

Primary school students' perception of technology

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ABSTRACT

Research on students' perceptions and understanding of technology has shown that students have a narrow view of technology: for example, technology is often manifested in students' descriptions as artefacts or objects. This paper aims at investigating how students develop understanding of how technology is manifested during classroom activities in technology. The study was conducted at a compulsory primary school with eight-year-old students.

The data (video and audio recordings) were collected in small-group interactions and whole-class discussions. In the interactions, the students utilised self-taken photographs to visualise their understanding and perception of technology. The analysing process is grounded in Mitcham's (1994) manifestations of technology: object, activity, volition, and knowledge.

Based on the students' prior knowledge, they perceived technology as contemporary electrical artefacts. The findings indicate that students achieve a more nuanced perception and understanding of technology as objects during classroom activities in technology.

Key Words interactions; manifestations of technology; primary school; technology education; technological artefacts

1. INTRODUCTION

In technology education, a common approach is to introduce students to technological artefacts as they are easy to comprehend and visualise. In addition to that, de Vries (2016) states that students commonly view technology as artefacts. However, this approach could lead to students having a limited understanding of technology. The studies reviewed in this paper, using Mitcham's typology, agree that students of various ages have a limited perception of technology with most viewing technology primarily as artefacts or objects and some also describing it as activities. Nonetheless, it is essential to support students to enhance their understanding and knowledge of technology. This is a crucial aspect of technological literacy, as students need to comprehend central technological concepts as well as the relationship between technology, society, individuals and the environment (ITEA, 2006). Additionally, if students realise the impact of technology on their lives, it can provide them with agency and responsibility. While

previous studies highlight the importance of improving students' perception of technology, there is a lack of empirical research examining how students encounter a wider perception of the manifestations of technology during technology education activities. Therefore, the present study seeks to address this research gap.

Su and Ding (2022) concluded that students generally define technology by its contemporary characteristics, such as artefacts requiring electricity to function. Similarly, Ankiewicz (2016) noted that students' concepts of technology are often insufficient and primarily focus on contemporary artefacts. Therefore, primary school technology education plays an essential role in shaping and developing students' understanding of technology (Su & Ding, 2022). Additionally, this understanding is essential for developing technological literacy, which involves, amongst other things, understanding of what technology is, how it evolves, and how it is created (ITEEA, 2020).

This paper aims at exploring how primary school students, in interactions with fellow students and teachers, perceive and communicate understanding of technology manifestations. This understanding involves Mitcham's (1994) aspects of technology that may become visible in student interactions. This study considers the interactions between students in small groups (2–4 students in each group) and between teacher and student in whole-classroom discussions (e.g., Mercer & Littleton, 2007). Thereby, it is possible to identify and analyse in what ways students communicate an understanding of how technology can be manifested by using verbal language to formulate ideas and construct an understanding of technology together with fellow students and their teacher (e.g., Howe et al., 2019; Hennessy et al., 2020; Mercer, 2000; Vygotsky, 1978). The research question addressed in this study is:

In what ways do students perceive how technology is manifested?

2. LITERATURE REVIEW

Technology may include a large number of basic concepts (de Vries, 2016b), which can be divided into five categories: designing (elements in designing, such as invention and practical reasoning), system (concept of systems and subsystems, such as artefacts, structure and function), modelling (visualisation etc.), resources (such as material, humans and information) and values (sustainability, risk/failure etc.). Various concepts have been employed in technology education to clarify the functioning of artefacts. Thereby, those concepts are considered essential to students' development of a comprehension of how society and technology are interrelated and affect each other (de Vries, 2016b; Koski, 2014) and therefore taught in schools. According to de Vries (2016) technology can be described as experience-based, macrotechnologies and microtechnologies. Experience-based technologies are technologies that have been developed through human experimentation throughout history. Macrotechnologies are based on fundamental theories such as mechanics. Finally, microtechnologies are essential parts in microscopic technology.

Technological artefacts are humans' first encounters with technology and any object that is intentionally designed, made, and utilised by humans to achieve a certain goal (de Vries, 2016).

Thus, technological artefacts only exist in relation to humans' intentionality, meaning that the artefacts are manufactured rather than just existing as physical objects. In that context, Kroes and Meijers (2006) state that technological artefacts have a dual nature: described from physical and functional aspects, which combines different ways of perceiving the world. The dual nature of technological artefacts indicates that technological artefacts are physical structures designed to fulfil functions determined by humans' intentions (Kroes & Meijers, 2006).

Mitcham (1994) categorised technology into four modes of manifestation: objects, knowledge, activity, and volition. According to Mitcham (1994), technology as object refers to the most immediate and visible mode of technology, encompassing human-made material artefacts, such as clothes, utensils, tools, and machines. Technology as knowledge involves mental knowledge, which is required for making and using technological artefacts. Technology as activity relates to the combination of knowledge and volition in constructing artefacts and can be seen in various human actions such as crafting, inventing, designing, manufacturing, working, operating, and maintaining. Lastly, technology as volition is associated with different kinds of will, motives, and intentions (Mitcham, 1994).

2.1. Previous research on students' perception of technology

Blom and Abrie (2021) found that students (South African ninth- and tenth-graders) have limited perceptions of technology. By utilising Mitcham's typology of technology in the analysis they concluded that the students most often associated technology with objects and/or activities, thus disregarding technology as knowledge and volition. The findings also imply that a majority of the students related technology to new electronic objects and the technological activity to designing, making and utilising technology (Blom & Abrie, 2021).

In the same way, Su and Ding (2022) conducted a study on Chinese primary school students, 9–12 years of age, and investigated their conception of technology, how technologies affect human life and the interrelations between science and technology. In the study, the researchers used images to encourage students to describe technology and also interviewed the students. The findings indicate that students describe technology from various aspects, such as the dimensions of its features, production, function, operation, and use. Su and Ding (2022) stated conclusively that primary school students, in the study, perceive technology insufficiently and have difficulty understanding the relationship between science and technology. Although some studies found that students perceive technology in a limited sense, Su and Ding (2022) stated that, regarding Mitcham's typology, all four aspects of technology were represented in their findings.

Svenningsson's (2020) study revealed that, like previous research, Swedish students describe a limited view of technology. By utilising a deductive method in the analysis of the 164 students (aged 12–15) descriptions of technology, Svenningsson found that the students most commonly describe technology as objects, with modern electrical objects being the most frequent examples mentioned. Although Svenningsson investigated other ways in which students could potentially describe technology, such as volition and knowledge aspects of technology, students' perceptions of technology were largely limited to technology as objects and activities. However, the results indicate that students have the potential to describe technology more broadly by using all four manifestations of technology outlined in Mitcham's typology.

3. METHODOLOGY

3.1. *Setting and participants*

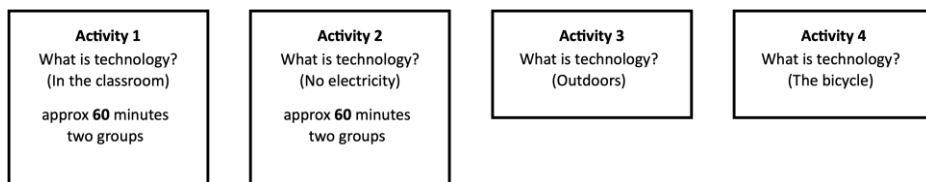
To approach the research question, communicative situations were arranged, in which the students were encouraged to discuss, explain, and talk about technology. The study adopted a qualitative research method grounded in a sociocultural perspective on learning, which implies exploring students' learning through spoken interactions, communication, and reasoning together (Hennessy et al., 2020; Jakobsson & Davidsson, 2012). The tablet camera constitutes decisive support as it helps the students focus attention on a specific object and the self-taken pictures purposively provide appropriate support for the students to evolve interactions in the follow-up dialogues between students (e.g., Hennessy et al., 2020; Lind et al., 2019).

In the analytic process, Mitcham's (1994) typology of technology was the starting point. This was perceived as suitable when analysing students' descriptions of technology as it includes concepts found in students' descriptions of technology, in previous research (Blom & Abrie, 2021; Su & Ding, 2022; Svenningsson, 2020).

3.2. *Collecting data*

For data collection, audio recorders (10 pcs) and video recorders (2 pcs) were utilised: and placed in the student groups' workplaces. In this way, it was conceivable to get close to the students' interactions by being able to see and listen to the material multiple times (Cohen et al., 2011). The data were collected in two classes during two teaching sequences and comprised two occasions of 60 minutes (activity 1 and activity 2). The regular teachers were responsible for the teaching and learning activities.

Figure 1
Classroom activities



The overall purpose of the teaching sequences was to enable students to perceive technology in their nearby surroundings. The data collection occasions constitute pre-decided learning situations from the whole teaching sequence (Figure 1). This means that the students had approximately seven lessons of which two are in focus for this paper. Between the data collection sessions, the teacher used the students' pre-understanding of technology, identified in a previous activity, to create situations where the students were given the opportunity to develop an understanding of the world around them and how it is structured. A significant part was understanding how and why technological artefacts are developed and how they work. In this context, the teacher and students use subject-specific terms, such as artefacts, components, and

technological systems, to broaden students' conceptual understanding of technology. An additional aspect was to make students perceive that technological solutions, like artefacts, are surrounding them. These situations involved engaging the students in conversations around their photographs and the teacher's questions, which involved different aspects of technology and thus enabled a broadening of understanding of the concept of technology. The questions were identified as very important in guiding the students' conversations and thereby leading them towards a broadened understanding of technology.

The two occasions were selected because the classroom activities provided possibilities for taking pictures, time for discussions and working in groups. In total, there were approximately 8,5 hours of collected data.

3.3. Ethical considerations

As the students in the present study are young (aged 8-9), it is ethically required to obtain informed consent from the guardians, even though the data collection is taking place in an ordinary teaching situation (Shammo and Resnick, 2015; Utbildningsdepartementet [Department of Education], 2021). Accordingly, I applied for and received ethical approval from the Scientific Council (Codex, 2022).

3.4. Analytic process

The analytic process comprised three separate but interrelated phases. The first phase involved identifying all situations in which students expressed ways in which technology can be manifested. This was done by using the critical incident technique (Angelides, 2001). A critical incident could be described as the interpretation of the significance of a situation (Angelides, 2001), which characterises and reveals a particular feature of a student's behaviour, such as a question, an action, or an expression of understanding (Cohen et al., 2011).

The second phase took a deductive approach using Mitcham's typology of technology and the four modes of manifestation: Objects, Knowledge, Activity, and Volition. The choice of framework for interpretation is grounded in the fact that this is a well-explored model (e.g., Ankiewicz, 2019; Blom & Abrie, 2021; Su & Ding, 2022; Svenningsson, 2020) and that it contributed to increasing our understanding of how eight-year-olds consider and understand how technology is manifested. Furthermore, the framework was found to be fruitful as it could be used for this data material to explore how the students discuss technology during the activities.

The third phase of the analysis included a discussion, regarding technological artefacts: the manifestation of technology as objects. The results of the analysis are described both through excerpts from student interactions related to various manifestations of technology and by relating students' perceptions of technological artefacts to previous research to develop a broader understanding of primary students' perception of technology.

4. FINDINGS

The chosen excerpts are of interest because they demonstrate significant examples of how students perceive technology throughout the collected data material. The excerpts are extracts from longer interactions.

4.1. Activity 1

In the first activity, the students worked unconditionally with the question “What is technology?” and used a tablet camera for documentation. The students photographed and focused their attention on technology in the classroom. In the subsequent interactions, they mainly focus on technology, which could be described as contemporary objects.

Table 1
Excerpt 1

Teacher	Which images did you choose for technology?
Ava	iPad, iPad cabinet or charger, laptop, headphones, and watch
Teacher	Why is it technology?
Ava	We believe because we think because they conduct current

In this excerpt, Ava interacts with the teacher and argues that iPad, iPad cabinet or charger, laptop, headphones, and watch are technology, which are considered objects or artefacts. Further, she states that it is technology because it conducts current. Here, one could emphasise that the student might have misunderstood the concept of conducting current, it would be more appropriate to say function with current. However, as this is a learning situation, it is most likely that the teacher utilises their utterances as a way to deal with expanding students’ understanding of the concept of technology as the work proceeds. After the first activity, it was obvious that the students’ perception of technology was related to contemporary artefacts functioning with electricity.

4.2. Activity 2

In the second activity, the students continued working with the question “What is technology?”: now requested to exclude electric-powered artefacts. The camera was used in a similar way as in the first activity. The students looked for artefacts that function without electricity and identified, photographed and utilised the pictures in the group interactions. The class discussion started by referring to the previous activity to challenge the students’ understanding that artefacts can function with or without electricity.

Table 2
Excerpt 2

Milad	Things that humans have made
Teacher	Why have humans made these things? Discuss in your group
Cy	To have a better life, you can use them for different things
John	I know
Cy	Kind of like the iPad
John	You can use it to write and stuff like that
Cy	Pencil too, you can write

The statement from Milad allows the teacher to post a question to the class and ask them to proceed with discussions in their groups. In the group discussion following that, Cy and John elaborate on Why have humans made these things?. Cy's To have a better life, you can use them for different things could indicate that he believes artefacts (technology as objects) are intentionally created for humans' lives to be better. However, he continues his argumentation on the question by stating Kind of like the iPad and invites John to display his perception of technology You can use it to write and stuff like that. Finally, Cy adds the pencil as he likely compares the two artefacts, iPad and pen, and their joint opportunity for writing activities. By comparing the artefacts' features, the students, without thinking about it, make a reflection on technological development and how diverse writing tools can be used. It is possible to interpret the students' presented technology as objects as both microtechnology (the iPad) and experience-based technology (the pencil). According to Kroes and Meijers (2006), elaboration on the artefact's feature (to write) could be looking at one of the aspects of the dual nature of artefacts: artefacts to fulfil human needs.

Table 3
Excerpt 3

Milad	We took pictures that have electronic in them
Xeni	You can use
Milad	Yeah
	...and eh ...which are important
George	What?
Milad	Which are important
George	Which are important
Xeni	Should we use these pictures?
Milad	...and which we need
George	Yeah. They are good stuff...
Milad	Yeaah
Xeni	You need to talk to me as well
Milad	...that is needed
George	... which you can drive with
Teacher	Could you tell me about 2-3 artefacts that you have taken pictures of
George	Mobile phone, iPad, charging locker, car
Teacher	Why is this technology?
Milad	Humans have made them
Teacher	What was our thought in the beginning
Milad	That there were electronics in them

In this excerpt, the students are discussing the artefacts they have photographed. Their teacher adds questions in the whole class discussion to promote the students' thinking about their chosen artefacts. Milad starts, in the small group interaction, by stating that the artefacts [...] have electronic in them, which is outlined in the above-presented research as a common perception of technology amongst students. However, it is also apparent that Milad, Xeni, and George jointly elaborate on technology and additionally utilise several of the modes presented by Mitcham (1994), for example, object (mobile phone, iPad, car), activity (Humans have made them), volition (They are good stuff.....that is needed). Technology as knowledge is harder to recognize in the discussion. Nonetheless, it is possible to interpret Milad's final utterance [...] there were electronics in them as a way of expressing knowledge on how the technological artefacts function to achieve a human need (Kroes & Meijers, 2006). In this case, the students' descriptions, in addition to objects, now refer to all the manifestations of technology.

5. DISCUSSION AND IMPLICATION

In this paper, the aim was to explore how primary school students perceive how technology is manifested. The students take pictures of and talk about technology mainly as objects and micro-technologies, which is in line with previous research, as students often mention different electronic devices when they are asked to identify and describe technology. It is likely that students discuss technology from the perspective of modern high-tech artefacts, functioning through electricity and that this also might be a prevailing discourse in society (Ankiewicz, 2016; Blom & Abrie, 2021; Svenningsson, 2020).

During the interactions and classroom activities, it was evident that Mitcham's typology was too broad. Therefore, it was possible to further evolve the students' interactions by looking at Mitcham's mode technology as objects. As described in the theoretical background, de Vries (2016) divides artefacts (objects) into three subcategories: experience-based, microtechnologies and macrotechnologies. The aspect of microtechnologies is the most common among the students' pictures and in their interactions, for example, laptops and headphones. However, as the technology activities proceed, both experience-based and macrotechnologies become a part of the students' interactions, for example, pencil, and car. The activities between lessons are important because the teacher can create situations where in-depth conversations about technical concepts and the manifestations of technology arise. However, these activities are not primarily the focus of the study.

The findings didactically indicate that by using the tablet's camera as a tool to tap into students' pre-understandings of technology, teachers can construct learning situations in the classroom that build on students' perceptions of technology. This was done by the teacher using the photographs to create interactions that, supported by questions, led the students towards a deeper and broader understanding of technological artefacts. By looking, for example, at Mitcham's technology as object, it can be easier for the teacher to, before the lesson, prepare didactic questions (Why have people created this technology?, Why do we need this technology?, What do we need to create artefacts?). In this way, it was also possible to add ethical perspectives to technology development. Young students are fully capable of discussing technological objects from various aspects, such as why and how they are created.

Conclusively, the findings suggest that young students, with the support of photographs, interactions, and questioning in learning activities, are competent to develop and expand their understanding of how technology is manifested during activities in technology education. In line with Su and Ding (2022), the analysis of the findings indicates that students can learn and utilise all four manifestations and several subcategories of technology. This means that the teaching and learning activities impact students' understanding of technology as object as well as developing an understanding of technology as activity, volition, and knowledge. Thereby, students develop an expanded understanding of the manifestations of technology.

6. REFERENCES

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