The SAGE Encyclopedia of Out-of-School Learning

Transfer of Knowledge

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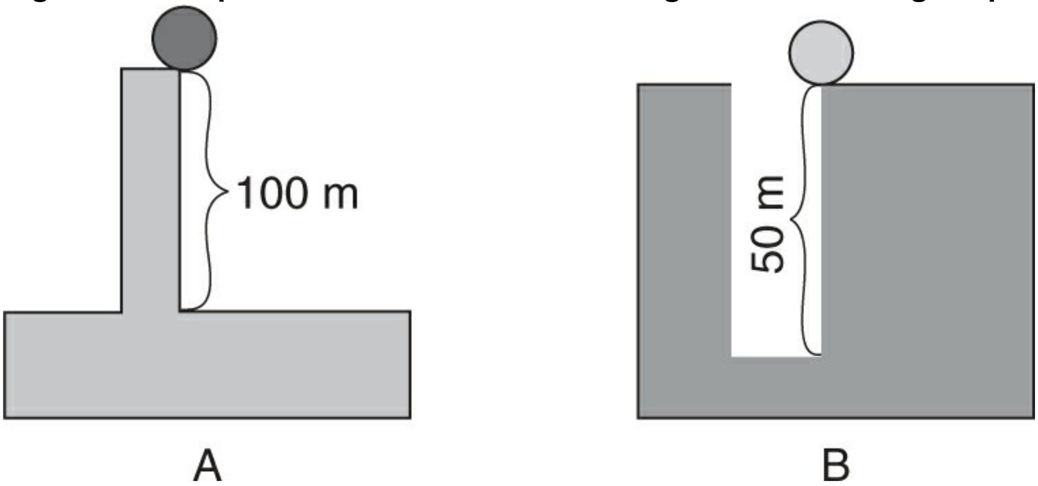
Transfer of knowledge is the application of knowledge learned in one context to new, dissimilar problems or situations where the knowledge would be useful. Teachers, coaches, camp counselors, parents, and learners often have the experience of a learner showing apparent understanding when questioned about a topic in a way that closely matches how it was initially presented but showing almost no understanding when queried in a new context or with novel examples. This entry further explains the concept of knowledge transfer. It then discusses several different strategies used to support knowledge transfer.

Several recent studies have shown that when information is learned in a very rich, specific context, it is understood and applied very well within that context—but it is also especially resistant to application in new situations. For example, education researcher David Perkins describes an anecdote in which physics students learned to calculate the time required for an object to fall to the bottom of a tower of a given height. On an exam, however, those same students did very poorly on an analogous problem about an object falling to the bottom of a well (complaining that they had not done any "well problems" in class). A large body of research has demonstrated that even small changes in context or concrete details can significantly impair learners' ability to take advantage of their relevant knowledge. Figure 1 shows the first falling ball problem Perkins describes (A), in which students were shown how to determine how long it would take the ball at the top of the 100-meter tower to reach the ground, and one of the problems students were later tested on (B), in which a ball started at the top of a 50-meter well and fell down to the bottom.

Figure 1 A Graphic Illustration of the Challenge of Transferring Acquired Knowledge



Source: Goldstone and Day (2012, p. 150).

In some ways, out-of-school learning may hold an advantage over traditional classroom-based instruction in this regard. It is often especially difficult for students to recognize the relevance of material from the classroom when confronted with the very different contexts of the outside world, and this fact poses a formidable challenge for educators. Out-of-school learning opens the opportunity for knowledge to be acquired in situations that are more similar to the real-world environments in which they will ultimately be used, meaning that knowledge transfer could be significantly easier.

However, out-of-school learning could pose some distinct challenges for transfer as well. By embedding learning in a real-world environment full of concrete detail, out-of-school learning risks constraining the extent to which learners may take advantage of their knowledge more broadly.

Fortunately, a great deal of research has examined the factors that influence and support knowledge transfer. For the most part, this research has been conducted in the context of direct, formal instruction. However, the principles that have been established are quite broad, and the lessons from that research are very relevant for learning that takes place outside the classroom. The strategies considered here are (a) structured comparison, (b) structural language, and (c) preparation for future learning and invention.

Structured Comparison

One strategy for helping learners make connections between situations that they might otherwise have missed is to have them engage in a comparison of the deep structures of the situations. This approach differentiates between the superficial features of a situation and the deep relations among its elements. For example, consider the situation of a maker movement hobbyist experimenting with a microphone feeding into, and placed near, an amplified loudspeaker. The elements in the situation have many superficial features related to their appearance and behavior. The microphone is hand sized, the speaker is black, and the sound is shrill. There are also structural relations among the parts that make the scenario an archetypal example of a positive feedback system in which an increase to a system variable (sound) leads to a further increase of the same variable. In particular, the sound from the microphone is amplified and increased as it comes out of the speaker, where it is once more picked up by the microphone, perpetuating a cycle of ever-increasing decibels, until one of the components reaches its limit.

A second example of positive feedback might be children in a community service program designing, fabricating, and selling a new bracelet with proceeds benefitting local nonprofit organizations. In designing an advertising campaign, they may notice that children have a tendency to buy a particular brand of toy that other children in the city had already purchased, leading to still more children buying the toy. Successive fads of friendship bracelets, lanyards, power bracelets, and Silly Bandz attest to the strength of this particular positive feedback loop. However, in terms of superficial features, this bracelet scenario has little in common with the microphone feedback example. The challenge of transfer of learning is the challenge of how to help learners apply their understanding of the positive feedback loop structure from one scenario to the other despite their strikingly different contexts and superficial features. A considerable body of evidence confirms that it is difficult for people to spontaneously disregard superficial dissimilarities between situations and recognize their deeper common structure.

One proposal for helping learners appreciate and benefit from the deep commonalities shared by disparate scenarios is to have them explicitly compare the scenarios. Psychologists Mary Gick and Keith Holyoak present a classic demonstration of the power of comparing multiple examples in their study of problem solving using the class “radiation problem” created by Karl Duncker. In that problem, individuals are told about a patient with an inoperable tumor in his stomach. There is a kind of ray that could be used to treat the patient; but at intensities sufficient to destroy the tumor, a great deal of healthy tissue would also be destroyed. At lower intensities, the ray would be harmless to healthy tissue, but it will not affect the tumor. Individuals are asked to propose a solution that could destroy the tumor while also leaving healthy tissue intact. The intended solution involves a convergence approach, in which several low-intensity rays are administered from different locations but converge at the site of the tumor, creating a greater aggregate intensity there. Previous research has shown that participants have a very difficult time solving this problem independently and are also unlikely to make spontaneous use of relevant analogous examples, such as a story about soldiers simultaneously converging on a fortress. However, when participants receive two stories involving the same "convergence of low-intensity forces on a target" solution, and are asked to explicitly compare them, participants show greater application of this solution to a new problem. Providing three examples prior to the transfer problem yields even more successful solutions to the new problem.

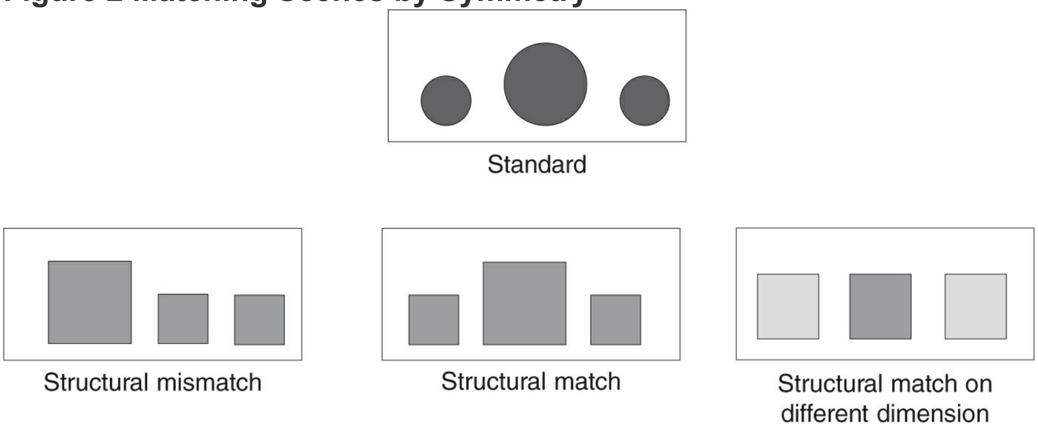
Results from many other studies across a variety of contexts are consistent with the idea that comparison and mapping between dissimilar cases facilitates structural processing. In one example from a real-world educational setting, education researcher Lindsey Richland found that explicitly cuing the meaningful commonalities between two math problems—for example, by visually presenting both examples at once and gesturing between the corresponding aspects of them—improved students' ability to transfer to new cases.

Out-of-school learners can take advantage of structured comparison in various ways. Within a given domain, it would be recommended that learners are not only exposed to a variety of examples but also encouraged to actively map and compare those cases. To truly maximize the potential benefits of comparison, learners should also be challenged to make connections more broadly, considering the ways in which similar principles may be manifested even in very dissimilar situations.

Language

The language used to describe situations can also play a powerful, albeit indirect, role for allowing their underlying structures to be applied to new cases. Assigning the same words, label, or phrase to two situations can lead students to spontaneously consider comparing them. For the comparison of microphone feedback with a bandwagon of toy purchasing in a community, a recommendation from several studies might be to explicitly use the term *positive feedback loop* when presenting them in order to help students extract their commonality. For example, when Laura Kotovsky and Dedre Gentner asked 4-year-old children which scene is most like the standard scene in Figure 2, the children had difficulty appreciating the similarity between the standard and the "structural match" scenes—that is, the symmetry that they share and that is not shared by the "structural mismatch" scene.

Figure 2 Matching Scenes by Symmetry



When the children were asked to compare the top (standard) scene in Figure 2 with three other scenes, they were better able to see the shared symmetry between the two matching scenarios and the standard when the label “even” was applied to the standard scene. (The label provides an intuitive cue that highlights the symmetry in the scenes that have symmetry.) Seeing the commonality is easier when the symmetry is on the same size dimension, as it is for the standard and “structural match” scenes, than when it is on different dimensions, as it is for the standard’s small–big–small size symmetry and the “structural match on different dimension” scenes’ gray shading symmetry.

Likewise, preschool-aged children were better able to recognize and take advantage of commonalities in spatial structures between two physical models when the spatial locations of one of the models were meaningfully labeled (e.g., *in*, *on*, *under*). There is evidence that these labels are effective because they elicit comparison. This research suggests that words are most effective for promoting comparison when their natural interpretations are strongly connected to the structural pattern that they are intended to highlight and when the same language is used to describe superficially different but structurally related situations.

In addition to using labels to explicitly highlight connections between different cases, research suggests that out-of-school learners may benefit by being exposed to labels that are broad and general rather than overly specific. For example, Cathy Clement and colleagues asked individuals to read passages that described situations in either domain-specific terms (e.g., a politician *plagiarized* ideas and *typed* them into his speeches) or domain-general terms (e.g., a politician *stole* ideas and *incorporated* them into his speeches). The individuals who had been exposed to the domain-general terminology were better able to notice structural commonalities between that passage and new, analogous cases.

Preparation for Future Learning

Preparation for future learning (PFL) focuses on the ways in which our prior experience shapes our interpretations of new information. Prior knowledge serves as a lens for the construal of new content rather than being the direct focus of cognition itself. PFL research has demonstrated powerful interpretive effects of knowledge that would have been overlooked by more conventional measures. For instance, most transfer studies involve a simple manipulation during the study phase (e.g., viewing a relevant analog vs. viewing an unrelated control example) followed by an assessment of this manipulation’s effect on a transfer task (e.g., solving a problem). In contrast, education researcher Daniel Schwartz designed a “double-transfer paradigm,” in which some participants received additional training between the study and test phases. Importantly, this additional training was identical for the different conditions. The researchers found no difference between the groups in terms of direct transfer (testing immediately after the manipulation), which would typically be interpreted to mean that the manipulation had no effect. However, the initial conditions did influence performance for those individuals who had received additional training. The strongest influence of the initial exposure to the relevant analog was that it prepared learners to learn from supplemental training.

One way of creating learning material with an eye toward PFL is invention-based training in which learners are engaged in trying to construct knowledge for themselves before they are told the “standard” solution. For example, somebody struggling with the notion of variability in statistics might try coming up with his or her own measure of variability such as “largest value minus smallest value” or “absolute difference of each number from the average” before being given the formally defined measure called “variance.” Advantages of learning by invention are that learners develop an understanding of the constraints and possibilities in a situation, and when they are finally told the “official” solution, they are sufficiently invested in the material to sincerely want to know the answer. Invention-based training seems especially well suited for out-of-school learning environments and represents a promising avenue for taking advantage of the benefits of PFL in those contexts.

Conclusions

In addition to these three strategies for achieving transferable knowledge, other research has focused on getting learners to adapt their perceptual processes so that commonalities are apparent between situations that did not originally look similar. By this approach, rather than hope for transfer between scenarios that look dissimilar, the hope is that learners can change how they group, discriminate, and attend to elements so that originally hidden similarities are noticed. A final approach to transfer that is achieving increasing recent buy-in is to not treat transfer as a “cold,” detached, cognitive process but as tightly integrated with motivation, identity, and a learner’s self-assigned mission to master and apply learned material. Given the cognitive effort required to make clever connections across disciplinary and contextual gulfs, strong learner motivation is often needed to make the leap. Future studies should extend these new areas of transfer research to the growing area of out-of-school learning.

See alsoActive Learning; Cognitive Development; Connected Learning; Constructivist Learning; Linking In-School and Out-of-School Learning; Problem-Based Learning; Situated Learning; Systems Thinking

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Further Readings

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