Expertise development : the transition between school and work

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Expertise development:
The transition between school and work

Inaugural Address

Expertise development: How to bridge the gap between school and work

Henny P.A. Boshuizen, Open Universiteit Nederland

Conference

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To 'my' MHPE students,
lifelong learners par excellence
and great gap-bridgers.

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Inaugural Address

spoken upon the public acceptance of
the professorship in Educational Technology,
at the Open Universiteit Nederland
on Friday, January 31, 2003

by prof. dr. H.P.A. Boshuizen

Expertise development:
How to bridge the gap between school and work

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Dear rector and other members of the Executive Board,
Colleagues and invited guests,
Family and friends,
Ladies and gentlemen,

Expertise and experts: what is that, and what kind of people are we talking about? Are the people who are asked for comments on the news and who we can see on television daily experts? What about the specialists who assess and evaluate objects of art in programme like Antiques Roadshow, are they experts?[1] Or is it better to stay closer to everyday life and ask the same question about the educational designer, the plumber or the doctor?

Years ago (Boshuizen, 1989), when I wrote the introduction to my doctoral thesis, I asked a rather select group of colleagues, friends and acquaintances the same question. They told me the following: an expert is someone who is very talented in a specific domain, has a lot of experience, has a very extensive repertoire of knowledge but also knows his or her limits, has good or even excellent skills in his or her domain, delivers quality work and quickly and purposefully finds a solution to a problem or designs and delivers a product that meets the requirements. Another aspect of experts is that they have spent thousands of hours developing these skills; they have acquired only some of them in formal education, and the rest through self-directed learning in other environments and by deliberately practising[2], sometimes starting at a very young age in the case of computer skills, sports and art, but also in the case of history, biology or science. More recently the discussion of expertise has extended to topics such as the ability to develop professionally, the flexibility to remain on top even in a changing environment, and to social recognition (being recognised as an expert by superiors, colleagues within the same or in other professions, and/or the clientele, Van der Heijden 1998).

I am not sure whether it is a typically Dutch characteristic to have an ambivalent attitude toward expertise and experience. On the one hand, expertise is very much valued; on the other, it is very difficult to judge someone's expertise. The very nature of expertise implies that those who are able to judge the quality of experts' work probably don't need them, whereas those who need them most cannot evaluate it (Brown & Duguid, 2000). Things get even more complicated when we are dealing with a very

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dynamic field like computer sciences or financial estate management, and when the field the expert is involved in directly influences our health or well-being. To make this horror story complete, Weggeman (2000) claims that there is a natural process of development among professionals in business in which an 'over the top' stage can be discerned. Professionals in this stage work on the basis of routine, no longer incorporating new developments in their work. These professionals have standard solutions that may no longer match the new problems surfacing in society, or that do not conform to recent insights in the field[3]. It is not surprising that people sometimes prefer newcomers who have just graduated, because they 'know all the latest insights and standards and have everything fresh in their memory'. The latter sentence encapsulates everything I want to deal with here this afternoon. It can be broken down into the following elements:

– Expertise and its development
– The transition from school, college or university to work and the problems that may accompany this transition
– How learning in school, college or university may affect expertise development
– How experience and learning in practice affect expertise development
– And opportunities and threats in this process from the perspective of learning and education.

These are the topics we are going to deal with for the rest of the time available.

Expertise and its development

We expect experts to be better in their domain than novices and laypeople. Is that indeed the case? I will give you a couple of examples of research revealing different outcomes.

The first is a very recent study by Jos Arts and colleagues in Maastricht that has not yet been published (Arts, Gijselaers & Boshuizen, in preparation). A total of 115 (!) subjects participated, representing nine different levels of expertise ranging from younger novices to older experts in business administration with more than 25 years of experience. They analysed a business case and one of the measures derived from these analyses was the quality of the solution. Except for a delay around the time of the transition from education to work, we found a continuous improvement in performance over the whole period of thirty years encompassed by the results. More detailed analysis also showed that the number of mistakes decreased and that particularly during formal education, the number of partially correct solutions increased, mostly because students could not adapt their solutions to suit the context of the case. Only after graduation did the number of partially correct solutions decrease.

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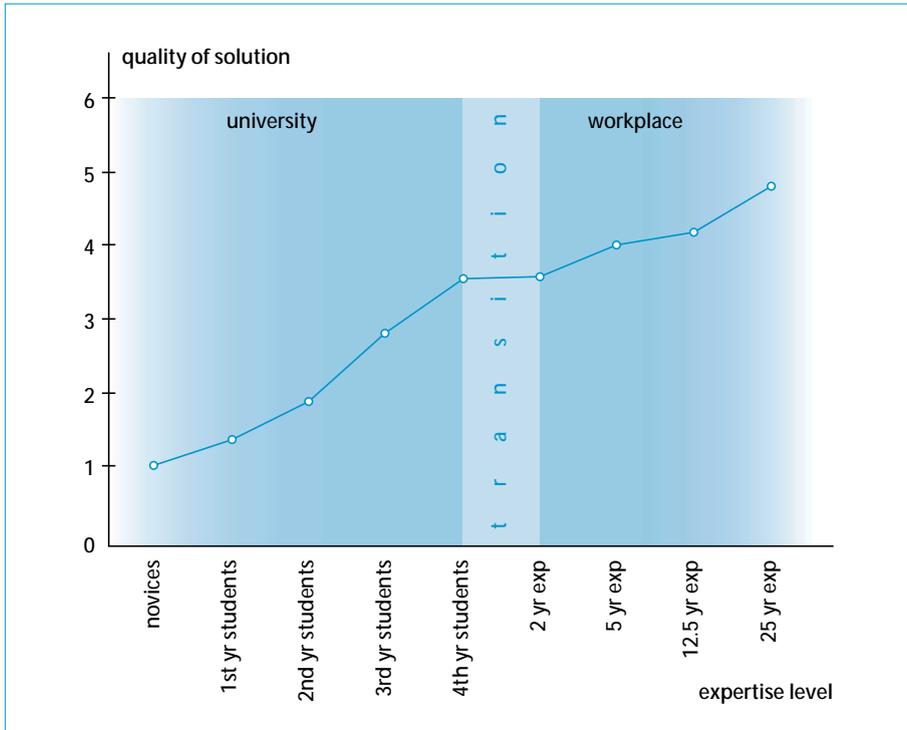
Figure 1 Quality of the solutions of a management case by students and experts in the domain. Derived from Arts et al. (in preparation)

Another example is from research done by Hofstra and Hobus et al. in 1988. This study involved family physicians who had between three and thirty years experience. These physicians saw 18 incomplete cases and were asked to give the most likely diagnostic hypothesis. Here again, we see a continuous improvement in performance.

However, there are also studies that show a less rosy picture. For instance, Krol, De Bruyn and Van den Bercken (1992) compared students and experts in the classification of dysfunctional behaviour in children. They did not find any significant differences between the groups. They even questioned whether one could speak of expertise, since the classification structures of some so-called experts' could not stand up to comparison with epidemiological findings (Krol, 1992).

Finally, again in the domain of family medicine, Yvonne van Leeuwen (1995) compared students, interns and experts (the most experienced had been in practice more than 20 years). She used a more conventional knowledge test and found that the state-of the-art knowledge of the diagnosis and treatment of conditions and diseases was at its best

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at the time students graduated as family physicians. The more experienced the physician, the lower his or her score.

What can be concluded from this? For now I will go no further than to say that in some domains and on some measures we see that more experienced people perform better than less experienced ones and than those still in training. However, in other cases we see that recent graduates perform better. Why that should be so is a question I will return to later. First I want to look more closely at a couple of related factors .

From novice to expert

Let me start with the following claim, which is not a very surprising one given the amount of evidence supporting it and the length of time this evidence has been around. The claim is that, in medicine at least but probably in the many other diagnostic professions, differences between experts and novices cannot be explained by differences in reasoning (see Elstein, Shulman & Sprafka, 1978; in the domain of accountancy, Bédart, 1989, is a good example). Everyone, novice and expert alike, generates hypotheses in diagnostic reasoning and tests these hypotheses by gathering discriminatory information that either confirms or denies them[4]. Despite the overwhelming evidence it is important to bear this in mind, since many educators in medicine see students' problems in clinical reasoning as a lack of general skill, as a lack of proper training in this area, or as a competence that students have not yet mastered completely. Contrary to this view, I claim that building up domain knowledge, in combination with learning the required skills, is the key (see Boshuizen & Schmidt, 1992; Schmidt et al., 1990, 1992; Schmidt & Boshuizen, 1992). In this sense, acquiring medical expertise is no different a process than acquiring expertise in other, non-diagnostic domains (e.g., in chess: De Groot, 1965; engineering: Ackermann & Barbichon, 1963; statistics: Allwood & Montgomery, 1981, 1982; mathematics: Bloom & Broder, 1950; physics: Chi et al., 1981). I therefore use the novice-to-expert learning process in medicine as a prototype in order to derive hypotheses for other domains.

Medical knowledge consists of thousands of concepts, principles, rules, skills, procedures, patterns and so on that are not learned for their own sake, but with the aim of diagnosing and treating sick people. It is therefore necessary for this knowledge to be organised in a way that it can be verified, easily activated in relevant contexts, easily applied in reasoning, et cetera. There are a couple of learning processes that guarantee that this goal is reached. One of these consists of knowledge accretion, validation and integration, a process that takes much more time than teachers might expect. The integration and integrated use of knowledge from different domains (e.g., biochemistry, pathophysiology or microanatomy integrated with the clinical sciences) are particularly tricky (see Boshuizen & Van de Wiel, 1998; Groothuis, Boshuizen, & Talmon, 1998). This kind of learning takes place mostly in the first years of training, when the student's

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clinical reasoning process is characterised by lines of reasoning consisting of chains of small steps commonly based on detailed, biomedical concepts, sometimes supported by notes and sketches. These kinds of exercises result in a well-integrated, validated knowledge network.

Once the student has acquired these well-integrated networks, he or she can make direct lines of reasoning between different concepts. The more often these direct lines are activated, the more the concepts they include cluster together and the more student is able to make direct links between the first and last concepts while skipping the intermediate ones. This is the second learning process we have discerned. We labelled this process 'knowledge encapsulation', a term that refers to the clustering aspect of the process and accounts for the automation involved (e.g., Boshuizen & Schmidt, 1992; Schmidt & Boshuizen, 1993; Margje van de Wiel's PhD thesis was devoted to this topic, 1997). As a result of this encapsulation process, the level of granularity in clinical reasoning protocols increases and such supporting tools as sketches are no longer necessary. A new type of clinical or semi-clinical concept appears in the protocols, such as micro-embolism, aorta-insufficiency, forward failure, or extra-hepatic icterus, providing a powerful reasoning tool.

The third learning process is illness-script formation. Scripts are based on experience. They are knowledge structures that describe stereotyped sequences of action (Schank & Abelson, 1977). The archetype of a memory script is the restaurant script, which describes the procedure of eating in a restaurant, the roles of the different participants and their actions, the objects involved, et cetera. Scripts also indicate where variations are allowed and what is really necessary. The restaurant script requires that food is served and that the guests pay for it. Scripts can form families with a common structure but with different combinations of variables, such as fast-food restaurant, Chinese take-away, sushi bar, and so on. Likewise, illness scripts describe the process of contracting a disease: the conditions or constraints under which a disease occurs (the Enabling Conditions), the pathophysiological process that takes place (the Fault, represented in encapsulated form) and the signs and symptoms caused by a specific disease (the Consequences). Illness scripts also include the course a disease may take and the kind of action required to cure it. Physicians have scripts similar to restaurant scripts for all the disease and patient types they commonly see in their practice (also see Feltovich & Barrows, 1984, who introduced this theoretical notion).

There is a big difference between clinical reasoning based on networks of concepts and clinical reasoning based on illness scripts. Network-based reasoning is done step by step. In the case of encapsulated networks, these may be big steps, but they are still taken one at a time. Illness scripts, on the other hand, are activated as a whole. Once an illness script has been activated, the other elements of the script are also activated, immediately and automatically. People whose knowledge is organised in illness scripts

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therefore have an advantage over those who have only semantic networks at their disposal. While solving a problem, a physician activates one or a few illness scripts. The illness script elements (Enabling Conditions and Consequences) are subsequently matched to the information provided by the patient. Not only do illness scripts incorporate matching information volunteered by the patient, they also generate expectations about other signs and symptoms the patient might have. Hence, activated illness scripts provide a list of phenomena to look for when taking the patient's history and during his or her physical examination. In the course of this verification process the script is further instantiated, i.e. expected values are substituted by real findings, while scripts that fail in this respect are de-activated. The fully instantiated script yields a diagnosis or a differential diagnosis when only a few competing scripts remain active. For the sake of completeness we must add a fourth learning process. Diagnosing and treating patients leaves traces in the memory. These traces can be used later and function as a shortcut to activate relevant knowledge (Kolodner, 1993).

These changes in the organisation of knowledge not only bring about changes in the appearance of clinical reasoning but also in the amount of control required and, hence, in the demands made on cognitive capacity (see Table 1)[5]. I will not go into further detail at this point, but will return to this idea in my discussion of the implications for education and research.

Table 1 Knowledge structure, learning and cognitive demand in problem-solving at subsequent stage of expertise development

Expertise level	Knowledge structure	Learning	Problem solving	Control required in clinical reasoning	Demand on cognitive capacity
novice	networks (incomplete and loosely linked)	knowledge accretion, integration and validation	long chains of detailed reasoning steps through networks	active monitoring of each reasoning step	high
inter-mediate	networks (closely linked)	encapsulation	reasoning through encapsulated network	active monitoring of each reasoning step	medium
expert	illness scripts	illness script formation	illness script activation and instantiation	monitoring of the level of script instantiation	low
	memory traces	instantiated scripts	automatic reminding	check relevance	low

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Place and source for learning

The knowledge and skills we are talking about are partly built up within the context of formal education and partly later, in actual practice , when one works independently or under supervision. At which point in time this transition should take place can be the subject of serious dispute.

It is often thought that, ideally, graduates should only enter the labour market as a 'finished product', as someone who is ready for work and who can function independently from day one. This opinion is the logical end result of a trend that started in the Netherlands in the 19th century and that made labour and education increasingly separate and independent. Education and training could no longer take place on the job due to several processes: the introduction of new techniques required knowledge that could no longer be learned at work; precious materials and expensive, complex and heavy machinery increased the risk of accidents, so that new workers had better build up skills first before they were allowed to operate or even come near this equipment; rationalisation of labour processes interfered with supervision of apprentices; and a long period of schooling and training raised the status of a profession or vocation (De Vries, 1992). There is another view, however, which is that young adults or adolescents should start working and be economically productive as early as possible. Though very outspoken, this view does not tell us where one best learns specific content and skills. Instead it seems to be the product of economic circumstances, industrial development and a general perception of man and society.[6] Although the topic of this address is expertise development, I want to take you on a short excursion to the economics of education and the labour market to show that changes in the economic climate have an impact on educational strategies and the choice of place and time best suited to learning a specific competence. The central issue in this economic debate is the question of the shelf life of knowledge or its half-life, as it is often called. Neither term refers to the normal decay of knowledge and memory ('forgetting' in the vocabulary of psychology and everyday life or 'technical skills obsolescence' in terms of labour market economy, De Grip and Van Loo, 2001). What is meant is that technical and scientific knowledge and standards develop so rapidly that, depending on the field, someone's body of knowledge can become obsolete within only a couple of years. Den Hertog and Huizenga (1997), for example, claimed that over a period of ten years the half-life of knowledge in the field of engineering was reduced from ten years to five. This means that half of the knowledge of an engineer who graduated five years ago is probably now outdated. According to Weggeman (2000), two factors have contributed to this shorter life cycle: the tremendous advances in several fields[7] and the enlargement of our environment from local to global. The latter is leading to a sort of absolute benchmarking affecting the way businesses as well as professionals work and are evaluated. Physicians, for instance,

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are increasingly confronted with clients (especially patients with a chronic disease) who are very well informed about the most recent breakthroughs in diagnosis and treatment in countries as far away as Canada, Brazil, India or Australia.

The preferred educational strategy to prepare people for work in such a field will depend largely on its pace of development. In fields with a knowledge half-life that is virtually eternal, a 15-year course of study does not give rise to any problems in terms of the practical usefulness of the knowledge acquired in education. How different is the case of a student of information science. This field sees a paradigm shift every ten years. Such dramatic changes have two implications for the training of software engineers. One is that students should not be kept in schools or universities so long that by the end of training the content and principles learned in the first years of study have become completely outdated. The other is that the students must learn how to handle these paradigm shifts: which principles remain, which move to the background, and how to integrate new developments with existing skills and knowledge.

Not only can discipline knowledge develop at an unexpectedly rapid pace, but society itself is also susceptible to change, and so are the boundary conditions that must be observed when applying the skills and competencies that someone may still be acquiring. In addition to national and global economic and technological trends, the ageing population and the expansion of the EU will have a major impact on society in the near future.

In domains and disciplines undergoing rapid development, the question as to whether a graduate must be 'ready' for the labour market, or a 'finished product', is irrelevant; instead the question should be whether a student has enough stock-in-trade to get a job and start working as an apprentice or as a young professional and – possibly– continue to develop his or her competencies at the same time, either with the help of a coach or supervisor or independently, not only during the first few years after entering the labour market, but for the rest of his or her professional life. If we also give credence to the idea that few communities and societies can afford to exempt their young generations from being economically productive[8] (e.g., in order to study something exotic for 15 years like old Assyrian), then it will be evident that the wish to deliver or receive a 'finished product' is unrealistic in most cases, if not undesirable. And if learning should take place at least partly in practice (which is my claim), we must take care that the conditions for learning are optimal.

The transition from school to work

In our present society, pupils and students are exempted from work. In this period of their lives, which they spend in schools or other educational institutions, they have the opportunity to learn large amounts of knowledge and skills without that learning process being embedded in work. However, the result must be such that they are

capable of applying the knowledge and skills they learn flexibly and adequately. Students and recent graduates are expected to master their skills and knowledge to such an extent that they know when to use them and when not. They should be able to recognise application conditions, and to flexibly apply their knowledge and skills by adapting them to the characteristics of a specific situation. Examples of this adaptive use of knowledge can be found everywhere: children of a certain age should be vaccinated against several infectious diseases, but not if they have a condition that increases the risk of their suffering side-effects beyond the risk of their catching the disease; reasonable wishes of a client should always be satisfied, but not if that brings one in conflict with other clients or tasks; et cetera. This adaptation sounds easy, but it is left to the student to decide which of the two applies, the rule or the exception. However, at the point of transition from school to work this is not the 'only' thing. The students should also be ready for further professional and self-development. For instance, the software engineer who graduated five years ago must have remained up to date by learning java and must also be prepared for the next paradigm shift and be capable of adapting to completely new concepts and technologies.

How does one go about doing that? Are such attempts successful? I have to say that this transition is an uphill battle. Even those who indicate that they were looking forward to leaving their student days behind them agree that the transition from school to work is a hard one. What kind of problems do they face? To answer that question, I will restrict myself to the findings of research I was myself involved in during my previous job at Maastricht University.

The first project is one in which I found an unexplained dip in the development of students (Boshuizen, 1996; in preparation). It was the most extensive study of its kind ever conducted and the only study that zoomed in on the moment of transition from pre-clinical education in medicine to clinical education. The phenomenon I was interested in was an earlier finding by Henk Schmidt and myself that fifth-year medical students (i.e. shortly after they have entered their clinical clerkships) applied hardly any biomedical knowledge during clinical reasoning, but that the biomedical knowledge they used in their post hoc explanations did not show a corresponding dip. The knowledge was therefore accessible and they could have used it afterward, but they did not apply it during clinical reasoning. Other observations suggested that the biomedical and clinical knowledge bases were not yet integrated (Boshuizen & Schmidt, 1992). Subjects in the 1996 study were fourth- fifth- and sixth-year medical students. A reference group of a sample of experienced physicians (gynaecologists) was also included. Subjects were asked to diagnose two paper cases while thinking aloud.[9] What I found was a profound dip in the performances of the fifth-year students in virtually every aspect measured: in the extent of the protocol, in number of knowledge

application propositions in the protocols, in the number of biomedical concepts used and in the auxiliary lines of reasoning. The only measure that did not show a clear drop was the accuracy of the diagnosis, but that did not significantly improve either during the same period, a finding similar to the plateau revealed by Arts et al. (in preparation). Given the large number of participants in the study and the combination of cross sectional and longitudinal comparisons, it seems unlikely that student selection can explain this phenomenon.
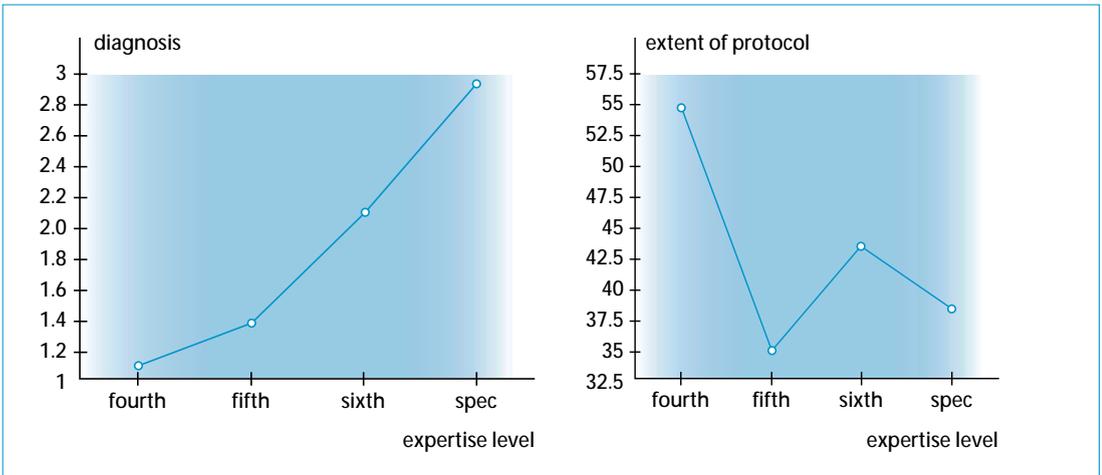
Figure 2 Diagnostic accuracy of subjects of four expertise levels. Derived from Boshuizen (1996)

Figure 3 Extent of the protocols (number of utterances) generated by subjects of four levels of expertise. Derived from Boshuizen (1996)
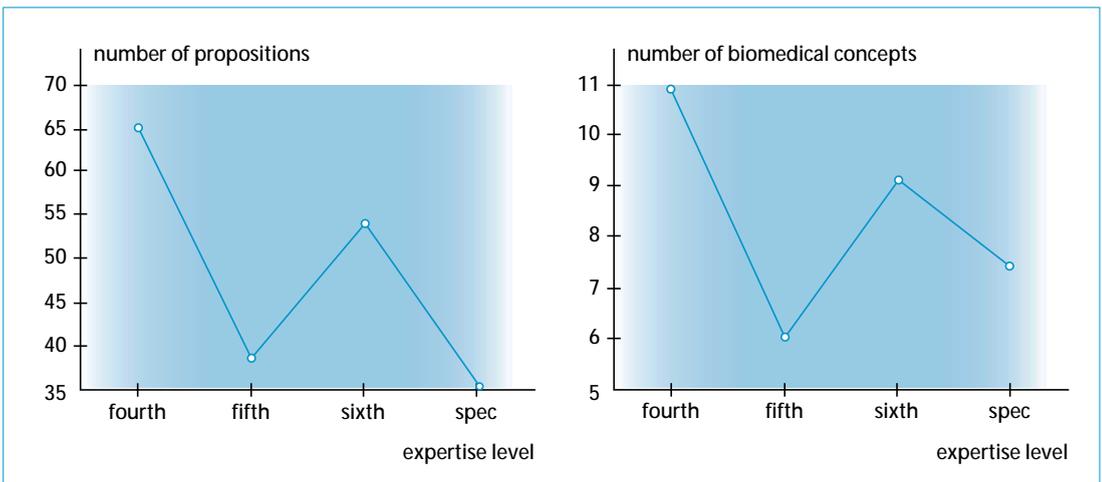
Figure 4 Number of knowledge application propositions. Derived from Boshuizen (1996)

Figure 5 Number of biomedical concepts. Derived from Boshuizen (1996)
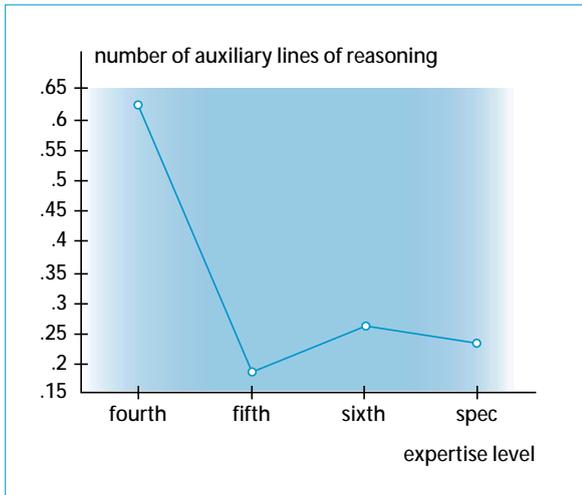
Figure 6   Number of auxiliary lines of reasoning. Derived from Boshuizen (1996)

Another phenomenon was found by Prince et al. (2000). They did a focus-group study with medical students at the start of their fifth year, soon after they had begun their clinical training. This study showed that the students were quite confident about their clinical skills, but felt very insecure about how well they had mastered the biomedical basic sciences, especially anatomy and pharmacokinetics. These basic sciences form the scientific foundation and legitimisation of the applied clinical sciences (see Bouman & Snellen-Balendong, 1996). There is also, however, a strong claim that biomedical knowledge is needed to interpret complex cases appropriately (see, for instance, Feltovich & Barrows, 1984; Patel, Cytryn, Shortliffe, & Safran, 2000).[10] So the students' discomfort about their situation should not be slighted. Another thing the students observed was that in practice they had to think the-other-way-round from what they were used to in their Problem-Based Learning sessions; the strategy they were used to applying when dealing with a clinical case was to find the clue for the diagnosis (e.g., chest pain radiating to the chin or the arm → heart attack) and to reason back from this assumed diagnosis to the case findings to see whether they fit. In real life things turn out differently. Key findings can hardly ever be found and normally a hypothesis is based on a combination of findings that make one more probable than another. These students consequently felt a lack both in terms of available knowledge and clinical reasoning. This was not a long-term problem – the clerkships were meant to help them through this difficulty – but that was definitely not the case when it came to their knowledge of the basic sciences.

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Finally, research by Agnes Wagenaar et al. (2001), carried out in co-operation with Master's students Kathelijne Dik and Crista van Oosterwijk, was another heroic attempt to find out which knowledge and skills are applied in diagnostic action. This time no paper cases were used, but a 'real' simulated patient, with the participants' task being to perform an intake on this patient, who had been referred to an ambulatory mental care setting by his GP. The 44 (!) participants varied in level of expertise (thirteen health sciences students prior to their practical internship, thirteen students during their internship, five who had recently graduated and were specialising as mental health care psychologists, and thirteen experienced therapists). The method used was video-stimulated recall, which entails that the student or therapist and the client first had a 30-minute intake interview immediately followed by a session in which the experimenter and the student or therapist viewed the video with the aim of making the therapist's thoughts during the interview explicit. Of course this procedure has many disadvantages, but it is the only way to acquire some insight into the therapists' dynamic use of knowledge, and that was what we wanted to unearth.
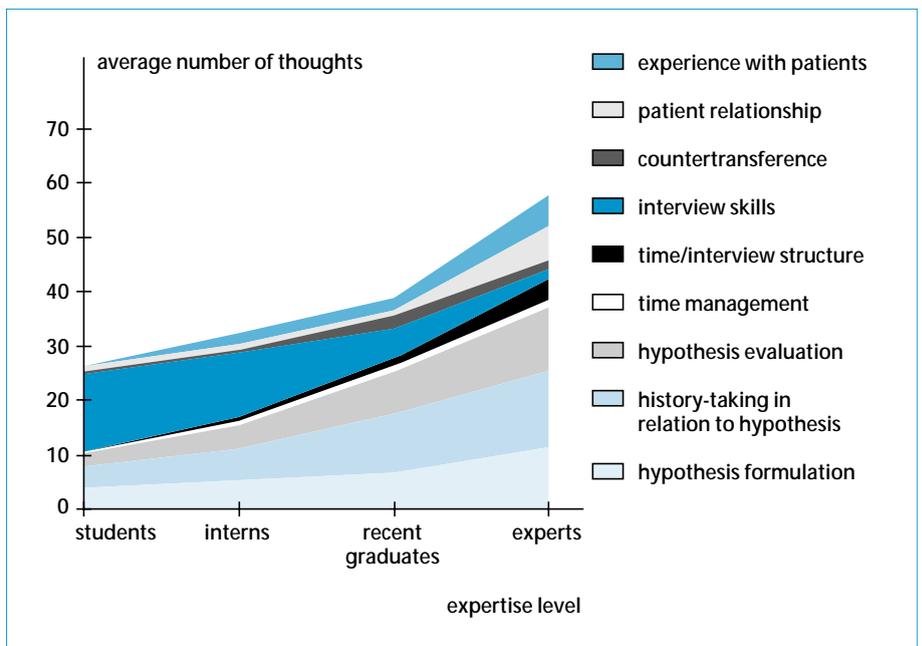What did we find?

Figure 7   Thinking in action. Average numbers of thought spent on different topics in a video-stimulated post hoc protocol of an intake interview with a simulated patient. Derived from Dik, 2000

We found an increase in the number of thoughts reported by the therapists. The more experienced the therapist was, the more ideas crossed his or her mind. That was not the most interesting part of the story, however; far more interesting was what thoughts occupied them. More than half of the students' thoughts concerned the interviewing process itself: how to ask questions (open, non-leading questions for instance); in many cases they expressed some worries about their ability to handle the case. The experts' thoughts, on the other hand, mostly concerned hypothesis generation and evaluation; they were very aware of conducting the interview so as to collect the information necessary for that purpose efficiently.[11] As they did so, the experts were very conscious about building or at least enabling a good therapeutic relationship with the client, taking into account the hypotheses they had in mind.[12]

What we see here is that the students had a level of mastery in which their main interest was to conduct an interview that was technically okay. The interview lacked focus and structure, however, and like the medical students they failed to integrate the knowledge they had about relevant conditions into their clinical reasoning. The more experienced the subjects were, the more hypothesis-driven. Once they had graduated and were working as therapists, they developed the skill to monitor the interview in terms of relationship-building and process efficiency.

What can we conclude so far from these studies? Based on their outcomes, the image emerges of a graduate who has the relevant knowledge but perhaps not enough of it, in his or her own judgment; who feels s/he has adequate technical and social skills, but fails to integrate these skills in problem-solving, probably due to a lack of integration and contextualisation of knowledge (assuming that his or her knowledge is otherwise sufficient, which is probably not the case). When we combine that with the outcomes of the follow-up studies one year after graduation (Ramaekers, 2002)[13], we have to add a lack of leadership and management skills, communication skills (especially at the 'other' Dutch universities, but also at the UM), computer skills, and a lack of preparation when it comes to dealing with change. All this leads us to conclude that the gap between education and work is considerable.

Learning from practice

Concluding that there is a gap or a mismatch does not automatically imply that we have a real problem on our hands. Such a problem only emerges when students and graduates are unable to learn while in practice and from it, and when the environment in which they work does not offer a good and safe place for learning. In other words, there is a problem when students and graduates are not prepared for learning in a way that is very different from what they are used to[13] and when the working environment does not see them as trainees, but expects that they can function as full-fledged professionals.

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The goals of a clerkship or internship may vary widely, depending on the field and the student's progress. Clerkships can have as a goal that students see in practice what cannot be learned from books (ranging from what patients, clients, buildings and business processes look like to how professionals work together and cultural issues in working environments) and practise skills that they are already supposed to have at a more rudimentary level. Some of these goals are very explicit and sometimes students are given all sorts of help and guidance to reach them. For example, at Salford Hospital, one of the teaching hospitals associated with the University of Manchester, students use a sign-up system that shows them which clinics, teaching, et cetera will be available for them in the coming week. Depending on the specific activity, they can perform simple procedures or observe. In combination with the intended learning goals made available at the beginning of the clerkship, students should be able to plan their learning experiences.[15] That may look straightforward, but it is not.

This brings us to a point with many unknowns. One of these unknowns is the role of and the optimal conditions for implicit learning, a way of 'unconscious' or at least undirected learning that happens as a by-product of action or experience.[16] The very nature of implicit learning makes it hard for learners or even teachers or coaches to plan. The only possibility is to offer or seek out opportunities. All an individual can do otherwise is try to make the best of it. This, however, requires students to at least understand what their experiences entail and what it is that they have come across. Better students know in advance what they might see and experience in an upcoming situation.[17] Without an interpretation frame and without preparation, students may completely overlook essential aspects of a situation they observe. For example, a student told us that he had been sitting in with a psychotherapist who had told him that his plan was to tell a client that it was about time to pick up the thread of her life again and get a job. The student had been rather sceptical about this plan and was very surprised that it worked out the way the expert had told him it would. Without knowing this plan in advance, the student might not have even known that something remarkable, at least by his own standards, had taken place before his eyes. Now he was aware that he had witnessed something very instructive, and afterward he was able to identify the critical elements that had contributed to this positive outcome. Having an interpretation frame (developed by the student him or herself or passed on by an expert) and planning and preparing for experiences contribute to learning results. The question is whether students do this routinely as a strategy for learning from experience.

Another strategy that is supposed to be effective in learning from experience is the action-reflection-action cycle that we find in many different forms in the work of such authors as Boud, Keogh, and Walker (1988), Korthagen (1992, 1999), Kolb (1984), and Schön (1987). These authors assume that reflecting on experiences plays a critical role in learning from these experiences. Reflection should lead to plans for new actions in which novel approaches and ways of dealing with problems can be tested. Again, the question is whether students do this.

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A study undertaken by Wagenaar et al. (2002, in press) showed that students (again medical and health science students during their clerkships) thought that they learned mainly by doing, which is an implicit way of learning, and a little bit by observing or from preparation and reflection (see table 2). No student reported full cycles of action-reflection-action. Korthagen (1999) found similar results, i.e. that novice teachers display little continuity in their reflection-based learning process. This means that novice teachers may well come to conclusions about the good and less optimal aspects of their behaviour and problem solutions, but they then fail to draw conclusions on how these could be improved, never draw up concrete action plans for future situations or, if they do, don't implement these concrete plans. Korthagen also investigated barriers to reflection in beginning teachers, who evidently hold beliefs about learning that reflect the passive 'hand over' view of learning. In regular sessions with a coach, the subjects of the study frequently tried to tempt the coach to make statements about what is good and what is not, and how it should be changed, instead of reflecting on their own behaviour and generating possible alternatives.[18]

Table 2   Learning from experience; learning processes described by medical and health sciences students during a practical internship or research training

Learning process	MHS students research	MHS students practice	Medical students
Information processing			
– by seeing things in practice	–	4	5
– direct teaching	–	–	1
– actively overcoming gaps in knowledge and skills (SDL)	2	2	5
Performing tasks			
– learning by doing	18	23	20
– learning through preparation and evaluation	–	3	1
Total	20	32	32

So far we have only spoken about newcomers and their learning. However, learning is not expected exclusively from novices and intermediates in the field. To prevent skill obsolescence, every professional and every employee must remain up-to-date. Ilse van Eekelen investigated how experienced teachers learn, under which conditions, from whom and with whom, et cetera. She also investigated what and how much teachers learn, apart from implicit learning. She found four categories of teachers in her sample, varying in their will and ability to learn, with the same kind of behaviour, the same lack

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of reflection and planning and the same inability to see the others' perspective as in the student sample, at least with respect to those whom she characterised as not-willing-to-learn (see Van Eekelen et al., in preparation).

To conclude this section on learning from experience, I would like to mention a couple of features of the workplace that can have a major impact on how fruitful actual practice is as a place for learning. The first feature relates to the learning strategy of preparation and trying out new action. The better one can predict and control situations, the easier it is to use this strategy. However, in many domains an experience does not consist of discrete episodes. An experience can be hard to prepare for in the way the student did who witnessed a client being helped back on her feet again. For newcomers in particular, many real-life tasks can be quite unpredictable. It is hard for them to see when and in combination with which other competencies a specific competence should be applied. In such situations deliberate action is the exception, not the rule. Teaching is a good example once again. Teachers have to apply multiple competencies simultaneously, depending on the emerging situation, for example teaching the subject matter, monitoring the students' understanding of it, monitoring and evaluating student behaviour and acting on it, taking the person of the student into consideration, and all this in real time. Eraut (2002) calls this a situation in which routines are punctuated by rapid decisions. Learning in these situations will require whole-task approaches to make sure that the student learns the conditions under which things can happen and the rhythm of the situation. Situations may be simplified (e.g., schools should not give the most difficult groups to newcomers), support and scaffolding may be offered, but the tasks cannot be reduced nor can the rapid decisions be practised and prepared for in isolation. Training isolated subtasks is only relevant for tasks that can be routinised independently (Van Merrienboer, 1997).

Finally, let's return to Krol's remark about 'expertise' in diagnosing dysfunctional behaviour in children. Supposed experts had knowledge structures that were a poor match with the epidemiology of the field. There can be many reasons for this. One of them might be that implicit learning is not an effective tool in this field. A professional may not see this kind of patient frequently enough or not be given feedback on the quality of the diagnosis or only after a very long delay. The bureaucracy of the field is a contributing factor. It would be very tempting to say more about this issue, but this is not the time or place to go into it at great length. I will therefore confine myself to saying that it is the task of professional or trade representative organisations, or of the government if these organisations do not or cannot take the responsibility, to guarantee the quality of the services provided.

How to bridge the gap

Let's summarise what we have so far. Expertise development goes through several stages in which three learning processes play a role: knowledge accretion, validation and integration, knowledge encapsulation and script formation. At the same time, the amount of cognitive control required in learning and problem-solving decreases. All processes are based on formal teaching and shaped by the tasks students perform. The more authentic these tasks are, the more the learning results fit the contexts and tasks of the field. Scripts are largely affected by the experiences the learner has.

Real work experiences and episodes are the most authentic tasks one can imagine. Learning from experience includes implicit learning. More advanced learning requires planning and preparing for an experience, which in turn requires that one can predict to a certain extent what is going to happen, and can reflect on the experience. This is how an extensive, integrated, flexible and adaptive body of knowledge is formed that allows pattern-based retrieval. This, and not excellent problem-solving skills, is the core of expertise. Learning from experience requires different, self-directed learning strategies than does learning from the official media and applying what has been learned in problems and exercises. It also requires an environment that provides feedback and a learner who can anticipate, generate and use that feedback to adapt his or her future performance and to learn.[19]

Certification must take place at some point along the road to expertise; it cannot be postponed till someone has reached the expert level. Neither can practical experience be postponed until after certification. The educational institution is responsible for the competencies for which the graduate is certified. These competencies include the tasks expected of a new professional, as well as the ability to develop further, especially under changing circumstances. Businesses, professional organisations and/or the government are responsible for an environment that provides all the elements required for further learning.

This state of affairs has several implications for the Open Universiteit Nederland. Some of these implications apply to all educational institutions, some are unique to the OUNL and are related to the kind of students catered for and the present concept of competency-based education delivered by means of distance teaching.

- The Open Universiteit offers its educational products by means of distance education. This implies that the choice of methods and media tips the balance between implicit and explicit teaching and learning towards the familiar explicit side: books, multimedia kits, explicit assignments are the main learning tools, used by the students at home and on their own. The more implicit methods such as modelling (especially the supported and guided forms), projects and academic

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discussions and forums with experts are used less often, but when they are used the more asynchronous and place-independent methods areapplied. The introduction of CSCL tools can support these processes, and it seems even improve them (see Kirschner, Buckingham Shum & Carr, 2003).[20] On the other hand, what is lost on the implicit side should be reconsidered. As the OUNL is a distance education institution, implicit learning is not a major vehicle for learning. And yet, academic values, a sense of the direction in which new scientific advances are moving, the pros and cons, ethical issues, and imminent paradigm shifts are often picked up by students implicitly, by being around, sharing a lunch table, overhearing or participating in discussions after presentations, and so on. Where possible these elements should be brought back, for example by organising conferences with renowned experts on topics at the cutting edge of development, by fostering student-student contact, by teaming up more experienced students with less experienced ones, et cetera.

- The Open Universiteit caters for students who are on average more than ten years older than the students at 'normal' universities in the Netherlands and Flanders. Many of these students take courses or enrol in a complete course of study to improve their working and personal lives. Nevertheless, many of the students make slow progress compared with part-time students at a 'face-to-face' university. Most of them do all their studying in their 'own' time and take about twelve years to complete a programme that would normally take four years full-time. Adult students are more likely than younger students to demand that what they learn is directly relevant to the goal which they are studying to achieve.

- As an educational institution, the OUNL's first concern is the pre-certification part of the road to expertise, rather than post-graduate development in the workplace, although educational institutions should be very aware of what the workplace offers and requires (see Eraut, this volume). This pre-certification part entails levels of expertise appropriate for the novice and intermediate. At present there are four levels of course difficulty plus a thesis requirement representing a fifth level of difficulty linked to these expertise levels. Level of expertise and the related learning processes and required cognitive control are not accounted for in the design. More research is needed to develop design guidelines.

- Most programmes offered by the Open Universiteit prepare students for a scholarly profession or for other work that requires academic competence in environments that can be described as fast-changing. The shelf life of the knowledge taught varies (information science and law are fast-changing, the humanities seem quite stable). The OU has so far come up with two ways of dealing with changes that arise in a domain during the average length of time

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that OU students customarily spend in a programme. One way is to limit the period of validity of exams. The other assumes that students learn general competencies that can be used in other settings and under other paradigms. In this view it is not necessary to limit the validity period. If that option is chosen, the graduates' adaptability and preparedness for change should be guaranteed.

- When the aim is the integration and contextualisation of knowledge, this goal should be made explicit in the course or courses in which that knowledge is acquired. That means rethinking the competencies a student must have upon graduating and how these can be built up and warranted. Since competence-based education is the core of the educational concept at the OUNL, this rethinking could have far-reaching consequences. One of the major points of this address is that the core of expertise development is the development of a well-integrated, validated, well-connected, flexible or adaptive body of knowledge. I seriously doubt whether that should be considered a competency. And if it is, it is a huge one. The only way to learn this 'competency' is to apply every bit and piece of knowledge in relevant, authentic contexts in which knowledge integration and enrichment of scripts can take place. Educators and students should not fall into the trap of thinking that they are training skills in such a case, and that having done three or four of these exercises should be enough. The challenge will be to develop tasks to assure integration and contextualisation that do not take much time to work out, that are adapted to the students' level of mastery (including in terms of cognitive load) and that have environmental and cognitive authenticity.

These factors alone make teaching at the Open Universiteit a challenge. However, the particular combination of factors complicates things even more.

In my view, the most serious problem is that the following factors coincide: a short shelf life of knowledge associated with frequent paradigm shifts; the necessity of knowledge integration; and the extended period of enrolment of OUNL students. This combination of factors requires a new way of looking at the curriculum and at the competencies to be acquired.

Curricula are traditionally organised in the following way: starting with the basic sciences and followed by the applied sciences, knowledge is built up, integrated and contextualised, slowly but steadily. The emphasis is on theory first, with practice being gradually integrated, in turn leading to script formation and refinement. Simultaneously, self-directed and lifelong learning skills are supposedly accrued. This situation is depicted in Figure 8. The left axis reflects the growing level of expertise that extends far beyond graduation, while the right axis reflects the emphasis on theory that is later (partly) replaced by practice as a context for learning, coinciding with the increased authenticity of the learning environment that is required.

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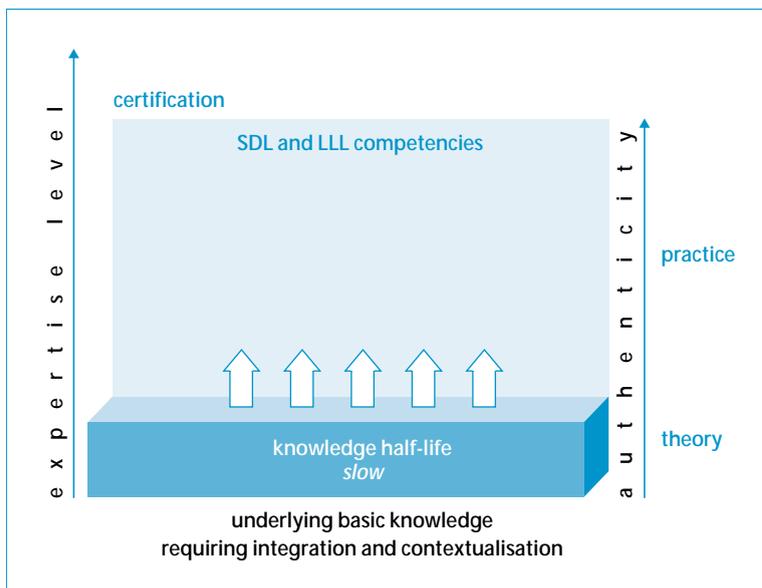
Figure 8 Model of a curriculum applicable for knowledge with a long shelf life. See text.

However, when knowledge has a short shelf life relative to a long period of student enrolment, this bottom-up approach does not work, since students will never reach the level of mastery at which they can independently use the new knowledge as a tool. When a programme involves knowledge with a very short shelf life, it is important that students quickly reach a level of expertise in subdomains that allow them to develop that skill further in practical situations in their daily work.[21] To be able to continue developing such skills independently, students also need to develop self-directed and lifelong learning skills at a very early stage of their academic career. That is not as obvious a progression as it may sound, and I will therefore return to this topic later. Figure 9 shows a diagram representing a curriculum approach of this kind; it depicts a 'lateral' procedure in which all-round expertise is developed per domain. It is not unthinkable that such an approach would work in fields like the management sciences.
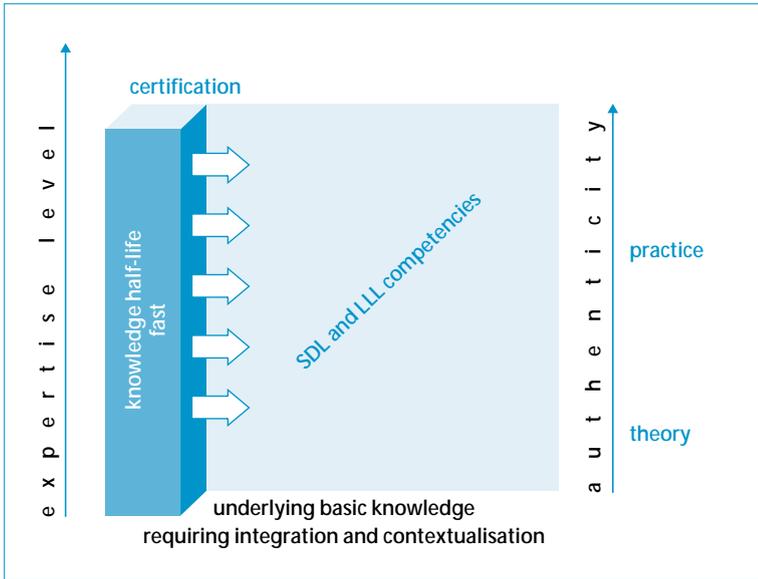
Figure 9   Model of a curriculum applicable for knowledge with a short shelf life. See text.

A comparison of these two extremes soon leads to a mixed proposal in which students work on a broader range of basic knowledge from the start, but develop one aspect of this knowledge to the level of complete mastery. Again, self-directed and lifelong learning skills should be developed at an early stage of their programme. Both in the lateral and in the diagonal approach, it is important to investigate whether the students' own needs should determine which aspect is developed first (see Figure 10).
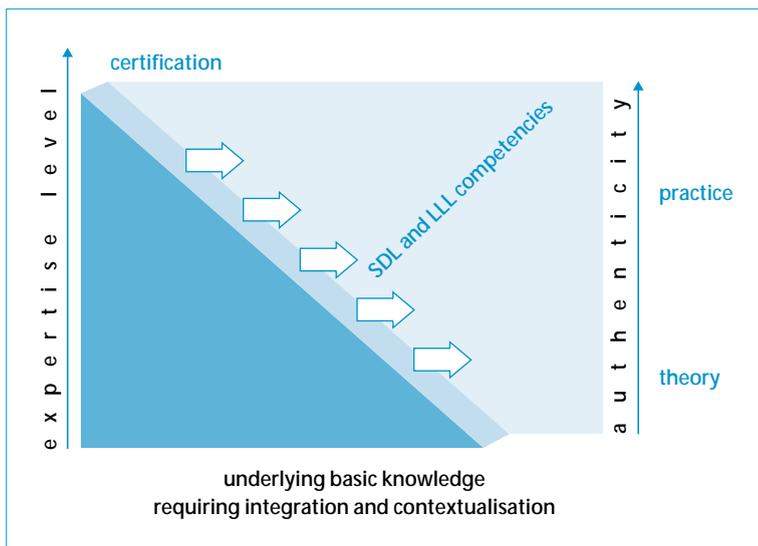
Figure 10   Model of a curriculum, which is a mix of the two previous, assumed to be applicable for knowledge with a short shelf life. See text.

As I said, the development of learning strategies is not a self-evident process. That is true of the self-directed and lifelong learning strategies mentioned, but also of more basic learning skills. For example, knowledge application in the context of new, authentic situations should be considered a learning strategy that a student must acquire, and not just a task that he or she has to fulfil. Learning strategies are like all other skills. They can be practised and it is very helpful when learners have some meta-cognitive understanding of their usefulness and the conditions for their application. It is worth our while to work this out and experiment with different kinds of instructions. Another learning skill that students must acquire long before graduation is learning from experience. Research (Wagenaar et al. 2002 in press; Van Eeekelen et al., in preparation) has shown that most students do not plan and reflect spontaneously or do so infrequently. However, when we organise their environment in such a way that these steps are part of the process, much ground can be gained.

The combination of a short shelf life of knowledge and adult students who study to improve in their work cries out for the introduction of real tasks in Open Universiteit courses. Why should we wait to have students apply knowledge and skills until they have achieved the required level of expertise? Why should we use the workplace only to maintain and update competence? Why shouldn't students instead work on projects in their own workplace as much as possible? Where applicable, the Open Universiteit and the students' employers could form a partnership in which the Open Universiteit adopts suitable projects, in which other students may also participate, that can lead to at least three kinds of results: learning outcomes for the participating students, a completed project for the employer, and organisational learning in terms of feedback and altered working procedures. In our plans for the new Master's programme Educational Design for Active Learning, we plan to investigate the possibility of such partnership projects.

Before I conclude, I would like to mention one more aspect that deserves attention, an aspect that lies hidden in the terms of 'practice' and 'authenticity'. Most practical situations and workplaces require co-operation with other disciplines and/or other branches of the same discipline. Even a soloist physician works with an assistant, a nurse, a pharmacist, a dietician, the public health services, the social services, the police, financial and administrative specialists, et cetera, and has patients of many different ages and cultural and social backgrounds. Similarly, architects work with specialists in the field of civil engineering, draughtsmen, contractors, project developers, financial planners, specialists in logistics, municipal services, city planners, and they may also have to deal with pressure groups focusing on environmental protection or sustainable building, landmark protection and more. Authentic tasks will always include the participation of other disciplines. Students have to learn to co-operate with others, and to co-operate with people who have different kinds of expertise. At the beginning of this address I discussed in more general terms how difficult that may be.[2]

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Bridging the gap – do we have the material to do that? Maybe we are asking too much. What we do have is a better idea of the gap and where it is located. We also have a better idea of what is or should be on the other side of the divide. We have identified strategies to narrow the gap and to bridge it. But as yet we do not have the material to do so. There is as yet much to be developed, tried out, rethought, investigated, in a field that itself requires further exploration. I would love to be part of that expedition.

Reflections

I am coming to the end of my inaugural address and would like to reflect for a moment on what brought me here, on my own developmental process. Much of what I have considered here is based on work I did with Master's and PhD students, colleagues, and supervisors. To mention a few: Hanneke Duijkers, Nathalie Ummels, Geert van de Brink, Arno van Rooijen, Ameike Janssen, Marleen Gulikers, Ilse van Eekelen, Tim Dornan, Katinka Prince, Agnes Wagenaar, PJ Beers, Piet van den Bossche, Margje van de Wiel, Rina Vaatstra, Maureen Machiels, Willem de Grave, Eugene Custers, Remy Rikers, Metta Hofstra, Pie Hobus, Hein Claessen, Jan Vermunt, Mien Segers, Wim Gijselaers, Paul Kirschner, Jan van Bruggen, Iwan Wopereis, Cees van der Vleuten, Albert Scherpbier, Henk Schmidt, Jan Elshout and Nico Frijda. Although more than 20 years have passed since I completed my own formal education, much of what I do now is rooted in what I learned at the Psychological Laboratory of the University of Amsterdam, where the project 'Thinking and Memory', initiated by De Groot and Frijda, and of which Jan Elshout was one of the directors, provided the focus for a lot of research. I even witnessed a real paradigm shift there, and saw how the concept of learning changed its shape completely, without which my later study of expertise would not have been possible. It was also there in my job as a student assistant that I acquired many of my research skills.

The former Rijksuniversiteit Limburg, now Universiteit Maastricht, where I did my PhD, gave me the opportunity to learn from experience in research, education and management. This is where I worked with most of the people I have just mentioned. I want to thank Wynand Wijnen, Henk Schmidt, Arie Nieuwenhuijsen Kruseman, Karl Dittrich, Gerjo Kok, Ed Sprokkel and Cees van der Vleuten for the opportunities they gave me.

This brings me to my most recent milestone, Heerlen and the Open Universiteit Nederland. You probably think that the distance between Heerlen and Amsterdam is the same as the distance between Maastricht and Amsterdam. I can assure you that for me it is not, academically speaking. At ETEC, my new workplace, I met a couple of people who have the same background as I do, people with whom I could easily pick up on some 'old' but still very worthwhile stuff relating to domain-dependent

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reasoning. It was almost waiting there to be integrated into my thinking on expertise in different domains, and it is one of the things I would like to pursue in the future, if we can find funding for it.

The biggest challenge here is, however, of a different order. We have to bring the old programme in Education to a good end and start a new Master's programme in Educational Design for Active Learning. The team working on this project is very dedicated and I am happy to be able to work with them: Henk Münstermann, Arjan Dieleman, Marion de Bie, Marcel van de Klink, Ad Schellekens, Olga Firssova, Linda Luchtmans, Miriam Goes, Carlien Erens and the others who are about to join us. I thank the Open Universiteit's Executive Board, especially President Thijs Wöltgens and Rector Fred Mulder, and ETEC's Management Team for giving me this opportunity. ETEC is a workplace that has not disappointed me. The quality of the people and the structure provided are a blessing. Wim Jochems, Freek Gastkemper, Jos van de Broek and Jeroen van Merriënboer are my closest colleagues; thanks very much. Fellow educational deans and Alexander Udink ten Cate: my appointment to ETEC means that our working relationship is not as self-evident as it might have been if I had taken a position within the Directorate of Education. I take it for granted and see it as the best of both worlds, and I hope that we can work with one another to improve education, and go together on the expedition I just described.

Back to my daily environment, at work that is: Marina Pongraz and her colleagues, Ingrid, and all the others, thanks for all your support.

Having lavished so many words on work, management and colleagues, I want to end with the most important persons, my family: my grandparents, my parents and their brothers and sisters and my stepfather. They saw that I grew up healthy and happy, and they also provided the climate of trust and expectations that made it possible for me to find my way. I particularly want to thank my mother for her patient and non-interfering support during my academic career. You never tried to push me, and to my great fortune only told yourself that it would not matter if the child that I was at the time became a professor one year later. I am glad that you did not voice those expectations until I received my PhD. Finally, the home front: Hein, Rogier and Louise, you help me keep my feet on the ground. You help me to reduce work and science to their normal proportions. The three of you are so important and at the same time so natural and obvious a part of my life that most of the time I do not even think about it. To you as well, thanks so much.

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Notes

1 The Dutch equivalent of these TV programmes is *Tussen Kunst en Kitsch*.

2 The term 'deliberate practice' was coined by Ericsson, Krampe and Tesch-Römer (1993) and refers to self-organisation and strategies in practising the skills and subskills necessary for (excellent) skilled performance. Initial research on this concept was carried out in the domain of sports and the arts, but it was extended to the field of teaching (Dunn & Shriner, 2000), insurance (Sonnentag & Kleine, 2000) and is presently being carried out in the domain of management as well, where Van de Wiel, Szegedi and Weggeman (in preparation) are investigating differences between top and subtop managers with respect to deliberate strategies of self-improvement.

3 To prevent these effects, professional organisations may require their members to participate in continuous education and may develop evidence-based standards of dealing with specific problems.

4 I do not claim that this is also the case in other kinds of argument structures, such as reasoning based on examples and counterexamples, investigation of extremes, reduction ad absurdum proof, or formal logic.

5 Cognitive demands play a major role in instruction theories such as Sweller's (1988).

6 Even in highly industrialised societies, one will find groups and communities that have a different economic organisation. Examples are the Amish in the USA or communities of circus performers or showmen and owners of fairground attractions.

7 Technology, information science and the life sciences are at the forefront momentarily.

8 This does not only apply to the poor, but also to communities with a skewed age distribution.

9 An elegant design with parallel cases presented in balanced order was used, making it possible to gather 184 analysable protocols, 59 of which were produced by fourth-year students, 66 by fifth-years, 43 by sixth-years and 17 by medical specialists.

10 In addition, laboratory research currently being conducted at McMaster University, Hamilton, Ontario, by Norman, Brooks and colleagues suggests that knowledge of underlying mechanisms leads to better recall of clinical knowledge. Personal communication.

11 Experts felt real time pressure. Normally they have an hour for an intake interview, whereas in the experimental session they had no more than 30 minutes. The students found it hard to fill this time, since they were very dependent on what the patient volunteered.

12 The patient was a quiet man who had had very little schooling, was probably dyslexic, and showed signs of depression and hypochondriac tendencies with headaches and a fear of cancer. Dealing with such a patient can be difficult because of the demands they make on their environment, the discrepancy between their own interpretation of pain and other physical complaints and the therapist's and referring GP's interpretation ('I am not crazy!'). It requires the therapist to build trust and motivation and acknowledge the patient's interpretation without complying with it. Experts were aware that the intake lays the foundation for the success of the therapeutic relationship.

13 ROA, the Research Centre for Education and Labour Market, routinely collects data about the labour market position of graduates of all Dutch universities, 1, 5 and 10 years after graduation. Graduates are asked to choose no more than three out of fourteen competencies that they believe have not received enough attention: knowledge, technical methods and skills, *computer skills*, numeracy, *social skills*, working in a team, *management skills*, *leadership*, independence, creativity, initiative, *dealing with change*, accuracy, international orientation. The italics indicate the competencies mentioned most often.

[14] Even a transition from one school to another, either within a single educational level or from primary to secondary education, can have tremendous effects on pupil learning and performance. For example, in the UK it was found that about 40-50% of the pupils in the first class of secondary education had not improved on English, reading comprehension and math. The authors concluded that this should be mainly attributed to variation in the teaching approach and the failure of pupils to account for these differences in their learning strategies (Galton, Morris, & Pell, 2000).

[15] Research on the feasibility of the system is presently being carried out by Tim Dornan, Albert Scherpbier and myself.

[16] Script enrichment and refining are probably the results of implicit learning, as is link strengthening in knowledge networks.

[17] Similar situations can be identified in perceptual learning, where advance knowledge of a certain phenomenon can be a great help to students. Learning support of this kind is called 'cueing' (Patrick, 1972).

[18] Other findings by Korthage (1999) were that novice teachers often tended to search for solutions without thoroughly exploring the real problem, a tendency they share with novices in many other fields. Furthermore, novice teachers were very self-centred and had problems seeing the perspective of others and their interpretations of a situation. This phenomenon resembles Wagenaar's finding that Mental Health Care students were mainly concerned about asking the right kind of questions and did not monitor the relationship they were building up with the client.

[19] Some of these points were also mentioned by Robert Glaser at a symposium during the annual AERA conference in 1995.

[20] This book includes many experiences in different settings with software tools and infrastructures that help communities to better tackle problems they are dealing with. The book has a website with links to on-line resources www.visualizingargumentation.info.

[21] The assumption here is, of course, that once a certain level of mastery has been achieved and when students use that knowledge and skill in their work, they will be able to maintain and develop that competence further. The analysis in this adress shows that this does not happen as a matter of course when the workplace fails to provide feedback.

[22] It is very tempting to go into detail here. Instead, the reader is referred to Boshuizen and Tabachneck-Schijf (1998), and to Van Bruggen, Boshuizen, and Kirschner (2003), for an analysis of the difficulties that may arise when people with different forms of knowledge which are represented differently, different argumentation styles and different assumptions of what makes a valid line of reasoning work together.
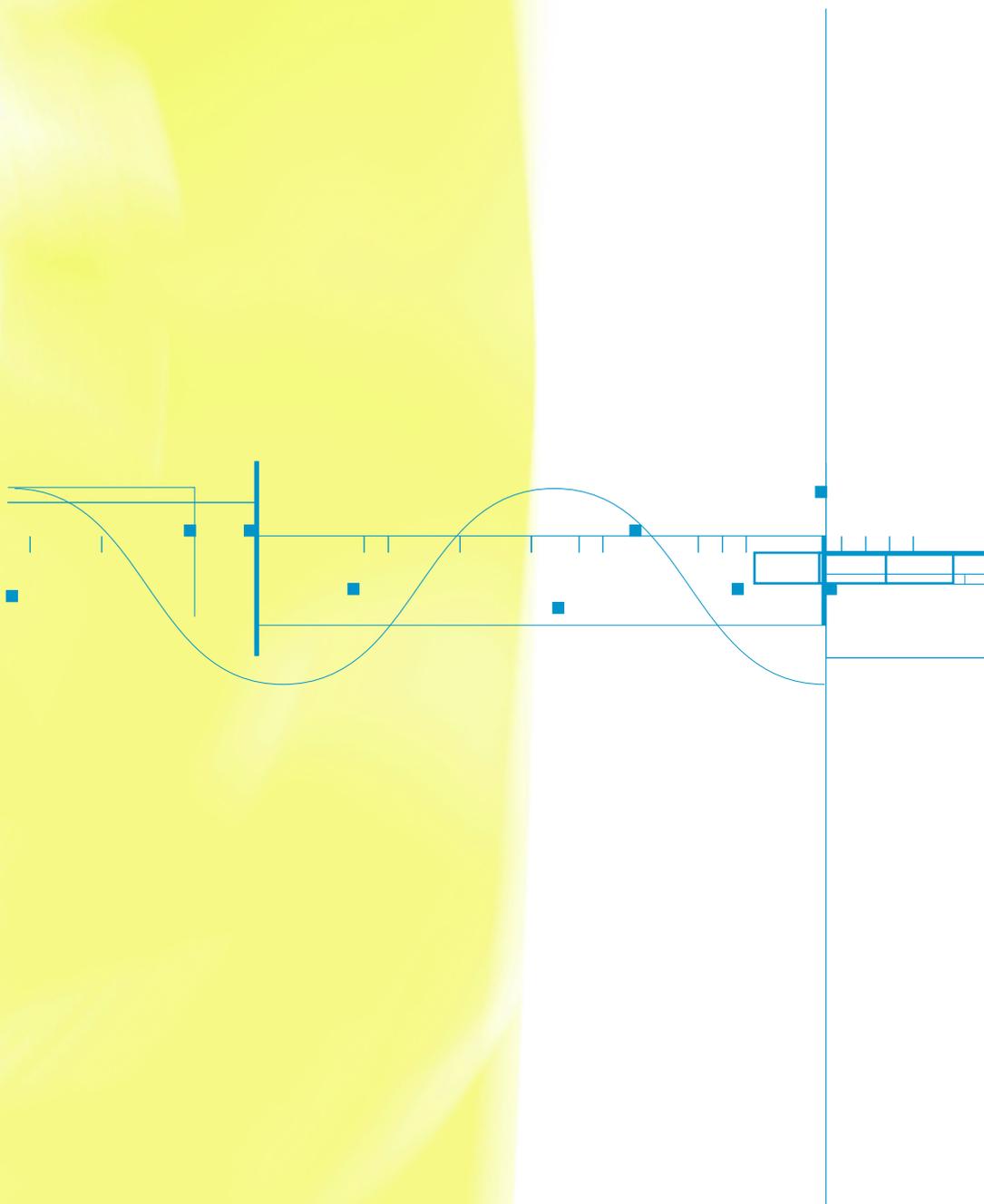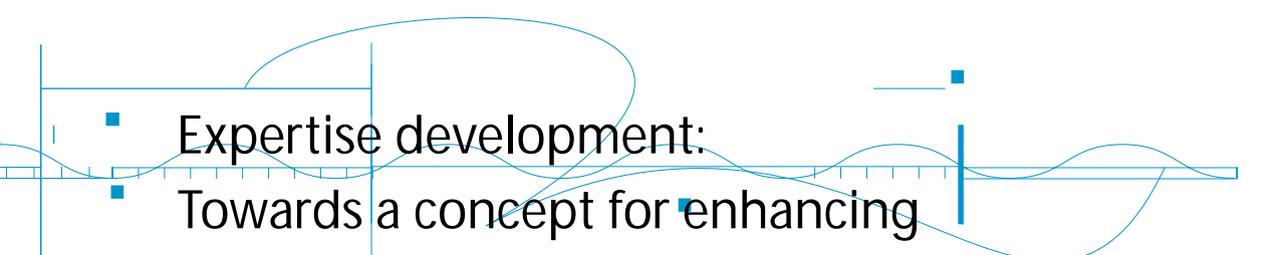
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Expertise development: Towards a concept for enhancing distance education

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Expertise development:
Towards a concept for enhancing distance education

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The development from beginner to expert in a specific domain is a process that starts in higher education, although it extends over many years. The emphasis gradually shifts from the acquisition of domain knowledge towards the application of knowledge and skills. Education plays an important role in this process. In most expertise domains universities are responsible for the initial part of the developmental path, while the remainder of the learning process takes place in practice, with the former student working as an apprentice or as a full-fledged professional. Accordingly, one of the questions an institute for higher education has to answer is how it will facilitate the inevitable transition from school to work. For a distance education institute like the Open University of the Netherlands (OUNL), this question is even more important because of the nature of its students. Most of them are part-time students who have a job but are in search of additional expertise that enables them to perform better and foster their career.

In this contribution we first describe the way the OUNL attempts to tackle the problem by developing an educational concept that corresponds with the specific position occupied by a distance teaching university. We then discuss the question of why an educational concept is needed and present two kinds of considerations. Next we focus on the question of what the main components should be and briefly describe four interesting components. Two are related to the specific position of an Open University, while two are of a more general type. One of them refers to the transition from formal learning towards learning in the workplace. This is elaborated in Michael Eraut's contribution. The other refers to the transition from monodisciplinary to multi-disciplinary, collaborative learning, which is discussed in Wim Gijselaers' contribution. Both aspects are of great importance for an institute that focuses on lifelong learning as this kind of learning differs in many respects from formal, institutional learning. For an overview of relevant differences see Hagen (2001, 80-81).

A new educational concept

In September 1999 on the occasion of its 15the Foundation Day the Open University of the Netherlands formulated a new educational concept, namely competency-based learning in an electronic learning environment (Jochems, 1999). The name reflects two

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main elements, which will should like to explain briefly. According to the first element, competency-based learning, the educational programmes delivered by the OUNL should aim at developing competencies or complex skills in which, among other things, theory and practice are integrated. For instance, students have to be provided with authentic tasks. Moreover, these tasks should stimulate active and self-directed learning, which is based on a constructivist view on learning leading to certain design considerations (Elen, Lowyck & Van den Berg, 1999, p. 195). The competency-based approach was necessitated by the fact that most students of the OUNL are lifelong learners who already have a job and are therefore interested in courses in which theory is closely related to practice. Review committees of higher education programmes in the Netherlands have often made complaints about the fact that a large number of programmes in Dutch higher education do not prepare students in an appropriate manner for their future jobs; too much attention is spent on theory without relating it to solving the practical problems one has to face when one has a job.

The second element of the concept refers to learning in an electronic learning environment. As a result of the fact that web technology was developing very rapidly at that time and providing new technical facilities which seemed rather useful for distance education, it was expected that electronic learning environments would be able to boost the effectiveness of the OUNL programmes. In 1997, the implementation of 'Studyweb' – an e-learning facility developed at the OUNL for the delivery of course materials at a distance – played a significant part as was revealed in the positive results it achieved (Jochems, 2002, p. 51). For that very reason the educational concept was also dominant in the technology development programme within the Educational Technology Expertise Centre at the OUNL.

In September 2002, it was felt that there was a need for a review of this educational concept for a number of reasons. One was that the policy of the university had been changed, so that cooperation with other higher education institutes in the Netherlands had become much more important. However, this raised the question of whether the use of one educational concept might be rather problematic for other institutes. Moreover, our experiences of using the concept, plus the need for greater efficiency and a considerable number of new staff in the management of the programmes, provided additional considerations with the result that the OUNL decided to review the concept. We need to ask two questions: First *why* does an educational institute or an educational programme need an educational concept? What does it hope to achieve? One could argue that it takes some time to develop a concept; that it limits the degree of freedom given to course developers and teachers and is therefore rather difficult to implement; that it doesn't guarantee more effective or attractive courses; and that it doesn't

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necessarily reduce costs. So the first question is why an educational concept is needed at all.

The second question is the *what* question, namely what would be a good or an appropriate educational concept for higher education or distance education, at least for our institute? There are quite a number of instances of them, such as problem-based, case-based, project-oriented, activity-based, student-oriented to mention only a few. We have to specify what our concept will be and what considerations we have with respect to its core elements.

In this introduction we provide provisional answers to these two questions. This is not only to show the importance of such a concept for an educational institute but also to structure the contributions of Eraut and Gijselaers in this book, contributions which provide valuable elements for an educational concept. They both focus on two elements of an educational concept that are of great importance for higher education institutes, at least for the Open University of the Netherlands.

Why we need a concept

An educational concept or an educational model can be described as a guiding principle with respect to education. Some principles are problem-based education, case-based, project-based and competency-based education. An educational concept provides a general model, a global blueprint for the type of instructions or learning arrangements the institute wants to offer its students and it therefore affects education on three levels, organisational, curricular and course.

At the *organisational* level the educational concept influences the educational organisation of the institute. The concept could have impact on the roles and accountability of all those who are involved in the educational processes, for instance on the role and position of the director of study or programme director because he or she is responsible for its implementation. It could influence the course production and course delivery processes in the event that the concept demands different approaches as compared to the old situation, which might in turn need changes in the infrastructure of the institute. Finally, it might be part of the profile of the institute and more or less related to its mission. A more detailed example of the impact of a concept on organisational level is given below.

At the *curricular* level the director of studies will use the concept to format the shaping of a curriculum or an educational programme. It defines types of courses, the structure of the programme, the rhythm of the curriculum (the timetable, the way learning and testing or assessing alternate, and the preferred interactions with the students), the sequencing of modules and so on.

At the *course* level the concept provides guidelines for course developers and teachers with respect to the preferred types of learning arrangements, types of learning activities, instructional settings to be achieved, prescribed testing or assessing procedures, the educational media allowed and so on.

Let us consider competency-based education as an example to illustrate the impact of an educational concept on the three levels mentioned above. The dominant element in competency-based education is that the building blocks of a curriculum are not the subject matter areas or domains but competencies to be mastered. This has several implications of which we will illustrate only a few:

- The curriculum is not organised according to the subject matter to be mastered but according to the competencies that are perceived to be characteristic. These competencies are analysed in sub competencies and learning tasks or series of such tasks that are set to facilitate and stimulate the development of these competencies. So, for instance, a course is not 'owned' by a specific teacher who has considerable expertise in that particular subject matter area but is the responsibility of a group of experts who together cover the competency under consideration. The roles and responsibilities of experts involved will change by introducing competency-based education.
- Teachers are, among other things, expected to minimize the number of lectures and maximise active learning by creating learning arrangements in which theory and practice are well-integrated. In this respect, competency-based learning has a great deal in common with concepts like problem-based learning and project-based learning, all stressing the use of rich, meaningful and realistic learning tasks as the driving force for learning (Merrill, 2002).
- The mastery of a competency is not tested in the conventional manner by the use of paper and pencil tests and examinations but by setting authentic tasks and by keeping record of students' performance on these tasks. Thus portfolios and assessment procedures are important. A student who proves able to complete these tasks is deemed competent. Decisions with respect to passing or failing are no longer made by individual teachers but by a group of teachers with peer assessment also possibly playing a part.

The essence of an educational concept is that a curriculum is no longer perceived as the sum of a series of more or less independent courses or modules that have to be completed in a certain order but as an integrated whole. The concept is describing the way the integration should be organised. In other words, a curriculum is not the sum of the performances of individual teachers but is considered to be a team performance with the concept indicating the principles the team members will use in developing

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and delivering the learning arrangements. Thus an educational concept is a sketch of the team's strategy. From the student's point of view, a curriculum is not a series of loosely connected courses leaving the integration to the student but an organic whole into which the element of integration is incorporated.

At this point we begin to glimpse an answer to the why question. We expect an educational concept to contribute to the quality of a curriculum. It can help to improve the consistency and coherence of an educational programme because it expresses the intended relations between components in the programmes (at the curricular level), because it explains the roles to be performed by the various players (at the organisational level) and because it indicates a pedagogical approach to be realised (at the course level). In this way the introduction of a concept sets a standard. Whether this standard is actually met in a particular programme is a different question. We also expect an educational concept to contribute to a more clearly and explicitly educational profile of an institute. Learning arrangements will be more easily recognised as belonging to a programme of the specific institute. The expected study behaviour will be clear to students who have already completed a course. They know how to handle the materials, so accessibility might increase. It also becomes easier to exchange course materials from different programmes within the institute. Of course there are also a number of disadvantages. It might for instance become more difficult to cooperate with other institutes employing different models or even using none at all.

What concept do we need?

What would be an adequate concept for an institute like the Open University of the Netherlands, a distance education institute with students generally older than 30, who already have a job and are interested in mastering additional competencies that are useful in their work? The characteristics of distance students provide a number of considerations that will play a part in defining such a concept. I should like to mention four types of considerations but without going into too much detail.

From theory to practice

As lifelong learners in employment, most of the students are interested in the development of expertise that is applicable to their work. Accordingly, authentic learning is an important element. Authentic learning refers to learning to solve real life problems and to carry out real life tasks, projects and so forth. Thus learning should not only focus on acquiring theory but should also pay a great deal of attention to skills development. Learning arrangements are needed with authentic problems and tasks.

From institutional learning to lifelong learning

Most of the students are part-time students who have opted for distance education for a number of reasons. They have a limited amount of time, have to combine work and study and are spread all over the country, so they need maximum flexibility. This could be achieved by searching for an optimal mix of different educational methods such as self-study of written course materials; coaching at a distance and collaborative learning with fellow students by use of web technology, supplemented by occasional face-to-face meetings; and possibly learning on the job, for instance in the form of fieldwork. Thus the so-called media mix is an important aspect of an educational model for lifelong learning.

From formal learning to learning in a workplace

Even more than in face-to-face higher education the integration of learning and working is an essential element in lifelong learning and distance education. Nevertheless, both face-to-face and distance education have to answer the question of how to facilitate the transition from a more formal educational setting to learning in the workplace. This question is treated in Michael Eraut's contribution.

From monodisciplinary to multidisciplinary, collaborative learning

Higher education tends to be monodisciplinary and as a result students develop a monodisciplinary disposition. However, students should be prepared to work collaboratively in a multidisciplinary context. This means that higher education has to support another transition in order to prepare students to work together with others across the disciplinary divide. This topic will be treated in Wim Gijselaers' contribution.

Overview

This book contains three presentations on expertise development, with particular regards to the transition from formal education to the working environment. Three experts in this field focus on the problems of this change by analysing the nature of the transition. It was written for a symposium held at the Open University of the Netherlands on 31st January, 2003, on the occasion of the inaugural address of Els Boshuizen as professor at the Educational Technology Expertise Centre.
The first contribution, entitled 'Transfer of knowledge between education and the workplace' by Michael Eraut of the University of Sussex in Falmer, Brighton, UK, analyses the relation between learning in the workplace and formal education. He discusses these both from a theoretical and an empirical point of view.

The second contribution, entitled 'Transfer of knowledge within the managerial workplace' by Wim Gijselaers of Maastricht University, Maastricht, the Netherlands, analyses the multidisciplinary and collaborative aspects of work. He identifies factors that that might affect learning to cooperate in multidisciplinary and multiprofessional teams.

The third contribution, 'Expertise development, how to bridge the gap between school and work' is Els Boshuizen's inaugural address, spoken upon the acceptance of the position of professor at the Educational Technology Expertise Centre at the Open University of the Netherlands. She focuses on expertise theory, formal and informal learning, and the influence of different environments on learning outcomes. She also discusses educational measures and design principles that can be used to promote expertise development over the whole trajectory of learning.

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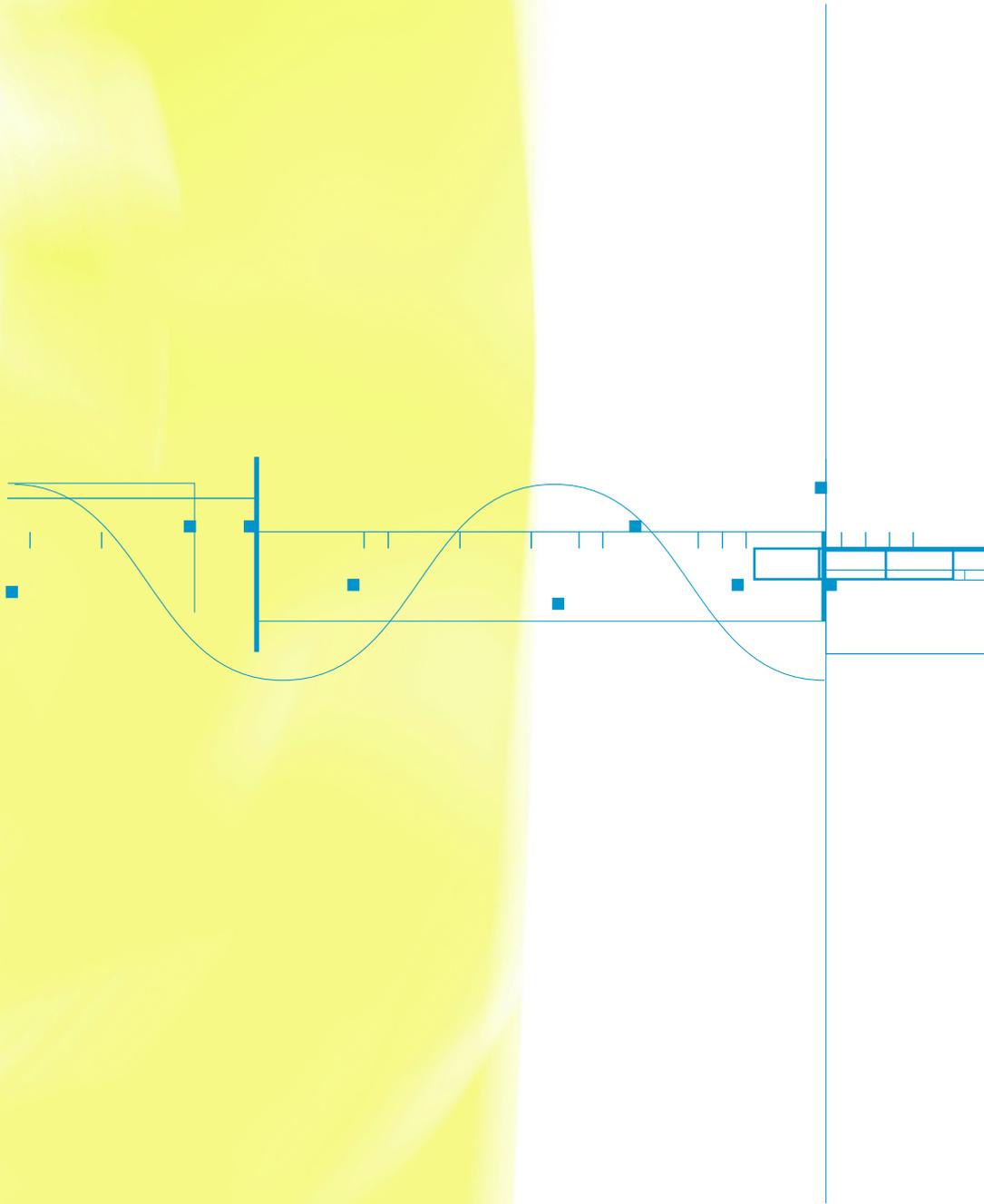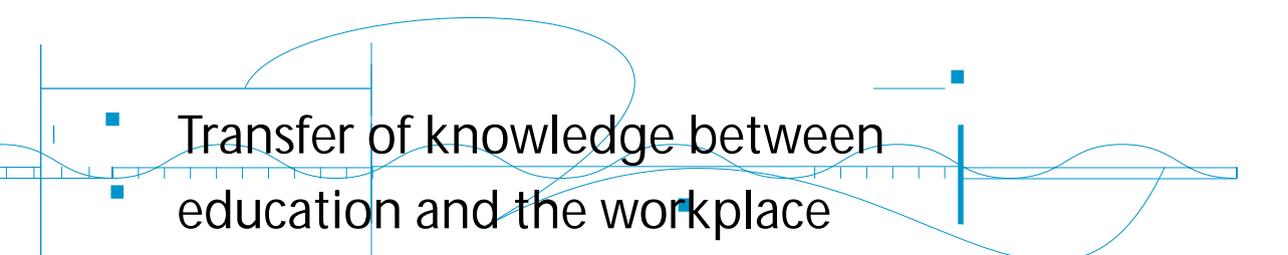
Transfer of knowledge between education and the workplace

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Transfer of knowledge between education and the workplace

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Both knowledge and learning can be examined from two perspectives, the individual and the social. These can be considered as analogous to the particle and wave theories of light. An individual perspective on knowledge and learning enables us to explore both differences in what and how people learn and differences in how they interpret what they learn. A social perspective draws attention to the social construction of knowledge and of contexts for learning, and to the wide range of cultural practices and products that provide knowledge resources for learning. In formal higher education, the most prominent of these resources are the codified academic knowledge embedded in texts and databases and the cultural practices of teaching, studentship, scholarship and research. Codified knowledge which is not academic can be found in nearly all workplaces, including those of educational organisations, in the form of textual material containing organisation-specific information, records, correspondence, manuals, plans, etc.

Cultural knowledge that has not been codified, plays a key role in most work-based practices and activities. There is considerable debate about the extent to which such knowledge can be made explicit or represented in any textual form; and the evidence gathered so far suggests that its amenability to codification has been greatly exaggerated (Eraut, 2000). What does appear to be generally acknowledged is that much uncodified cultural knowledge is acquired informally through participation in social activities; and much is often so "taken for granted" that people are unaware of its influence on their behaviour. This phenomenon is much broader in scope than the implicit learning normally associated with the concept of socialisation. It is a prominent feature of educational institutions in spite of the overt dominance of codified academic knowledge; and it occurs in both formal and informal settings.

As a counterpart to cultural knowledge, I define *personal knowledge* as what individual persons bring to situations that enables them to think, interact and perform. Codified versions of personal knowledge are associated with the concept of authorship; and provide the basis for assignments and assessments within educational programmes from which more than the replication of publicly available knowledge is expected. But my definition is intended to include non-codified personal knowledge and a far broader concept of knowledge than academic performance. For example, it includes not only personalised versions of public codified knowledge but also everyday

knowledge of people and situations, know-how in the form of skills and practices, memories of episodes and events, self-knowledge, attitudes and emotions. Moreover, it focuses on the use value of knowledge rather than its exchange value in a world increasingly populated by qualifications. This implies a holistic rather than fragmented approach to knowledge; because, unless one stops to deliberate, the knowledge one uses is already available in an integrated form and ready for action.

During the last two decades, several distinctive theories of "situated learning" have been developed. Their most prominent common feature is the assumption that what is learned in any given situation is significantly determined not only by the codified knowledge presented in that situation but also by the manner of its representation and by other features of the situation such as the social relations between the participants. A second common feature that follows from this recognition of the situated nature of learning is a more flexible view of knowledge itself, which becomes more a property of social interaction than a property of an authorised text. Gruber et al. (1996) provide an excellent review of the implications for transfer of five varieties of situated learning theory, which I will not attempt to summarise.

However, while strongly supporting these two common features, I strongly dissent from those theorists, such as Lave and Wenger (1991), who attempt to eradicate the individual perspective on knowledge and learning. Their research, based mainly on fieldwork in stable communities, focuses selectively on common rather than differentiated features of people's knowledge; and fails to recognise the need for an individual situated (as well as a socially situated) concept of knowledge in the complex, rapidly changing, post-modern world. Individuals belong to several social groups in which they both acquire and contribute knowledge, and their experiences of multiple group membership cannot be ring-fenced. Many of these groups have changing memberships and relatively short lifetimes. Thus members of a group acquire only part of the knowledge present in that group, and interpret it within a personal context and history that has been shaped by their experiences in other groups, both prior and contemporary. There will also be aspects of a person's knowledge that have been constructed through lifelong learning and have become unique to them, i.e. outside the circle of shared cultural knowledge, because of the unique set of situations in which they have participated. For example, a single idea will acquire a distinct web of meaning for each individual user according to the sequence of situations in which they used it. The greater the range of usage, the more distinctive its personal meaning is likely to be (Eraut, 2000).

Theories and the manner of their acquisition

Theory is an inherent part of how we interpret and understand the world around us. The way in which we conceptualise our environment depends on our personal theories. Our assumptions about what causes what or what will happen if we do X also can be characterised as personal theories. Such theories are pervasive and unavoidable but what is their status as knowledge? Several possibilities come to mind, all of which might be considered to be true in certain circumstances; and their relationship with formal theory found in books is highly differentiated. There is no need to elaborate on the role of theory within the domains of codified knowledge we refer to as academic disciplines, except to point out that academics can be considered as a particular group of users who operate within a range of contexts from being key interpreters of a theory within the heartlands of a discipline to importers of that theory into cognate disciplines or more applied fields of study. Each makes its own assumptions about the role of theories in their discourse, which can be readily inferred by critical reading of the journals favoured by different groups and factions. Although elements of this discourse may carry connotations that are picked up by only a small group of 'insiders', these serve only a micropolitical function. The theory and range of interpretations and criticisms are explicitly described and publicly available to those with sufficient prior knowledge to understand them.

In contrast, at the other end of the range are *implicit theories* which are seldom explicitly stated by the knower but used by psychologists (and other social scientists) to explain observed regularities in his or her behaviour. Those observed behave as if they are using the implicit theory imputed to them. If knowers are informed about their own implicit theories, they often recognise them but also sometimes deny them. Recognition is extremely important, because it helps to bring actions based on theory under the critical control of the actor. Being unaware of the theories informing one's actions is tantamount to not being responsible for the effects of those actions. Such implicit theories can be developed by the unconscious aggregation of experiences of similar situations or by participation in a community of practice for whom certain implicit theories form part of their taken-for-granted world. The denial response, often only temporary, is usually because the implicit theory conflicts with the knowers' self-image or with the theories they use to justify their actions. Argyris and Schön (1974) made a very useful distinction between *espoused theories*, often ideologically correct and acquired during professional education, and *theories in use* which determine what people actually do; and go on to discuss how mid-career professionals and managers can be helped to reconcile them.

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Between these two extremes are a wide range of situations in which some explicit use is made of theory in professional/vocational contexts. Theories in use may be explicitly derived from personal experience informally acquired from colleagues, or learned from private study or formal education and training. Unless the use of theory is repetitious, it will have to be reinterpreted/transferred to fit each new situation; and this will require a little or a great deal of further learning, depending on how different the new situation proves to be from those previously encountered. Thus a person's theoretical capability will depend not only on the range of theories which they 'know and understand' or even on the range of theories they have used; but also on the range of contexts in which they have used them, and their accumulated expertise in, and disposition towards, further use of those theoretical resources.

Reframing the concept of transfer

Before 1980 research on transfer focussed on two main variables: the nature of what is being transferred and the differences between the contexts from which and to which the transfer was, or was not, observed to occur. To these I wish to add the disposition of the transferee and the time and effort devoted to facilitating the transfer process; because research into knowledge use outside laboratory settings clearly indicates that these variables are important influences. Transfer should not be conceptualised as an event but as a learning process whose progress is affected by a large number of variables. Thus my definition of transfer is " the learning process involved when a person learns to use previously acquired knowledge / skills / competence / expertise in a new situation". This may be short and easy if the new situation is similar to some of those previously encountered; but long and very challenging if the new situation is complex and unfamiliar.

In the complex situations encountered by most professional workers, the transfer process typically involves five inter-related stages:

1 The extraction of potentially relevant knowledge from the context(s) of its acquisition and previous use;
2 Understanding the new situation, a process that often depends on informal social learning;
3 Recognising what knowledge and skills are relevant;
4 Transforming them to fit the new situation;
5 Integrating them with other knowledge and skills in order to think/act/ communicate in the new situation.

The whole process is much more complicated than just desituating and resituating a single piece of knowledge.

Higher education defines its interest in terms of transferring its knowledge, whose significance is taken for granted; and will, at most, attend to stages (1) and (3). The workplace may give some attention to stage (3) and generally takes stage (2) for granted. It expects knowledge from higher education to be "ready to use" and questions its relevance if it is not. Thus both cultures not only ignore the very considerable challenges of stages (4) and (5) but deny their very existence! Since transfer is a social process as well as an individual process, this lack of preparedness is best described as disastrous.

Types of knowledge acquired in education contexts

Teachers in secondary and post-compulsory education are organised according to the subjects they teach, each of which forms a distinctive sub-culture and provides a major part of their professional identity (Becher, 1989; Goodson, 1983). Most learning pathways that precede full-time employment comprise mainly subjects, which have potential vocational relevance, but are taught primarily under the auspices of general education. When subjects are claiming territory on the timetable, arguments based on vocational relevance are used with vigour, if not rigour. But, once their territory has been established, historical traditions, the prevailing assumptions of the subject culture and the expertise of the current teaching staff dominate the selection and treatment of academic content. The prime objective becomes progression within the discipline and increasing participation in its culture to first degree level and beyond, even though only a small minority of students follow that particular path. In many subjects applied aspects are given just a "walk on part" and an occasional mention.

Professional and vocational education programmes typically include three kinds of content: these derive from (1) disciplines which feature prominently in general education and form major components of honours degrees, e.g. Mathematics, Sciences, Social Sciences, Languages, (2) the applied field which sponsors the programme e.g. Business, Engineering, Education, Health Professions and (3) occupational practice itself. According to their background and orientation, individual teachers have a primary allegiance to one of these three types of content, but are sometimes also required to teach a second. In every case the treatment of the content and its relationship to practice are significantly influenced by the academic and vocational experience of those who teach it.

Most teaching within an applied field in is also strongly influenced by an often quite recently constructed body of knowledge about that field, which thus becomes either a quasi-discipline like Education or Nursing or a constellation of quasi-disciplines like Business Studies or Engineering. Over time, teachers in the applied field are drawn from

its own graduates and a cultural succession becomes possible whereby new teachers are recruited with little or no work experience in the relevant occupation. These may remain a minority, but the codified academic knowledge of the field, as represented in publications, begins to dominate knowledge derived from personal experience of occupational practice, both culturally and experientially, as the impact of early occupational experience recedes. Some of this theory of the applied field is concerned with the application of theories and concepts from scientific disciplines; some is based on empirical research and conceptual frameworks peculiar to the applied field; some is based on the elaboration of practitioner maxims and practical principles; some is based on what can best be described as a preferred view or ideology of the occupation, a theoretical justification of its purposes and practices in terms of moral principles, views of society and occupational beliefs about the effectiveness of various practices.

This last aspect of "applied field" theory is strongest in occupations based on personal interaction with clients, where there is a strong tendency to construct theories of practice which are ideologically attractive but almost impossible to implement. The main problem is that the professionals concerned are urged to adopt practices that involve much greater levels of time and effort than service users and/or the public purse can possibly finance. Hence, there is a significant gap between the theories of practice taught by former practitioners, based on how they would have liked to have practised, and the activities performed by current practitioners. This contrasts with the common workplace stance, in which current practice is uncritically accepted as an inevitable reality, and any impetus towards improving the service provided by an occupation is lost. Neither provides an adequate basis for a professional career. There are so many variants of problem-based learning curricula and staffing strategies that it is impossible to discern the extent to which PBL even attempts to bridge this cultural gap between education and workplace settings.

The third type of course found in Education settings involves teaching occupational practice through skill workshops or simulations; or, if there is concurrent work experience, seminars linked to discussions that interpret that experience and introduce relevant theory in order to facilitate learning in the workplace. This last is commonly described as the "reflective practitioner" model. To be successful these skills sessions or reflective seminars require small student groups, good facilities and hyperactive staff who sustain close working links with practitioners. Recruiting and retaining such staff is often difficult; and in Higher Education the demands of such bicultural work tend to conflict with activities more likely to lead to promotion.

To conclude this section, I shall briefly summarise the kinds of knowledge which Vocational and Professional Education Programmes claim to provide:

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1 *Theoretical Knowledge* constructed in the context of either a subject discipline or an applied field. This introduces concepts and theories to help students to explain, understand, and critique occupational practices and arguments used to justify them; and to appreciate new thinking about the role of the occupation and proposed new forms of practice.

2 *Methodological Knowledge* about how evidence is collected, analysed and interpreted in academic contexts and in occupational contexts; and the procedural principles and theoretical justifications for skills and techniques used in the occupational field.

3 *Practical skills and techniques* acquired through skills workshops, laboratory work, studio work, project work etc.

4 *Generic Skills* claimed to be acquired during Further and/or Higher Education, either through direct teaching, or more often, as a side effect of academic work. These include:
   • basic skills in number, language and information technology
   • modes of interpersonal communications
   • skills associated with learning and thinking in an academic context
   • self-management skills

5 General knowledge about the occupation, its structure, modes of working, cultural values and career opportunities.

Although most of these types of knowledge are described as transferable, there is little evidence about the extent to which 2, 4 and 5 are acquired by students and about the chances of 1 and 3 being subsequently transferred (or not) into the workplace. There is even some doubt as to whether the phenomena described as "transferable skills" have sufficient affinity with workplace activities for the term "transfer" to be a valid description of any suggested connection.

Types of knowledge acquired in the workplace

My research into mid-career learning in a wide range of settings (Eraut et al. 1998, 2000) led to a rough typology of knowledge found in the workplace, which contrasts with that found in Education settings. This is summarised below in a slightly modified form:

1 *Codified Knowledge* acquired during initial professional training and further episodes of formal learning; or in the workplace itself. The former includes codified academic knowledge of concepts, theories and methodology. The latter includes job-specific technical knowledge and knowledge of systems and procedures.

2 *Skills* needed for competence in a wide range of activities and for performing several work-related roles, including leadership and working collaboratively within a team. These can be grouped under four headings – technical,

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interpersonal, thinking and learning – and are acquired through practice with feedback. Progression is associated with increasing fluency, responsibility and complexity.

3 *Knowledge Resources* include a range of materials and on-line resources; but learning from other people is even more important in most work settings. These include immediate work colleagues and other members of one's organisation; networks of clients/customers, suppliers and competitors; professional networks; and other personal contacts developed over time.

4 *Understanding* provides the basis for most action, although it is inevitably incomplete. It encompasses the understanding of other people- colleagues, clients, managers, etc.; the understanding of situations and contexts, including one's own organisation and its environment; self-understanding and strategic understanding of a range of changes and developments. This includes both explicit and implicit theoretical perspectives and theories of action.

5 *Decision-making and Judgement* vary with the conditions in which they are exercised. Decisions may be rapid, with little time for analysis or consultation, or deliberative and consultative. When situations are complex or information is sparse, judgement becomes a critical aspect of decision-making: judgement of people; judgement of the quality of products, practices and processes; judgement of the relative significance of, and interaction between, different factors; judgement of priorities, options and strategies.

Unlike many typologies, this one gives considerable emphasis to working contexts and conditions. Not only is situational understanding context specific, but it requires knowledge acquired through experience; and the capability to decide and act requires both experience of working in the context, and adaptation to a range of local conditions. One cannot understand the knowledge needed for doing a job without a detailed description of what I like to call its *performance domain*. This comprises three types of variable:

1 The contexts and cultures in which the performer will have to operate, including likely locations and their salient features;

2 The conditions under which the performer will have to work, e.g., degree of collaboration and supervision, pressure of time, crowdedness, conflicting priorities, availability of resources;

3 The situations which the performer may encounter, covering such factors as client types and demands, tasks to be tackled, interpersonal events, emergencies, etc.

Like other typologies, however, mine has one very serious weakness. It cannot represent the knowledge that results when several different kinds of knowledge are combined to achieve a complex task or performance. The difficulties entailed in trying to solve this

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problem of knowledge representation can be best understood by adopting other approaches to the study of knowledge in use, which allow for the possibility of interference between tasks and draw attention to problems of prioritisation and deciding which task to do when.

Studying performance periods

The period chosen for analysis will vary according to the focus and the occupation; for example one could consider a lesson, a clinic, a shift or a day. A major aspect of professional experience is that many tasks do not get completed during a performance period, so there is the constant problem of 'picking up the threads' at the beginning or receiving new information that will cause a change of plan; then a need to record progress at the end and/or to hand over clients to a colleague. This is reflected in the separate boxes for Initiation to indicate the initial briefing and reading of the situation when the period starts, and for Ending to indicate what has been achieved, or left undone, by the time the period ends.
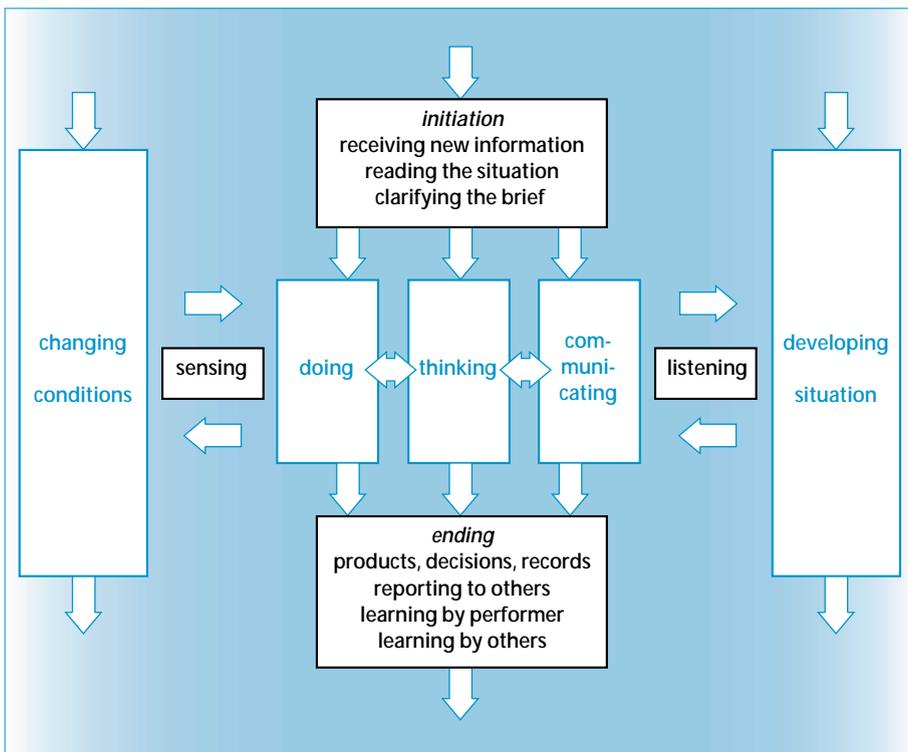

Figure 1   Activities during a performance period

One advantage of using a performance period is that situations often develop over time. So, instead of a static model in which all decisions and plans are made at the beginning of a period, one has a dynamic model in which a constantly changing environment provides a changing input that leads to the constant modification of plans. The input side is shown by placing the activities within a context characterised by changing conditions and a developing situation, with the opportunity for inputs prompted by sensing and listening. A great deal of competent behaviour depends not just on being able to do certain things (output) but also on the correct reading of the ongoing situation (input) so that the appropriate action can be taken. Nor is it only the external environment that changes of its own accord. The performer is an actor who affects that environment, not always in totally predictable ways. So another role of input is to provide feedback on the effect of one's own performance. This applies whether one is making something and sensing it change, or talking to people while listening to their reply and observing their reaction.

The interpretation of this input is just one aspect of the cognitive clement, indicated by a central column marked Thinking. Other aspects of thinking include planning and monitoring one's activities and solving problems. People are constantly thinking and making decisions as they go along, even though they could probably tell you very little about it afterwards. Hence Thinking is shown in constant interaction with Doing and Communicating. These activities overlap to some extent, the main distinction being between acting on inanimate objects and interacting with other human beings.

Factors affecting modes of cognition in workplace performance

The performance period approach introduces issues pertaining to the pace and pressure of the workplace; and, through emphasising the importance of cognition, raises the question of when and how workers find the time to think. This led to a model linking four types of professional activity to different amounts of thinking time, and hence, to examining the *modes of cognition* employed in professional work (Figure 2). The four types of activity were:

1 Assessing clients and situations (sometimes briefly, sometimes involving a long process of investigation) and continuing to monitor their condition;

2 Deciding what, if any, action to take, both immediately and over a longer period (either on one's own or as a leader or member of a team);

3 Pursuing an agreed course of action, modifying, consulting and reassessing as and when necessary;

4 Managing oneself, one's job and one's continuing learning in a context of constrained time and resources, conflicting priorities and complex inter- and intra- professional relationships.

These activities can take many different forms according to the speed and context and the types of technical and personal expertise being deployed. Although analytically

distinct, they may be combined into an integrated performance that does not follow a simple sequence of assessment, decision and then action. For example a health professional will often have to decide whether to take action and then reassess whether to continue with a further assessment of their client or whether to simply wait and see. There may be several assessments, decisions and actions within a single period of consultation and treatment. Indeed recording both the nature of these activities and the ways in which they are sequenced and combined is another very useful approach to describing professional practice.

In order to understand the nature of workplace performance, one has to examine the thinking entailed in carrying out these activities, which depends on both (1) the conditions and constraints on the performer, and (2) what the performer has learned to do, with or without stopping to think. Sometimes the situation itself demands a rapid response; sometimes rapid fluent action is the hallmark of the performer's proficiency; sometimes the number of activities proceeding simultaneously limits the attention that can be given to any of them i.e. the workload is so heavy that there is little time to think. Thus the model assumes that *time* is the variable that most affects *mode of cognition* and divides the time-continuum into three sections, headed Instant, Rapid and Deliberative. These terms attempt to describe how the time-scale is perceived by the performer, and are interpreted differently according to the orientations of performers and the nature of their work. For example, in one context *rapid* might refer to any period less than a minute, while in another context it might include periods of up to ten minutes or even half an hour. The critical feature is that the performer has little time to think in an analytic mode.

Type of process	Mode of cognition		
	Instant/Reflex	*Rapid/Intuitive*	*Deliberative/Analytic*
Reading of the situation	pattern recognition	rapid interpretation	review involving discussions and/or analysis
Decision-making	instant response	intuitive	deliberative with some analysis or discussion
Overt activity	routinised action	routines punctuated by rapid decisions	planned actions with periodic progress reviews
Meta-cognitive	situational awareness	implicit monitoring short, reactive reflections	conscious monitoring of thought and activity self-management evaluation

Figure 2   Interactions between time, mode of cognition and type of process

The *instant/reflex* column describes routinised behaviour that, at most, is semi-conscious. The *rapid/intuitive* column indicates greater awareness of what one is doing, and is often characterised by rapid decision-making within a period of continuous, semi-routinised action. Typically it involves recognition of situations by comparison with similar situations previously encountered; then responding to them with already learned procedures. The time available affects the degree of mismatch that is tolerated, because rejection of action based on precedent leads to deliberative, problem-solving and hence to a more time-consuming approach. The *deliberative / analytic* column is characterised by explicit thinking about one's actions in the past, present or future, possibly accompanied by consultation with others. It involves the conscious use of prior knowledge, sometimes in accustomed ways, sometimes in novel ways or in a more critical manner.

The interesting question arises as to whether performers are aware of the knowledge embedded in their practice when it is not explicitly used at the time. Four very different circumstances may pertain:

1 The practice was modelled on that of other professionals without understanding the reason for it or being aware of any underpinning knowledge.

2 The practice was developed with awareness of its rationale and underpinning theory, but that awareness dissipated over time and with it the ability to explain or justify it.

3 The practice can still be justified by citing underpinning theory, but cannot withstand any challenge because there has been no critical evaluation of the practice since it was first adopted.

4 The practice cannot only be justified but remains under the professional's critical control because it has been periodically re-evaluated.

The need for knowledge transfer during initial training and the period of workplace learning that follows it will largely be determined by whether the desired option is (1) or (4) above.

Two problems are likely when the use of underpinning knowledge is not under critical control. First, conflicts may arise in problematic cases between competing responses based on different practical principles – these cannot be resolved unless the underlying reasons for these principles are understood. Second, there is a danger that "scientific" knowledge will be replaced by unscientific knowledge – that which falls within the domain of a discipline but is regarded by leading professionals as either incorrect or alarmingly incomplete. The normal assumption is that being a competent professional implies keeping one's practice under critical control; and therefore keeping up to date with relevant areas of theory and research. Reviews of practice may arise from individual reflection and consultation or, more officially, from the work of an appointed group. They examine the rationale for the practice, the evidence for its effectiveness,

alternative approaches and recent research; and may lead to a decision to retain the practice unchanged, modify it, or adopt an alternative. But, in spite of the growing emphasis on audit and on evidence based practice, such reviews are far from frequent and are restricted by the limited, and often exaggerated, scope of research based evidence.

Heuristic devices for investigating and learning scientific knowledge

Over the last few years, and with support from colleagues, I have been developing a heuristic framework to address the problem of investigating the use of scientific knowledge, to enable people to focus their attention on areas of particular concern to them and to help them appreciate the complexity of the issues involved. This heuristic can be represented as a two stage process:

1 establishing which areas of knowledge are relevant to a particular case or situation;

2 focusing more precisely on what knowledge is needed for a particular investigation, decision or action; and ascertaining how that knowledge is interpreted in a manner appropriate to each particular situation and context.

Establishing which areas of knowledge are relevant is not as simple as it seems. When teachers in education settings spend time discussing how their theoretical contributions relate to practice, a large collection of potentially relevant theory is quickly assembled. But who uses which parts of it, why and when? Our earlier section on modes of cognition noted that time to consider theory is at a premium in the workplace; and suggested that most theory was more likely to be embedded in practice than explicitly used in daily decision making. There is a marked contrast between the very large number of knowledge areas deemed relevant by those who teach them and the very limited number of knowledge areas that can be taken into account at any one time by a busy practitioner with a high caseload. The practitioner has to assess the priority to be accorded to each particular area of knowledge in each particular situation; but in practice patterns of attention will soon be developed and only some knowledge areas will even be considered.

Recognising what theory you need in any particular situation is mainly learned through participation in practice and getting feedback on your actions; and most components of a practitioner's theoretical repertoire remain dormant until triggered by a very specific aspect of the situation. In healthcare contexts the nature of the client(s) is the main factor determining what knowledge and skills are relevant; but time-scale is also important. Figure 3 presents a useful framework for discussing and deciding not just which areas of theory are relevant to a particular case but also their respective priority. It can be supported by an appropriate checklist of areas of theory.

Status of knowledge	Emergency	Short-term action	Medium to long-term future	Review of practice
Embedded in – assessment – decisions – behaviour				
Explicit influence on – assessment – decisions – behaviour				

Figure 3   Framework for deciding priority areas of knowledge

The two rows allow a distinction to be made between (1) knowledge embedded in practice through routines or protocols but which remains essential for the justification of that practice and (2) knowledge which needs to be explicitly considered at the time. Such knowledge may influence how the client is assessed, what decisions are made and/or how the practitioner interacts with the client.

The column headings reflect the assumption that priorities will vary according to the time scale. For example, the knowledge used to treat a patient in hospital with a stable condition will not necessarily be given priority in an emergency; and yet other kinds of knowledge may become important when longer term issues are being considered. The fourth column, headed Review of Practice, has been added for two reasons. First to ensure that embedded knowledge is reviewed at some time; and second to enable contextual factors constraining practice to be identified and addressed in a way which would not normally be possible when an individual client is the focus of attention. Such reviews of practice might occur in the context of audit, continuing professional development, a formal evaluation or funded research.

The framework presented in Figure 3 can be used both to find out what practitioners currently do, in which case embedded knowledge may be difficult to elicit without using special methods of inquiry (Eraut, 1999; Fessey, 2000); and to discuss what they ought to do. Repeated use on a case by case basis would reveal common patterns of practice, differentiation between clients and concerns about the efficacy of practice, including the cumulative effect of neglecting longer term issues. Using this framework to broaden the scope of cases used in problem based learning could also play an important role in orienting students towards the significance of a wider range of theory without inducing cognitive overload.

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The second stage of the process focuses more specifically on what scientific knowledge is used when and how; and uses knowledge maps developed during research into the use of scientific knowledge by nurses and midwives (Eraut et al., 1995, 1996). Our approach was to interview experienced practitioners, engaged in mentoring students, about recent cases involving the use of particular areas of scientific knowledge and to use a matrix to summarise the information we gathered.

Figure 4 on page 70 is the first half of a map depicting aspects of knowledge about Acute Pain used by Surgical Nurses, and when they are used. The rows cover relevant topics of codified knowledge within the area of Acute Pain, while the column headings describe the range of activities that constitute the practice of Surgical Nurses. The missing half contains a further fourteen columns under the headings of Alternative Methods, Drugs and Assess Response. The use of knowledge from a particular topic (row) during a particular activity (column) is indicated by making an entry in the appropriate box. Our research found significant differences in the headings of the matrix between specialisms, and some variation according to the type of clinical setting. Relatively few differences were noted between respondents from similar settings, but samples were not large enough for that to be a definitive finding.

The entries in the boxes indicate different kinds of knowledge use, codified for brevity. The R coding indicates that Recognition is all that is required, very little further interpretation is needed, and the transfer problem is mainly that of spotting when it is relevant; whereas the U coding indicates that significant Understanding of the knowledge is required, and probably some transformation. The knowledge has to be reinterpreted in order to be resituated. The numerical headings relate to the mode of cognition and correspond to the Instant, Rapid and Deliberative modes of response portrayed in Figure 2.

1 *Simple application*, for which recognising that some specific piece of knowledge was relevant was virtually all that was needed in order to take appropriate action;

2 *Situational adaptation*, where the appropriate response from an established repertoire was selected according to how the situation was understood, usually by matching one's model of the situation with situations previously encountered (described by Klein (1989) as Recognition Primed Decision Making); and

3 *Problem solving*, where the appropriate course of action had to be worked out from first principles.

Areas of Knowledge	Assess patient			Assess pain			Interpret cause					
	Perso-nality	Knowledge	History	Vital signs	Ability to cope	Intensity	Unrelated to surgery	Signs of infection	Haema-toma	Retention of urine	Consti-pation	Wound assessment
1 nerve pathways				U3			R2					
2 transmission/ perception of pain		U2										
3 causes of pain	U2	U2		U3	U2	U2	U2	U2	U2	U3	U3	
4 effects of pain	U2	U2		U3	U2	U2	U2	U2	U2	U2	U2	
5 bacteriology							R2	U3				R2
6 pharmacology										R2		
7 anaesthesia			U2	U2			R2					
8 wound healing				U3			U3	U3	U2			
9 barriers to expression of pain	U2	U2	U2		U2	U2						
10 pre and post operative care			U2	U2	U2	U2		U3	U3	U3	U3	U3
11 alternative methods	U3	U3		U3	U3	U3			U3	U3	U3	U3

Figure 4 Knowledge of acute pain used by surgical nurses

Accessing knowledge
R Appreciating the relevance
U Understanding and interpreting

Using knowledge
1 Simple application
2 Situational adaptation
3 Problem solving

Only with this third category was scientific knowledge explicitly used during the relevant episode of practice. In categories (1) and (2) any scientific knowledge used was embedded in already familiar understandings and actions. Since category (2) depends on the knowledge user having sufficient prior experience of similar situations, those lacking such experience have either to consult more experienced colleagues or engage in a slower, problem-solving approach that makes more explicit use of scientific knowledge. Resorting to consultation is quicker, but usually leads to new practices being acquired without any theoretical justification.

Parboteeah (2001) found that the use of knowledge maps is best taught to student nurses in practice settings, and in "real time" as and when relevant events occur. But, after an initiation period of 'on the spot' tutoring, students become able to use knowledge maps on their own with consultative access to 'experts' and even to create new maps as part of a group project. Newly qualified practitioners will need a similar induction, before they can begin to use knowledge maps as a guide to the kinds of knowledge that need to be fed into their decision-making processes, for the identification of their learning needs and for the debriefing of experts who find it hard to explain their apparently intuitive decisions. We have found them to be especially useful in initiating discussions about knowledge use and the more hidden aspects of practice during Continuing Professional Development.

The final stage in transfer involves combining the various relevant aspects of knowledge and skill into an *integrated, holistic, performance*. It will probably interact with those aspects of the previous stage that are relatively new; and will cease to be distinguishable as a separate stage when sufficient practice has created a rapid response. In practice reviews, prior attention should be given to the selection of the most relevant aspects of knowledge (see Figure 3), before using knowledge maps as aids to probe more deeply.

Conclusions

First degrees are no longer considered as qualifications for a lifetime, but nor are they regarded as preparation for only one or two years of work. The knowledge resources that graduates take with them into the workplace have to last longer than that; so they must relate to a reasonable range of jobs, roles and workplaces. However, most of these knowledge resources will not become useful until they have been further transferred and resituated in one or more working contexts. Hence knowledge perceived as irrelevant in the workplace may not necessarily be irrelevant; those who possess it may not yet know how to use it in a new context. With these considerations in mind, the selection of content and modes of learning for programmes intended to provide knowledge resources for a particular occupation should be conducted with great care and the reasons for the selection should be public and subject to review.

Learning in Education settings cannot be substituted for learning in workplace settings. Practice components of professional programmes have to be authentic. However, learning to practice and learning to use knowledge acquired in Education settings do not happen automatically. The conclusions we can draw from the above discussion are that:

1 learning to use theory in practical situations is a major learning challenge in its own right – it is *not* a natural consequence of learning theory on its own and practice independently of any critical theoretical questioning of its appropriateness and effectiveness.

2 Such learning requires both time and support. Learning programmes rarely allocate any time to this form of learning, but just assume (wrongly) that it will occur spontaneously.

3 Not only has little thought been given to the kind of support needed for this kind of learning, but there is rarely any clarity about who is responsible for providing it.

The solution to these problems is first to develop more integrated programmes, in which theory and practice components are continually linked and not separated by time, space and culture; and second to commit significant time and resources to the critical process of knowledge transfer both during and after graduation. This is most likely to succeed if staff are employed in practice settings with a practice development role that incorporates responsibility for both students and new staff, and the facilitation of continuing professional development.

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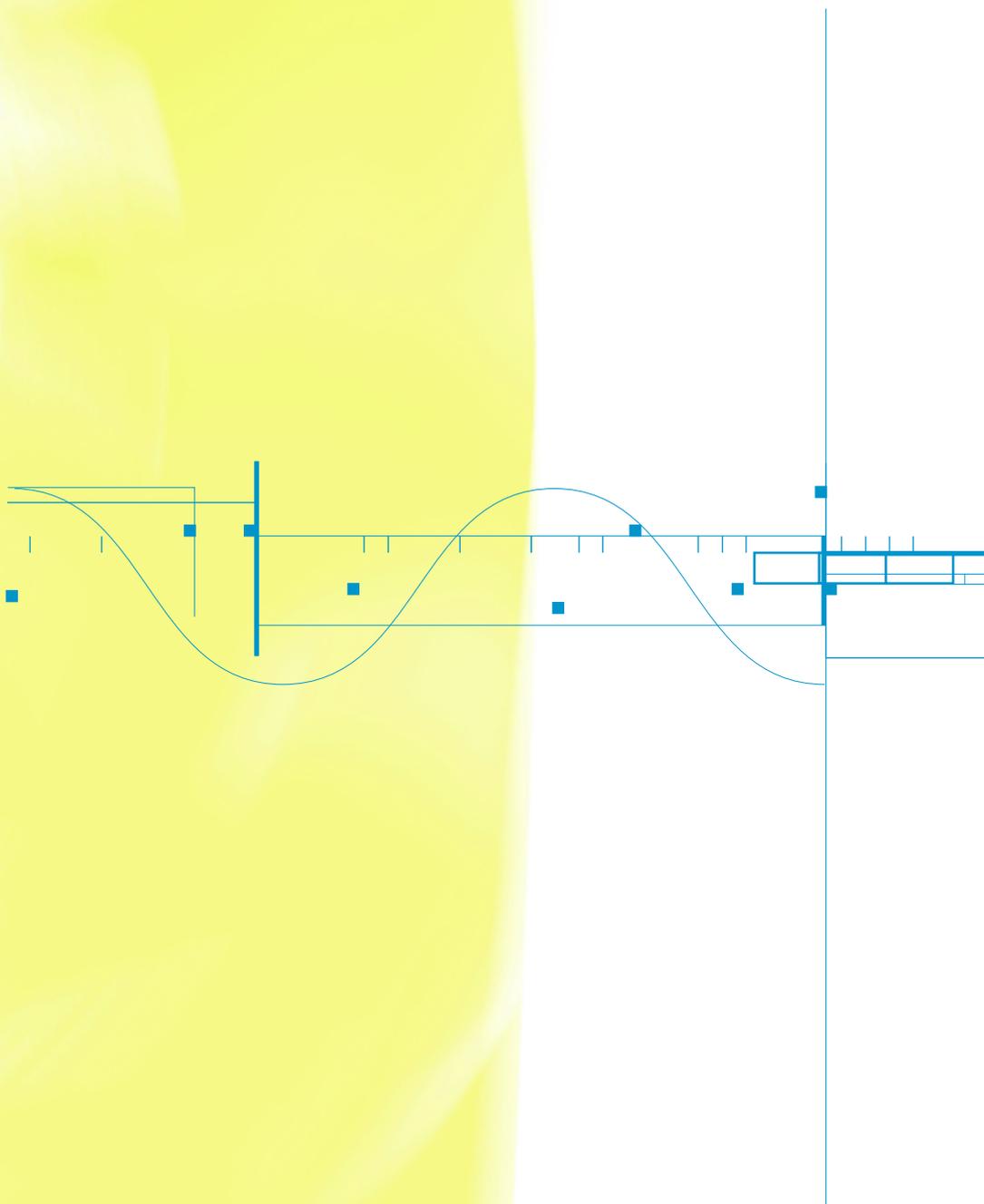
Transfer of knowledge within the managerial workplace

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The graduate: transfer of knowledge within the managerial workplace

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Organisational environments have become more complex and dynamic environments, involving increased organisational resources to assure managers make strategic decisions leading to increased competitive advantages. Accordingly, organisational decisions may address complex and ambiguous business planning issues where situation assessment is critical, and acceptable actions need to be sought. Well-taken decisions can be crucial for the future of organizations as these decisions can lead either to competitive advantages or even to decay of organizations. The importance of how managers attend to, interpret, and make decisions about problem situations is underscored by the fact that boards of directors are increasingly monitored by media and institutional investors (Forbes & Milliken, 1999).

It is generally agreed that as our economy moves further, collaboration and innovation are getting increasingly central to improve organizational effectiveness. It is assumed that more attention needs to be paid to the sets of relationships that people rely on to accomplish their work (Cross, Parker, Prusak, & Borgatti, 2001). Particularly in knowledge intensive work requiring employees to engage in solving complex and often ambiguous problems, significant efforts are made to develop sufficient opportunities for access of information and knowledge. Such efforts may entail the development of information systems like databases or procedure manuals. But recently, more emphasis is put on development of knowledge management focusing on the capture and sharing of codified knowledge. Cross and his co-workers (2001) argue that access to information does not necessarily imply access to databases or files. They refer to research showing that engineers and scientists were roughly five times more likely to turn to a person for information than to an impersonal resource such as information systems built on databases. In their view improving business performance requires more than development of information technology alone: "it requires attending to the often idiosyncratic ways that people seek out knowledge, learn from and solve problems with other people in organizations (Cross et al. p. 101)."

The knowledge that workers bring to work is considered to be a key resource of enterprises (Husted & Michailova, 2002). The nature of knowledge work puts more emphasis on cognitive functions than perceptual-motor functions, requires a good understanding of information and knowledge systems, and urges the joint functioning of people. But empirical research has questioned whether 1) knowledge workers use

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information technology indeed in the way these systems aim to support decision-making in solving complex or ambiguous problems (Baldwin, Paul, & Williams, 1999), and 2) whether knowledge workers are willing or able to share knowledge in teams (Knight et al., 1999; McNeese, 2000).

Consider the following examples from different kinds of industry, each engaging knowledge workers in complex and / or ambiguous problems, and all dealing with different levels of cooperative work. Try to identify the social and cognitive factors that helped or hindered knowledge workers to make sense of a situation, to converge multiple perspectives, and how knowledge was transferred from one worker to another worker or from one context to another context.

- 1991, Texas, United States. The Continental Express Flight 2574 (EMB 120) from Laredo to Houston violently pitched over while descending through 11,500 feet. The pilots lost control and the aircraft crashed. The leading edge of the left horizontal stabilizer was found over a mile away from the wreckage. All 47 of the upper attachment screws were missing. The night before the accident, maintenance had removed the horizontal stabilizer leading edges. The upper screws on the left part were not reinstalled (example taken from Masson & Koning, 2001).
- At Ericsson, a telecommunications equipment provider, a Montreal product development manager is faced with a marketing decision: how should I estimate the market size for a new mobile Internet application? After fielding the question to an on-line community discussion board, he is pointed to a database of all the operators in the market – and has his business plan approved (example taken from Foote, Matson, Weiss, & Wenger, 2002).
- At IBM Corp. a very worried manager is going to see his boss right after the failure of the big innovation project he had headed. Wasting no time he said, "I suppose you're going to fire me." "Why should I do that," replied the boss, "when I've just invested $6 million in your education?" (example taken from Sugarman, 2001).

These examples show several ways of thinking about how knowledge is accessed, how knowledge is communicated, and the consequences of decision making in term of mistakes or success. They illustrate how individuals may access group knowledge through modern technology, how electronically mediated cooperation influences decision making, and how lack of knowledge transfer may have dramatic consequences in terms of costs or human lives.

The first example is obviously the most appealing because it reveals communication problems, and work organization problems within a team or between teams. It gets even more appealing because the accident results from non-adherence to procedures and not because the maintenance problem as such was overly ambiguous or too complex. The next two examples seem to have a less fancy appeal because they

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obviously don't contain ingredients like technical failures or fatal loss. At first glance they merely illustrate some current business views and problems with regard to effective use of knowledge in organizations. However, the question may be raised why so much attention is being paid in business research to the role of assessing "learning capacity" or the role of "knowledge sharing" in organizations. An even more intriguing question is why educational sciences still seem to avoid this area and leave research about knowledge sharing to our colleagues from business sciences.

Sugarman (2001) contends that during the 1990s the concepts of "the learning organization" and "knowledge sharing" became popular because management realized that it is not the availability of technology making a company competitive, but the capacity to develop new technology. Lack of openness in the workplace is not only very costly, but it contains the risk that for example design engineers once they have solved their part of the problem can not connect to other people responsible for other key parts of the required design. But knowledge sharing as such is not a new phenomenon; it always takes place in organizations. However, what is new is that organizations aim to systemize knowledge-sharing activities, because in practice knowledge workers collaborate in teams crossing cultural and geographic boundaries. They work together in teams with a number of highly specialized disciplines, and bring together different ideas and different approaches to work (Distefano & Maznevski, 2000). Due to such developments, the importance of managerial decisions has increased. Abilities such as situation analysis and decision-making are nowadays considered to be core competences of management curricula. Nevertheless, management education has been regularly criticized for offering education too alienated from the managerial workplace. Management education is considered to be an indispensable institution to contribute to knowledge development and skills acquisition. Meanwhile it is frequently criticized for not sufficiently contributing to the needs of corporate world. The present paper will first explore current viewpoint on the requirements set by the managerial workplace. Then we will pay attention to required changes in management curricula as advocated by industry and business researchers. It has become popular to argue that as organizations continue to face a changing global economy, the educational learning model must adapt to the needs of culture, technology and innovation. But this assumes that the academic community knows what the constituents of management expertise are and how it is valued by business organization. This paper will proceed to question the transition between management education and the managerial workplace. Attention is paid to research on development of managerial expertise. Finally, we will argue that research on transfer of knowledge within or between teams shows inconsistent positive effects on managerial decision-making. We will conclude with some implications for transfer of knowledge between or within teams, and new challenges for educational research.

Views on the managerial workplace

In a recent paper, Arts, Gijselaers and Boshuizen (2003, in prep) argue that getting and processing information and informing others, accounts for about 50 % of a workday for the average Chief Executive Officer. They point out that processing, exchanging and reasoning with managerial information are very important activities of managers. In this perspective, managers are "information-processing workers" spending their time on absorbing, processing and disseminating information. This view of "information processor" is currently more relevant than ever as organizational information environments are complex, ambiguous and dynamic. Information has to be filtered, selected and interpreted. A current cognitive view is that managers meet this complex challenge by employing their knowledge structures as mental "templates" on data. This implies that the complex managerial data that managers encounter in their 'information worlds' is transformed into meaningful interpretations such as inferences (Walsh, 1995).

In the 1980s, a renewed interest came up in the managerial area to investigate cognitive factors that are related to information processing and decision-making abilities of managers. In his cogent review on managerial and organizational cognition, Walsh (1995) points out that if managers are to be considered as a source of variation contributing to firm value, one may question how managers select, process, and disseminate information about managerial issues and problems.

In studying determinants of cognitive performance (e.g. decision-making), there appear to be two distinct streams of managerial cognitive research. The first stream is dominated by management researchers, largely interested in managerial outcomes as reflected in managerial decision-making. Typically, it focuses on how managerial decision-making varies between teams or between individuals by examining team variables (Amason, 1996; Forbes & Milliken, 1998; Simons et al., 1999) or by assessing the role of psychological variables (Wally & Baum, 1994). In both approaches, the major interest lies in examining decision making as a consequence of either interaction processes or psychological variables (Walsh, 1995). The second stream is dominated by (cognitive) psychologists. It concentrates on how individual managers process information, assess and interpret situations, and how they solve problems (e.g. Isenberg, 1984; Lash, 1988; VanFossen & Miller, 1994; Wagner, 1991). A major interest of research in this area lies in identification of knowledge structures that enable managers to under-stand and process complex information (Walsh, 1995). These knowledge structures are considered as manager's 'frames of reference', or 'mental models', representing their organized knowledge build on previous experiences.

The importance of studying the role of knowledge within companies derives from the growing awareness that the capture and spread of knowledge within companies

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provides a significant explanation for marked differences in productivity and profitability between companies. To successfully foster the sharing and implementation of a company's best ideas, management tools are needed to emphasize knowledge sharing and resolve problems hindering knowledge sharing. Lubit (2001) contends that competitive advantage is increasingly found in knowing how to do things. Specialized knowledge and management of this knowledge is considered to create sustainable competitive advantage.

In this context, knowledge management forms a key issue in recent research on effective organizations. From the number of definitions of knowledge management, it is clear that success of a knowledge-based organization will require hybrid solutions of people and technology (Baldwin, Paul, & Williams, 1999). Co-operative working in multidisciplinary teams on the one hand, supported by information technologies on the other hand, can support knowledge management.

What is known from research? First, traditionally, research investigated the individual development and use of knowledge by experts. The use of expertise in tackling problems has primarily been focused on experimental tasks requiring individuals to solve a problem in an isolated fashion (Bromme & Nückles, 1998). This holds especially true for laboratory studies on expertise (e.g. chess playing), but also for studies analysing use of expertise in authentic problems. Second, a few recent studies addressed the issue of the development, the use and the sharing of knowledge for problem solving in multidisciplinary teams. They indicate that these teams encounter a number of difficulties while working on complex problems (Boshuizen & Tabachneck-Schijf, 1998; Vennix, 1998), namely: 1) dissimilarities of problem representations between team members; 2) communication problems in sharing mental models; 3) preference for a single perspective on a problem; 4) insufficient knowledge codification (cannot be expressed as sharable information); 5) vagueness about how much knowledge needs to be shared; 6) lack of common goals between individuals about individual tasks and the common goal of the team; and 7) insufficient skills to define responsibilities of the team members and the social structure that co-ordinate these individual responsibilities.

Kirschner, Segers, Gijselaers, and Boshuizen (2001) define knowledge management as the management of professional intellect, which as such necessitates capturing expertise and making it available to/for others. They argue that this knowledge is often tacit (also referred to as intuitive or implicit) meaning that it is both unarticulated and difficult to articulate, but is revealed in one's intelligent decisions and actions. They consider the extraction and harvesting of such tacit knowledge and its conversion into codified knowledge to make it available for and usable by others, though problematic, as imperative.

Although there is a growing consensus that the managerial workplace has become more and more complex, it would seem useful to get a better understanding of what knowledge and skills are needed for the workplace, and how management education can make a contribution. In general, two issues form a recurring theme in discussions about the growing complexity of the workplace. They may even be regarded as two sides of the same coin: 1) what type of managerial knowledge is needed to improve managerial decision making, and 2) how transfer of knowledge can be facilitated at the workplace.

But much work needs to be done. One of the first steps which need to be taken is to investigate the design of management curricula, and develop a clear view of what their current outcomes are with respect to knowledge and skills.

Views on management education

Management graduates have long been criticized for their lack of preparation to deal with day-to-day management realities. Boyatzis et al. (1995) summarized several common critics on MBA graduates, as expressed by many authors in books, news-papers, and magazines. They conclude that typical critics are that MBA graduates were commonly viewed as not practical and often too analytical. Baldwin and his co-authors (1999) showed similar concerns when connecting graduates' competencies to the needs of managerial workplace. They question whether academic education may contribute one way or another to produce new and useful knowledge for the managerial workplace. They refer to Goldberg (1999, p.10) saying: "Management may be filled with MBAs, PhDs and hoards [sic] of other supposedly accomplished and intelligent individuals, but this will not help to share what they know, or provide them with the necessary thinking skills for effective knowledge management." Stinson and Milter (1996, p. 34) arrive at similar conclusions when saying that curriculum change...
"was prompted by criticism of graduate business education. The popular business press published several reports critical of business education during the early eighties. Business schools were chastised for being too theoretical and out of touch with business realities, for producing narrow-minded technicians who lack interpersonal and communication skills, and for concentrating on esoteric research which has little if anything to do with the business world. While some of the reports were sensationalized and demonstrate a lack of understanding of both business schools and the business world, there was merit to the concerns expressed. Many business schools, including ours, heard from members of their executive advisory boards, that graduates were not well prepared for the business world. They noted that graduates do not have a realistic understanding of the business world, they criticized graduates for ineffective communication skills, they noted the lack of leadership skills, and they commented on the need to train new graduates, teaching them concepts they supposedly learned in school."

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This set of complaints is not unique to the 1990s. A review of critiques of business education reveals that such comments have been voiced intermittently since the 1970s. Porter and McKibbin (1988, p. 122) articulated in their hallmark study that management education delivers graduate students that posses a lot of knowledge but are not yet able to use acquired knowledge in a business context, neither can graduates choose between appropriate knowledge to resolve practical situations. They argued that "The [undergraduate business] graduate is not regarded [by businesspeople] as particularly well prepared for encountering various day-to-day realities of the business world nor for exercising requisite levels of personal skills, including both communications, and leadership that is capable of influencing others with whom they work." Bigelow (unpublished) contends that following the release of this study, there has been little evidence that (under)graduate programs have responded to this criticism. For example, recent reports from the Business-Higher Education Forum (1995) reflect similar conclusions as drawn in the Porter and McKibbin study (1988). Employers keep complaining about a lack of communication skills, interpersonal skills, and a lack of understanding of business practice.

Nearly all criticisms have in common that graduates are not prepared to frame work situations in ways that the workplace is calling for. Even although graduates may possess certain management skills, the key issue is that they don't recognize that certain situations require those skills. A second common complaint is that graduates do not possess "soft skills". That is, skills which are needed to work together with other people at the workplace. As argued in the previous section, the call for development of soft skills is not surprising giving the growing awareness that transfer of knowledge between or within teams, requires more than possessing knowledge.

Over the past few years, several studies haven been conducted to evaluate the degree to which management education prepares students for the management profession. Typically these studies employ interviews or surveys with human resource executives, management practitioners, program directors and graduates (e.g. Douglas Johnson & King, 2002; Giannantonio & Hurley, 2002; Hansen, 2002). A consistent research finding is that about four required competencies may be identified: 1) functional competencies (discipline specific), 2) systemic competencies (cross-disciplinary knowledge and skills), 3) personal competencies (self-management), and 4) organizational competencies (managing others). It has been found that a growing emphasis is put on skills like "interpersonal communication", "problem solving", and "team-building". Douglas Johnson and King (2002) conclude that Human Resource programs are doing an excellent job when focusing on academe's traditional functional competencies, but they should put more emphasis on personal competencies. A striking result of their study is that more attention should be paid to skills needed in dealing with (cultural) diversity in organizations. Giannantonio and Hurley (2002) found that the most important issue

human resource executives face is "management of change." Hansen (2002) concludes that more attention should be paid to the graduate's ability to combine traditional content (academic functional knowledge) and acquired skills in creative ways that add value to their employers. Again, it was concluded (Hansen 2002, p. 536) that "substantial gaps exist between what employers seek to find, and what students believe they should be getting from these programs, if they are to be adequately prepared for ever more challenging employment opportunities."

Despite the growing awareness that management education should prepare graduates being capable to function properly in a complex workplace, one may question whether 1) sufficient attention is paid to the nature of knowledge underlying managerial work, and 2) whether survey methods are likely to be of any help in providing guidelines for redesign of management curricula. This skepticism is nurtured by the fact that even carefully designed studies like the ones cited from the Human Resource Management Review fail to make clear in their "conclusion" or "implications for instruction" section how we should proceed given the consistent finding that more attention needs to be paid to interpersonal skills or problem-solving skills. Because research in cognitive sciences has consistently shown that it doesn't make sense to teach generic skills courses like "creativity", or "problem solving" to improve the graduate's capability to connect acquired knowledge and skills with demands from problem situations. We argue that research on the socio-cognitive factors in the acquisition and transfer of knowledge (as presented in journals like "Cognition, Technology and Work", and "Organizational Science") may provide better insights into how individuals learn and transfer knowledge in the workplace. The next sections contain a brief description of recent research in our department on "expertise development in management" and on "transfer of knowledge in multidisciplinary teams."

Research on expertise development in management

Next to the established professions as medicine, law and engineering, the field of management sciences is considered as one of the new professions. For a long time management sciences were dominated by the view that managers are rational technicians or management engineers (Wagner, 1991). This resulted in the development of rational, behaviourist approaches to managerial problem solving with an emphasis on general principles of problem solving. Content knowledge was considered as less important. However, in the 1970s and the 1980s a growing scepticism rose about the power of general principles of problem solving. For example, Mintzberg (1973) found on the basis of observations and interviews that managers rarely employ rational approaches. As Mintzberg lacked modern tools from cognitive psychology for further examination of managerial problem solving, he considered his own study as "sketchy".

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In later years the managerial cognition perspective gained stronger interest. Research from this point of view assumes that managers are knowledge workers who face complex and ambiguous business environments full with facts, and ambiguous information challenging their ability to make sound strategic decisions (Walsh, 1995). It concentrates on how individual managers process information, assess and interpret situations, and how they solve problems (e.g. Isenberg, 1984; Lash, 1988; VanFossen & Miller, 1994; Wagner, 1991). A major interest of research in this area lies in identification of knowledge structures that enable managers to understand and process complex information (Walsh, 1995). These knowledge structures are considered as manager's 'frames of reference', representing their organized knowledge build on previous experiences. Examples of knowledge structures are related sets of managerial facts ('patterns').

Arts, Gijselaers and Boshuizen (2000, 2003) conducted a series of studies aiming to identify managerial knowledge structures underlying problem solving by using research techniques adapted from expertise studies in other professional domains (medicine, physics). By comparing management students and experienced managers, they tried to assess the nature of managerial knowledge while solving managerial cases. Previous research by Isenberg (1986) showed that managers were less demonstrative on their performance, and restricted their information searches, even although they knew that complete information was available. Lash (1988), and VanFossen and Miller (1994) conducted similar expertise studies. Again, they found substantial differences between experienced managers and management students in the knowledge structures underlying managerial performance.

Nowadays, the general agreement about development of expertise is that the ability to solve problems in a certain knowledge domain is not only a result of better heuristics but also depends on one's knowledge of a specific domain. Few studies, however, exist that examine this knowledge of novice and expert problem solvers in management sciences. One of the first studies by Arts et al. (2000) aimed at evaluating the development of managerial expertise over time. In particular he was interested whether he could reproduce the so-called intermediate effect by comparing novices and experts in management. This effect is one of the most consistent findings in novice-expert comparisons in the area of medicine (Schmidt, Boshuizen, & Hobus, 1988). Intermediate students not only recall more propositions than novices but typically they also recall more than experts. The intermediate effect can be characterized as a time stage in the development of expertise. Arts et al. (2000) reproduced this effect in a large study involving more than hundred subjects with wide ranging levels of expertise. This study confirmed their hypothesis that the nature of expertise development in management resembles expertise development in other professional domains when investigating recall.

In a second series of studies they aimed to assess the transition from management education to the managerial workplace (Arts, Gijselaers, & Boshuizen, 2003). They questioned the idea that graduate students are capable to connect acquired managerial knowledge and skills with what is called for by managerial problem situations. Arts presented his subjects (ranging from one week experience as management student till more than 25 years postgraduate professional experience) typical problem situations as may be found in managerial practice. Next to assessment of recall, he analysed both the production of managerial diagnoses and managerial solutions. Although providing a problem solution is a cognitive different activity while making a problem diagnosis, research most often does not distinguish between these two activities (Eraut, 1994). In this particular study, a case diagnosis was considered as accurate when it included all elements of the case diagnosis in the canonical case model. A case solution was defined as providing directions or decisions for further action. Problem diagnosis requires analytic activities, while solution providing is rather a synthetic activity.
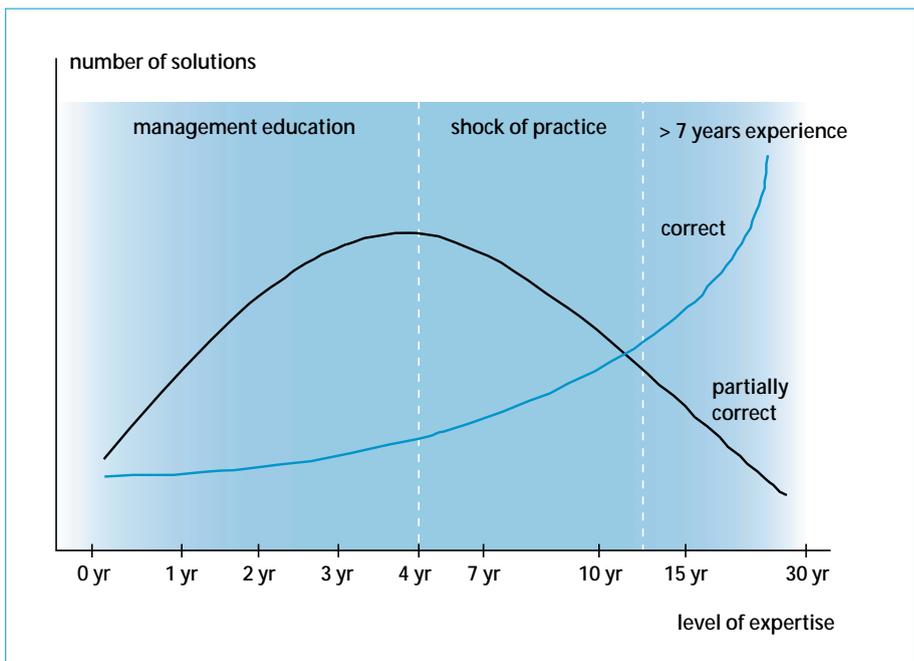

Figure 1   Number of solutions as a function of level of expertise (Adapted from Arts, Gijselaers, & Boshuizen, 2003)

Arts made a distinction between correct solutions and partial correct solutions. A case solution was considered as accurate ('correct') when it included most elements of the solution in the canonical case solution. A case solution was considered as incorrect when it contained hardly any elements of the canonical case solution. Figure 1 contains the results from Arts' study with respect to the production of solutions. Arts found three typical stages in the development of managerial expertise. In the first stage the mean number of partially correct solutions keeps growing and reaches a maximum at the level of intermediate students. Meanwhile, the number of correct solutions increases only slightly. In the second stage, after graduation, the average number of correct solutions increases strongly. Once the subject groups enter professional practice, the ability of making correct solutions grows strongly while at the same time the number of partially correct solutions decreases sharply. It seems that as from the moment of graduation, the production of correct and partially correct solutions makes a trade-off. Experts enter a third stage after at least more than 10 years experience in professional practice. At this point the mean number of correct solutions surpasses the number of partially correct solutions. Concerning the production of diagnoses he found different effects. The production of correct diagnoses was linearly related to level of expertise, while production of incorrect diagnoses showed a sharp decrease after three years of management education.

The results from Arts's study suggest that graduate students enter a stage which may be described as 'shock of practice'. Even although management students learned to diagnose managerial problem situations in a correct way, this doesn't necessarily imply they are capable to produce a correct solution. Figure 1 suggests that after graduation, students enter a period of relearning managerial knowledge enabling them to establish a connection between what is called for by managerial practice and required managerial knowledge and skills. These results confirm the previous mentioned criticism on management education "that graduates are not prepared to frame work situations in ways that the workplace is calling for. Even although graduates may possess certain management skills, the key issue is that they don't recognize that certain situations require those skills."

The study conducted by Arts (2003) shows that there seems to be a problem with the transition from the "academic workplace" to the "professional workplace." Arts found that the major problem is not whether students acquired sufficient academic knowledge and skills, but whether they are capable to relate academic knowledge with demands set by the managerial or professional workplace. Arts contends that producing a diagnosis is a largely analytical activity, whereas producing a solution is a more creative activity, which demands extensive knowledge on how to assess and interpret the context of the managerial problem.

Research on transfer of knowledge within or between team learning

While the work of Arts and his co-workers focused on acquisition of knowledge within individuals, a growing body of studies is becoming available on how teams acquire and share knowledge. Research on managerial cognition suggests that managers' mental models are influencing the decisions they make (Walsh, 1995). It is assumed that mental models can operate on the group level. Typical terms are shared cognition, team mental model, collective cognitive map or dominant logic. Shared cognition refers to agreement or overlap among individual team members' mental models of strategy. Knight and his co-workers (1999) contend that shared cognition doesn't necessarily imply a deliberative consensus-seeking process.

Research on strategic decision-making in teams has focused on social interaction patterns (Amason, 1996; Forbes & Milliken, 1998; Simons, Pelled, & Smith, 1999), the influence of demographic diversity on group processes (Knight et al., 1999), or cognitive diversity and firm performance (Miller et al., 1998). These studies attempt to identify variables determining cognitive capabilities of (top) management teams and the interactive processes through which teams produce their decisions. Amason (1996) shows for example that a typical outcome of these studies is that top management teams with diverse cognitive capabilities make more high-quality decisions when solving complex managerial problems than teams with less diverse capabilities. However, a growing number of studies has been published showing that although diverse teams have a lot of potential – as compared to homogenous teams – research is inconsistent whether diverse teams are more creative, generate more and better alternatives to problems, and generate more and better criteria for evaluating alternatives. Distefano and Maznevski (2000) argue that a review on multicultural teams shows diverse teams outperformed homogenous teams; they found only one study where the homogenous team equalled the diverse team. At the same time they mention anecdotal evidence that in some case diverse teams perform better than homogenous teams. Similar concerns have been expressed in the Strategic Management Journal. For example, research by Miller et al. (1998) shows that contrary to common assumptions of researchers and executives of strategic planning, diversity among upper-echelon executives inhibits rather than promotes comprehensive examinations of current opportunities and threats. McNeese (2000) found similar results while analysing the effects of working in dyads as compared to individuals. He argues that the value of learning groups is often overstated and granted for different types of problems. In his view working in teams on ambiguous or complex problems requires more than knowledge alone. He found that individuals working on complex problems outperformed dyads. But a secondary data analyses showed that in those cases where dyads got engaged in meta-cognitive activities did better at solving the most complex

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elements of the problem. McNeese (2000) concluded that cognitive benefits accrue from dyads when people 'naturally' work together. He argues that cooperative learning groups are quite dependent on meta-cognitive strategies to come to a solution. Socio-cognitive factors mediated problem solving and learning. He concluded that "the social construction of knowledge is highly dependent on being situated within a perceptual context and having the cognitive benefits of working with others." In particular whether dyads were capable to establish non-dominant working relationships, seemed to determine whether the potentials of team learning were realized.

Related research by Knight et al. (1999) found similar results for Top Management Teams (TMTs). They investigated the effects of team diversity on group processes and strategic consensus. Again, the basic assumption in business research is that diversity in groups and teams is often portrayed as a positive force leading to effective functioning of the team. Their results showed that demographic diversity is negatively related to consensus, that functional diversity increases the potential for interpersonal conflict – which in turn negatively influences agreement seeking. Finally, it was found that group processes play an important role in shaping a manager's mental model of his firm's strategy. It was found that team members perceived group processes differently due to differences in experience, adherence to different values about how teams should operate, and how interpersonal conflict should be handled. One of the most striking results was that functional diversity (which is equal to differences in academic knowledge) and educational diversity (differences in the number of years of postsecondary education across team members) were negative on team consensus.

The research cited in this section illustrates a large number of recent studies as has been reviewed in journals like Organization Science and Organizational Dynamics. Current insights from the field of management sciences show that knowledge sharing within teams or between teams is not taken for granted. Quality of team work is to large extent determined by members capability to reflect on perceptions of power and interpersonal risk. Psychological safety is commonly mentioned as a basic and essential requirement before any claimed potential of team work may be realized. Availability of knowledge and skills follows the capacity of individuals to build a team.

Transfer of knowledge reconsidered

The changing nature of business problems and the profound changes in market competition, require new skills of professionals in business organisation. The central role that information technologies play in business, innovation and creativity places a high premium on developing substantial competitive advantage. This has resulted in the recognition and appreciation of the importance of managing intellectual capital in companies.

Kirschner, Segers, Boshuizen, and Gijselaers (2001) argue that teams play a central role in both developing new knowledge and in sharing existing knowledge in order to meet the demand of delivering new products on the market as quickly as possible. But, as was argued in the present paper teams encounter a number of difficulties while working on complex or ambiguous problems. Kirschner, Segers, Boshuizen and Gijselaers (2001) conclude that it seems clear that powerful information technology should incorporate how these social variables affect teams involved in complex problem solving. Therefore, research is necessary examining what type of (IT) tools need to be developed to facilitate mutual understanding and mutual agreement, activation of existing knowledge (for making explicit tacit knowledge), communication (for accumulating and updating common ground) and envisioning (deciding what to do).

From the research cited in this paper, it may be concluded that assumptions about the alleged benefits of team learning in business organizations sound rather naïve. Organizational learning is not automatically fostered by engaging individuals in diverse teams to enhance decision making. Expectations have not been met given the inconsistent research outcomes on this issue. However, some studies indicate that potentials of teams may be realized if more attention is paid to socio-cognitive determinants. A particular role seems to be played by factors dealing with "psychological safety". That is whether individuals feel free to communicate with others. Although this may look like "grandmothers' wisdom", research has also shown that creating an atmosphere of psychological safety is partly dependent on interpersonal competencies and – last but not least90knowledge. Differences in knowledge explain to a large extent how managers "read" information from the environment and how they are capable to communicate with others in teams. Unfortunately, research on the role of managerial knowledge with respect to transfer of knowledge in teams is still scarcely available. Drawing on the importance of transfer of knowledge, we also questioned the traditional view of knowledge management. It looks like we are using the wrong terminology, because in practice knowledge management basically refers to infor-mation management. Connecting insights from knowledge management with research on knowledge development is necessary to get a better understanding of how diverse team may improve decision making and transfer knowledge within or between teams. There is much work to do. In particular Educational Sciences should pay more attention on this type of research given their extensive research body on cooperative learning and expertise development. Therefore it seems unforgivable that this discipline has so far shown only minor interest in this type of research questions. Education is about learning, and it doesn't matter whether many learning events take place outside institutionalised educational settings called "schools."

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Researchers from the Open Universiteit Nederland and Universiteit Maastricht have recognized that knowledge management is not only an issue of systematically managing that knowledge is connected and communicated to work on certain complex or ambiguous problems. They realized that the difficulties teams are facing while working on these problems is a function of the nature of knowledge required, features of the problems addressed by a team, and social factors. They also understood that research on expertise development singled out any study on how groups exchange knowledge and develop expertise to function in a viable way. For that purpose a research proposal was submitted to (and granted by) the Dutch Science Foundation addressing the role of socio-cognitive factors in team learning facilitated by information technology. Over the past two years, Boshuizen, Kirschner, Segers and Gijselaers serving as supervisors of two PhD researchers (Open Universiteit Nederland and Universiteit Maastricht) have learned that to build a learning community for research, it is necessary to band together and test the premises we use to assist others in their learning. Boshuizen's work on expertise development played a prominent role in crafting this project on multi-professional team learning. The other researchers provided input on the additional factors that play a significant role on team learning. This paper was written in this spirit and aims to be of genuine service to those seeking to learn.

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