

# Is Transfer Ubiquitous or Rare? New Paradigms for Studying Transfer

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**Abstract.** Classic and emerging views of transfer are discussed; examples of research are provided to illustrate each.

## INTRODUCTION

Transfer of learning has been an important research theme in educational/cognitive psychology for many years.<sup>1</sup> Considerable research, and even volumes reviewing transfer findings<sup>2</sup> have occupied researchers attempting to understand the conditions under which knowledge learned in one context transfers to new contexts. After decades of research and debate, no consensus exists on whether transfer is ubiquitous or rare. Clearly this question is important for an educational system such as ours built on the premise that what is learned in school is useful in other contexts in school, outside of school, and in the workplace. In this article I will review two views of transfer, the classic view and an emerging view, and discuss how the controversy over whether transfer is ubiquitous or rare depends on which of the two views one uses to interpret findings. I will then provide specific examples to illustrate the types of questions that can be answered using the two views.

## TWO VIEWS OF TRANSFER

### Classic View

The classic view of transfer is exemplified by the following types of definitions:

*[Transfer is] defined as the ability to extend what has been learned in one context to new contexts (ref 3, p. 74).*

*Central to traditional approaches to transfer is a dominant methodology that asks whether people can apply something they have learned to a new problem or situation (ref 4, p. 67).*

*As a construct in educational psychology, [transfer] refers to ... a person carrying the product of learning from one task, problem, situation ... to another (ref 5, p. 101).*

*[Transfer is] the degree to which a behavior will be repeated in a new situation (ref 6, p. 4).*

*[Transfer is defined broadly] to mean the ability to apply knowledge or procedures learned in one context to new contexts (ref 7, p. 3).*

Definitions such as these suggest that transfer consists of measures of appropriate use of prior learning in new contexts, contexts which are of the researcher's choosing and based on the researcher's perception of similarities to the learning context. This view is researcher-centered in that the researcher pre-defines the underlying concept that should transfer and designs an experiment to seek evidence for whether or not transfer occurs. Within this view, transfer is measured as an all-or-nothing event, and when measured in this way there is ample evidence that transfer is rare indeed.<sup>4,6,8-9</sup>

To illustrate consider a well known example from an experiment<sup>10</sup> in which college students were given the following situation to study:

*A general wishes to capture a fortress in the center of a country. There are many roads radiating outward from the fortress. All roads have been mined so that while small groups of men can pass over the roads safely, a large force will detonate the mines. A full-scale direct attack is therefore impossible. The general's solution is to divide his army into small groups, send each to the head of a different road, and have the groups converge simultaneously on the fortress.*

Minutes later, after determining that students had understood this situation, they were given the following problem:

*You are a doctor faced with a patient who has a malignant tumor in the stomach. It is impossible to operate on the patient, but unless the tumor is destroyed, the patient will die. There is a kind of ray that may be used to destroy the tumor. If the rays reach the tumor all at once and with sufficient high intensity, the tumor will be destroyed, but surrounding tissue may be damaged as well. At lower intensities, the rays are harmless to healthy tissue, but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?*

It was expected that students would apply the underlying concept from the first situation to the second, but few students were able to solve the tumor problem. When explicitly told to use information from the first situation, over 90% of the students could solve the tumor problem. Findings like these led some researchers to argue that transfer is rare:

*...most studies fail to find transfer ... [and] those studies claiming transfer can only be said to have found transfer by the most generous of criteria and would not meet the classical definition of transfer. ... in studies ... that claim transfer, transfer is produced by 'tricks' of one kind or another. ... Transfer is rare, and its likelihood of occurrence is directly related to the similarity between two situations. (ref 6, p. 15)*

### **Emerging View**

In the emerging view transfer is defined more broadly as a complex, dynamical process where

knowledge is activated and applied in response to context. The focus is on studying what students do (both productively and unproductively) during a task. In contrast to the classic view, the emerging view is student-centered.<sup>4,11</sup> For example, Lobato's<sup>12</sup> "actor-oriented model of transfer" relies on "personal creations of relations of similarity" by the learner between learning and transfer contexts rather than similarities perceived by researcher.

Within this view, different types of questions can be studied, such as: What is the nature of the knowledge activated during a transfer task? How does the knowledge activated depend on context? How are representations of context created and of what do they consist? What can be said about the transfer dynamic (e.g. how reliable is it)? How can instruction be designed to promote flexible and positive transfer?

## **RESEARCH EXAMPLES FROM EMERGING VIEW OF TRANSFER**

### **Images in Mirrors**

In a simple yet compelling example of the context dependence of transfer, Hammer and his collaborators<sup>13</sup> describe a task in a graduate course for teachers where students worked in groups to decide what size mirror is needed to see an image of your entire body. One student, "Sherry," stated that you need a mirror the same size as your body because your whole body has to fit in the mirror. Other students in her group argued that a mirror only half the size of your body is needed, but Sherry still defended her position. Days later she told her group of a discovery: She had a bedroom mirror that was about half her size and she was able to see a reflection of her whole body daily at home. Despite this daily experience, this knowledge did not transfer to the context of a question about images posed in physics class.

Hammer et al., argue that what is happening in this example is complex. Had she simply recalled the fact that she saw her full image daily in a mirror half the size of her body, this might be considered simple recall rather than transfer. Sherry's reasoning revealed that she was not using her experiences with mirrors in answering the original question, but something else. Perhaps, Hammer et al. argue, it was her experience with doors, which require a size at least as big as your body to allow passing without obstruction; perhaps it was her experience with life-size images printed on

surfaces that triggered her argument. She was clearly transferring something that was more abstract than her daily experience with mirrors. Examples like these has led Hammer and his collaborators to think of transfer in terms of activation of “resources” (fine-grained knowledge units) that an individual uses to frame the context. Different resources are activated to frame the question about mirrors and images in physics class, and viewing herself in the mirror in her bedroom.

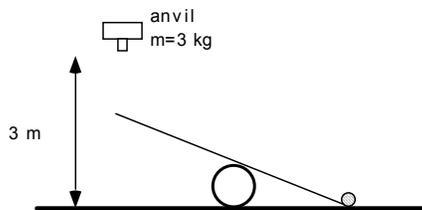
## Problem Posing

In my own problem posing work<sup>14</sup>, I found that students transferred lots of knowledge learned in physics class, but did it piecemeal rather than holistically. This led to posing of problems that were locally coherent, but globally incoherent. For example, consider the following “concept scenario” around which students were asked to pose “textbook like” problems that matched the scenario:

*Mechanical energy is conserved, followed by conservation of momentum, followed by conservation of mechanical energy with potential energy increasing and kinetic energy decreasing*

One student posed the following problem:

*A 3 Kg anvil is dropped from a height of 3 meters an (sic) falls on a lever that transfers its energy of the anvil to a tennis ball weighing 0.5 Newtons. At what height will the ball climb to. (See figure.)*

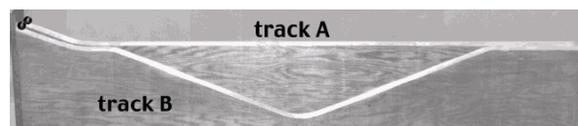


The student correctly explained that as the anvil falls, mechanical energy is conserved, with kinetic energy increasing and potential decreasing, in accord with the first part of the scenario. Then he claimed that energy is transferred exactly from the anvil to the ball in the collision, which is impossible given that the anvil loses considerable energy to the earth when it stops. Further, he wants to conserve momentum in the collision by setting the mass times the velocity of the anvil equal to the mass times the velocity of the ball. The last portion in which the ball rises matches the last portion of the scenario. Clearly this student matched different portions of the scenario, but did not create a consistent overall problem that matched the entire scenario.

From a transfer perspective, he was transferring lots of knowledge learned in physics class, yet his understanding was not refined enough to allow him to construct a coherent problem. The inconsistency in matching the momentum conservation portion of the problem and scenario has to do with the two portions that require conservation of mechanical energy at the beginning and the end of the scenario. This, as well as other students interviewed, showed a reasonable understanding of conservation of energy but only within the context of objects rising or falling in the Earth’s gravitational field. In attempting to satisfy the two energy conservation portions of the scenario, the student had to reverse the direction of the object’s motion from beginning to end, and hence the need for the see-saw arrangement that did not conserve momentum. Viewed from a classic perspective, transfer failed, yet viewed from the emerging perspective, transfer was ubiquitous.

## Judging Realistic Motion

The last example is from our work<sup>15</sup> in which students judged which among several animations of balls moving along tracks is realistic. The apparatus used is shown below. Students were shown five animations of the ball on track B first, followed by the same five animations with both balls moving together in a race. A major finding was that the types of strategies that students used to make decisions about the realism of the ball’s motion when a single ball moved along track B differed substantially from the strategies used to reason about the realism of both balls moving together in a race. In the one-ball motions, students relied on judging the realism of speed changes in the various portions of the tracks against their expectations of what the motion should be. In the two-ball animations, the expected race outcome played a major role in judging realism of motion. More specifically, one particular animation of the ball in track B moving by itself was rejected by all 50 students interviewed (26 enrolled in an educational psychology course and 24 enrolled in an honors physics course); in this animation, the ball’s motion was unphysical in the upward section of the “V,” namely the ball speed up while moving uphill.



This unexpected motion was not missed among the student participants. When this same animation was run with both balls moving in a race, the result was a

tie at the end of the race. Given that the expectation of a tie was very strong among the physics students (which they justified in terms of conservation of energy—the potential energy lost equals the kinetic gained, hence the balls have the same speed in the final flat shelf and hence they should tie), over 60% of the physics students (and none of the psychology students) selected this animation as most realistic. Clearly different types of knowledge were being activated and applied by the two groups of students, and in this instance the physics knowledge (conservation of energy) activated by the physics students in the two-ball race led to a tie selection despite one of the balls undergoing unphysical motion. This led us to posit that the type of knowledge that students activate and apply depends very strongly on both context and on the prior knowledge they possess. In this case, the more prior physics knowledge possessed by the physics students did not help them since that knowledge was not transferred appropriately.

## DISCUSSION

Two views of transfer have been presented, the classic view from educational/cognitive psychology, and an emerging view. In the classic view the researchers designs experiments to test whether or not transfer of some body knowledge/learning occurs wholesale to another scenario. In the emerging view, transfer is explored in terms of the type of knowledge activated by students in response to context in order to make sense of the situations they are considering. In PER we are more interested in the types of questions that the emerging view of transfer allows us to answer, which revolve around the nature and functioning of the student's knowledge architecture, rather than questions about whether or not a particular piece or pieces of learning/knowledge was successfully applied at some instant in time in some new context.

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