HOWARD MIDDLETON & LIESBETH BAARTMAN

1. TRANSFER, TRANSITION, OR TRANSFORMATION?

INTRODUCTION

> Schools are supposed to be stopovers in life, not ends in themselves. The information, skills, and understandings they offer are knowledge-to-go. Not just to use on site. (Perkins & Salomon, 2012, p. 248)

Transfer of learning has been a periodic topic of research during the 20th century and a topic of research and critique in the late 20th and for most of the 21st century so far. The seemingly simple task of examining how learning in one setting affects learning or activity in another setting commenced in modern times with Thorndike and Woodworth's (1901) study. After many studies, Thorndike (1913) concluded that transfer did not actually occur and that the human mind was organised such that it learned things separately and apparently in isolation.

Others (Bransford & Schwartz, 1999; Wenger, 1998) have argued that Thorndike and Woodworth came up with the conclusions they did because they were using the wrong way to identify or measure transfer. Bransford and Schwartz (1999) argue that Thorndike and Woodworth used an experimental method they described as sequestered problem solving (SPS) that was not a valid way to measure transfer. Bransford and Schwartz argued that we should be examining transfer in terms of preparation for future learning (PFL), rather than what is directly seen to be transferred. Perkins and Salomon (2012) argue that motivation is a key to understanding successful and unsuccessful transfer. Stevenson (1986, 1998) explores the related concept of perceptions of ownership of learning by learners and the effect this has on transfer, and particularly, far transfer. Marton (2006) argues we have been looking at the wrong aspect of transfer, concentrating on identifying sameness between learning settings instead of differences.

Schwartz, Chase, and Bransford (2012) argue that particular teaching and learning strategies can impede transfer by inducing a phenomenon they call overzealous transfer (OZT). OZT occurs when people use learned routines on the basis of similarities between new situations and existing knowledge, when the capacity to identify new learning is more appropriate. Theories on boundary crossing (Akkerrman & Bakker, 2011) focus on the values of differences between learning settings and how to create possibilities for learning at the boundaries of diverse practices. Finally, Beach (1999) has argued that transfer is not the appropriate metaphor and we should be thinking of what we currently call transfer as a process of transition where both the learner and the learning materials are transformed.

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We are thus in an exciting period in terms of exploring what these fundamental aspects of learning look like in terms of contemporary research and theorising. This book includes researchers involved in undertaking studies that explore the concept of transfer or more recent conceptualisations that fit within the general terms of transitions and transformations. These three themes are addressed within the overall learning area that is the focus of this book series: technology education.

In this introductory chapter, we attempt to do two things. In the first section, we provide an overview of issues in past and current research on transfer, transitions, and transformations that are addressed in the different chapter in this book. This provides the foundation for the remaining chapters. In the second section we provide an introduction to each of the succeeding chapters.

WHAT IS SUCCESSFUL TRANSFER: SEQUESTERED PROBLEM SOLVING (SPS) VERSUS PREPARATION FOR FUTURE LEARNING (PFL)

The first issue regarding transfer that is often addressed in the chapters of this book is the question: What is successful transfer? The classical definition of successful transfer is that it is a product of the learning process where something learned in one context is used to assist learning in another context (Thorndike & Woodworth, 1901). Thorndike and others were some of the first to examine common assumptions about learning, such as the belief that learning difficult subjects such as Latin increased people's general learning skills (Bransford & Schwartz, 1999). Thorndike's work showed that while people might do well on a test of content they had previously learned, they would not necessarily use that learning in a new situation where it would appear to be applicable. Based on many studies, Thorndike (1913) argued that transfer did not happen and that the human mind was not wired to perform transfer.

Bransford and Swartz (1999), however, argued that most previous research into transfer employed a transfer task that they labelled sequestered problem solving (SPS), alluding to a process that is like that used in courtrooms where juries are sequestered to ensure they are not exposed to contaminating information. In the same way, subjects in transfer tests are kept isolated and have no access to texts, or the ability to try things out, receive feedback, or revise. It is easy to see why SPS would be used from an experimental perspective. However, Bransford and Schwartz argue that direct application of remembered information to the solving of a new problem does not represent an authentic way to measure transfer. They advanced an alternative approach to understanding transfer and argued that it is more appropriate to measure the degree to which particular learning prepared people for future learning (PFL).

SPS and PFL can be thought of as representing general differences between much of the research on transfer. That is, SPS can be seen to represent, in a general way, research that accepts that transfer occurs and the issue of interest for research is in establishing how to facilitate transfer. PFL argues for a more oblique approach to transfer that poses the question of whether the traditional concept espoused by

Thorndike and Woodworth actually exists. The following paragraphs in this first section examine research that is relevant to the chapters that follow.

THE INFLUENCE OF MOTIVATION ON SUCCESSFUL TRANSFER

Perkins and Salomon (2012) have advanced the argument that motivation is a key factor in any explanation of transfer, both in terms of successful and unsuccessful instances of transfer. Similarly, Bransford and Schwarz (1999) mention people's willingness to seek others' ideas and perspectives as an important aspect of the active nature of transfer. Perkins and Salomon's starting point is the observation that transfer occurs easily in many normal life circumstances but failure to transfer learning is a common feature of formal learning settings. They therefore argue that motivation to transfer can be examined using a "detect-elect-connect" model where the three aspects of the model are described as "bridges" where it is possible to identify if the process of transfer is occurring.

In the Perkins and Salomon (2012) model, "detect" is used to describe the action where a person becomes aware that there may be a link between previously learnt information and a current situation. They argue that motivation is a factor determining whether a person will detect the link. Perkins and Salomon argue that motivation is even more critical to the "elect" bridge in their model. They argue that old learned practices and habits often get in the way of using knowledge detected to elect to do something different. The last bridge in Perkins and Salomon's model is "connecting," where, after detecting a possible relationship and electing to explore it, people go on to make the connection between the prior knowledge and the current situation. Perkins and Salomon argue that understanding the role of motivation as the driver to connect each of the three bridges in their model of transfer provides a way to predict whether transfer of learning will be successful.

Using a concept related to motivation, Stevenson (1986, 1998) supports Perkins and Salomon's (2012) argument that motivation is a key to successful transfer. Stevenson undertook studies with automotive apprentices and examined the features that led to successful transfer. Stevenson examined transfer where the learning was similar to the transfer requirements and where there were significant differences between the learning and transfer requirements. Stevenson found that students' sense of ownership of learning is a key motivator of learning that is important for successful transfer, in general, but is particularly important if the goal of learning is to achieve far transfer.

SAMENESS AND DIFFERENCE AS A KEY TO UNDERSTANDING TRANSFER

A second issue addressed in many chapters in this book is the sameness or difference between situations and the influence on whether or not transfer occurs. Marton (2006) argues that we need to widen the focus when examining transfer, from the consideration of how learning one thing helps people to do something that is a bit different, to considering how perceptions of difference and sameness

between tasks might help people transfer learning. That is, Marton argues that understanding difference is as important as, and may be more important than, understanding sameness between learning situations. In doing so, Marton argues for the importance of the perceptual aspect of transfer: what people attend to or notice. Similarly, Bransford and Schwarz (1999) argue for perceptual learning and the importance of contrasting cases.

Marton provides a number of examples to show the limitations of the emphasis on similarities between situations. He argues that if we have students learn and practice addition and then we give them the task again, we will not be able to determine whether they learned the tasks by rote or that they understand how to add. If they are given different addition tasks, we can say that they have learned and understand how to add. Marton extends this argument for the importance of perceiving difference to achieve transfer by pointing out that this is how we learn in everyday life:

> We learn to notice differences and to make distinctions. We see everything against the background of our experience. We see someone as tall because we have seen people of different heights. We experience wine as fruity because we have had wine before that was not fruity. (Marton, 2006, p. 512)

Marton argues that the perceiving of difference occurs at two levels. First, learning occurs as a function of perceiving differences within the learning situation, and second, transfer is regarded as a function of the perception of differences between learning and other situations, or put another way, between one context and another context. Bransford and Schwarz (1999) describe how experience with contrasting cases can affect what a learner notices about subsequent events and how the learner interprets them. They add that just contrasting different cases is not enough. It sets the stage for future learning, but learners need an explanation for the patterns of similarities and differences they discover. In their study, analysing and contrasting different cases prepared learners to understand the explanation of an expert in a later lecture.

In this book, this issue is addressed in Chapter 11 by Bjorklund, who draws on Marton's (2006) research to explain the issue of implicit pattern recognition as a key component of his dual memory model of transfer. In a similar way Banks and Plant explore the similarities between science and technology in Chapter 3 as a way of challenging the traditional view of technology as applied science. Kimbell draws on notions of sameness and difference in Chapter 7 as he examines the way teachers use collective judgements to achieve reliable assessment of student performance.

AVOIDING UNPRODUCTIVE TRANSFER STRATEGIES

Building on earlier work by Bransford and Schwartz (1999), Schwartz et al. (2012) examined the phenomena of positive and negative transfer and the role of instruction. They draw on summaries of transfer research by Chi and VanLehn (2012) that conclude that successful transfer is often achieved by using instruction

that helps individuals to treat a new problem as being similar to one they have already learned. However, while these instructional strategies work some of the time, Schwartz et al. (2012) argue that the strategies can be overdone and describe a phenomenon they call overzealous transfer (OZT) where learning is overgeneralised and transferred into situations where it is inappropriate.

Schwartz et al. draw on work by Schwartz , Chase, Oppezzo, and Chin (2011) that found that 75% of studies of transfer in science, technology, engineering, and science (STEM) content used tell (teach) and practice routines. Schwartz, Chase & Bransford (2012) argued that one problem with tell and practice routines is they can emphasise efficiency at the expense of finding new ways to look at learning materials (Bonawitz et al., 2011). Stevenson (1986) noted that tell and practice methods were efficient for near transfer but did not encourage far transfer.

Schwartz et al. (2011) found that the negative effects of OZT could be reduced by having students use a technique called inventing with contrasting cases, where they had to, in essence, invent a way to understand the learning material. This is analogous to Perkins and Salomon's (2012) adaptive transfer. That is, students had to engage in a form of far transfer or look for new and purposeful ways to learn. In other words, they had to engage in what is, arguably, creative behaviour. Another strategy for achieving effective transfer is to ensure initial learning involves the learning of concepts and principles within a range of contexts (Schwartz et al., 2012). De Vries explores this strategy as a way for learners to cope with the changing nature of technology in Chapter 2. As such De Vries' chapter also fits within the frame of preparation for future learning (PFL).

CONSEQUENTIAL TRANSITIONS INVOLVING TRANSFORMATION

All of the research and theorising reported so far in this introduction addressed issues concerned with understanding the phenomenon of transfer. What they do not do is question the legitimacy of the concept of transfer. In this section, Beach argues for a different approach to what we call transfer.

A perspective on transfer adopted by a number of chapters in this book is that of transfer as consequential transitions. Beach (1999) and others (for example, Lave & Wenger, 1991) find traditional research on transfer limited in its ability to explain how learning, at its most basic, occurs, and, more generally, how people develop knowledge and understanding. Beach advances an alternative explanation for transfer. Adopting a sociocultural approach, Beach argues that there is a body of research (e.g., Beach, 1995a, 1995b; Cole, 1996; Whitson, 1997; Lemke, 1997; Evans, 1999) to support his conclusion concerning the "centrality of symbols, technologies, and texts, or systems of artifacts, in propagating knowledge across social situations" (Beach, 2003, p. 41). Thus, the idea that people generate knowledge across social activities rather than transfer it from one situation to another is a key feature of Beach's theory.

Beach argues that when looking at the situation where transfer is assumed to have occurred, transfer of knowledge from learning task A represents "a very narrow band of all that potentially goes on in learning task B" (1999, p. 108).

Beach argues further that there is a conceptual isolation between the material assumed to have been transferred from learning activity A and the other learning that is or will occur in learning activity B. Beach argues that while transfer happens in general life situations, intentional transfer, or facilitated transfer, as is assumed to occur as a result of formal learning, does not occur or occurs rarely. This proposition appears to be supported by Detterman (1993), who argues that true transfer only occurs spontaneously. Beach uses this argument to suggest that the metaphor of transfer is best discarded and replaced by the metaphor of transitions. Beach (1999, 2003) argues for a sociocultural approach described as consequential transitions.

A consequential transition is defined as a developmental change in the relation between an individual and one or more social activities. Beach (2003) argues that this developmental change occurs via four types of consequential transitions. The first type Beach calls *lateral transitions*, where an individual moves in a single direction from one activity to another activity that is historically related. An example might be moving from school to work after education finishes. Lateral transitions are regarded as being most closely related to classical transfer in terms of their unidirectionality. That is, there appears to be a developmental link between learning at school and the learning required for work (see Baartman et al., Chapter 5).

The second type of transition Beach (2003) describes as *collateral transitions*, where an individual is simultaneously engaged in two or more historically related activities. An example might be a student moving between different classes in school. Collateral transitions are thus multi-directional, but the issue of development is less clear than with lateral transitions because of the multi-directionality. Collateral transition is often assumed to occur across different subjects in school where, for example, learning of compound ratios in mathematics might transfer to understanding gear ratios in mechanics or engineering classes. The evidence for collateral transfer in schooling, however, is not strong.

The third type of transition is what Beach (2003) calls *encompassing transitions*. Encompassing transitions occur when participants engage in a single social activity and the activity occurs within the boundaries of that activity. Encompassing transitions are a function of the change in the activity. Beach draws on Lave and Wenger's concept of legitimate peripheral participation where: "learners inevitably participate in communities of practitioners and … the mastery of knowledge and skill requires newcomers to move to full participation in the sociocultural practices of a community" (1991, p. 29).

The final kind of transition is what Beach (2003) calls *mediational transitions*. They occur within educational activities that simulate involvement in an activity where the participant has not yet experienced the activity. Beach provides an example of a mediating transition from a study of adults learning to become bartenders in a private vocational school. Students initially memorised drink recipes using written materials, however, the pressure to achieve speed and accuracy meant the students were assisted in moving from written materials to mnemonic materials more closely related to the mixing of the drinks themselves.

The students were highly literate part-time actors, restaurant managers, and graduate students and the vocational activity acted as a bridge between the two other systems of activity; that is, between their role as part-time actors, students, or managers and their role as bartenders. Beach argues that mediated transitions always provide the stimulus to allow the learner to move beyond their current point, to the developmental position they are working towards. In this sense Beach argues that mediated transitions are roughly equivalent to Vygotsky's (1978) concept of a zone of proximal development and always involves the notion of developmental progress.

Beach (2003) also argues that the transition of self and social activity usually involves a struggle and that transition does not occur unproblematically as is sometimes thought to be the case with transfer. Beach argues that consequential transitions involve a struggle and in the process both the learner and what is learnt are transformed. The concept of consequential transitions from competence to expertise is explored in Chapter 8 by Middleton in terms of the activities in which architects engage at various stages of their development. Pavlova examines the idea of transformation of the self through learning activities concerned with sustainable development in Chapter 9. In doing so, Pavlova argues for problem solving-based learning activities to ensure students do not regard the learning material as inert knowledge. MacGregor explores the development of teacher professional development in Chapter 10. Macgregor accomplishes this by analysing the transformations that occur as a group of 10 teachers transition to full participating members of the teaching community.

TRANSFER AS BOUNDARY CROSSING

Akkerman and Bakker (2011) argue that all learning involves boundaries and this is the case whether we are talking about the development of expertise or gaining knowledge of something. At the personal level, boundaries are the distinctions between what is known and what is not yet known. Akkerman and Bakker argue that at the occupational level, boundaries are becoming more explicit as a result of increasing specialisation. In order to avoid fragmentation, people look for ways to connect across work practices. An example of boundaries was identified by Alsup (2006), who found that student teachers encountered pedagogical values at the school level that differed from those found at university, and these represent one form of sociocultural boundary.

Akkerman and Bakker (2011) and others (e.g., Tuomi-Gröhn & Engeström, 2003) argue that developmental learning occurs as a consequence of a process they describe as boundary crossing, where meaning between different sides of the boundary are negotiated across the boundary, hence the term boundary crossing. Evidence of boundary crossing, both explicitly and implicitly, can be found in a number of chapters in this book.

Adapting to new situations (that is, transfer) often involves "letting go" of previously held ideas and behaviours. This requires an attitude to resist making old responses by simply assimilating new information to already existing schemas and

mental models. Instead, effective learners need an attitude to look critically at their current knowledge and beliefs (Baartman & De Bruijn, 2011). Learning processes involved in such transfer are accommodation and transformation or expansive learning (Illeris, 2004), which involve not only cognitive but also social and emotional changes. Studies on boundary crossing show that people often try to keep or establish boundaries between different practices (e.g., professions) because of feelings of uncertainty or threat. For example, Timmons and Tanner (2004) discuss how nurses feel threatened in their professional identity by the emergence of a new, slightly similar profession.

The issue of boundary crossing is addressed in three chapters. Bjurulf argues in Chapter 4 that school-based workplace learning that runs parallel with workplace learning is not a simple transfer of school learning to a workplace setting, but an iteration of both forms of learning that can be regarded as a form of boundary crossing. In Chapter 5, Baartman et al. employ the idea of boundary crossing as a way to advance learning between nurses and technicians. In Chapter 6, Kilbrink explores the boundary that is created by the perception of formal learning as theoretical and workplace learning as practical. Kilbrink found that the boundary was artificial and that boundary crossing occurred as a consequence of the need to integrate theory and practice across both sides of the school-workplace boundary.

OVERVIEW OF CHAPTERS IN THIS BOOK

In this next section we introduce each of the remaining chapters and draw connections where appropriate between these chapters and issues raised in the first part of this introduction. In those chapters already discussed the authors theorise about transfer via concept learning (De Vries), the relationship between "useful" technological knowledge and its relation to other knowledge (Banks & Plant), transfer between school and work (Bjurulf; Baartman, Gravemeijer, & De Bruijn; Kilbrink), transfer and assessment (Kimbell), the transition to expertise (Middleton), transformation via sustainable development education (Pavlova), the transitions and transformations from university to school (MacGregor), and transfer between formal learning and learning from practice (Bjorklund).

In Chapter 2, De Vries advances the idea that with the rapid changes in technology that are characteristic of modern life, learning about technology in ways that do not become rapidly redundant could be achieved by employing concept learning to develop learning that is more robust and able to be used in a variety of appropriate contexts.

Banks and Plant explore the distinctions and relationships between science and technology and other knowledge in Chapter 3. Banks and Plant advance the argument that history and practice does not support the technology-as-applied-science belief that is dominant in both society and in the schooling system.

Bjurulf reports in Chapter 4 on research examining the transfer of learning between upper secondary school vocational studies and the workplaces in which students spent half their school time. Bjurulf found that transfer was an interactive

process between school learning and workplace learning and not the one-way transfer sometimes thought to be characteristic of such programs.

In Chapter 5, Baartman, Gravemeijer, and De Bruijn present a study from the perspective of boundary crossing as an alternative to traditional transfer. They focus on the communication and collaboration between nurses and technicians, who work on the boundaries of their professions, and the learning opportunities offered by this boundary crossing.

Kilbrink examines the relationship between theoretical and practical learning in a school and workplace collaborative learning in Chapter 6. Kilbrink argues, on the basis of her research, that the dichotomised view of theory and practice is false and that, in reality, there is a necessary integration between theory and practice and that it is this integration that facilitates the transfer of learning.

In Chapter 7, Kimbell addresses the complex issue of the ways by which assessors of national school examinations transfer their judgements across different assessment items. Kimbell explores the cognitive processes that allow assessors to achieve coherence across judgements. That is, he is interested in how the transfer of assessment criteria and standards is achieved.

In Chapter 8, Middleton draws on a study he conducted with architects. The study examined the transition from competence to expertise. Middleton found that expertise in architecture had features in common with expertise generally, as did the transition, but that it was represented through both words and images and that, contrary to earlier views, imaginal data in the form of sketches provided a much fuller account of the transition to expertise in architecture. Middleton argues for the importance of utilising visual data when researching transitions in areas where learning is mediated by more than words, such as in design.

Pavlova employs Mezirow's (1978) work on transformative learning and Habermas's (1971) domains of learning research in Chapter 9 to develop the argument that education for sustainable development is more than students learning about environmental issues. Pavlova argues that for education for sustainable development to be successful it needs to be critically self-reflective and emancipatory.

Transitions and transformations of self are the topic of MacGregor's research in Chapter 10. MacGregor draws on a year-long study of beginning design and technology teachers to argue that the process of professional identity formation involves many transitions and the transformation of self. MacGregor identifies the factors that help and hinder beginning teachers transitions and transformations.

In Chapter 11, Bjorklund explores the discontinuity between formal learning, which is explicit and easily described, and learning in practice, which is often implicit and difficult to describe. Bjorklund argues that for transfer of learning to occur there needs to be a constant interplay between the explicit and implicit memory systems. Bjorklund calls the learning system based on this interplay a dual memory system.

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Howard Middleton
Griffith Institute for Educational Research
Griffith University
Australia

Liesbeth Baartman
Eindhoven School of Education
Eindhoven University of Technology
and
Faculty of Education
Research Group Vocational Education
Utrecht University of Applied Sciences
The Netherlands