

How to teach the doctor?

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How to teach the doctor? Ten laws to teach medicine

H. P. A. Boshuizen

When new doctors graduate, we expect a lot from them. Not only do we assume that new doctors immediately fit into their new role and are immediately ready for their increased responsibility and new relationships with other health care providers, but we also assume that they have all the knowledge needed for this (Prince, Van de Wiel, Van der Vleuten, Boshuizen & Scherpbier, 2004). That is contrary to what they find themselves. Not only do young graduates indicate that these things fall heavily onto them in the first period of their new existence, research also shows that they have still not reached the knowledge level of their experienced colleagues. On the other hand, there is evidence that when it comes to up-to-date knowledge, recent graduates score best. This ready knowledge seems then to decrease in the course of the medical career (Van Leeuwen et al., 1995). These two observations suggest, therefore, that although much is improved during the medical career (and hence is learned), a lot can also be improved. In this article I will try to show how such improvement may look like. I do this on the basis of 10 laws of cognitive psychology.

Law 1. The knowledge: Knowing is better than problem solving, problem solving is better than half or poor knowledge

There was a time when it was proclaimed that physicians should be particularly good problem solvers and ready knowledge mattered less. There were several reasons for this view. Among other things, it was noted that knowledge becomes obsolete rather quickly these days, which is true. To achieve good problem-solving skills, medical students had to practice a lot of case studies. The latter solution proved to be a lucky approach. Not because practicing case studies are so suitable to learn to solve problems – students can actually do that when they enter college – but because of the simultaneous knowledge gain. This knowledge was then easily suited for use when the students again encountered such a similar case. A student who can solve this problem because s/he already knows the answer is faster and more certain about the solution than anyone who first has to analyze the problem, generate all alternatives and test them, etc. However, a problem arises when the knowledge is incomplete or contains errors, particularly when one is not aware of the possible errors. Then a wrong solution is generated, with the same certainty. But that's no reason to throw out the baby with the bathing water.

Law 2. Knowledge begets knowledge: Who knows a lot, learns more, faster and better than anyone who knows little about a topic

This law could also have been formulated as "All beginnings are difficult." To calculate the workload of junior year students, one can apply a simple calculation rule that takes into account only the number of pages. For senior students that rule no longer applies. Beginners in a domain study differently from more advanced students. When I go back to my old first-year textbooks, I find margins full with translations of unfamiliar concepts and a lot of underlinings that I used to catch the essence of the text. There are also notes containing diagrams of difficult parts of the text. The biggest problem for beginners is that domain concepts have hardly any meaning for them, and that they have few key concepts they can link with the new study material. Research into the effects of problem-based education has shown that activation – even little, but relevant – of the prior knowledge leads to better learning performance.

Intermediates and experts in a particular field do not have these problems. They can go straight to the essence of what is new to them, what is different from what they already know, or what actually offers support to new developments that they have read or heard elsewhere. When I look through the books and articles that I read today, I find critical remarks in the margin and references to the work of others except when it comes to things that are completely new to me. Then I struggle again as a beginner.

Law 3. Repetition leads to improvement, spaced repetition does that better

This is a very classic psychological law, investigated in the laboratories of Ebbinghaus in the late 19th century. It is also well known to high school students. When they have to learn vocabulary, they will not do it all at once, but they will repeat it several times, preferably at different moments. It applies not only to pure rote learning, but also to the application of knowledge to relevant problems. For example,

we have seen that students who were working on a complex case only applied a limited part of their knowledge. Just as if their heads were 'full'. In a second case with similar underlying problems they then took up the thread again where they had dropped it in the previous case. The second time they were able to give a more complete explanation of the presented symptoms, and a more complete diagnosis, even though they had not studied relevant subject matter in between the cases.

Law 4. Use of knowledge leads to changes in the structure of knowledge

Research by Boshuizen, Custers, Hobus, Hofstra, Rikers, Schmidt, and Van de Wiel (Boshuizen & Schmidt, 2001), among others, has shown that physician's knowledge develops in such a way that clinical reasoning becomes more efficient and accurate. This occurs in a couple of phases, which appear to correlate with the way the curriculum is organized. In the first phase, knowledge increases and evaluation occurs, and some integration of disciplines takes place. In this phase, students are capable of solving

problems, but the reasoning proceeds in small steps. Accuracy of reasoning must be checked step by step, and thus requires a lot of attention. By repeatedly applying this knowledge to real cases, however, two things happen: 1) Gradually the reasoning steps increase, because people learn to use macro-concepts that summarize parts of such reasoning. Clinical examples of such concepts are forward heart failure, extrahepatic jaundice and micro-emboli. We have called these macro concepts 'encapsulations'. 2) In

addition to encapsulations, the use of medical knowledge in authentic contexts also leads to the development of 'illness scripts'. Illness scripts have a fixed format: a) the factors leading to or protecting against the emergence of a particular illness (enabling conditions), b) the processes of the said illness (fault), and c) its consequences, the signs and symptoms (consequences). In contrast to the knowledge in the first stage that is activated step by step, illness scripts are activated as a whole. Research also shows that with increasing experience the power of illness scripts and their activation in the diagnostic process increases. The first hypothesis that experienced GPs generate about a certain patient is often better than what their less experienced colleagues come up with. Maybe more importantly, in this kind of studies that first hypothesis is based on not much more than some patient information or information about the patient's context and the complaint.

Law 5. To rest is to rust

Knowledge which is not used becomes less readily accessible. That knowledge is not kept up to date. After all, knowledge that is 'in use' is activated over and over again, and thus improved and expanded. For various reasons, old, never used knowledge is not very reliable. Yet, there is a small bright spot. Research into the long-term effects of learning shows that much knowledge once learned remains available. The trick is to "unlock" it again.

Law 6. Learning from experience is different from studying books

After having completed medical training, a graduate has become very accomplished in one thing, namely studying. A graduate has learned, eventually by trial and error, how to study texts, how to train skills, and how to pass exams. However, in practice that s/he then enters, this is not so important. In fact, in working life learning from experience is much more important. Experiences and events, even 'teachable moments', however, cannot be read as text, neither is the meaning of an experience explicitly presented, as is the case in study texts. Experiences and events are not static and do not have clearly delineated units. Experiences have a beginning and an end, but its definition is determined by the participants. Just like quarreling children who have their own interpretation of 'who started' and what action provoked the chain reaction, does the interpretation of what exactly happened determine how someone defines the boundaries. Finally, many experiences cannot be 'read' while doing. In many professions, one will have to do first and finish the planned actions before it is possible to reflect on the exact sequence of events and their positive or negative results (Eraut, 1994).

Law 7. Learning from experience requires learning competencies

Much has been written about learning experience, but not everything is empirically well founded. The first empirical fact is that a lot of learning from experience happens incidentally, without explicit consideration. We improve by doing something and trying to do it well. Thus acting and learning overlap each other partially. This learning insofar requires no learning competences. However, this automatic learning can be regulated, for instance by searching for feedback, or by ensuring that new procedures are demonstrated to you and that you are allowed to practice them with or without supervision.

Fessey (2002) studied how surgical nurses who had just finished their training organized their own learning in their new environment. She found among other things that there was a sort of 'something in' system, an exchange system in which the newcomers perform chores in exchange for explanation and demonstration of activities and procedures by experienced colleagues, before doing these themselves for the first time. Those who do not participate in this system will miss all kinds of learning opportunities.

Reflection is a very powerful way to learn from experience: reflection on what went well and what went less well, considering alternatives, performing the alternative chosen on a following occasion, and assessing its impact on the result. In order to perform this kind of reflection–action cycles a number of conditions must be met. Firstly, reflection is much more easy to perform when an action can be stopped at the moment where it appears to develop the wrong way. In medicine, this is usually not the case. In addition, immediately after the event there is often no occasion for reflection. Secondly, knowledge of results is required. One who does not know what the results of his/her actions are, does not have a basis for improvements either. Thirdly, the alternative action should be planned and implemented at the earliest opportunity. The sooner, the better. Unfortunately only some medical care can be planned and predicted, which has implications for learning too. A physician must therefore ensure that the good intentions for improvement are well remembered and seize the opportunity for learning when that occurs.

Experiences are not always neutral, in emotional respect. We speak of good experiences in which we felt ourselves comfortable, and bad experiences that seized us emotionally and gave a bad feeling. Learning from "bad" experiences can be very difficult and people may prefer to simply deny that they are emotionally affected, rather than tackle the bull by the horns and rationally analyze the situation. Many students and professionals lack the coping strategies that are needed to reflect and act accordingly. This is not just a question of lack of learning competences; the learning culture of the team or organization someone belongs to may contribute much to this as well.

Law 8. Experiential knowledge is often tacit

Because a lot of experience and knowledge is gained incidentally, its outcome is often built into the knowledge that was active at that time. As a result, the same knowledge is automatically activated when a similar situation is met. This is a very effective way of learning, but the downside is that the same knowledge is difficult to activate in dissimilar situations. And knowledge activation is a prerequisite to be able to think about new knowledge. For example, asking oneself whether this knowledge is true or whether it is applicable in other situations. A specific form of incidental learning is 'fine-tuning' of illness scripts. Fine-tuning can regard both the enabling conditions and the consequences part of such a script.

The best way to activate tacit knowledge is telling stories with colleagues and then analyze a number of specific questions. The story of one person is the key that helps uncover similar or different experiences others have. Specific questions are needed to systematize the experiential knowledge.

Law 9. Increasing experience tends to lead to experience concentration

This law is an extension of Law 2. Someone who has expertise in a certain area can easily improve knowledge and skills on that same point. Furthermore, those are often the issues one is interested in. In this way, someone may build a competency profile with a number of outliers to the top, but also to the bottom, the neglected parts of the skill set. During the course of time these latter areas can become deficient.

Law 10. People tend to have a blind spot for the gaps in their knowledge and skills, which can make their self-assessment of learning needs unreliable

This is perhaps the oldest law of all so far: the biblical version speaks of the beam in the own eye. When choosing training activities this tendency is also apparent: One prefers topics that add to the experience concentration of Law 9. I'm not going to argue for a mandatory test and periodic training, based on this, but the above points suggest a number of actions that can definitely help to improve the awareness of this type of gaps. For instance, we can miss the point in exchanging stories (Law 8) when this is a social activity only. It can become a conversation between deaf people if we only politely take turns and do not try to understand similarities and dissimilarities with our own experiences, how boring or exotic other people's stories may be.

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