Transferring knowledge from one context to another

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ABSTRACT

This current case study examines the knowledge expressed by students in grade 9 (14-15 years old) when they have been taught about a specific technical system, the wastewater system, and are then asked to describe another optional technical system. They have been taught about the wastewater system through activities such as drawing their own system model and receiving specific guiding questions. In the case study, three students were interviewed after being taught about the wastewater system, and during the interview, they were asked to describe another optional technical system. They drew a system model and described the chosen system. The students' descriptions and their drawn models constitute the data in the case study. The data has been analyzed with transfer theory, and the results are discussed in relation to previous research on certain interpretations of transfer. The results show that the students describe structure and flow. A linear thinking is transferred to the students' descriptions of the new technical system, which may indicate that the relatively linear structure of the wastewater system is transferred to the new system, which, however, has a more circular structure. In conclusion, this study highlights the importance of equipping students with effective learning strategies for comprehending and describing various technical systems. The findings emphasize the need for additional guidance to facilitate the generalization of system knowledge, particularly when transferring knowledge between systems with different structural characteristics.

Key Words Transfer, technical systems, self-drawn system models.

1. INTRODUCTION

The ability to generalize and transform previously learned knowledge into a new context is important in today's rapidly changing society, where demands and technologies are constantly evolving. The goal is to leverage existing knowledge and experience to solve new problems and address new challenges, rather than starting from scratch every time. This saves time and is beneficial for the individual. By acquiring new skills and abilities, students increase their competence, which in turn can contribute to improved performance and knowledge development and deepening based on previously acquired knowledge (Schwartz, Chase, & Bransford, 2012).

Within educational research, this phenomenon is referred to as "transfer of knowledge". The idea is that a deeper understanding of transfer is important for designing learning activities that allow students to apply their knowledge of a technical system and thereby improve their ability to learn about another system. Empirical material consists of interviews and students' own system models.

The term transfer (Jensen, 2006) is used to describe various phenomena or processes in different scientific and academic disciplines. It can be positive transfer, where previous learning facilitates new learning, or negative transfer, where previous learning hinders or complicates new learning.

The idea that knowledge and skills acquired in one context should be useful in another context other than the original one is grounded in most learning situations.

2. LITERATURE REVIEW

2.1. Knowledge transfer

Knowledge transfer is an important part of education in schools. Transferring can be done in various ways. This process of knowledge transfer is important because it enables students to be more effective in their work and build upon previous knowledge when learning something new. Teachers need to help students make connections between what they learn in one subject or lesson and other areas. Bransford & Schwartz (1999) have studied knowledge transfer and learning. They have examined how students can transfer and apply their knowledge and skills in different contexts and situations, emphasizing the importance of bridging previous experiences with new knowledge to facilitate knowledge transfer and learning. Some examples of such bridges in knowledge transfer include actively activating and connecting previous knowledge and experiences with new knowledge or finding similarities between previously known situations and new problems, allowing students to transfer their knowledge and strategies from one context to another. Teachers can assist by making clear connections between what students have previously learned and what they will need to know in the future. Thus, knowledge transfer is about helping students develop the ability to use previously learned knowledge to learn something new. By showing them how they can apply what they already know in new situations, teachers can help students develop critical thinking skills and become more confident in their ability to learn and grow. In this case study, the concept of transfer is used in relation to learn (cf. Bransford & Schwartz, 1999; Marton, 2006).

2.2. Challenges with transfer

There are several factors that can affect transfer in learning, such as the similarity between the initial learning and the target situation, as well as the level of understanding of previous knowledge and experiences, and the interest in transferring and applying previous learning to new situations. Previous research on transfer has been subjected to critical discussion. Criticisms have been directed, for example, at the notion that transfer implies that knowledge is something that individuals "have" and can easily be moved between different contexts (Day & Goldstone, 2012). There has also been criticism of a narrow view that involves using knowledge from one situation in another similar situation (cf. for example Bransford & Schwartz, 1999; Marton, 2006). Transfer studies have been criticized for overlooking the situated nature of knowledge and treating transfer as a clearly defined action. Instead, many emphasize the importance of seeing knowledge transfer as a dynamic, continuous, and actively constructive process where the interpretation of knowledge always takes place in a new context (Kilbrink, Bjurulf, Baartman & de Bruijn, 2018).

Research has discussed what hinders transfer, and one challenge highlighted is understanding the similarities between different contexts, a phenomenon called "recognition failure", where essential knowledge is not recognized and utilized (Day & Goldstone, 2012). Similarly, research has also pointed out that recognition can hinder transfer or represent an example of "negative transfer" (Schwartz, Chase & Bransford, 2012, p. 205). Negative transfer can occur when phenomena appear to be the same and are therefore perceived in the same way, despite only superficial similarity ("Surface similarity") (Day & Goldstone, 2012).

3. METHODOLOGY

3.1. Data collection

To capture students' knowledge and examine aspects related to transfer, interviews have been conducted. Three individual interviews were conducted with students who had undergone instruction on the wastewater system over a few weeks. They worked on developing and deepening their own system model during the lessons as they acquired more knowledge. During the interviews, students were asked to think of a new technical system, draw it, and describe it. The interviews lasted approximately half an hour. The interviews can be defined as semi-structured, meaning they were open-ended but focused on specific predetermined themes (Brinkmann & Kvale, 2015). Initially, an open-ended question was asked for the students to explain and draw their own system model of any chosen technical system. The students had been taught about technical systems using a specific educational model (Engström & Svensson, 2022), which included drawing their own system model. The educational model as a whole can be seen as guidance for teaching system thinking in technology education. The educational model is composed of insightful questions that encompass a wide range of topics, for example questions about the structure, purpose and challenges of a technical system, that a teacher can ask their students and examples of activities that students can carry out. The students' drawn models, their responses, and other transcribed descriptions formed the data for this case study.

3.2. Analyze

In this case study, the Transfer theories of learning, as outlined by Day & Goldstone (2012), are utilized. This theory is relevant for this type of analysis as it focuses on capturing how students can benefit from their previous knowledge in their knowledge development. In the analysis of the empirical material, particular attention is given to what and how students relate their theoretical knowledge of the wastewater system to their description of another technical system. Two central concepts, "recognition" and "recognition failure," have been employed. The analysis involves studying and thematizing the students' drawn models and their accompanying descriptions to identify examples of transfer challenges.

4. RESULTS

The results are organized based on the analysis findings, which identified two types of transfers in the material: "recognition" and "recognition failure." Finally, these results are discussed in relation to previous research, exploring how instruction can be designed to facilitate transfer and enhance students' ability to transfer knowledge from one technical system to another.

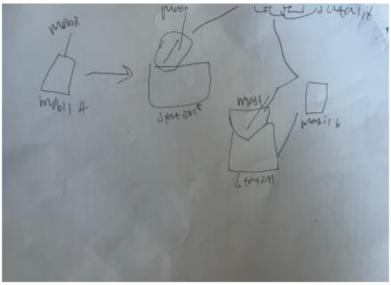
4.1. Recognition

The students describe that they can benefit from the opportunity for knowledge transfer and from having strategies to learn about another technical system.

> "I can use the questions [from the educational model used in teaching the previous system] if the systems have the same principle and can be delimited. We can take mobile communication as an example, like this, input, parts, and output. Making a model helps because it's easier to explain to others." (John)

This statement highlights the student's recognition of the value of using transfer strategies, such as identifying similarities and creating a model, to understand and explain different technical systems. It suggests that providing students with structured approaches and tools for knowledge transfer can enhance their ability to apply their previous knowledge to new contexts.

Figure 1.
John



The students also describe experiencing challenges in learning each time it is done in different ways, and that it takes time to learn the strategy, which takes away from learning the actual content.

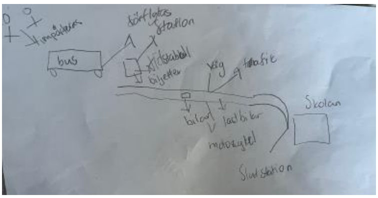
> "From my perspective, I found it easier to think about another system when I did the same thing as with the wastewater system, that is, I had the questions [from the educational model used in teaching the previous system] ready, and then it was good to draw because then I can show that it leads to that and it leads there and continues there, so I think it's much easier, and I didn't have to think about it [how to do it]" (Fredrik).

The students' descriptions demonstrate that the strategies of structure, flow, and linear thinking are transferred to their descriptions of the new technical system.

> "A transportation system is something completely different with cars and stuff, the input is people, for example, those who need to go to school, here are three roads and here is a bus, and it has different schedules. I should maybe draw the subway too, it's underground, you can compare it to the pipes in the wastewater system, and here is the school, and finally, the end station" (Anna).

These statements indicate that the students rely on their previous knowledge and the strategies they have learned, such as using questions and creating visual representations, to approach new technical systems. They also highlight the transfer of structural and linear thinking from the previous system to the new one. However, they also express the need for time and effort to learn and apply these strategies effectively, suggesting that facilitating transfer requires ongoing support and guidance from teachers.

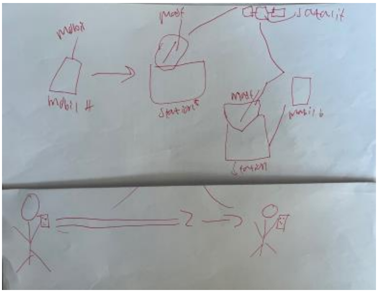
Figure 2.
Anna



The students also demonstrate flow with directional arrows in their system models, for example, showing how information flows from input to output.

> "A person talks on their mobile phone, and with the help of the internet, I think, the signal that is sent, so to speak, will be transmitted to the next person who may live on the other side of the world or maybe the neighbor. It is part of the communication system, and you understand the principle: a mobile phone, satellites, and to the other mobile phone" (John).

Figure 3.
John



However, the students don't seem to escape linear thinking, as they express how the components need to interact in the system.

4.2. Recognition failure

The students express how the subject matter differs significantly, meaning that the wastewater system is different from the transportation system, making it difficult to generalize and transfer subject content. "I can draw an input and an output, but I need to find out how the transportation system actually looks because the wastewater system is something completely different" (Anna).

However, the same student also expresses that the strategies they learned in the previous system's instruction help her systematically learn about another technical system, like "if I can learn about all systems by answering the questions and stuff, the questions [from the educational model used in the instruction of the previous system] that we did with the wastewater system."

In the students' newly drawn models, it can be observed that linear thinking is transferred as they draw components in a row, but they also mention that the components need to interact. There seems to be a belief that if you work with different technical systems, it is not possible to compare them. One student expressed, "For me, no, or I don't know, we have worked with so many different systems in a short time, and it was difficult to compare them" (Fredrik). "The first questions [from the educational model used in the instruction of the previous system] about the overall picture fit any system you want, but the last questions were in-depth questions about the wastewater system only, and it was easy to make the drawing the same." In the above quote, it becomes evident that both subject matter and principles are significant. If you have the same general questions and have practiced drawing your own system model, it is perceived that these can be used to learn about a new system.

5. DISCUSSION

The findings of the analysis have been organized into two distinct categories of transfer, namely "recognition" and "recognition failure." These outcomes are now discussed in relation to existing research, while also exploring how instructional methods can be tailored to support effective transfer and the enhancement of students' capacity to apply their knowledge across different technical systems.

5.1. Recognition

Within this category, students articulated the benefits of employing transfer strategies and structured approaches when grappling with new technical systems. For instance, John highlighted the utility of employing questions and constructing models, drawing parallels between familiar and unfamiliar systems. This acknowledgment of transfer strategies suggests that providing students with systematic tools could enhance their aptitude for adapting prior knowledge to novel contexts.

Furthermore, students mentioned challenges associated with varied learning approaches, highlighting the time and effort required to internalize these strategies. Fredrik, for instance, discussed how using a consistent approach improved his ability to tackle new systems. These anecdotes underscore the significance of consistent strategies for fostering successful transfer.

The students also demonstrated an inclination toward structural and linear thinking when interpreting new systems. Anna's description of a transportation system showcased how she employed her previous understanding to create analogies and connections between components. Evidently, there was a transfer of not only knowledge but also thinking processes from the prior system to the new one. Nevertheless, it was evident that mastering these strategies necessitated continued guidance and support, emphasizing the role of educators in facilitating transfer.

5.2. Recognition Failure

In the context of recognition failure, students acknowledged the distinct nature of subjects, exemplified by Anna's comment on the dissimilarity between wastewater and transportation systems. This divergence in subject matter posed challenges in generalizing content from one system to another. However, Anna's subsequent statement revealed that strategies acquired from previous instructions still supported her in systematically approaching new systems.

While linear thinking was observed in the models drawn by students, they also recognized the need for interaction among components. Interestingly, some students expressed a belief that comparing dissimilar technical systems might be infeasible due to their distinctiveness. Fredrik voiced this sentiment, mentioning the difficulty in drawing parallels between systems due to the rapid exposure to diverse subjects.

Nonetheless, it was evident that students found value in employing the same set of general questions and system modeling practices across different contexts. This finding suggests that transfer could be facilitated by maintaining consistent practices while allowing room for adaptations to suit the unique attributes of each technical system.

6. IN CONCLUSION

The results indicate that students exhibit both successful recognition of transfer strategies and challenges associated with recognizing transfer opportunities in varying contexts. While they demonstrate a capacity for applying prior knowledge and thinking strategies to new systems, they also encounter hurdles in generalizing these approaches across distinct subjects. These findings underscore the importance of tailored instructional methods that empower students with adaptable tools while acknowledging the nuances of different technical systems. By providing consistent strategies and guidance, educators can enhance students' ability to transfer knowledge effectively, fostering a deeper and more interconnected understanding of diverse technical domains. Consciously integrating learning transfer into education can contribute to improving students' utilization of prior knowledge and strategies and applying them in a new context. This can be relevant in areas such as education, professional practice, and lifelong learning (Barnett & Ceci, 2002). By actively promoting the transfer of prior knowledge and skills to new situations, teachers can help students leverage their existing knowledge and use it in meaningful ways. Through deliberate integration of transfer skills in teaching, educators can assist students in developing the ability to generalize and adapt their knowledge to various situations (Jensen, 2006). This concept is applicable in various domains, including education, professional practice, and lifelong learning. By teaching students to identify common principles and strategies that can be applied across different domains and problems, they can develop a more flexible and effective approach to learning. Research, such as the study referenced (Barnett & Ceci, 2002), emphasizes the importance of promoting learning transfer in education to support students' knowledge development and application of skills in different contexts. By deliberately structuring and designing instruction to include transfer exercises and reflection, students have the opportunity to integrate and apply their knowledge in a deeper and more meaningful way.

In summary, consciously integrating learning transfer in education can help students transfer and utilize their prior knowledge and strategies in new contexts. This can promote a more flexible and adaptable learning process and contribute to long-term knowledge development and application.

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