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Chapter 3

Transfer of learning: paradoxes for learners

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Abstract

There are three kinds of transfer: from prior knowledge to learning, from learning to new learning, and from learning to application. The central thesis of this chapter is that all three should start from the dilemmas or paradoxes learners may have when trying to reach transfer. Six of these are described. They are finding relevant prior knowledge; the paradox of tacit knowledge; using relevant prior knowledge while learning; recognizing relevant situations and conditions; the paradox of near transfer and far transfer; and the paradoxical "what" of transfer, including learning to learn. In order to optimize transfer one needs to help learners solve the problems they encounter and to find ways out of the various dilemmas and paradoxes. For the three kinds of transfer exemplary studies are described that illustrate the kinds of solutions developed and their effectiveness.

1. Introduction

Transfer of learning occurs whenever previously learned knowledge and skills affect the way in which new knowledge and skills are learned and performed (Cormier & Hagman, 1987). There are three ways in which transfer can occur: from prior knowledge and skills to new learning, from new knowledge and skills to new learning situations (learning now preparing for later learning), and from new knowledge and skills to applications in work and daily life (learning for practice) (Simons, 1990). An example of the first category of transfer is a (Dutch) student who learns to read an English text and uses knowledge and skills from his or her native language (Dutch). An example of the second category of transfer is a student who is learning to use a text-processing program like WordPerfect but knows that he or she has to learn Microsoft Word later. How can this student learn to use WordPerfect in such a way that he or she will be able to learn Word as easily as possible later? An example of the final category is a student who learns to speak the French language in the classroom and has to do it in real-life context when receiving a French guest.

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In line with the three types of transfer are three research questions. The first is "how can we facilitate or increase the use of prior knowledge in instructional situations?" The second is "how can we design instructional situations in such a way that chances of better later learning are maximized?" The third is "how can we build instructional or organizational environments that help facilitate transfer from one situation (learning) to another situation (application)?" In the literature on transfer the third research question is emphasized most. In terms of this question, some researchers focus on the more specific question of how instructional environments can be designed in such a way that later use of the knowledge and skills in working or daily life conditions are optimized. Others study the question how working conditions can be designed in such a way that people *use* what they learned in a training or at school in their work. The other two major questions (first and second, above) are either ignored or studied under other headings (such as prior knowledge, tacit knowledge, and preparation for lifelong learning).

Theoretically, however, the basic mechanisms and principles of transfer are either identical or very similar for the three kinds of transfer (Cormier & Hagman, 1987; Simons, 1990). In all three cases, the fundamental problem is how knowledge and skills learned in one or more situations are used or applied in one or more other situations. The first situation can be a specific learning situation (questions 2 and 3) or an entire range of different learning situations (question 1). The second situation can either be a learning situation or a range of learning situations (questions 1 and 2) or an entire range of "application and use" situations (question 3). Table 1 illustrates these possibilities.

Furthermore, these three primary research questions are mostly treated from the perspective of the design of instructional or organizational environments. From the constructivist viewpoint, however, the learners' perspectives must be considered first, before proper environments can be designed. In this chapter, an analysis is presented of learner perspectives on transfer problems. In doing this, the transfer dilemmas or paradoxes that learners confront when learning have been sought. In what follows, the three types of transfer are illustrated with a series of studies. Some of the paradoxes are specific to one of the transfer questions, others are generic.

Table 1
Three research questions in relation to first and second situations

		Second situations	
		Learning situation(s)	Range of application or use situations
First situations	One specific learning situation	Question 2: From learning to new learning	Question 3: From learning to application(s)
	Range of learning situations	Question 1: From knowledge and skills to new learning	—

2. Paradoxes

What are paradoxes? Perhaps the most famous books about paradoxes is Charles Handy's (1994) *The age of paradox*. He wrote: "Every coin, I now realize, has at least two sides, but there are pathways through the paradoxes if we can understand what is happening and are prepared to act differently" (p. 17). Quinn and Cameron (1988) defined paradoxes as "contradictory mutually exclusive elements that are present and operate equally at the same time" (p. 5). This is a rather strict definition of paradoxes. A less rigid one is from Fletcher and Olwyler (1997): a paradox is a "seemingly contradictory statement that may nonetheless be true" (p. 7). It is important to realize that paradoxes are only seemingly contradictory. There is a contradiction from a certain perspective only, not from other perspectives. Therefore, paradoxical thinking fits well into constructivism: it focuses thinking on the perspectives of actors in their environments and how these restrict their thinking. In changing our perspective or mental model, paradoxical contradictions may be overcome. We may find ways to reconcile the seemingly irreconcilable tensions.

Finding and describing paradoxes may accomplish five aims (Simons, 1998):

- Looking for dimensions and degrees instead of dichotomies. Instead of a dichotomous distinction between short- and long-term learning, for example, there is learning for the next day, the next week, the next year, for the exam, for life, etc.
- Focusing on how the two sides of a coin can be combined instead of on their contrast. For instance, finding ways to combine structure and freedom.
- Finding ways to use the one side of the coin to strengthen the other. Can a learner, for instance, reach better short-term results by focusing on long-term results?
- Scaffolding, i.e., replacing the one side gradually by the other. Can we, for example, help learners to learn more and more independently through a gradual increase of self-control?
- Finding determining conditions. For instance, under what conditions to use support and when to withhold it?

2.1. Paradox of finding prior knowledge

Many prior studies have demonstrated the importance of informal and formal prior knowledge (see Dochy, 1992). This prior knowledge can be described as all the knowledge learners have available when entering a learning environment, that is potentially relevant for learning new knowledge. This prior knowledge is often tacit or inert. Moreover, implicit and explicit knowledge may be wrong (as compared to scientific or cultural standards) or only partially correct. As was shown in many studies, wrong or partially correct prior knowledge tends to resist change. Even after years of formal education, some misconceptions (re)appeared in the answers students gave when solving problems (Eylon & Linn, 1988).

On the other hand, students also have much prior knowledge that is correct and relevant. When learning, students use much of this prior knowledge without

awareness. It enters automatically in the learning process. For instance, in learning from a text one automatically uses all kinds of domain-specific knowledge and reading skills. Other kinds of knowledge do not enter automatically in the learning process. The learner must do this purposefully or should be helped by an instructional system to use this knowledge. The amount of prior knowledge a student has is a powerful predictor of new learning (Dochy, 1992).

Few students use much of their prior knowledge intentionally, spontaneously, and actively (see for instance De Jong & Simons, 1990; Dochy, 1992). Prior knowledge may pose several contradictory problems for students that may explain why they tend not to use much of their prior knowledge actively. There is so much prior knowledge that learners may not know which prior knowledge is relevant in a certain learning environment and which is not. Part of the problem for a learner, then, is selecting the relevant prior knowledge from an almost endless amount of explicit knowledge that is available. How can a learner make the decision as to what prior knowledge to include and which to ignore? Furthermore, he or she may not know which part of the prior knowledge is correct and which is incorrect or partially correct according to scientific and or cultural standards.

2.2. Paradox of tacit knowledge

Automatized implicit or tacit knowledge will sometimes come into action without awareness or even influence on the part of the learner. Once a situation is recognized or defined as one in which a certain set of routines or automatized procedures is relevant, the transfer process "runs on its own" and perhaps cannot be stopped. But this poses a problem if it is incorrect or partially correct according to scientific or cultural standards. How can a learner become aware of his or her misconceptions if they are so "tacit"? Some students may not be aware of the different kinds of prior knowledge (formal and informal, correct and incorrect) and their advantages and disadvantages.

2.3. Paradox of using relevant prior knowledge

Once students are aware of relevant prior knowledge, they may decide not to use it; they may, for example, be afraid of interference of new and prior knowledge. Although it seems logical to make use of all the prior knowledge you have to facilitate your learning, there are also several good reasons not to do so. Learners may not be aware of the importance of the active use of prior knowledge. Using prior knowledge may require a great deal of work, it may create confusion, it may distract you from the main points, and it may make your learning too idiosyncratic. Thus, from the perspective of the learner, the problem is when to use prior knowledge actively and when to protect oneself from its influences. In this active use of prior knowledge there are two other dilemmas: when to compare old and new ideas actively and when to test and evaluate the effectiveness of new knowledge and skills in new situations.

2.4. Paradox of recognizing relevant situations and conditions

This is the problem of recognizing relevant situations and conditions. Whereas the previous paradox focuses on the active use of prior knowledge (or not), the present one refers to the recognition of situations and conditions where transfer *could occur*. In these cases learners simply do not see that two or more situations or conditions are similar. When is a situation similar to another one? Indeed, there are so many dimensions on which situations differ (time, place, content, culture, mood, etc.). Bereiter (1995) describes the main problem of transfer as a transfer between situations. There are so many environmental conditions that may determine the use of a certain strategy or of certain knowledge. How can learners find their ways in these environmental conditions?

The main problem for learners is that they oftentimes do not and cannot know when and where they should and will use what they learned. How can one prepare for situations one cannot know? Especially in the case of far transfer, where there are many different application possibilities, it is difficult for learners to find ways to prepare themselves for later use of their knowledge. The only two things a learner can do (see also Bereiter, 1995) is to strive for real and deep understanding (optimizing the accessibility of the knowledge) and to collect knowledge about the situational conditions. In this respect there is perhaps a disposition for transfer or a set of abilities related to transfer: "transfer-ability" (Simons, 1990).

2.5. Paradox of near and far transfer

Another paradox relates to the distinction between near and far transfer. In near transfer there is a close connection between the learning situation (or the prior knowledge) and the application (or the new learning situation). In far transfer the distance between prior knowledge or learning and application (or the second learning situation) is much greater (see Mayer & Greeno, 1972). This is no dichotomy; rather, it is a dimension of distance. This distance can sometimes be measured or manipulated (see Bassok & Holyoak, 1989). Basically, however, the distance is a subjective measure that varies among individuals (Simons & Verschaffel, 1992). An important hypothesis is that one has to do different things for near and far transfer; a strategy for near transfer may be inappropriate or ineffective for far transfer and the other way around. For near transfer one needs the "low road to transfer" (Salomon & Perkins, 1989): to automatize and practice in a small range of situations (contextualization) (see Simons, 1990). For far transfer, however, the "high road" (Salomon & Perkins, 1989) is better: decontextualization and practice in a variety of different situations are important strategies. For learners, the basic paradox is whether to go for near transfer and to confine the range of situations, focusing on practice and automatization, or to go for far transfer, searching for decontextualization and variety.

2.6. The paradoxical "*what*" of transfer

What should a learner take with him or her from one learning situation to another? Salomon and Perkins (1989) wrote: "In general, the 'what' (of transfer) might be

a subroutine developed in the learning context but also useful in the transfer context, an overarching principle abstracted in the learning context but applicable in the transfer context, a piece of factual knowledge useful in both but in quite different ways, a learning strategy that becomes used in new domains, a cognitive style, or even a complex strategy of approaching new problems" (p. 116). Collins, Brown and Newman (1989) distinguish four types of transferable elements: (a) domain-specific knowledge (concepts, rules, algorithms); (b) heuristic problem-solving strategies; (c) strategies for self-regulation; and (d) learning strategies.

For learners the paradox amounts to choosing among the various elements that could be transferred. What should and could the learner take with him or her to other situations? Is it possible to combine several elements? One specific dilemma is how to transfer learning skills to new learning situations. In every learning situation there are also opportunities to learn about the learning processes themselves. When people always learn in the same way, they will probably develop a habit to learn just in that way. This way of learning becomes the natural one and people even adapt their conceptions of learning in that direction (Simons, 1997). This becomes, however, problematic when new ways of learning are needed, for instance when schools make new demands, when a student changes from one school to another, or at the transition from school to work. The dilemma for a learner in this respect is how to learn about the other kinds of learning situations: a kind of far transfer of learning skills and strategies.

3. Three sets of studies

In this section studies that illustrate the interrelationship among the three research questions are reviewed. The studies all focused on helping learners to solve some or all of the paradoxes described above.

3.1. Dealing with prior knowledge of learners

How can instructional systems help students use their correct or partially correct prior knowledge without creating interference with new knowledge and at the same time to deal with wrong or partially incorrect prior knowledge that tends to resist change? Although many studies demonstrating the problems of students and instructional systems with prior knowledge are now available, few have shown how they might be solved. Strike and Posner (1985) proposed a theoretical framework about cognitive accommodation. Students should feel dissatisfaction with their existing conceptions. They should understand new scientific notions lying behind the new conceptions. These new conceptions should enable students to solve problems. They should also have opportunities to actually test and evaluate their new conceptions.

Prawat (1989) stressed the importance of metacognitive awareness. "Students should be aware of their pre-conceptions before they will be able to restructure them. Students must first recognize that the new information is related to what they already know; they then have to link this information to two types of prior knowledge — that

which is consistent with the scientific notions and that which is incompatible with those notions. It is the latter connection that leads to the realization that their own ideas are not complete or satisfying explanations and that the scientific view is a more convincing and powerful alternative" (pp. 12–13). As Siegler (1983) showed, however, awareness is not enough: cognitive accommodation also implies acceptance. Students should find the new notions plausible. Nussbaum and Novick (1982) proposed the so-called "exposing events" that evoke students' pre-conceptions. Hewson and Hewson (1984) emphasized comparison and contrasting activities that students should use.

Inspired by these theories Ali (1990) and Biemans (Biemans & Simons, 1995,1996) created an instructional strategy (the CONTACT strategy) consisting of five steps. Students should be (1) helped in searching their own relevant pre-conceptions (through an exposing event); (2) stimulated to compare their pre-conceptions with the new information; (3) asked to formulate the new idea; (4) asked to apply the new conception in a concrete problem and (5) asked to evaluate the adequacy of the new conception in relation to step 4. Of course, this strategy helps to solve only a few of the problems of students mentioned above. It is a strategy that is especially useful in domains where there are many misconceptions to be corrected through instruction. Furthermore, it does not help students to solve the metacognitive problems mentioned, like becoming aware of the functions of the different kinds of prior knowledge, the critical role of misconceptions, and so on. Finally, it is a strategy that can only be applied when there is some knowledge about frequently occurring misconceptions.

In a series of studies Biemans (1997) showed that the CONTACT strategy significantly improved the learning of students of 11–13 years of age. Nine lessons about physical geography, including concepts such as equator, earth rotation, condensation, rain, atmospheric pressure, wind, and weather were presented by computers. Each lesson started with a concrete problem or question to be solved by the student in order to find his or her pre-conceptions (step 1). An example of such a question is "When Columbus set sail in 1492, the wind did not blow him straight to the equator. Instead he was blown to America with a curve to the right. Can you explain this?" Subjects had to choose from six alternatives and to give argumentation for their choices. The distracter answers represented misconceptions found in prior studies to be typical for students of this age level.

Next, the new information was presented. Students were asked to compare their old idea with the information presented (step 2). Then the original question (from step 1) was posed another time and students had to select the correct answer and to give an argumentation for it again (step 3). Following that, a new but similar concrete problem was presented which students had to solve with the newly acquired knowledge (step 4). Finally, students had to evaluate the new knowledge and compare the old and the new knowledge another time (step 5). If students gave the wrong answer in step 3, they were asked to re-read the information. For each of the five steps there was extra information available about its relevance (Why is it important?) and how to perform it. During some of the lessons the "why" and "how" information was presented to all students. In other lessons the students could consult this information whenever they wanted. The five steps were also visually illustrated by way of graphic metaphors.

The dependent variables consisted of multiple-choice tests. The immediate achievement test contained nine items (three reproduction, three insight and three problem-solving items). Two weeks after the last lesson was completed a retention test consisting of 18 reproduction, 18 insight and 18 problem solving items was administered. At the end of each lesson subjects also solved a concrete problem that was used in the beginning phase to elicit their pre-conceptions. The answers to these problems were called the "final idea". The full strategy of all steps was contrasted with a "before–after" condition where students only executed the first and the last step of the strategy and received no feedback or extra help and with a control condition.

In one study, the CONTACT strategy resulted in significantly higher scores on all the tests and subtests (i.e., reproduction, insight, application) than the before–after condition. In addition, the latter students performed significantly better than students in the control condition. The results of another suggested that it was possible to teach students to use the CONTACT strategy on their own. After a while, students were taught how to use the CONTACT steps independently. The help offered by the computer was scaffolded and faded out systematically and gradually. This study showed that a learning to learn approach resulted in better physical–geographical conceptions (final idea responses) and in higher learning performance on the multiple-choice tests than the regular CONTACT strategy. One may conclude from this study that it is possible to teach students to learn by themselves according to the principles of the CONTACT strategy.

3.2. Learning now for later learning

Ideally, learning environments do not only help students get involved in productive learning processes and achieve high learning results, but also prepare them for later learning (see, for example, Candy & Crebert, 1990). How can instructional systems help students to prepare for future learning situations? Teurlings (1993) conducted a study that demonstrates how to do this. Adult students learned in a series of lessons how to work with Wordperfect 5.1 (WP). In the control condition the lessons were organized like they normally are. In the experimental condition students learned not only to typewrite with WP, but also how to learn the rest of WP (to find their way in the computer) on their own. This was done using the following procedure.

First, there was a video demonstrating that learning WP is not a matter of physical skill acquisition (many students think that it is like learning to typewrite) but a matter of learning to think like the computer. Second, by drawing an analogy with a complex building students learn how to find their way in the computer: where to look at the screen; how to find out where one is in the program; what the basic structure of the program is. Third, students learned how to work with the various help functions (a minimal manual, on-line support). Fourth, the students were stimulated to experiment and to try out new things: nothing serious can happen as long as you do not make one or two mistakes (like format c:). Fifth, the actual skill training was brought back to the bare essentials to make time for the instruction in learning skills. This meant, for instance, that students only learned to underline text and that they were encouraged to learn similar procedures like making text bold on their own. The results suggested

that the students in the experimental condition not only learned more than those in the control condition, but, more importantly, were much faster and much more effective in learning a new part of WP on their own, both immediately after the training and six weeks later.

3.3. Learning for transfer to work

For this last section the underlying question is: how can instructional and work-related environmental conditions be designed in such a way that learners are helped to solve the paradoxes they encounter? Several studies were carried out focusing on this transfer from training to work situations. Subjects were adults working in organizations. In the design, there are three ways to proceed: focusing on far transfer; focusing on near transfer and focusing on organizational measures (with respect to both far and near transfer). In order to promote far transfer learning environments can be designed to optimize the chance for transfer to occur from the training situation to several different "real life" situations.

In essence this is a question of improving the accessibility of memory representations. Simons (1990) has described the conditions found in the literature that increase the accessibility of information and skills in memory. Examples include:

1. Increasing the connectedness of the memory representation by making the relations between concepts more explicit or by confining the instruction to key concepts that are very central in the relational network;
2. Increasing the subjective relevance that people attach to the knowledge and skills to be learned by explanation of their utility or by giving the assignment to students to find out what the relevance is on their own;
3. Improving the binding of learning with varying contexts of work, for instance through on the job training or by using the practical experiences that workers can bring with them;
4. Increasing the metacognitive skills of workers by teaching them directly or by creating learning environments that call upon these kinds of skills;
5. Broadening the generality of knowledge and skills by giving opportunities for reflection or by offering a variety of practice; and
6. Organizing an affective climate directed at transfer (a "transfer culture", see Pea, 1987).

In the literature about transfer of training in industrial or work settings, however, the attention for near transfer prevails over the attention for far transfer. Broad and Newstrom (1992), Claas, Pouwer and Thijssen (1986) and Gaines-Robinson and Robinson (1989) reviewed the empirical studies done and concluded that, by way of example, the following principles should guide the design of instruction aimed predominantly at near transfer:

1. Explicit learning goals should be formulated, aiming either for near transfer or for far transfer;

2. These goals should follow from a needs-assessment and connect to professional practice;
3. The goals should be formulated as concretely as possible;
4. The goals should be tuned to the entering level of the learners and an adaptation to differences in entering level should be possible;
5. At the start of a course information should be given about the goals and the contents in order to correct incorrect expectations;
6. The choice of learning contents should be such that there is a connection with concrete or simulated work situations;
7. The criteria that will be used to judge learning performance should be clear; and
8. Learning performance should be evaluated and tested regularly. Then, feedback can be given about the progress and the existing gaps in knowledge can be determined.

Apart from these two kinds of transfer-promoting instructional designs, there are also transfer-promoting organizational designs (see, for instance, Baldwin & Ford, 1988; Claas et al., 1986). These are designs at the level of the organization that promotes transfer to the work situation. This means, on the one hand, that some of the (instructional) design elements are translated into activities of managers. On the other hand, there are special measures of the organization that can be taken before and after learning takes place and that help the process of transfer to the workplace. In essence, these activities fit into the "training for impact" approach developed by Gaines-Robinson and Robinson (1989). The main strategies of this approach can be summarized as follows:

1. At forehand, important decision-makers should commit themselves.
2. They should agree that the goals of the training are important for the organization and they should convince other relevant people that this is the case
3. Several people in the organization should control that the goals match real and important business needs.
4. An adequate selection of participants is important (having the required prior knowledge and being ready to learn).
5. A good support-system in the work environment is thought to be important (for instance exempting workers from their job when following a course and having someone take over their work).
6. After training, its effects should be made explicit: Both the direct learning results and the influence on the work behavior and on the organization as a whole.

Claas et al. (1986) reviewed the relevant literature and found empirical support for ten effective organizational elements. Examples include:

1. Gaps between the learning goals and organizational goals should be diagnosed and should lead to supplementing integration measures;

2. There should be an "integration counselor" who creates and monitors the conditions for optimal integration;
3. The time span between the learning and the use in work environment should be as short as possible; and
4. The learner should get ample opportunities to use the learned knowledge and skills in the work environment.

In several studies the use in practice of the various instructional and organizational near and far transfer-promoting elements was investigated. The findings (for example, Geelen & Hendriks, 1998; Kerstens, 1990; Ter Heinen & Termote, 1990) showed that most of the possible transfer-promoting measures elements were not evident in daily practice. Elements of near transfer tend to dominate. Ter Heinen and Termote (1990)) showed that the extent to which transfer elements were in place was significantly correlated with the adequacy of application of theory in work-practice.

Lether (1997) studied the transfer effects of a course for insurance agents who had to become more employable. Telephone operators who previously sold home owners and automobile insurance had to learn how to sell travel insurance. In a training program they learned all about the contents of travel insurance. Furthermore, they learned strategies for cross-selling (how to seduce clients to buy other products than the ones they ask for) and how to be client-centered (how to act in accordance with the needs of the client). Most of the instructional design elements intended to promote transfer as described above were included in the training program. The organizational design elements, however, were not included at all.

There were two variants of the training. In the first, there was a regular classroom instruction. In the second, the "contact hours" with the teacher were minimal; students learned independently using a specially prepared self-instruction package. On an immediate post-test the self-instruction group outperformed the classroom group significantly. A simulated client (a so-called "mystery caller") phoned all participants to determine whether the telephone operators would try to do cross-selling in unobserved practice. If they would not do this spontaneously, the simulated client would give hints like " I will soon take a holiday". If the operators still would not try to sell, the client would directly ask for the travel insurance. The results of this mystery calling were quite clear: almost none of the 43 operators offered travel insurances spontaneously. When prompted a small number of people offered an insurance themselves, but most of them connected the client to the travel insurance department. There was a small (but significant) difference in these transfer results in favor of the self-instruction group.

Instruction aimed at promoting transfer apparently did not result in a high degree of transfer either under the self-instruction or the classroom condition. The self-instruction students, however, had slightly higher transfer "scores" than did those in the classroom group. Perhaps some of the organisational design elements should have been included in order to really help the insurance sellers to overcome the transfer paradoxes. Other causes of the low transfer might be that the workers felt insecure, that they did not like the phenomenon of cross-selling, or that they had to work under great time pressure.

4. Conclusions

There are three separate but interrelated transfer questions that have much in common. They all deal with the use of knowledge and skills learned in one situation in other situations, be they learning or work situations. In promoting transfer, it is useful to start from the learner's perspective. What are the paradoxes that learners encounter when they are moving toward transfer? In promoting transfer it is important to take these paradoxes into account and to try to help learners to find solutions or ways to deal with the contradictions inherent in them. The studies mentioned here showed how this can be done and that important effects can be reached. Transfer can be promoted in various settings if and when we have the learner's perspective as the focus. Young students can be helped to use their prior knowledge more actively and to overcome some of their pre-conceptions. Moreover, they can learn how to do this on their own. Adults can learn how to learn to transfer their knowledge and skills when a learning to learn approach is embedded into their regular training.

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