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Learners in a Changing Learning Landscape: Reflections from an Instructional Design Perspective

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Abstract

Both learners and teachers find themselves in a learning landscape that is rapidly changing, along with fast societal and technological developments. This paper discusses the new learning landscape from an instructional design perspective. First, with regard to what is learned, people more than ever need flexible problem-solving and reasoning skills allowing them to deal with new, unfamiliar problem situations in their professional and everyday life. Second, with regard to the context in which learning takes place, learning in technology-rich, informal and professional 24/7 settings is becoming general practice. And third, with regard to the learners themselves, they can more often be characterized as lifelong learners who are mature, bring relevant prior knowledge, and have very heterogeneous expectations and perceptions of learning. High-quality instructional design research should focus on the question which instructional methods and media-method combinations are effective, efficient and appealing in this new learning landscape. Some innovative instructional methods that meet this requirement are discussed.

Both learners and teachers find themselves in a learning landscape that is constantly and dramatically changing in terms of the modalities through which people learn, the purposes for which they learn, and the context in which learning acquires its meaning. This chapter reflects on this phenomenon from an instructional design perspective. Instructional designers, on the basis of studying learning as a natural human drive, try to construct or select instructional methods in the attempt to make learning effective, efficient, and appealing under specified circumstances. They typically do so on the basis of an analysis of, among others, what ought to be learned, in which context or under which conditions it is learned, and by whom it is learned. Researchers in the field of instructional design carefully investigate the conditions under which particular methods yield desired effects and organize those methods in instructional design models or theories. In this chapter, we will first sketch the new learning landscape in terms of changes in contents, changes in contexts, and changes in learners. Then, we will briefly discuss the implications for selecting instructional methods, that is, the implications for the field of instructional design.

Changing what is Learned

In order to deal with rapid societal and technological changes, people more than ever need problem-solving and reasoning skills that allow them to deal with new, unfamiliar situations in their professional and everyday life. This focus on complex skills or professional competencies implies the integration of knowledge, skills, and attitudes in such a way that transfer of learning is enhanced. Thus, learning is no longer primarily about reaching specific learning objectives, but about the ability to flexibly apply what has been learned in new problem situations.

These changes determine a shift away from the traditional instructional design paradigm, which can be defined along the following five dimensions: (a) from well-structured towards ill-structured problems; (b) from domain-specific towards domain-general competencies; (c) from cognitive towards metacognitive processes; (d) from 'expert-novice' towards 'expert-expert' performance mappings, and (e) from specific learning objectives towards authentic reference situations. Instructional design typically begins with defining learning outcomes, then identifies the cognitive processes and structures involved in achieving these outcomes, determines the relevant methods and techniques to activate these cognitive and personality dispositions, and finally measures the effects of the instructional arrangements according to particular criteria. Defining learning outcomes is related to analyzing possible reference situations for a particular educational program, which contains a set of ill-structured problems. This means confronting learners with authentic real-life situations and constructing a set of ill-structured learning tasks representing these situations. The question, however, is not only to involve learners in solving ill-structured problems but also to provide them with necessary and sufficient operational support, which is matched to the individual needs and preferences of learners. Learning to cope with ill-structured learning tasks requires not only domain-specific knowledge and skills but also domain-general competences. Domain-general competences are based on metacognitive strategies that operate on the cognitive structure and processes, which themselves are bound up with domain-specific knowledge and skills. Observing and comparing the performances of high profile professionals provides valuable information for the ways these experts behave in ill-structured problem situations, which can be used for modeling instruction in the most effective way.

The direction in the five dimensions is an attempt of the instructional design paradigm to react adequately to the scale, rate and dynamicity of the changes that the society is experiencing nowadays (see J. Visser's argumentation on the nature of change, this book, pp. xx-xx). With regard to the five dimensions, it should be clear that the changes along the dimensions imply an extension rather than a replacement, the poles are inclusive rather than exclusive. Thus, whereas ill-structured problems become increasingly important, this does *not* imply that well-structured problems are of no interest to the field of instructional design anymore. Ill-structured situations contain some routine or recurrent procedures as well. They are important pre-conditions for handling complex, non-routine skills. The same argumentation emphasizing on inclusiveness rather than exclusiveness applies for the other four dimensions. Furthermore, the 'novel' poles of the dimension are not new in the sense that they have never been studied before. But they do have the highest priority in order to address current societal and technological developments. The following sections briefly explore each of the five change dimensions in the instructional design paradigm.

From well-structured to ill-structured problems

The capability of solving problems is widely recognized as the most important competence that students should acquire to behave adequately in various professional contexts (Ge & Land, 2004; Jonassen, 2004; Merrill, 2002). Current theories of problem solving mostly reflect the results of research conducted on well-structured problems, while "...ill-structured problems are ill understood" (Pretz, Naples, & Sternberg, 2003, p. 9). The focus on ill-structured problems is determined by the new challenges, which the society faces nowadays (see J. Visser's argumentation for the new societal and technological problems, challenges and opportunities, this book, pp. xx-xx). Ill-structured problems are characterized by the availability of incomplete data or insufficient access to information; the existence of alternative and often conflicting approaches; the lack of a clear-cut problem-solving procedure; no agreement on what can be accepted as an appropriate solution, and a solution that may not always be recognizable as such (Jonassen, 2004; Schön, 1996). Another distinguishing feature of ill-structured problem solving is the combination of multi-contextual influences and dynamics of uncertainty (Mirel, 2004). Often, the problem solver has to take different perspectives on a problem before finding one that gives insights into viable solution paths (Pretz, Naples, & Sternberg, 2003).

Recent research points out that different intellectual skills are needed for solving well-structured problems, which rely on *applicative* or recurrent skills that are highly domain-specific, and ill-structured problems, which rely not only on applicative but also on *interpretive* or non-recurrent skills that are less domain-specific (Cho & Jonassen, 2002; Hong, Jonassen, & McGee, 2003; van Merriënboer, 1997). In this respect, the meaning of domain-specific and domain-general competencies is also changing because the combination of both is needed to solve ill-structured problems.

From domain-specific to domain-general competencies

Domain-specific knowledge, skills, and attitudes are a substantial part of professional competence. But sometimes they are not sufficient for adequately responding to the challenges posed by ill-structured problem situations. Then, another type of competencies is required to manage the problem-solving process, in particular, the analysis of the problem situation, the generation of alternative solutions, the selection of the most appropriate solution for the given situation, and its implementation into practice. Pretz, Naples and Sternberg (2003) describe these domain-general competencies as 'metacognitive' components of professional competence. This is indicated by the fact that these components emphasize the regulation, monitoring, and control of problem-solving activities to make the best use of technical, domain-specific knowledge and skills (Chambres, Izaute, & Marescaux, 2002; Metcalfe & Shimamura, 1996; Zimmerman & Campillo, 2003).

Domain-general competencies may prevent the negative effects of *functional fixedness* (Davidson, 2003; De Bono, 1990; Gick & Holyoak, 1983; Holyoak & Thagard, 1995; Keane, 1997; Weisberg & Alba, 1981) and *analysis-paralysis* (von Wodtke, 1993), which are often present in ill-structured problem solving. Functional fixedness reflects the hindering effect of past experiences on problem solving, emphasizing the negative role of a problem-solving strategy that works well for certain tasks, but not for other tasks. When functionally fixed, people tend to look for existing solutions and easily jump to conclusions, completely ignoring the opportunity to identify better solutions. Analysis-paralysis is the tendency to spend unlimited time on analyzing the problem situation and generating ideas, with an inability to select among alternative solutions, draw conclusions, and plan the next steps in the problem-solving process. In an experimental study, conducted recently, we found that domain-general problem solving support generated a significant difference in the problem-solving production of people confronted with an ill-structured situation. The data also provided evidence that the domain-general type of support applying brainstorming with a remote and postponed reference to the problem was more effective in producing qualitative better solutions (originality) than brainstorming with a direct reference to the problem type of support. No significant difference between the two types of problem solving domain-general support was found in relation to the number of ideas (fluency), although mean figures of the brainstorming with a direct reference to the problem were higher (Stoyanov & Kirschner, submitted) .

The results of this study can be explained by different cognitive processes that underlie domain-specific and domain-general problem solving competencies. The next section focuses on these structures and processes while paying special attention to “the paradox of knowledge structure”.

From cognitive to metacognitive processes

Most research on problem solving refers to the limited capacity of working memory as the most important cognitive factor to deal with (Hambrick & Engle, 2003; Kirschner, 2002; Paas, Renkl, & Sweller, 2004; van Merriënboer & Sweller, 2005). However, several cognitive theories emphasize the crucial role of long-term memory as well (Ericsson & Kintsch, 2005; Lubart & Mouchiroud, 2003; Robertson, 2001; Wenke & Frensch, 2003). Whereas long-term memory may be unlimited in terms of storing information elements, the retrieval of relevant information elements may cause problems in ill-structured problem-solving situations. Then, the information might actually be available but not be accessible, which affects problem-solving performance of both novices and experts. Most of the issues related to the role of long-term memory in ill-structured problem situations and the negative problem solving effects such as functional fixedness, dominant thinking patterns, routine expertise, and negative transfer, can be explained by the “paradox of knowledge structure”. A recent study provided empirical evidence for the existence of this phenomenon (Stoyanov & Kirschner, submitted). The “paradox of knowledge structure” states that the structure of knowledge both enables and restricts ill-structured problem solving. Knowledge organizes itself in knowledge structures (patterns, schemas), which are absolutely necessary for successful problem solving. They are easy recognizable, repeatable, give rise to expectancy, provide useful short-cuts to the solutions, and offer a platform for interpreting incoming information and communicating new solutions.

Knowledge structures, however, may have a detrimental effect that hinder problem solving, especially in ill-structured situations. A knowledge structure can establish a dominance, which forces the problem solver to see and follow only one path and not be aware of other possibilities (Anderson, 1983; De Bono, 1990; Qullian, 1988). People tend to quickly pick and apply a dominant problem-solving schema without investigating the problem situation for possible alternative solutions. Because of that, individuals are prone to select an inappropriate schema. Once a knowledge structure presents itself, the tendency is for it to get larger and more firmly established. This makes it very difficult to break off and jump into an alternative line. A person with insufficient knowledge structures might be unable to look at the information in a meaningful way but a person with strong knowledge structures might not be able to look at the information in a new way. .

Recent research on experts' problem solving performance in ill-structured situations emphasizes the crucial role of meta-cognitive knowledge and strategies for regulation, monitoring and control of problem solving activities, which could prevent the negative effects of the "paradox of knowledge structure" (Jonassen, 2004; Pretz, Naples and Sternberg, 2003; Zimmerman and Campillo, 2003). Metacognitive processes operate on the internal representations of the problem solver, such as cognitive schemas, mental models, and plans. Metacognition emphasizes two essential functions: self-management and self-appraisal (Paris & Winograd, 1990). Self-management refers to 'metacognition in action', that is, operational support of problem solving in terms of analysis of the problem situation, idea generation, idea selection, and solution implementation. Self-appraisal refers to self-reflections on cognitive and affective processes in a problem-solving situation. Awareness about the existence of the "paradox of knowledge structure" is metacognitive knowledge. The next step is successfully managing this phenomenon: promoting the enabling part and suppressing the restricting part.

Studies on expertise provide evidence that the "paradox of knowledge structure" should be attributed to not only novices but to the high profile professionals as well (Ericsson and Kintsch, 1995; Ericsson, 2003; Holyoak, 1991). High levels of domain knowledge can sometimes be an impediment to problem solving limiting the search space to readily available ideas.

From expert-novice to expert-expert mappings

Research on expert-novice differences has been very fruitful to determine cognitive factors that play a role in the acquisition of expertise (Chase & Simon, 1973; Chi, Feltovich, & Glaser, 1981; De Groot & Gobet, 1996; Frensch & Sternberg, 1989). Comparing the performances of experts in different professional domains are valuable tasks as well (see Ericsson, 2003; Ericsson & Charness, 1994). Holyoak (1991) identified issues in expert performance that cannot easily be explained by findings from classical novice-expert research: Experts do not always easily accomplish what novices accomplish with difficulties; expert search strategies are extremely varied and often opportunistic; expert performance does not show continuous improvement with practice; knowledge can sometimes be transferred across domains; the teaching of expert rules often does not lead to expertise; expertise depends on induction, retrieval, and instantiation of schematic knowledge structures rather than the acquisition and use of highly specific production rules, and skilled performance depends on the parallel integration of multiple sources of information rather than serial information processing.

It has become clear that not only novices but also experts need specific support to improve their performance (Stoyanov & Kirschner, 2004). Investigating what makes one expert better than another expert in ill-structured problem situations is a valuable research target in the field of learning and instruction. Such research may identify specific skills and underlying cognitive and metacognitive processes, such as factors related to 'deliberate practice' (Ericsson, 2003), which may have important consequences for instructional design.

From learning objectives to authentic reference situations

The formulation of learning objectives has always been a critical part of the instructional design process. Traditional design models analyze a learning domain in terms of distinct objectives, after which instructional methods are selected for reaching each of the separate objectives. This often yields instruction that is fragmented and piecemeal (Van Merriënboer, Clark, & de Croock, 2002). Holistic design models stress the importance of highly integrated sets of objectives, and reference situations are used to ask the learner to demonstrate that such an integrated set of objectives has been reached. The real-life reference situation puts learning objectives in a broader context and makes them meaningful. Integrated sets of objectives should thus be formulated as a reference to real-life contexts, in which learners have to apply their acquired knowledge, skills, and attitudes to perform authentic tasks, thus promoting far transfer.

To conclude this section, it is important to stress that developments in “what is learned” must have clear implications for instruction. Nowadays, there is an increasing emphasis on whole, meaningful learning tasks as the driving force for learning (Merrill, 2002; van Merriënboer & Sweller, 2005). Instructional methods primarily pertain to experiential learning in real or simulated task environments, and include the design of learning tasks or learning experiences, the sequencing of those experiences, and ways to scaffold the learning process (see van Merriënboer, Kirschner, & Kester, 2003). As a rule, the learning tasks are ill structured and allow for several acceptable solutions. They make a strong appeal to domain-general skills that sustain problem solving and reasoning. Problem sequencing and scaffolding help learners to develop expert approaches, which also ask for “metacognitive” skills that allow for independent learning, such as information problem solving, self-assessment and self-regulation skills, and learning-to-learn. And finally, assessment of complex task performance is not based on distinct learning objectives but on the learner's ability to integrate knowledge, skills, and attitudes in such a way that real-life problems are effectively dealt with in a specified set of reference situations.

Changing Contexts

In addition to changes in what is learned, there are also major changes in the contexts in which learning nowadays occurs. Time- and place-independent learning in technology-rich, informal and professional settings is becoming general practice. Maybe even more important, modern society and education are developing from a production economy to a service economy, where educational services are available on-demand and customized for the individual learner (‘mass individualization’). These changes in context have important implications for our thinking about the delicate relationship between instruction and technology, or, methods and media.

Time and place-independent learning

Changing contexts result, among others, from new technologies that allow for time- and place-independent learning. In modern societies, people have 24-hour opportunities to connect to other people and to vast information resources through mobile phones, MP3 players, Personal Digital Assistants, laptop computers, and devices for ubiquitous computing, ambient intelligence, and augmented intelligence. These technologies have built-in affordances that allow for the realization of many instructional methods that sustain a wide range of different types of learning. The conspicuous consequences are that people learn more and more in out-of-school contexts, at all stages in their life (‘lifelong learning’), and in ever-changing, highly heterogeneous groups of learners.

With regard to learning outside school, there is a remarkable increase of learning activities in informal and in professional settings. There are at least three causes for this phenomenon. First, as already discussed above, the combination of professional and domain-general competencies is becoming increasingly important in our society. Real-life settings are indispensable for learning those competencies (Merrill, 2002). Second, due to fast technological and societal changes, domain-specific knowledge and skills are quickly becoming obsolete. Thus, there is an obvious need to regularly update those knowledge and skills and learn outside school. Third, learning outside school is facilitated by the availability of new technologies, which enable learners to study materials, consult others, and discuss with peers anywhere, anytime.

A strongly related issue is the upsurge of lifelong learning, reflecting the idea that it is never too soon or too late for learning. Lifelong learning, often in non-formal settings, is becoming a necessity to survive in a society in which jobs and technologies quickly change. The idea of informal life-long learning is very close conceptually to the definition of learning as a natural drive and a human disposition towards adapting to the constantly changing environment (see definition of learning and four level of adaptive behavior in J. Visser, this book xx-xx). Learning is becoming a constant attribute of personal human life, not only for adapting but also for pleasure, satisfying curiosity, and in terms of Maslow (1970) self-actualization and self-fulfillment. Instructional design focuses more on creating conditions in formal educational settings for enhancing life-long learning, as informal activity, to accomplish personal aspirations and social goals in the most effective and efficient way. This raises new questions for the field of education and instructional design (European Commission, 2000). Some research questions are directly related to changes in what is learned and changes in contexts, for instance, *which new competencies are needed for lifelong learning?* (new basic skills) and *how can new technologies help to realize time- and place-independent lifelong learning?* (ICT tools). Other questions are related to necessary changes in instructional methods, such as *which new instructional methods are suitable to sustain lifelong learning?* (learning innovations) and *how should lifelong learners be given proper help and advice?* (guidance). Finally, new research questions pertain to societal and organizational changes, such as *how can be ensured that people have time and means for lifelong learning?* (human resource development) and *how can lifelong learning be valued and reinforced by organizations and the society at large?* (valuing learning).

With regard to groups in which learning takes place, there are also major changes. Rather than participating in one-and-the-same year group for a relatively long period of time, learners increasingly participate in more than one learning network, and the composition of those networks continuously changes. The typical composition of such learning networks is heterogeneous, including learners with different cultural and professional backgrounds, prior knowledge, and learning goals. In addition, rather than one teacher there may be several people in the network taking roles related to teaching, such as a tutor-role, an expert-role, a coaching-role, and so forth. Probably the most conspicuous development is that learning networks are often virtual. For instance, they may take the form of web-based learning communities. Wenger (1998) discusses learning communities as one kind of "community of practice", which is a social construct that places learning in the "...context of our lived experience of participation in the world" (p. 3). Web-based learning communities and communities of practice are sometimes seen as a new paradigm for learning in the 21st century. Interesting enough, this development into the direction of communities goes hand in hand with a further development of individualized and personalized instruction.

On-demand education

In the last decades, new technologies technically enabled the individualization of instruction. Nevertheless, up until now individualization in education has not been very successful because highly individualized learning trajectories can only be realized if the number of *possible* trajectories is very large. Thus, there is the need to develop a large amount of learning tasks and instructional materials beforehand in order to make individualization possible – and this threatens its cost effectiveness. Only since the upsurge of Web technologies it has become possible to develop instruction for very large target groups. And thanks to the combination of technologies and large groups individualization is now not only technically feasible, but also becoming cost-effective. This process is known as 'mass individualization' or 'mass customization', and may be expected to yield an enormous increase in the flexibility of education (Schellekens, Paas, & van Merriënboer, 2003). Traditional mass media (books, television, radio) are more and more intertwined and replaced with personalized media that provide adaptive online learning, that is, information and support that is tailored to the particular needs and preferences of individual users and learners.

Salden, Paas and van Merriënboer (in press; see also van Merriënboer & Luursema, 1996) discuss adaptive online learning with a focus on the dynamic selection of learning tasks. They describe adaptive learning as a straightforward two-step cycle: (1) assessment of learner characteristics, and (2) the selection of learning tasks of a particular difficulty and a particular level of provided support. Three types of models can be distinguished. In system-controlled models, some educational agent (teacher, online learning application) selects the optimal learning task, for a particular learner, from all available tasks. In shared responsibility models, some educational agent selects a suitable subset of learning tasks, for a particular learner, from all available tasks, after which the learner makes, on-demand, a final selection from this subset. Thus, there is partial system control (i.e., selecting the subset) and partial learner control (i.e., selecting the final task). In on-demand advisory models, an educational agent may or may not select a suitable subset of tasks, but the learner is advised on his or her selection of the next task to work on.

With regard to system-controlled models, Kalyuga and Sweller (2005) conducted a study in the domain of algebra in which both the level of difficulty and the given support for the next task were adapted to the mental efficiency of the learner. In the adaptive group, learners were presented with algebra tasks at three different difficulty levels. If their cognitive efficiency was negative for tasks at the lowest level, they continued with the study of worked examples; if their cognitive efficiency was positive for tasks at the lowest level but negative for tasks at the second level, they continued with simple completion tasks (i.e., they had to complete a partially given solution); if their cognitive efficiency was positive for tasks at the lowest and second level but negative for tasks at the third level, they continued with difficult completion tasks, and, finally, if their cognitive efficiency was positive for tasks at all three levels, they continued with conventional problems. Each learner in the adaptive condition was paired to a learner in the control condition, who served as a yoked control. As expected, higher gains in algebraic skills from pre-test to post-test and higher gains in cognitive efficiency were found for the adaptive group than for the control group.

A drawback of system-controlled models is that (1) learners have no opportunity to learn how to select their own learning tasks and plan their own learning, and (2) the lack of any freedom of choice over tasks may negatively affect learners' motivation.. With regard to the first point, a gradual transfer of responsibility over task selection from the system to the learner, as his or her self-regulation skills further develop, may be desirable. A first pilot study has been conducted to compare a system-controlled model with a shared-responsibility model on motivation/interest and learning outcomes (Corbalan, Kester, & van Merriënboer, in press). Results show that learners in the shared-responsibility group report, have as expected, a higher interest in the training and also tend to outperform learners in the system-controlled group. With regard to the second point, research indicates that *some* freedom of choice indeed has positive effects on motivation, but *too much* freedom may lead to stress, high mental effort, and demotivation (Iyengar & Lepper, 2000; Schwartz, 2004). Thus, a shared-responsibility model in which the system makes a pre-selection of suitable tasks, and the learner makes the final selection, is expected to be superior to a completely free on-demand model in which the learner has to select one task from a very large set of available tasks.

Finally, advisory on-demand models may or may not make a pre-selection of tasks but give learners advice on the task-selection process. They explicitly help learners to apply cognitive strategies for assessing their own performance and keeping the scores in a so-called *development portfolio*, for interpreting evaluation results of their performances, for matching evaluation results with the qualities of available learning tasks, for making an informed selection from those tasks, for planning their own work on those learning tasks, and so forth. First, an effective model provides heuristic 'rules-of-thumb' rather than algorithmic rules. This forces learners to reflect on their performance and may facilitate transfer to other learning domains and educational settings. Second, an effective model takes explicated strategies rather than feedback principles as a basis. This may help learners to develop cognitive strategies for regulating their own learning (Kicken, Brand-Gruwel, & van Merriënboer, 2005).

Technology vs. instruction

New technologies set high expectations. But in the field of education, they typically failed to live up the expectations. For instance, radio, television and even microcomputers did not greatly affect teaching practices in schools.(Clark, 1994; Kozma, 1994; Russell, 2001; WCET, 2006). Internet research agency Gartner group (2002) identified a Hype Cycle representing the maturity, adoption and application of specific technologies, including learning technologies. The Hype Cycle consists of five phases: (1) technology trigger, (2) peak of inflated expectations, (3) disillusionment, (4) slope of enlightenment, and (5) plateau of productivity. Most if not all of the technologies applied for educational purposes go through these stages. But the sad reality is that up until now, most of the learning technologies never reached the final two stages. Some authors argue that this is due to the fact that hardware and software issues have overshadowed more important people issues (Constantine, 2001; Kuniavsky, 2003, Holtzblatt, Wendell, & Wood, 2005). Nowadays, a shift toward people issues can be observed in the use-case movement, contextual design, and scenario building – but probably the most remarkable achievement is the concept of *peopleware* (Constantine, 2001; De Marco & Lister, 1999), which includes the whole range of people issues from gathering user experiences to managing teams of designers.

"Good software does not come from use-case tools, visual programming, rapid prototyping, or object technology. Good software comes from people. So does bad software" (Constantine, 2001, p. xvii). The main difficulty in designing software applications for educational and training purposes is conceptual and not technological in nature. The potential added value is not in the new technology or medium itself, but in their combination with appropriate instructional methods. New technologies and media are neither the problem nor the solution for instructional design. The promise that new technologies and media are a panacea for problems in the field of learning and instruction merely generates a feeling of "deja vu all over again". Online learning is neither good nor bad. As indicated by Mike Spector in this book, combined with the wrong methods "…online learning is as an alien ritual performed by people wearing masks." Only combined with appropriate instructional methods it may add value to learning.

Related to the Hype Cycle is the ongoing debate on the so-called non-significant effect of technology on learning (Clark, 1994; Kozma, 1994; Russell, 2001; WCET, 2006). Have new technologies a positive impact on learning or not? Too often, researchers have tried to answer this question without taking instructional methods into account (e.g., is learning from the computer screen better than learning from a book?). A better approach might be to study the conditions under which particular media-method combinations have an effect on learning, including not only a broad range of learning outcomes (recall, application, transfer) but also invested time, mental effort, and satisfaction. Then, it will probably show that 'high tech' in learning does not necessarily lead to positive effects. In contrast, it is the 'high touch' that makes the difference: The amount of personal attention, involvement and interaction are key and technology, whether high tech or low tech, must be placed in their service (Spitzer, 2002).

To conclude this section, contextual changes clearly affect the use of instructional methods. On the one hand, online learning makes experiential learning in simulated task environments only possible to a certain degree. That is, it should be perfectly clear that online learning alone would never be sufficient to educate medical doctors, who need to practice with patients of flesh and blood; lawyers, who need to practice in real court yards; or carpenters, who need to practice with real wood and tools. But, on the other hand, more and more instructional methods can be realized in online tools and mobile devices, and new media-method combinations emerge with their own specific affordances. For instance, methods that stimulate learners to construct knowledge may use the interactive possibilities of hypermedia; methods that help learners to learn from each other may take form in web-based learning communities, and methods that aim at the just-in-time provision of information during professional task performance may take advantage of mobile technologies (e.g., presenting operating instructions on-demand on a mobile phone, PDA, or augmented reality glasses). Furthermore, the selection of instructional methods will no longer be based on the general characteristics of a whole “target group” but on the specific characteristics of an individual learner.

Changing Learners

This brings us to the topic of the changing learner. At an abstract level, it is tempting to describe the emergence of the ‘online learner,’ a new species who is directing her or his own learning, who is focusing on the development of flexible problem-solving skills, who is having a rich mix of (online) media to his or her disposition, and who is expecting instruction that is fully tailored to his or her personal needs. But on the individual level, differences between individual learners may have far greater implications for the selection of instructional methods than the emergence of the so-called online learner. The following sections explore the implications for instruction of changes in learners’ age, prior knowledge and experience, and learning styles.

The older learner

Lifelong learning will evidently mean that more and more elderly people become involved in both formal and informal learning. A substantial body of research has demonstrated that cognitive aging is accompanied by a reduction of working-memory capacity, a general slowing of mental processes, and a decline of the ability to process irrelevant information. Van Gerven, Paas, van Merriënboer and Schmidt (2000) relate these phenomena to cognitive load theory (Sweller, van Merriënboer, & Paas, 1998; van Merriënboer & Sweller, 2005), the core idea of which is that working-memory capacity is limited and should therefore be managed with great care. The theory claims that this can be achieved by minimizing the level of so-called extraneous cognitive load, which is the portion of load that does not directly contribute to learning (e.g., because it is allocated to integrating information sources, searching for information, weak-method problem solving, etc.), and maximizing the level of germane cognitive load, which directly contributes to learning (e.g., constructing cognitive schemas, automation). Since instructions based on cognitive load theory deal with cognitive limitations in that they lead to an efficient use of the available resources, it can be hypothesized that they are especially effective when elderly people are involved.

A first set of studies tested this hypothesis by comparing learning by studying worked examples with learning by solving conventional problems (van Gerven, Paas, van Merriënboer, & Schmidt, 2002). According to cognitive load theory, novices in a domain learn more from studying worked examples than from solving the equivalent problems because the latter impose a high extraneous cognitive load. Due to the cognitive limitations of older learners, it is expected that the advantage of worked examples above conventional problems is even larger for them than for young learners. As predicted, the results of van Gerven et al. show that especially for older learners (above 60 years), who are novice in a domain, the efficiency of studying worked examples is higher than the efficiency of solving conventional problems, in that less training time and cognitive load leads to a comparable level of performance.

Another set of studies was specifically concerned with online learning (van Gerven, Paas, van Merriënboer, Hendriks, & Schmidt, 2003). Often online learning involves multimedia where learners study an animation or picture that is explained by a text. Such presentations can be either unimodal, when both animation/picture and the (written) text are presented visually, or multimodal, when the animation/picture is presented visually but the (spoken) text is presented auditory. Multimodal instruction is expected to be superior to unimodal instruction, because it uses both the visual and auditory subsystems of working memory and so increases the effectively available working-memory capacity. Furthermore, older learners are expected to profit more from multimodal instruction than younger learners. The results of van Gerven et al. indeed show an interaction of modality and age on cognitive load, indicating that older learners have a disproportional large advantage from the multimodal instruction. Summarizing, there is growing evidence that effective instructional methods for older online learners are different from effective methods for younger online learners, due to a significant decrease in working-memory capacity of the elderly.

The expert learner

Lifelong learning also implies that more and more learners are not novices in a particular learning domain, but are at various stages of expertise development. Recent research points out that this level of expertise is a major factor to be taken into account when selecting instructional methods. Kalyuga, Ayres, Chandler, and Sweller (2003) provide a review of research results on the 'expertise reversal effect', which indicates that instructional methods that are effective for low-expertise learners are often ineffective for high-expertise learners, and vice versa. For example, Kalyuga, Chandler, and Sweller (1998), using novices, demonstrated the so-called split-attention effect: Students presented diagrams and text in a format that separated the two sources of information learned less than students given materials that integrated the texts into the diagrams. Physical integration reduced the need for mental integration and reduced extraneous cognitive load. As levels of expertise increased, the difference between the separate and integrated conditions first disappeared and eventually reversed with the separate condition superior to the integrated condition. Indeed, rather than integrating the diagrams and text, totally eliminating the text was superior. The text had become redundant for these more expert learners.

Initially, using complete novices, both the diagrams and text were essential for learning. Under such conditions, extraneous cognitive load could be reduced by physically integrating the two sources of information in order to reduce the need for learners to mentally integrate them. Reducing the need for mental integration reduces extraneous cognitive load. As expertise increased, the textual explanations became less and less important. Eventually they were unnecessary, but if presented to learners with more experience in the area in an integrated format, they were hard to ignore. Processing such redundant information imposed an extraneous cognitive load reducing further learning. The redundancy effect had replaced the split-attention effect as expertise increased, providing an example of the expertise reversal effect.

Similar results were obtained by Yeung, Jin, and Sweller (1998) using purely textual materials. McNamara, Kintsch, Songer, and Kintsch (1996) found that low-knowledge learners benefited from additional explanatory text intended to increase coherence whereas high-knowledge individuals benefited most from the more sparse text. Kalyuga, Chandler, and Sweller (2000) found that among novices, dual mode, auditory/visual presentations were superior to visual only presentations, demonstrating the modality effect. With more experience, the auditory component became redundant and was best eliminated. Using novices Tuovinen and Sweller (1999), and Kalyuga, Chandler, Tuovinen, and Sweller (2001) demonstrated the worked example effect in which worked examples were superior to solving the equivalent problems. With increasing knowledge, the effect first disappeared and then reversed. Worked examples become redundant for more knowledgeable learners and so impose an extraneous cognitive load. All these examples of the expertise reversal effect have strong implications for the design of instruction and indicate that instructional methods for learners with relevant prior knowledge are different from methods for learners without relevant expertise.

The 'gaming generation'

A common claim is that young learners learn in new ways and have new conceptions and styles of learning. They would be better able to learn by trial-and-error, to seek helpful resources, to try out solutions, and so forth. This may be true for a subgroup of young learners, but research also points out that there are surprisingly large differences in students' perceptions of instructional methods and learning environments. For instance, Könings, Brand-Gruwel, and van Merriënboer (in press) studied the perceptions of young students (13-16 years of age) who were confronted with an educational innovation, characterized by the use of meaningful learning tasks, more independent learning, and individualization. Whereas some students perceived this innovation as desirable and an impetus for their learning, others perceived it as undesirable and not helpful at all for promoting their learning.

The differences in the perceptions of students can, among others, be a function of either their level of achievement (low vs. high) or their cognitive style. It is important to make a clear distinction between *level* (how much?) and *style* (in what way?) constructs. Level-type constructs are, for instance, abilities, knowledge, skills, and competencies. Style-type constructs are, for instance, learning styles and cognitive styles. Styles should also be distinguished from process constructs (e.g., learning or problem solving strategies). Actually, different levels and styles can be identified during different stages of a process. Style and behavior are not necessarily in agreement with each other. People are capable of behaving differently from their preferred style - but this is always at the expense of more invested effort, energy and time. In an experimental study on the effects of type of problem solving support and cognitive styles (innovator vs. adaptor) on ill-structured problem solving, we did not find a significant difference of the cognitive style for problem solving on the originality of ideas (Stoyanov & Kirschner, submitted). The results confirmed the hypothesis that styles are about preferences, not about level. Both cognitive styles were capable to generate original ideas, none of them was better than the another, but learners with different cognitive styles solved problems in different manners. It was the type of problem solving support that explained the substantial part of the variations in problem solving production. The same study supported the hypothesis related to coping behavior. The participants in the experiment performed equally well in both preferential and compensation conditions. Effective, efficient and flexible learning requires not only the application of learning strategies consonant with the preferred style, but also the ability to shift to less congenial learning styles when these are more effective in a particular situation.

Elaborating on these results, recently we started a project aimed at developing and testing an integrated instructional approach that combines two theoretical perspectives on adaptation: adapting instructional strategies to style (style-strategy interaction) and adapting them to achievement (achievement-strategy interaction). In the theoretical model of the study, learning style is defined according to the theoretical tradition that makes an extensive empirical validation to distinguish style, level, and process constructs (De Ciantis & Kirton, 1996; Honey & Mumford, 1992; Kirton, 2003). The integrated style-by-strategy/achievement-by-strategy approach will be tested against preferential adaptive approaches (i.e., chosen strategy is the preferred one for a student's style) as well as compensatory adaptive approaches (i.e., chosen strategy compensates for the weaknesses of the student's style). The integrated instructional approach supports students to build a learning strategy that is oriented towards learning to solve ill-structured problems. The learning resources are designed to accommodate the strong features of a particular learning style, to compensate for the weak characteristics of this style, and to continuously take the learner's level of performance into account.

To summarize, adapting instruction to learner's differences in achievement or differences in style have been considered as two confronting positions for a long time. But recent investigations show that it is possible and desirable to adapt instruction to the needs of individual learners by taking both their style and their achievement into account: Style-by-strategy and achievement-by-strategy interactions complement each other and should not be considered separately. This flexible approach allows instructional designers to develop adaptive instruction that is effective and appealing for many groups of learners, including the 'gaming generation'.

Discussion and Implications

The learning landscape is drastically changing in terms of what is learned, contexts in which learning takes place, and who is learning. The field of instructional design has to reflect these changes in its research agenda and propose adequate solutions. First of all, instructional designers must become *aware* of the major changes in the learning landscape. This is not a trivial issue. In the practical field, it is not uncommon that designers and teachers apply instructional design models that were developed in the 1970's and 1980's – models that do not meet today's requirements anymore. Second, instructional designers must develop a research agenda that enables the development of instructional design models and guidelines that fit the new learning landscape.

Traditional instructional design models focus on one particular domain of learning such as procedural, declarative or attitudinal learning (compartmentalization); they typically divide this learning domain in small parts (fragmentation), and they focus on the realization of specific learning objectives rather than transfer of learning (transfer paradox). These models cannot deal with current changes in what is learned, that is, the movement towards ill-structured problem solving, domain-general competencies, expert learning, metacognitive skills, and broad reference situations. New models are needed, which use real-life learning tasks as the driving force for learning. These learning tasks are somewhere on the continuum from ill-structured to well-structured problems, and different types of learning tasks might be identified that involve different cognitive and metacognitive processes. These different types of tasks would require different instructional arrangements in terms of sequencing, scaffolding, and information support.

With regard to the context in which learning takes place, time- and place-independent learning, outside school, lifelong, in heterogeneous groups is becoming general practice. On the one hand, this enables the development of communities of practice such as web-based learning communities. On the other hand, individualization and personalization of instruction becomes cost-effective due to the fact that a very large—potential—target group is dealt with. The main message for instructional design is not to be obsessed by new technologies and media. E-learning, for instance, refers to a motley collection of methods (presenting text on the screen, asking ready-made questions, showing video clips and animations, evoking discussions in asynchronous and synchronous discussion groups, engaging learners in highly interactive games and simulations, etc.) that invoke very different types of learning. This is not helpful to generate valuable research questions. Instead, the field of instructional design must focus on particular media-method combinations and carefully investigate the conditions under which those combinations yield desired outcomes.

With regard to the learners in the new learning landscape, notions such as “the online learner” are also too general to be helpful for doing research in instructional design. It suggests a homogeneity that simply does not exist. Effective instructional methods for different subgroups of online learners (e.g., young vs. old, high- vs. low-expertise, positive vs. negative perceptions) seem to be much more different from each other than methods for so-called online learners and ‘traditional’ learners. Moreover, what we need to develop for the future are not instructional methods for an intangible group of online learners, but methods that are tailored to the personal needs of individual learners. Only then, will we be serious in putting the learner at the center of the learning environment, whether it is online or not.

To summarize, the new learning landscape is characterized by more emphasis on complex skills and higher-order skills; by new technologies that allow for flexible time- and place independent learning as in web-based learning communities, and by better opportunities to adapt instructional methods to individual learner characteristics such as age, level of expertise, learning styles, and perceptions. High-quality instructional design research is badly needed and should focus on the question which instructional methods or media-method combinations are effective, efficient and appealing for teaching complex and higher-order skills, in a highly flexible fashion, and by taking learner’s individual needs and preferences into account.

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Resources for further exploration

1.
Claxton, G. (1999). *Wise up: The challenge of lifelong learning*. New York: Bloomsbury.
British psychologist and educator Guy Claxton advocates direct immersion, soft thinking, and imagination as useful tools for lifelong learning. A refreshing view on education in the 21st century.

2.
Jonassen, D. H. (2004). *Learning to solve problems: An Instructional design guide*. San Francisco, CA: Pffeifer.
This book by David Jonassen stresses that problem solving is the most important skill students can learn in any setting. The main thesis is that different types of problems require different instructional design solutions.

3.
Spector, J. M., Ohrazda, C., van Schaack, A., & Wiley, D. A. (2005). *Innovations in instructional technology: Essays in honor of M. David Merrill*. Mahwah, NJ: Lawrence Erlbaum.
This thought provoking set of essays on learning, instructional design and learning technologies deals with innovations and future directions in instructional technology. With an epilogue by David Merrill himself.

4.
http://www.nosignificantdifference.org/
This website is a repository of studies that found no significant difference in student outcomes between alternate modes of education delivery. Based on the work by Thomas L. Russell.

Questions for Comprehension and Application

1.
This chapter discussed major changes in what people learn in our modern society, with an increasing focus on problem solving, domain-general competencies and metacognition. What are in your view the main causes for these changes and the main implications for the design of instruction?

2.
The ‘paradox of prior knowledge’ states that past experiences both enable and restrict the quality of problem solving in new problem situations. Under which conditions dominate, in your opinion, either the enabling effects or the restricting effects of prior knowledge? Explain your answer.

3.
This chapter discussed the technology hype cycle. Discuss at least three learning technologies and their development according to the hype cycle. Is there a particular learning technology you expect to reach the last phase of the cycle in the near future?

4.
Suppose you have to design a workshop on presentation skills for both an experienced group of older bank employees and a group of high school students from the ’gaming generation’. On which aspects would the workshops for the two groups differ from each other?