"What do possums have to do with backpacks?" A preliminary investigation of student near/far transfer skills in design thinking

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Abstract

Research suggests that creative abilities, especially in design settings, may relate to the capacity to transfer ideas, concepts, and characteristics from one item to another. For example, many inventions and innovations have resulted from the creative processes involved in transfer. The capacity to recognize, dissect, and transfer in the context of design is not an automatic process amongst students and students may, or may not, see readily available opportunities to utilize transfer while designing creatively. Efforts were made to investigate student near/far transfer skills in the context of a design classroom for 9th graders (14-15 years old). Specifically, this National Science Foundation (NSF)-sponsored research centered on students engaged in Learning by Evaluating (LbE) – an activity in which students view pairs of items (e.g., pictures, design journals, etc.) related to their design task and choose which of the items is better based on a pre-determined criterion. While students were completing these comparisons, we intentionally provided them with items to compare that represented both near and far transfer opportunities for their design task. Student comments related to each comparison were collected and these provided the basis for our preliminary analysis and results.

Introduction

Hanes is a US-based clothing company primarily focused on the production of shirts, sweats, and underclothing. Hanes is popular enough that they report having products in eight out of ten households in the United States (Hanes Brands Inc, 2021). In 1989, Hanes contracted all-start basketball player Michael Jordan as a model, spokesperson, and commercial character advertising their brand (Mandel, 2014) – the beginning of a decades long advertising relationship between the clothing company and the professional athlete.

Why would Hanes do such a thing? The simple answer is *transfer* (Lohrey, 2019). In advertising, *transfer* refers to the phenomenon of transferring a person's feelings about one topic, idea, or product to another. In the case of the clothing company Hanes, they intentionally banked on the popularity of the basketball player Michael Jordan transferring over to their own product; in other words: as people watched Michael Jordan wear, talk about, or advocate for Hanes clothing, the positive feelings towards Michael Jordan would be attached to the clothing brand a well.

Transfer

The phenomenon of transfer is not new – famous athletes, celebrities, politicians, and others have all been intentionally employed as a spokesperson for any number of companies. Shaquille O'Neal wants you to buy and use Icy Hot, Tiger Woods wants you to wear Nike, and Serena Williams wants you to drink Gatorade – the list goes on and on. In each instance, the overarching goal is for the viewer's positive feelings towards the spokesperson to be subconsciously transferred to the product displayed.

While the idea of transfer can be easily understood in the context of advertising, transfer can further apply to a broad range of experiences and learning. Learning transfer, defined as "the ability to extend what has been learned in one context to new contexts" (Bransford et al., 2000; p. 51), involves the application of prior learning in new problems, new places, and over time. In each instance the skills, emotions, activities, or knowledge from one area can be applied in another. Transfer can take one of two forms: near and far. In a near transfer setting the task or problem is closely related to something the learner has already experienced and/or solved. In a far transfer setting, the task or problem is only loosely connected to previous experiences of the learner (Lee & Wong, 2013).

Take driving as an example of near transfer: learning to drive a Volkswagen as ones' first vehicle does not mean that the learner is confined to driving only Volkswagen's. Rather, the associated skills, emotions and reactions, activities, and knowledge tied to the initial experience of driving the Volkswagen can be applied to virtually every other make or model of vehicle. For example, an individual trained in a Volkswagen may need to make minor adjustments or learn subtly nuanced differences when driving a Chevrolet, Ford, or Dodge; however, the skills, feelings, and general knowledge related to driving is, for most, almost immediately, and seamlessly, transferred to new vehicles with little effort.

Many educational pursuits revolve around these instances of near transfer; for example, students who learn to read will start with a variety of different books ranging from

The Cat in the Hat to *Dick and Jane.* However, their capacity to read does not end with these children's books. Rather, these books are simply preparation along a student's journey into reading a wide variety of texts (e.g., newspapers, magazines, instructional manuals, job applications, etc.) throughout the remainder of their life – each an instance of transferring the initial skills associated with reading into new contexts. In each instance of *near* transfer the learner uses their familiarity and experience with reading to successfully navigate a new form of literature/text/typeface/etc.

A military leader using their experience playing the board game of chess is an example of *far* transfer. While basic concepts and principles of chess (e.g., control the middle, utilize different pieces to isolate an opponent, sacrifice is sometimes necessary) apply to military engagements, the setting is very different. However, many military leaders have successfully utilized Chess, and other strategy games, in their design and deployment of military missions (Has chess got anything to do with war, 2015). Far transfer is, of necessity, centered on deeper and more abstract principles and ideas than near transfer (Lee & Wong, 2013) as the immediate connections between settings may not be readily recognizable (Barnett & Ceci, 2002).

Transfer in Design and Design Education

The creative environments for designing, creating, and innovating offer ample opportunities for transfer - especially when design is combined with ever-emerging technology applications. The *Standards for Technological and Engineering Literacy* note this relationship between design, technology, and transfer in *Standard 3H* which notes that "students…should be able to analyze how technology transfer occurs when a user applies an existing innovation developed for one function to a different purpose (p. 40)."

Examples of transfer in design and technology settings include a host of innovations and inventions which represent applications of items designed for one purpose being used for another. Coca Cola, the most popular soda in the world (The Motley Fool, 2019), was originally intended as a tonic (Bellis, 2019); BubbleWrap, one of the most widely-used packaging materials, was originally a wallpaper; one of the most popular toys of the 1940s (the Slinky) was developed as American Naval Engineer Richard James watched a spring designed to stabilize naval equipment fall to the floor; and the plastic flying Frisbees seen in parks around the world were originally intended as pie dishes (A&E Television Networks, 2009).

In addition to applying existing solutions to new problems, fundamental knowledge from other domains can play a role in the development of design solutions in the first instance. Because design involves the application of knowledge across STEM (science, technology, engineering, and mathematics) and social disciplines (e.g., psychology, sociology) to specific contexts, successful design is often precipitated by learning transfer. Examples of such inspiration might include the design of Velcro based on naturally occurring burrs or biomimetic robots based on biological understanding (e.g., amphibious robots, Baines et al., 2021). Arguably, other ventures are designed to capitalize on social or psychological insights. For example, Misfits Market sells organic produce that does not meet the cosmetic standards of traditional grocers by direct-to-consumer delivery and messaging focused on health and sustainability (Vines, 2022).

Education around innovation and invention—and the associated examples of transfer—is often represented in design and technology (D&T) education classrooms (also known as "Technology Education" and "Technology & Engineering Education" in various parts of the world). These classrooms are an ideal setting, as students are engaged in hands-on problems solving scenarios – most often in the context of design (Niiranen & Rissanen, 2017). These classrooms are highlighted by their hands-on nature which includes designing, making, assessing innovation and thus offer ground for both teaching, and utilizing, transfer in design (Lee & Wong, 2013).

Methods

Recognizing the potential for students to learn and utilize transfer in design settings, we conducted a preliminary investigation into students' ability to transfer (both near and far) different ideas and concepts while engaged in a design problem. The collected data was derived from 35 9th grade students (14-15 years old) enrolled in a High School engineering and technology course at a school located in the Southeastern United States.

Specifically, the students in our study were engaged in *Learning by Evaluating* (LbE, see Bartholomew et al., 2020) as a brainstorming component of a larger design cycle in which students designed and created a new backpack. During LbE these students used a software program to view pairs of pictures which had been selected by their teacher for being related to their design task (i.e., design and create a new backpack; see Figure 1); in each instance students were asked to select one of the pictures displayed as "better" than the other based on the prompt: "Which item best helps you with your design and why?"

Twenty-five images were included in this task. Both authors independently categorized these images as near transfer, mid transfer, far transfer, and unrelated images and any initial disagreements were unanimously resolved. Ten of the were clearly backpacks and are classified as near transfer. Nine images were bags but not backpacks and are thus classified as mid transfer. Five images were not bags but represented things that could be used to hold and/or transport items and were thus classified as far transfer. One image was included as a distractor as it was unrelated to backpacks.

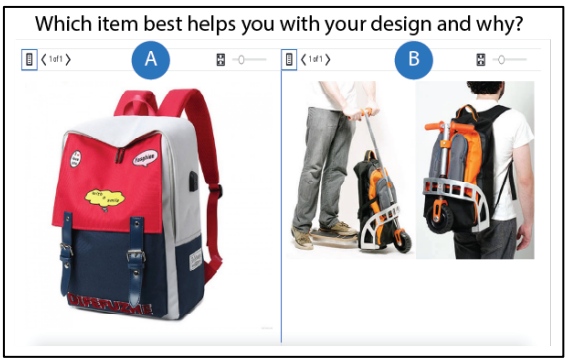

Figure 1. RmCompare software used for comparing items

In addition to selecting one item over another, the students were asked to type a rationale for their decision. Therefore, this additional data collected for this effort was qualitative in nature and took the form of student rationale statements for their comparative decisions made while viewing pictures related to backpack design. Lastly, quantitative data was collected including which images were selected by students in each of their comparisons. Students made between 3 and 20 comparisons and rationales while participating in the LbE component of the experience.

Following the collection of data (e.g., 585 comments from student comparative decisions, which images students viewed and chose, etc.), all data was analyzed using both quantitative and qualitative processes. These analyses were completed independently by two former K-12 educators with experience in D&T classrooms. Lastly, representative, and unique comments from students were collected for use in both describing and illustrating the larger findings resulting from the coding.

Results

Most students struggled to recognize the potential of far transfer in their design challenges. When given the option to select between two items with different levels of transfer, most students selected the image representing nearer transfer (see Table 1). For example, of the 30 instances where students compared a far transfer image to a near transfer image, students selected the near transfer item 21 times and the far transfer item 9 times.

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Table 1: Student Comparison Results

	Total	Selected 1st	Selected 2nd
far-far	11	11	
far-mid	22	8	14
far-near	30	9	21
far-unrelated	4	2	2
mid-mid	17	17	
mid-near	42	15	27
mid-unrelated	1	1	0
near-near	23	23	
near-unrelated	3	3	0
unrelated-unrelated	0	0	

When comparing far transfer items to near transfer items, far transfer items were selected only 30% of the time. When comparing far transfer items to mid transfer items, far transfer items were selected 37% of the time. While this does not necessarily mean that students see no value in far transfer items, it does suggest that students either see less value in them (i.e., the prompt asked students to select the image that would best help them with their design) or they do not understand the transfer opportunity. The prevalence of student selection between far transfer items and unrelated items is particularly telling as 50% of the comparisons between far transfer items and unrelated items showed that students felt the unrelated item was more useful than the far transfer option. This ratio was also similar when comparing mid transfer items to near transfer items. The mid transfer items were only selected 36% of the time.

These findings were further triangulated with the qualitative data provided by students' justifications for their selections. In most of the comparison's, students' responses were entirely unrelated to the near or far transfer nature of the item. However, there were a few comments collected from students which hinted at the ability and choice to transfer.

For example, in both instances when a student chose a far transfer item over a near transfer option, they justified themselves by explaining the innovation that this far transfer could produce – this student noted that: "using a Lama to carry you belongings is a good idea because it puts no strain on yourself and who doesn't want to walk with a lama?" Another student shared that "This image grabs the viewer's attention because it is an uncommon thing to see for many people, and shows another use for the object." These comments suggest that some students may have been able appreciate the value of far transfer ideas.

Four students relied of definitions to justify their comparison. Three of the four relied on a strict definition explaining that "the other is a bag not a backpack" and "A backpack will lay on your shoulders with straps, while a purse will irritate the skin on the inside of your elbow. It's just true". Only one of the explanations explained

how a more general definition could include more items, saying a motorcycle was "Not really a backpack but could be considered in the same class since its used to hold multiple people at once or even multiple supplies". This further suggests that students can make far transfer inferences, but the majority of students may have been caught up in strict definitions or other reasons for not making far transfer applications.

Notably, the most common explanations of far versus near transfer expressed confusion about the lack of a connection between far transfer items and backpacks. Students made comments like "poor horse", it's "better than whatever that is", "why is this relevant", "the other is a literal animal," and the bag is "better than whatever that thing is."

Conclusion

Some students were able to appreciate the value of using far transfer in design processes as evidenced by their selections in one-on-one comparisons as well as in their justifications for those decisions. However, the majority of student chose closer transfer items above far transfer items and expressed confusion over the inclusion of far transfer items. Some students failed to even select far transfer items above items that were unrelated to the task.

Knowing the value of far transfer inferences in design as evidenced by the many innovations brought about by that process, it is of value to consider ways that educators can assist students in this process. Teachers should consider these findings and examine their own instructional practices and scaffolding of student transfer; small changes in the introduction of an assignment or the framing of an exercise may lead students to further transfer activities; it may be as simple as a teacher explicitly telling students to look for far transfer opportunities. Future research could explore these ideas and include the use of prompts or scaffolding (Lee & Wong, 2013) that invites students to take some time to consider items that might at first seem unrelated and even direct prompting for students to look for transfer (Rebello, Zollman, Allbaugh, Engelhardt, Gray, Hrepic, & Itza-Ortiz, 2004). Alternatively, future efforts could explore the impacts of prompting students to explain more either through interviews or through more targeted questions regarding students' justification for their choice so that greater analysis can be done to better understand students' consideration of far transfer items.

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