Transfer Between Paired Problems In An Interview

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Abstract. This paper will cover a small portion of a larger study designed to address the issue of stability of knowledge in an interview and how it is influenced by transfer of learning. An interview over basic mechanics questions will be used to show how one question can influence a student's answer to another question. Based on this transcript and other data collected during the study, students' ideas appear to be influenced not only by their experiences and the context presented in the question, but also by the context of the question. This analysis was done based on a new model of transfer called the actor-oriented transfer model developed by Lobato that is based on the "personal construction of similarities" by the student between the learning and transfer contexts. This new model will also be discussed in further detail in the paper.

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INTRODUCTION

Transfer of learning has become a major focus of education research. Many educators now view transfer as the goal of all teaching and use slogans like "teaching for transfer." [1] These ideas rest on the belief that the purpose of education is to prepare students to take what they have learned in the classroom and apply it to the world around them. This belief seems especially appropriate in physics classes. Most physics professors want their students to walk out of the class with more than simply an appreciation for the brilliance of Newton's laws. Instead the professor hopes that the student is now prepared to apply Newton's laws to everyday situations.

A NEW MODEL IN TRANSFER RESEARCH

While the purpose of transfer is fairly well agreed upon, how to assess, document and teach for transfer are far from settled.[2] Transfer research has typically been done by choosing two tasks, a learning task and a transfer task.[3] The researcher then decides what information, knowledge or skills a student should be able to transfer from the learning task to the transfer task and then documents how many students were able to do this and how many did not transfer the appropriate information. Personal experience suggested that transfer should be a universal process – it should be happening almost everywhere and almost all the time. People spend their lives transferring knowledge learned from previous experiences to the new experiences they encounter. Yet, transfer experiments consistently found transfer to be a rare occurrence. This inconsistency has caused some debate in education research and has led some researchers to abandon the idea of transfer all together. [2]

Other researchers have chosen to redefine transfer by more specifically changing their perspective and research methodology. Joanne Lobato [4] redefined transfer as the "personal construction of similarities between activities." (p 106) Based on this definition Lobato created the actor-oriented model of transfer. [5] This work has immense implications for transfer research. Lobato's definition and subsequent model places transfer squarely back in the mind of the student or interviewee. Transfer theories typically saw transfer only in situations where a student applied a concept in a manner that was consistent with what the expert or researcher expected. [3] Lobato, on the other hand, saw transfer in any situation where a student saw a similarity between two situations and used that similarity in some way. This method requires

researchers to analyze research data with a more open mind than before. Since transfer is defined by the student, often the concepts transferred by students are not correct physics concepts. This means that transfer and problem solving must be considered independently. For instance, a student may see similarities between two situations and may even use this similarity, but may answer the problem incorrectly because the information transferred was not helpful in correctly answering the problem or other information was needed but not transferred. The following interview was done as part of a larger project unrelated to transfer [6], yet reanalyzing it from the perspective of transfer sheds new light onto the students' understanding and on the usefulness and importance of Lobato's actor-oriented transfer model.

INTERVIEW ANALYSIS

In the following transcript a student works aloud through two questions taken from the Force Concept Inventory (FCI). [7] The FCI is a popular conceptual physics survey that often asks students to choose between a correct physics answer and answers which correspond with their intuition. The first problem, the hockey puck problem (see Figure 1), was question 6 on the original FCI. This problem was intended to focus on Newton's first law and second law in the context of an impulsive force. The second problem, the space ship problem (see Figure 2), was question 24 from the original FCI. This problem was intended to focus on kinematics and Newton's second law in the context of a constant force.

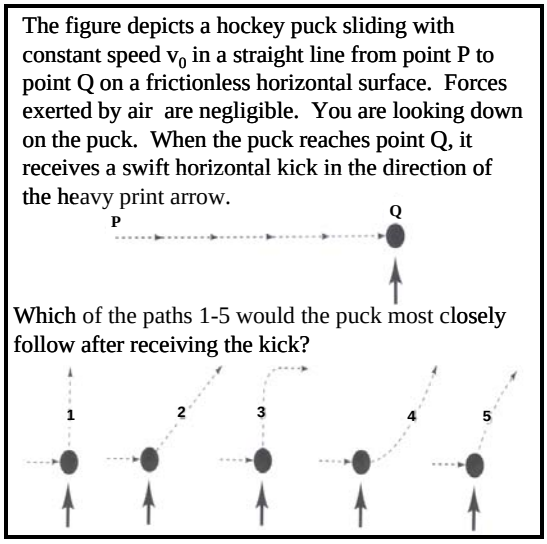

FIGURE 1. The hockey puck problem: The first problem presented to the student in think-aloud interview

The student interviewed in this transcript was enrolled in an algebra-based physics class at the time of the interview. The interview was intended to be a pre-instruction interview so the topic of forces had not been covered in the class and projectile motion had only just been introduced. This student had taken a previous physics class in high school.

I: Now if you could walk me through how you'd solve this problem.

S: Okay [the student reads the problem aloud]. Okay, it's moving at a constant speed forward which means that it's got inertia and it's already got momentum built up and once it gets hit in, I guess, a perpendicular direction it's going to want to slide at an angle. So, [choice] 4 looks like the best answer. Well. . .

I: Okay. (Pause) Okay, I didn't know if you wanted to look at it some more. If you can do the same thing with this [spaceship] question.

S: Okay [student reads problem aloud]. Ah, it looks like the same deal except this is in space and not under forces of gravity like the hockey puck was, so I think [choice] 4 is also going to be a good answer for this one. Actually, looking at this one I think on the first question [choice] 1 is probably the best answer for that one.

I: Okay.

S: Yeah, I think I mixed up the reasoning. In space the momentum and inertia are going to carry it at an angle to get to its right angle position.

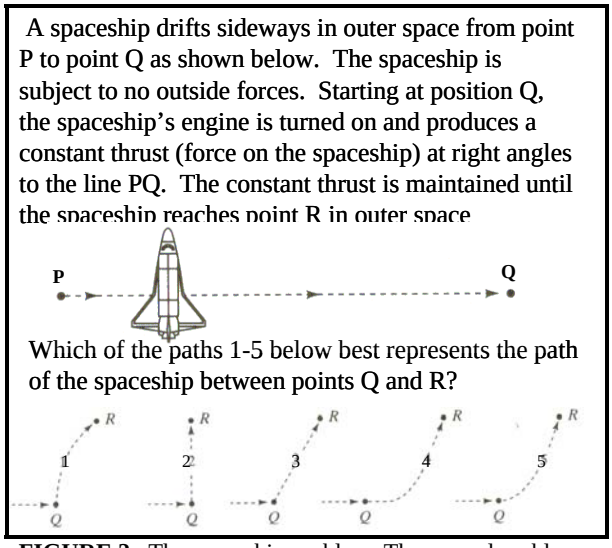

FIGURE 2. The spaceship problem: The second problem presented to the student in the think aloud interview

From a traditional transfer perspective one would look for two transfer goals in the above transcript.

- Does the student use vector addition to solve the two problems?
- Does the student recognize the difference between constant and instantaneous forces and adjust the solution accordingly?

According to the traditional perspective, transfer should take place from prior instruction, specifically in a high school physics class, to the FCI questions. Initially the student does appear to be using vector addition to solve both problems. Although the student does not explicitly indicate this, her responses appear to be consistent with this hypothesis. Her answer to the hockey puck problem is incorrect although she does appear to be correctly adding the vectors in the spaceship problem. While answer 5 is technically the correct answer to the spaceship problem, a careful reading of the transcript suggests that she did not notice the delay in path 4 and that path 4 in the spaceship problem is therefore different than the path 4 shown in the hockey puck problem. This student's decision to change her original answer to the hockey puck problem is unsettling since she switches from an answer that suggests she is at least attempting to add the vectors to one in which no vector addition is used. This student does not appear to recognize a difference between constant and instantaneous forces. Actually she makes no references whatsoever to forces throughout her explanation.

The actor-oriented model of transfer begins very differently from the traditional perspective. It does not begin by defining any transfer goals for the two problems; instead it simply looks at what information the student brings to the problem and where that information comes from. The student appears to be transferring information about inertia and momentum to the hockey puck problem from, most likely, her previous physics class. Again, although the student does not explicitly state this, her responses are consistent with this hypothesis. She then transfers her ideas from the hockey puck problem to the spaceship problem, because she believes that both problems "look like the same deal." After answering the spaceship problem she transfers information from the spaceship problem to the hockey puck problem and uses that information to change her answer, by noticing differences between the two problems. The question that remains is why the student chose to transfer information between these two problems. The above section of the transcript does not really help answer this, but the actor-oriented transfer model defines transfer based on the similarities (and/or as in this case differences) that a student sees between two situations. Therefore, what was transferred and why can be gleaned from the student's response shown below.

[After answering both questions]
I: Okay, now if we can look at both questions. While you were answering the spaceship problem did you find yourself referring back to the hockey puck?

S: Yes.

I: Anything particular?

S: Um, I guess with the spaceship it's the same situation only without gravity and earth forces on it so, yep.

To this particular student the hockey puck and spaceship problems are basically the same question asked in different contexts. This explains her decision to transfer information from one problem to the next. The only difference is the existence of other forces in the hockey puck problem, which cause her to revise her original answer. This student's view of the relationship between these two problems is further clarified when she is specifically asked what the similarities between the two problems are. She responds, "They're both dealing with an object that has a constant velocity in the direction and a quick change in direction and what would happen to its path in the process." According to the problems, only the hockey puck has a quick force applied to it. The spaceship feels a constant thrust. The student appears to have remembered the problems differently. This could be because she misunderstood what was meant by constant thrust, or because she does not see a difference between a constant force and an instantaneous force. Unfortunately this point was not probed during the interview. This discrepancy between the information provided in the problem and what is remembered by the student does help to explain why the student transferred between these two problems. To this student the only difference between the two problems is the existence of "earth forces" not a difference in the type of applied force.

CONCLUSIONS

The usefulness of Lobato's method is that it allows the researcher to see the interplay between the two problems. While previous transfer models would see previous experience or knowledge learned in class as

the key source of transferred information, looking at the transcript from the actor-oriented transfer perspective, it becomes clear that the main source of information can be the problems themselves. This student is not simply being uncertain of her answer, she is actually learning from the questions as she works through them. The spaceship question plays an important role in her answer to the hockey puck question. In previous research, not presented here, we found for two mutually related FCI questions, the order in which two questions are asked can affect the information the student reads from the question and how she answers the question. [6]

In the transcript discussed above, the spaceship question caused the student to switch from one wrong answer to another wrong answer. This isn't always the case, sometimes asking another question can lead the student to switch to the correct answer, as was seen in the larger study mentioned earlier. [6] Therefore, asking students to solve a pair of questions can allow them to see and correct errors in their reasoning. The actor-oriented model of transfer provides a framework for recognizing appropriate question sets. The most important aspect of these question sets is that students must recognize the relationship between the two problems. Two problems that appear to be obviously related to an expert may not be related according to a student. This is where Lobato's method becomes so important. This technique is similar to the instructional method used in Elby pairs. [9] Elby pairs ask students to answer two related questions. In one question students are likely to use their raw intuition and incorrectly answer the question. For the other question, students are more likely to use their new physics knowledge or refined intuition and correctly answer the question. The instructor can then lead students through a discussion of why the two answers conflict. The method described above differs from this technique since both questions used in the study can be answered using student's intuition and experience from the world around them. The actor-oriented model of transfer provides a theoretical basis for why these methods successfully allow students to correct their responses or ideas and therefore could serve as a guide to designing productive instructional strategies in the future. Further research is warranted to explore the effectiveness of such strategies.

Lobato's actor-oriented transfer model sheds light on a problem that is usually overlooked. Students usually do not walk into an interview with their answers already planned. Instead they often construct their reasoning as they work through the problems. [8] This means that a student's answer can be influenced by events that occur in the interview, as shown in this transcript. Previously, student knowledge has been considered relatively stable. This is apparently not the case. Students are constantly transferring knowledge from one situation to the next, including knowledge from a previous problem to and from the subsequent problem. This means that by simply asking a question, a researcher has possibly changed the knowledge of a student. This has possible repercussions not only for interviewing situations but also for research surveys and even for exams. [6]

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