences. We propose that there are five stages in the learning experience, which the learner needs to go through. The learner and the teacher will have particular responsibilities at
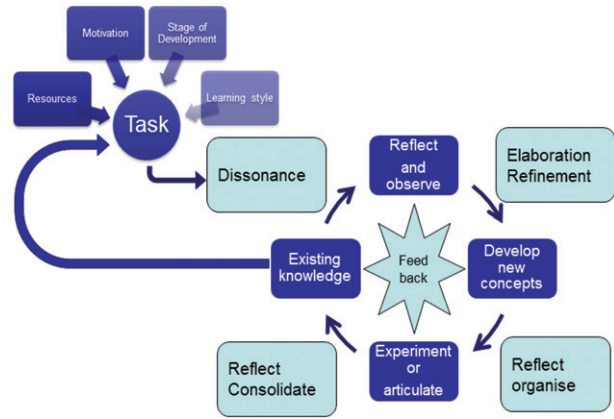
Figure 5. A proposed model of adult learning.

each stage. We shall outline the model first, describe the responsibilities and then discuss each element in greater detail.

Outline

All learning starts with the learner's existing knowledge, which will be more or less sophisticated in any given domain (Figure 5).

The *dissonance* phase exists when the learner's existing knowledge is challenged and found to be incomplete. The challenge can be internal, when a learner is thinking things through, or it can be external, provided by a teacher or patient. There are several things that influence whether the learner will engage with the dissonance phase. These include the nature of the task, the available resources, the motivation of the learner, and the learner's stage of development and their preferred learning style. It ends with the learner reflecting and determining their personal learning outcomes.

During the *refinement* phase, the learner seeks out a number of possible explanations or solutions to a problem (elaboration), and through completing tasks, research, reflection and discussion refines the new information into a series of concepts which are, for the learner, new.

The *organisation* phase is where the learner develops or restructures their ideas to account for the increased information they have acquired. There are at least two elements to this: reflection in action, where the learner tests and re-tests hypotheses to makes sense of the information and the organisation of the information into schemata which (for the learner, at least) make sense.

The *feedback* phase is arguably the most crucial, as it is where the learner articulates their newly acquired knowledge and tests it against what their peers and teachers believe. The feedback will either reinforce their schema, or oblige the learner to reconsider it in the light of new information.

During the *consolidation* phase the learner reflects upon the process they have undergone, looking back over the learning cycle and identifying what they have learned from it, both in terms of increasing their knowledge base, but also in terms of the learning process itself (reflection on action).

Adult learning model in action

During each of these phases, we propose that there are specific roles for teachers and learners.

Phase	Learner's roles	Teacher's roles
Dissonance phase	• Identify prior (base-line) knowledge, skills and attitudes • Recognise what is unknown • Recognise personal development and learning needs • Participate in planning personal learning objectives and relevant experiences	• Provide the context in which the student can learn. • Increase extrinsic motivation through appropriate tasks • Help learner to recognise or promote internal motivation factors • Explore the learner's prior knowledge and experiences • Help student to identify his/her learning needs and the relevance of each
Refinement phase	• Think of many possible explanations or solutions to the case or problem. • Work out which are the most likely resources to refine the possibilities • Actively participate in the activity and experiences • Refine the information into a hypothesis	• Ensure the relevant learning experiences are available – at the appropriate level for the learner
Organisation phase	• Test and re-test the hypothesis • Organise the information into a ''story'' that makes sense to the learner	• Provide advance organisers for the learners – structures upon which they can continue to build. • Encourage reflection in action
Feedback phase	• Articulate the knowledge, skills or attitudes developed • Provide feedback to peers and staff • Accept, and if appropriate act upon feedback received from others	• Reflection on the learning experience (in action and on action) • Provide feedback to the learner, formally or informally. • Accept, and if appropriate act upon feedback received from the learner
Consolidation phase	• Reflection in the light of prior knowledge • Reflection on the learning process • Evaluate personal responsibility for the learning • Development of knowledge, skills and attitudes	• Provide opportunities for the learner to rehearse and/or apply their new knowledge • Encourage reflection on action.

The model that we have given here shows that there are a number of ways in which applying the model can help in the design of learning activities, whether in one-to-one discussions, small group work, seminars or large lectures. The same principles apply to planning curricula, at short course, module or programme level. Whether working with an individual learner, or planning a major programme, the educator needs to recognise that the learner needs to move through a cycle, in order to truly understand and learn. We also need to be explicit that educator and learner have specific responsibilities at each stage of the learning process.

Adult learning model ''expanded'':

The dissonance phase. The key to success as an educator is probably providing the advance organisers. We need to know what we want the learner to learn, and how it fits into the greater scheme. That means that we must have clearly defined outcomes, at the appropriate levels of one of the modifications of Bloom's taxonomy (Figure 2). We may need a student to gain new knowledge, apply their knowledge or create a new hypothesis, for instance. Once we know our intended outcome we are in a position to start thinking about the best way of helping the learner to acquire, and demonstrate that they have acquired, the learning outcomes.

When we plan an educational intervention, we usually start with an idea of the task we want the students to be involved in (attend a lecture, take a history from a patient, write an essay, or whatever). There are, however, five considerations that define the most appropriate task, and they should come first.

Consider how the learner can be encouraged to articulate their prior knowledge. The entire learning process starts with what a learner already knows. In any intervention, we need to make sure that the learner has the possibility to articulate what they already know about something. There are many possible techniques, for instance "buzz groups" in lectures (Jaques 2003), the early phases of the PBL process where learners discuss what they already know (Taylor & Miflin 2008), or discussing something on the ward before performing an examination or obtaining a history from the patient. This stage helps the learner anchor the new knowledge in what they already understand, and places them on the first stage of the learning cycle. It also highlights to the learner where the gaps or uncertainties are in their knowledge.

Consider learning styles and their implications. If the aim of the educational intervention is simply to present the learner with new knowledge, then surface learning is the most appropriate learning style. It is not the most appropriate learning style, though, if the learner is required to understand, or later elaborate on the knowledge (Newble & Entwistle 1986; Biggs et al. 2001). Elaboration, and the later stages of Bloom's taxonomy require an increasing depth of understanding. There are complicating factors, since many learners are strategic in choosing surface learning styles before they enter University courses, so they may appear to show a preference for surface learning. Even at graduate level, if students know that they will be tested on their acquisition of facts, rather than their understanding, they will naturally choose a surface learning style. If the educator is aiming for a deeper level of understanding, then it will be necessary to make sure that the assessment process does not derail it.

It is possible, but challenging, to use lectures to provide more than surface knowledge. Deep learning comes through discussion, research and weighing up the evidence. Curricula that use PBL (Taylor & Miflin 2008), Team based learning (TBL: Michaelsen et al. 2002) and Case-based learning (Ferguson & Kreiter 2007) are designed with this in mind, but more traditional programmes can introduce elements of the more discursive styles, or require learners to complete particular tasks, such as research, small group work or preparing papers.

Consider the stage of development of the learner. In the same way that surface learning has attractions for many learners,

Perry's stage of duality has attractions for both the learner and the educator (Perry 1999). Lectures can reinforce a state of duality in which the learner accepts what the lecturer says. But learners need to be comfortable with uncertainty, dealing with a partial picture and recognising when they need to know more. It is not enough for a doctor just to know the right answers in a perfect situation; we rightly expect them to understand why they are the right answers, and how they are determined by circumstances. A senior clinician will have sufficient experience to recognise this, and it should come across in traditional bedside teaching. Learners can also develop their understanding of systems through well-facilitated PBL or case-based learning, where the facilitator encourages learners to think about the value they attribute to "facts", and the way in which they think about them. Helping the learner shift from duality to early multiplicity, and look beyond the obvious first impressions, is crucial to bedside teaching, for instance, where test results or images have to be related to the patient's account of their problem.

Consider the learner's motivation.   Sobral's (2004) work has shown that student's motivation can be strongly influenced by the educational environment and their frame of mind towards learning. This is also central to the self-determination theory (ten Cate et al. 2011; Kusurkar & ten Cate 2013). If that is the case, then early clinical contact that is both stimulating and relevant to the desired learning outcomes will be beneficial.

Although adult learners are expected to be self-motivated, they will also have a host of competing concerns. Balancing two or more imperatives is a normal state of affairs for both learner and educator. It is the responsibility of the educator to ensure that the task will engage the learner for long enough to allow the learner's enthusiasm to be captured. It is equally important not to squander the learner's energy and enthusiasm with poorly thought out tasks, or issues that are either trivial or too difficult.

There is more to consider here, particularly the dimensions of self-directed learning (Garrison 1997), which include motivation and self-regulation (Zimmerman 2002). There is some evidence that problem-based learning students are better at self-regulation (Sungur & Tekkaya 2006), which includes the ability to construct meaning. The goal, however is self-directed learning which transcends self-regulated learning to include motivation and, crucially, the ability to determine what should be learned (Loyens et al. 2008). Again, this is fostered by problem-based learning, but is easily destroyed by publishing or giving the students detailed intended learning outcomes.

Consider the resources.   Naturally, we need to consider physical resources such as space, books, journals, and access to electronic resources. The most precious resource, for all of us, is time. Whenever an educational activity is planned there must be sufficient time devoted to preparation and planning, including planning the way in which the activity will be evaluated and assessed. Clearly there will need to be sufficient time made clear for the educator/s involved in the delivery, but also in the evaluation and assessment processes. It is also important that there is sufficient time for the learners to engage with the learning activity and complete any necessary

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additional work, such as reading, and of course reflecting upon the material and the way in which they have learned.

Finally consider the task.   The task the learners are set has to take into account all of the preceding considerations.

It needs to have learning outcomes which are aligned with the curriculum as a whole and which are specific enough to be reasonably achievable within the allocated time. No one could learn the anatomy and physiology of the nervous system in a couple of days, but they might be able to master the anatomy and physiology that underlie the crossed extensor reflex.

Opinions are divided about whether every task should be assessed, but it is widely asserted that "assessment drives learning" (Miller 1990), so attention needs to be paid to the assessment opportunities, and the material covered should be included in the assessment blueprint (Hamdy 2006).

The elaborate and refine phase

The dissonance provided by the task has been sufficient to introduce new possibilities, facts and concepts to the learner. They must now start to make sense of them. The first stage in this process is to consider as many of the possible explanations for the new information as possible. This is equivalent to the brainstorming phase in problem-based learning and has two main advantages. The first is that it helps ensure that connections are made between the new information and previous knowledge, ensuring that everything is learnt in the context of what is already known. The second is that it reinforces our natural tendency to be appropriately inventive and to think widely. This skill will be crucial for the future healthcare professional, where the obvious explanation for a patient's symptoms may be wrong. Shortness of breath, for instance, may have a respiratory or a cardiovascular origin.

Elaboration without refinement will just lead to confusion, so once a number of possible explanations for a scenario have been determined, it is necessary to refine them into the most plausible solutions. This will be after some research, reflection and discussion or in the clinical environment after reading the patients notes or seeing the results of appropriate tests. In this phase we are mirroring the scientific and clinical method, which is a valuable exercise in and of itself. The outcome of this phase is the generation of a working hypothesis.

Most of what happens in the elaboration and refinement phase is internal to the learner, but the success of the venture will stem from the nature of the task they were set, and the provision of appropriate resources. The task must be such that it requires some thought and engagement to complete it, and the resources need to be appropriate to the task and the understanding of the learner. This phase is the key part of problem-based learning, but can also arise out of clinical and bedside teaching when the educator is aware of the possibilities and careful to exploit them.

The organisation phase

During this phase the learner looks at a problem from all angles, testing and retesting the hypothesis against what they already know. Part of this phase is fitting the information into

what the learner already knows, and part of it is in constructing the new information into a story that makes sense to the learner. This is a complex task and involves the learner reflecting in action, challenging him- or herself to reflect critically.

The educator has two roles in supporting the learner. The first role is to provide them with scaffolding, a skeleton to support their ideas and give them coherence and structure. This may be the framework of the programme, with a series of themes, or it might be a lecture or lecture series, or it could even be a syllabus. The danger with scaffolding is that if it is too detailed it removes any freedom or responsibility from at the learner. It then becomes very difficult to determine whether true understanding (rather than simple recall) has been achieved. It also means that the learner will not know, until too late, whether they truly understand the subject.

The second role for the educator is to encourage critical reflection. At its best the educator will model this in tutorials or the supervising clinician in bedside teaching, but it is perfectly possible to model one's way of thinking about a problem in a lecture or seminar. Given that so much of our knowledge base changes, critical thinking is probably the most important skill we can give our students.

It is essential that we provide students with opportunities to test their reflective skills. There are many possible ways but they include discussion with each other, informally, or in small groups, with the educator, or with critical friends. Although the idea of critical friends (Baskerville & Goldblatt 2009) is usually associated with teachers/researchers, there is no reason why it would not work between students, although they would need training and support in the first instance.

Feedback

There are two elements to feedback. The first is articulating what has been learned. All educators know that the real test of understanding something is explaining it to other learners. So the newly acquired material needs to be explained, or used in some way.

The educator's role, together with other learners, is the second element of feedback, which is to point out the strengths and weaknesses of any argument, and to ask further questions, until learner and educator are satisfied that the outcome has been met. In any facilitated small group session or bedside teaching session, this is part of the role of the facilitator – it is perfectly possible and acceptable to challenge constructively without handing out the correct answer or humiliating the student. In a group that is working well (whether a formal, structured group or a self-formed study group) other group members will pose questions and seek clarification. This is a combination of feedback and discussion, and can lead to co-construction of knowledge (Belenky et al. 1997). It is also relatively simple to provide feedback in a lecture theatre – either through team-based learning activities, or through instant feedback devices such as "clickers", or, dare one say, the raising of hands!

Although feedback is best given in frequent, small, doses, there are clearly times when it is crucial. The most obvious example is when the learner is being assessed. This is when learners realise the extent to which they have acquired and can demonstrate new knowledge. Any effective assessment system will provide learners with an indication of where they are going wrong, and which areas they should focus on for clarification of their understanding.

There are two further elements of the feedback phase that are often ignored. The first is the duty of the educator to seek and reflect upon the feedback they obtain about their own performance. In this way we can develop and hone our skills to become better at what we do. The second relates to epistemology. Educator and learner also need to reflect upon the way that they have been learning, and the relative highs and lows of the experience. This is to ensure that we can work smarter (rather than harder) next time.

The consolidation phase

The learner faces two challenges in this phase. The first is to reflect on what has been learned in the light of what was known before. Does it all make some sort of sense, or is there a logical inconsistency that needs to be thought through? How does the new knowledge help to explain the bigger picture and increase our understanding?

If the exercise has been subject to assessment, this is where the learner should ideally think about their assessment results, and their areas of relative strength and weakness, so as to ascribe confidence levels to what they think they know.

The learner will already have articulated (in the previous phase) how they felt the learning process worked. In this consolidation phase they need to consider the extent to which they took personal responsibility for their learning. How far are they along the continuum towards co-constructing knowledge? To what extent were they personally responsible for any breakdown in the process? What should they do differently next time?

The role of the educator in this phase is to provide encouragement for reflection on action. This might be through the provision of written feedback about examinations, high-lighting areas of relative strength and weakness, or it could be through an appraisal or portfolio process. The key is to move from a right/wrong type of feedback to one where the possibilities for future development are made explicit. The educator's role, after all, is to lead the learner towards a deeper understanding.

Institutional implications and applications of adult learning theory in medical education

At an institutional level connecting adult learning theory with practice is challenging. Some theories or aspects of a theory will be more relevant and helpful than others in a particular context. In exactly the same way that clinicians are expected to adopt practices on the basis of the best available evidence, educators should make use of the best available evidence to guide their educational decisions. Medical education institutions should rationalise and be explicit about their mission, vision, programme and curricula development, learning strategies, students' assessment and programme evaluation

guided by adult education theories and their particular socio-cultural context.

Institutional mission, vision and curriculum outcome

Many health care education programmes will have mission or vision statements describing graduates who have knowledge, skills and attitudes that allow them to respond to the health needs of the population with a high degree of moral and social responsibility. In outcome-based education one can expect a variety of strategies, each relying on one or more different educational theories. Understanding how people learn is important, and both learners and educators need to remember that learning is a process through which they weigh their knowledge against a critical examination of alternative possibilities (Ahlquist 1992). This understanding is basic to problem-based learning and the majority of clinical practice.

Although knowledge is the easiest, and most public domain, more than half of the outcome domains of medical education are related to attitude e.g. lifelong learning, empathy, utilitarianism, communication with patient and colleagues, ethics and professionalism. Transformative and experiential learning theories constitute an important theoretical frame for learning strategies suitable for these outcomes. The institution should be ready to embark on educational and cultural environment changes in order to operationalise these concepts.

Learning and teaching

Applying adult learning principles in medical education will probably necessitate changing educators' and learners' perceptions of their roles. Adult educators may consider adopting a view of themselves as both learners and educators. The learner's role is not only to receive knowledge but also to search, challenge, construct knowledge and change their own perception, views and beliefs.

Applications of these strategies necessitate significant institutional culture changes, active faculty development and increased learner autonomy and self-direction. To develop these skills all learners (including faculty members) should be trained to ask questions, critically appraise new information, identify their learning needs and gaps in their knowledge and most importantly to reflect and express their views on their learning process and outcomes.

The clinical environment is challenging for the learner and the educator. Clinical educators, students and patients interact together within the context of a hospital, clinics and community at large not just in a classroom. Time is at a premium, and the stakes for the patient are often high. Because of this it is important to make the best use of learning theories when helping people to learn.

Self-directed and experiential learning are key strategies, but feedback is crucial to help the learner make the best use of their contact time. Clinical reasoning, hypothesis generation and testing are essential skills for good clinical practice. The model of adult learning we have illustrated (Figure 5) shows that perception, insight, meaning-making and mental networking are interlinked and essential for good reasoning abilities.

The clinical teachers should explain how they come up with a diagnosis or take a management decision by exploring with the learner the mental processes in the teacher's and the learner's minds by which "the implicit becomes explicit".

Self-directed learning and student goal-setting should always be encouraged and supported but they should also be discussed, monitored and recorded. Portfolios, logbooks and reflective journals are particularly important tools for this. The key for successful implementation is for them to be more than "tick box" exercises, and we have found that using them as a basis for discussion makes them more effective.

Ethics and professional behaviours can be, and often are, taught but understanding them is demonstrated and consolidated within the clinical environment. Asking students to observe, record and discuss incidents that have ethical and professional implications is crucial to this development (Maudsley & Taylor 2009). Perspective transformation theory (Mezirow 1978) is most appropriate for acquiring these competencies. It supports reflection, and examination of the learner and teachers' assumptions and beliefs, hoping it may lead to individual and social change. An off-shoot of adult learning theories is situated cognition (Wilson 1993) developed by Wenger (1998) into the theories of communities of practice. Its application to the clinical environment is relevant. Learning and thinking are social activities structured and influenced by the setting and tools available in a specific situation (Lave & Wenger 1991). Learning and teaching approaches at the bedside are different from the operating room, emergency department or in the community (Durning & Artino 2011; Yardley et al. 2012). Each context has its educational power and value. Observing the performance and behaviour of a trainer as role model, reflection in and on action and feedback on performance are important education principles to be considered in teaching and learning in clinical settings.

Student assessment and programme evaluation

Awareness of adult learning theories is needed to develop and select evaluation systems and instruments that can measure the expected competencies and outcomes. What to measure, how, when, by whom are important key questions and their answers are not always easy. The assessment should be tied to specific learning outcomes, and the learner should be given whatever feedback will help them develop or consolidate their knowledge, skills or attitudes. Time constraints mean that some elements of the feedback will need to be the learner's self- and peer-evaluation, but this should not be seen as a problem. Encouraging discussion, debate and reflection will increase learning opportunities. It is important to allow time, and provide a structure, for these activities if they are to be properly integrated into the learning/assessment system.

As mentioned above, a well thought through portfolio/log book with elements of reflection will allow for the learner's progress to be documented for themselves, and, importantly, for the educator/assessor.

By applying adult learning theories consistently and carefully, the educator can be sure of helping learners become part

of the healthcare profession, and lay the foundations for a career of life-long development.

Summary

(1) Adult learning theories are related to several educational, social, philosophical and psychological theories. Most accessibly these were clustered by Knowles and called "andragogy" clarifying how adults learn best and their attitude towards learning.

(2) A simple model is proposed which has considered different aspects of adult learning theories and their implication to the learner's role and teacher's role. Although the model is presented as a cycle actually the learner and teacher can enter the cycle at any point.

(3) Adult learning theories should influence all aspects of health profession education, from mission and vision statements, outcomes, implementation and evaluation.

(4) The clinical teaching and learning environment is an ideal field for using adult learning theories and demonstrating their utility. Reinforcing clear thinking in both teacher and learner and considering them should improve clinical learning, and even clinical outcomes.

Notes on contributors

The Reverend DR DAVID TAYLOR, BSc (hons), MEd, MA, PhD, FHEA, FSB, FAcadMEd, is a reader in Medical Education at the School of Medicine at Liverpool. Although originally a physiologist, he now works almost exclusively in medical education. He has been heavily involved in curriculum reform in Liverpool and further afield for the past 20 years. His research interests are in problem based learning, pastoral care and professionalism, and in 2009 he was awarded a National Teaching Fellowship by the UK Higher Education Academy.

Prof HOSSAM HAMDY, MB ChB, MCh, FRCS (Edinburgh), FRCS (England), FACS, PhD (Medical Education) is the Vice Chancellor for Medical & Health Sciences Colleges at the University of Sharjah, Professor of Surgery and Medical Education, University of Sharjah. For the last 30 years, he has introduced innovation and quality medical education in the Middle East and Gulf region. His areas of interest are leadership, curriculum development, innovation in learning strategies, clinical education, assessment, programme evaluation, quality measurement and accreditation in Medical Education. In January 2012, he was awarded "Le Médaille du Chevalier Français" by the French Ministry of Education and in April 2011, he won the Sheikh Khalifa Award for Higher Education for "Distinguished Professor and Teacher".

References

Ahlquist R. 1992. Manifestations of inequality: Overcoming resistance in a multicultural foundations course. In: Grant C, editor. Research and multicultural education. London: Falmer Press. pp 89–105.

Anderson LW, Kratwohl DR. 2001. A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Longman.

Archer MS. 2012. The reflexive imperative in late modernity. Cambridge: Cambridge University Press.

Atherton JS. 2011. Learning and teaching; Bloom's taxonomy [Online]. [Accessed 19 March 2011]. Available from http://www.learningandteaching.info/learning/bloomtax.htm.

Ausubel D. 1968. Educational psychologyy: A cognitive view. New York: Holt, Rinehart & Winston.

Bandura A. 1977. Social learning theory. New York: General Learning press.

Baskerville D, Goldblatt H. 2009. Learning to be a critical friend: From professional indifference through challenge to unguarded conversations. Camb J Educ 39:205–221.

Belenky MF, Clinchy BM, Goldberger NR, Tarule JM. 1997. Women's ways of knowing: The development of self, voice and mind. New York: Basic Books.

Bernstein B. 2000. Pedagogy, symbolic control and identity: Theory, research, critique. Oxford: Rowman & Littlefield.

Biggs J, Kember D, Leung DYP. 2001. The revised two-factor study process questionnaire: R-SPQ-2F. Br J Educ Psychol 71:133–149.

Bloom BS, Engelhart MD, Furst EJ, Hill WH, Kratwohl DR. 1956. Taxonomy of educational objectives: The classification of educational goals. Handbook I, Cognitive domain. New York: Longmans Green.

Brookfield SD. 2000. Transformative learning as ideology critique. In: Mezirow, Associates J, editors. Learning as transformation: Critical perspectives on a theory in progress. Kindle ed. San Fransisco, CA: Jossey-Bass Inc. pp 125–148.

Bruner J. 1966. Toward a theory of instruction. Cambridge, MA: Belkap Press.

Choi J, Hannafin M. 1995. Situated cognition and learning environments: Roles, structures and implications for design. Educ Technol Res Dev 43:53–69.

Chomsky N. 1975. Reflections on language. New York: Pantheon Books.

Coffield F, Moseley D, Hall E, Ecclestone K. 2004. Learning styles and pedagogy in post-16 learning: A sytematic and critical review. London: The Learning and Skills Research Centre.

Cross K. 1981. Adults as learners: Increasing participation and facilitating learning. San Fransisco, CA: Josset-Bass.

Durning SJ, Artino AR. 2011. Situativity theory: A perspective on how participants and the environment can interact: AMEE Guide no. 52. Med Teach 33:188–199.

Duvivier RJ, Van Dalen J, Muijtjens AM, Moulaert VRMP, Van Der Vleuten CPM, Scherpbier AJJA. 2011. The role of deliberate practice in the acquisition of clinical skills. BMC Med Educ 11:101.

Ferguson KJ, Kreiter CD. 2007. Assessing the relationship between peer and facilitator evaluations in case-based learning. Med Educ 41:906–908.

Gagne RM, Briggs LJ, Wagner WW. 1992. Principles of instructional design. Orlando, FL: Harcourt Brace.

Garrison DR. 1997. Self-directed learning: Toward a comprehensive model. Adult Educ Quart 48:18–33.

Hamdy H. 2006. Blueprinting for the assessment of health care professionals. Clin Teach 3:175–179.

Hart R. 1992. Children's participation: From tokenship to citizenship. Innocenti Essays No. 4. Florence, Italy: UNICEF.

Hoban JD, Lawson SR, Mazmanian PE, Best AM, Seibel HR. 2005. The self-directed learning readiness scale: A factor analysis study. Med Educ 39:370–379.

Jaques D. 2003. ABC of learning and teaching in medicine: Teaching small groups. Br Med J 326:492–494.

Knowles M. 1988. The adult learner: A neglected species. Houston, TX: Gulf.

Knowles M, Holton EI, Swanson R. 2005. The adult learner:the definitive classic in adult education and human resource development. Burlington, MA: Elsevier.

Kolb D. 1984. Experiental learning. Englewood Cliffs, NJ: Prentice-Hall.

Kusurkar RA, Ten Cate OTJ. 2013. AM last page: Education is not filling a bucket, but lighting a fire: Self-determination theory and motivation in medical students. Acad Med 88:904.

Land R, Meyer JHF, Smith J. 2008. Threshold concepts within the disciplines. Rotterdam and Taipei: Sense Publishers.

Lave J, Wenger E. 1991. Situated learning: Legitimate peripheral participation. New York: Cambridge University Press.

Locke J. 1690. An essay concerning human understanding. London: Thomas Basset.

Loyens SMM, Magda J, Rikers RMJP. 2008. Self-directed learning in problem-based learning and its relationships with self-regulated learning. Educ Psychol Rev 20:411–427.

Luft J, Ingham H. 1955. The JoHari window, a graphic model of interpersonal awareness. Proceedings of the western training laboratory in group development. Los Angeles, CA: UCLA.

Maslow A. 1954. Motivation and personality. New York, London: Harper and Row.

Maudsley G. 2005. Medical students' expectations and experience as learners in a problem-based curriculum: A 'mixed methods' research approach. Doctor of Medicine. Liverpool, UK: The University of Liverpool.

Maudsley G, Taylor DCM. 2009. Learning professionalism in a problem-based curriculum. In: Creuss RL, Creuss SR, Steinert Y, editors. Teaching medical professionalism. New York: Cambridge University Press. pp 211–224.

Merriam SB, Caffarella RS, Baumgartner LM. 2007. Learning in adulthood: A comprehensive guide. San Fransisco, CA: Jossey-Bass.

Meyer JHF, Land R. 2006. Threshold concepts and troublesome knowledge: An introduction. In: Meyer JHF, Land R, editors. Overcoming barriers to student understanding: Threshold concepts and troublesome knowledge. London, UK: Routledge. pp 3–18.

Meyer JHF, Land R, Baillie C. 2010. Threshold concepts and transformational learning. Rotterdam and Taipei: Sense Publishers.

Mezirow JE. 1978. Perspective transformation. Adult Education (USA) 28:100–110.

Mezirow JE. 1990. Fostering critical reflection in adulthood: A guide to transformative and emancipatory learning. San Fransisco, CA: Jossey-Bass.

Mezirow JE. 1995. Transformative learning: Theory to practice. In: Welton MR, editor. In defense of the lifeworld. New York: Suny Press. pp 36–70.

Michaelsen LK, Knight AB, Fink LD. 2002. Team based learning: A transformative use of small groups in college teaching. Sterling, VA: Stylus Publishing.

Miller GE. 1990. The assessment of clinical skills/competance/performance. Acad Med 63:S63–S67.

Newble DI, Clarke RM. 1986. The approaches to learning of students in a traditional and in an innovative problem-based medical school. Med Educ 20:267–273.

Newble DI, Entwistle NJ. 1986. Learning styles and approaches: Implications for medical education. Med Educ 20:162–175.

Norman G, Eva KW, Brooks L, Hamstra S. 2006. Expertise in medicine and surgery. In: Ericsson KA, Charness N, Feltovich PJ, Hoffman RR, editors. The Cambridge handbook of expertise and expert performance. Cambridge: Cambridge University Press. pp 339–353.

Norman GR. 1999. The adult learner: A mythical species. Acad Med 74:886–889.

Norman GR, Schmidt HG. 1992. The psychological basis of problem-based learning: A review of the evidence. Acad Med 67:557–565.

Perry Jr WG. 1999. Forms of ethical and intellectual development in the college years. San Fransisco, CA: Jossey-Bass.

Peters R. 1966. The concept of motivation. London: Routledge.

Piaget J. 1952. The origins of intelligence in children. New York: International University Press.

Regan-Smith M, Obenshain S, Woodwarth C, Richards B, Zeits H, Small PJ. 1994. Rote learning in medical school. J Am Med Assoc 272:1380–1381.

Ryan RM, Deci EL. 2000. Self-determination theory and facilitation of intrinsic motivation, social development and well being. Am Psychol 55:68–78.

Schön D. 1983. The reflective practitioner: How professionals think in action. London: Temple Smith.

Schön D. 1987. Educating the reflective practitioner. San Francisco, CA: Jossey-Bass.

Skinner B. 1954. The science of learning and the art of teaching. Harvard Educ Rev 24:86–97.

Sobral DT. 2004. What kind of motivation drives medical students' learning quests? Med Educ 38:950–957.

Stein B, Littlefield J, Bransford J, Persampieri M. 1984. Elaboration and knowledge acquisition. Mem Cogn 12:522–529.

Sungur S, Tekkaya C. 2006. Effects of problem-based learning and traditional instruction on self-regulated learning. J Educ Res 99:307–320.

Taylor DCM, Miflin B. 2008. Problem-based learning: Where are we now? Med Teach 30:742–763.

Ten Cate OTJ, Kusurkar RA, Williams GC. 2011. How self-determination theory can assist our understanding of the teaching and learning processes in medical education. AMEE guide No. 59. Med Teach 33:961–973.

Thorndike E. 1911. Animal intelligence. New York: Macmillan.

Vygotsky L. 1978. Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Vygotsky LS. 1997. Interaction between learning and development (1978). In: Gauvin M, Cole M, editors. From Mind and Society. Readings on the development of children. New York, NY: W.H.Freeman and Company, Cambridge, MA; Harvard University Press. pp 79–91.

Weiner B. 1992. Human motivation: Metaphors, theories, and research. Newbury Park, CA: SAGE.

Wenger E. 1998. Communities of practice: Learning, meaning, and identity. New York, NY: Cambridge University Press.

Wilson AP. 1993. . In: Merriam SB, editor. The promise of situated cognitionAn update on adult learning theory. San Fransisco, CA: Jossey-Bass.

Yardley S, Teunissen PW, Dornan T. 2012. Experiential learning: AMEE guide no. 63. Med Teach 34:102–115.

Zimmerman BJ. 2002. Becoming a self-regulated learner: An overview. Theory Pract 41:64–70.