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Technical Blindness and the Limits of Artefact Thinking: A STEAM-Based Pilot Study in Teacher Education

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Abstract

This pilot study explores whether an iterative noticing-and-reflection activity, supported by children's literature, can help pre-service teachers broaden what they see as technology. Three students in Swedish primary teacher education (grades 4–6) participated in a three-phase sequence that included taking photographs and reading children's literature, with an explicit focus on the question "What is technology?". The analysis examined how participants described technology in terms of (i) function and use, (ii) explanations of how or why it works, and (iii) contextual and ethical considerations. Across the three phases, participants initially tended to identify technology mainly as artefacts, particularly electrified devices. After the seminar discussion and repeated documentation, the photographic examples more often included non-electrified tools and everyday technologies, suggesting a shift in what participants noticed and categorised as technology, which was made visible using a STEAM perspective. Participants' written justifications also moved, in some cases, from naming objects toward brief reasoning about purpose, constraints, and alternatives, while contextual and ethical aspects appeared less frequently. As a small exploratory study, the findings do not support any general claims. Still, they indicate that staying with definitional and boundary questions about technology, in combination with aesthetic and narrative resources, may help future teachers in technology education lead the way out of pupils' technical blindness.

Key Words: STEAM, Conceptions of Technology, Perspectives on Technology, Pre-Service Teachers, Aesthetic Learning Processes

1 INTRODUCTION

Technology education in primary school (age 10-12) offers many opportunities for pupils to explore how technology shapes daily life but teaching often relies on taken-for-granted ideas about technology and its purpose. This paper examines how pre-service teachers can be supported in questioning and expanding these ideas through an iterative activity that combines documentation, discussion, and narrative. First, the study background and problem are outlined, then the guiding theoretical perspectives are introduced, and finally, the design and results of a small pilot study are presented.

1.1 Background

Technology education influences how students understand and engage with the human-made world, shaping their ideas about technology and future aspirations (Frederik et al., 2011; Morieson et al., 2013). Early conceptions impact participation, confidence, and careers (Ankiewicz, 2015; Birney & McNamara, 2024; Pavlova, 2005). However, many hold narrow views equating technology with artefacts, overlooking its societal and cultural aspects. Interest in STEAM education—integrating science, technology, engineering, arts,, and mathematics—has grown, promoting interdisciplinary teaching that includes narrative, imagination, and multimodal expression. This broadens students' understanding of technology. Research indicates STEAM can enhance subject knowledge, understanding, and engagement (Cheng et al., 2021; Conrady & Bogner, 2020; Lu et al., 2021; Kress, 1997; Ozkan & Topsakal, 2021; Piila et al., 2021). Mejias et al. (2021) highlight that transformative STEAM approaches could improve educational outcomes. This provides motivation and focus for this study on how teacher education may help students in seeing technology beyond artefacts.

1.2 Aim and research questions

This pilot study aims to explore how an iterative, exploratory activity combining photographic documentation, guided reflection, seminar discussion, and children's literature may support pre-service teachers in broadening their conceptions of technology. To reach this aim, we formulated two research questions

- How do pre-service teachers initially articulate and visualise technology in their everyday lives?
- In what ways does the iterative activity (including discussion and literature) relate to changes in how they perceive technology?

2 THEORETICAL FRAMEWORK

This section presents the outline of the theoretical framework that guides the study.

2.1 Conceptions of technology

Technology is often described as a human activity directed toward artefacts as people make them and use them (Mitcham, 1994), but being human in a technical world also relies on different forms of knowledge (de Vries, 2016). These forms of knowledge help explain why teachers' views of what counts as technological knowledge can vary and shape what they prioritise in teaching (Norström, 2014). To analyse such variation, Nordlöf et al. (2022) proposed a heuristic framework that distinguishes three knowledge categories: technical skills (that it works), technological scientific knowledge (why things work, as well as that they work), and socio-ethical technical understanding (technology in society, including change over time, values, consequences, and competing interests). In this pilot, we used these categories as three analytical strands in the form of whether it works, why it works, and what it means in context, to analyse participants' photographs and reflections and to trace shifts in what they noticed and how they justified their choices.

2.2 STEAM and aesthetic learning processes

In 2013, Art was incorporated into STEM to form STEAM, not as an add-on but to integrate creative materials and multisensory tools into education (Taljaard, 2016). McGarry (2018) argues that including Art enables interdisciplinary collaboration by fostering divergent and imaginative thinking. STEAM is project-oriented, with process-based work allowing students to explore multiple subjects simultaneously and reinterpret prior knowledge across contexts (Skagerström Olsson, 2024). Mathematics, language, art, and technology can be seen as key to future learning and problem-solving (Saimon et al., 2025). Mathematics and language support understanding of the world, while technology enables exploration and representation, including through digital tools like mobile applications that extend perception (Saimon et al., 2025). Art supports expression and creativity, and aesthetic learning processes, using analogue and digital tools, create accessible communicative conditions (Alexandersson & Swärd, 2015). These processes occur through both expression and transferable learning, supporting knowledge development by integrating experiences, emotions, perception, and reasoning (Wiklund & Turlock, 2009). Mejias et al. (2021) note that STEM/STEAM definitions and implementations are often inconsistent, with Art sometimes included superficially or frameworks adopted for policy or funding purposes. While STEAM can support equitable education (Saimon et al., 2025), teachers often struggle to design truly interdisciplinary tasks. Advancing equity requires equipping teachers with appropriate approaches, though knowledge must ultimately be constructed through active student participation (Blomdahl, 2007). In this study, Art supports such participation by fostering creative engagement in understanding Technology.

3 METHOD AND DESIGN OF THE PILOT STUDY

The study is grounded in STEAM-based activities, using photography as an aesthetic medium to visualise technology. Photography involves deliberate composition; students actively choose what to include and emphasise through framing, cropping, and perspective (Lind et al., 2022). Reflecting on these images can provide valuable insights into their understanding. The study also incorporates children’s and young adult literature as an accessible entry point to scientific concepts. Fictional narratives can support the interpretation of key phenomena (Egidius, 2002) and offer new perspectives on technology (Edvardsson, 2024). As a form of knowledge distinct from scientific discourse (Johansson, 2005), narrative can make abstract ideas more tangible, connect personal and global contexts, and foster curiosity while bridging everyday and disciplinary language

3.1 Context and participants

The students taking part in the study are enrolled in their third semester, specialising in technology education, grades 4–6 in Sweden. This module aims to provide a foundational understanding of technology by integrating practical activities with didactic perspectives. The student group is heterogeneous, comprising individuals of varying ages and educational backgrounds. A few students have completed their schooling in another country, some have recently graduated from Swedish upper secondary school, and others bring extensive work experience.

3.2 Ethical considerations

We obtained informed consent from all participants, ensured anonymity by removing names and other identifiers, used only participant-generated photographs that avoided recognisable individuals and identifiable locations, and reproduced no copyrighted content from the children's books beyond what was necessary for analysis under fair use/fair dealing principles.

3.3 Three Phases of exploratory work

The study is structured into three phases, with Phases 1 and 3 including questions about students' educational backgrounds, leisure interests, and conceptions of technology. The purpose of these phases is to explore whether the students' backgrounds and prior knowledge influenced their choice of technology and their ways of thinking about technology and technological artefacts. The first Phase of the project focused on identifying what the students associate with technology and technological artefacts. They were asked to photograph what they personally connect to technology. And they should take ten pictures. They were asked to select technology from their everyday environment, for example, in their homes or along their route to school or work. This took place at the beginning of the technology course, and the students had not yet taken part in any lectures or workshops involving technological content before being asked to take the photographs.

Before Phase 2, relevant children's literature was distributed to the students. To identify suitable titles, the university librarians were consulted. They compiled a list of recommended books appropriate for pupils aged 9 - 12. The selected books needed to be suitable for discussion from a technological perspective, resulting in a mix of fantasy, adventure, and detective fiction. The students were free to choose which of the books they wished to read. To support their reading, they were provided with a set of guiding questions to answer as they read. These questions concerned, for example, the narrative setting and the role technology played in the plot. During Phase 2, the books were discussed in a Zoom seminar. The students shared their reflections on the stories they had read. The seminar functioned as a semi-structured interview, allowing students to speak freely based on their reading experiences and the guiding questions provided. We participated as facilitators to encourage deeper elaboration of their responses and to ensure that the discussion remained focused on the topic. In Phase 3, the students were once again asked to photograph ten technology meanings from their everyday lives. However, instead of responding to questions about their age, background, and leisure interests, they were given more analytically oriented questions. They were asked to reflect on whether their perceptions of technology had changed and whether they had become more attentive to its presence in their daily lives.

4 RESULTS

Across all three phases, participants most often represented technology as concrete artefacts. Tables 1–3 summarise the artefacts identified in the initial photo study (Phase 1), the book-based discussion (Phase 2), and the final photo study (Phase 3). In the tables, "E" marks electrified artefacts, meaning objects that require an electrical supply to function. In Phase 1, participants photographed everyday artefacts, many of which depended on electricity (Table 1). Electrified artefacts accounted for 52% of the identified items, including a computer, microwave oven, coffee maker, escalator, payment station, and self-scan system (Table 2). Non-electrified artefacts were also present (e.g., backpack, coffee cup, sneakers, tent), but participants more often highlighted technologies associated with electrical systems and automated services (Table 1).

Table 1

Photo study starts (Phase 1)

Backpack	Payment station (E)
Coffee cup	Roller conveyor belt (E)
Coffee maker (E)	Self-scanner (E)
Computer (E)	Sliding door
Crane	Sneakers
Crochet blanket	Hand blender (E)
Display with AI information (E)	Tent
Electric whisk(E)	Vacuum cleaner bags
Escalator (E)	Washing machine(E)
Instruments on stage	Writing pad
Microwave oven (E)	

E = Electrified artefacts, 52 %

During the book discussions, participants continued to focus mainly on artefacts (Table 2). The proportion of electrified artefacts remained high (52%), including cell phones, computers, computer games, GPS devices, lamps, televisions, and technologies connected to the "space hotel" and "space probe" (Table 2). Alongside these, participants also noted hand tools and mechanical components (e.g., hammer, screwdriver, hinge, bicycle valve), suggesting that the narrative sometimes also supported attention to non-electrified, everyday technologies (Table 2). The quotations illustrate how participants negotiated the boundary between "technology" and "magic" when the narrative introduced fictional elements. One participant framed the "agent" and the "magic pill" as potentially technical by reinterpreting them as devices. "…in the second part, it's a little more about the agent… which you can see as some kind of medical device if you want." Another participant questioned whether the story presented technology or "magic": "… it's like the technology is magic more than technology…" A third quotation shows how one participant anchored technology in familiar artefacts within the storyline, particularly bicycles and tools. "The technology is quite everyday… bicycle or bicycles are central to the story… it is about bicycle thieves who sabotage bicycles… someone uses tools… screwdriver, hammer, hinge… and… TV… computer games…" Together, these excerpts show that participants primarily used artefact recognition as their entry point, even when the book invited more speculative interpretations (Table 2).

Table 2

Technology said to have been seen during the seminar. Book discussion (Phase 2)

Bank vault	Lamps (E)
Bicycle valve	Magic pill
Bicycles	Pipe post device
Cell phone (E)	Power button
Computer (E)	Screwdriver
Computer game (E)	Space hotel (E)
Glass elevator (E)	Space probe (E)
GPS (E)	Telephone (E)
Hammer	Television set (E)
Hinge	

E = Electrified artefacts, 52%

In Phase 3, participants again photographed only artefacts, but the composition shifted (Table 3). Electrified artefacts dropped to 16%, with the set dominated by non-electrified household tools and everyday objects (e.g., cheese slicer, garlic press, scissors, screwdriver, key, clock, waste sorting bin) (Table 3). Electrified items were less common and included a ceiling lamp, fluorescent tubes, and a digital alarm clock (Table 3). This change indicates that participants broadened what they considered worth documenting as "technology" in everyday life, even though their representations remained artefact-focused.

Table 3

Photo study ending (Phase 3)

Bottle capper	Garlic press
Ceiling lamp (E)	Gas tube
Cheese slicer	Hooks
Clock	Key
Comb	Scissors
Digital alarm clock (E)	Screwdriver
Easter clip plastic	Stair railing metal
Element	Vacuum cleaner bags
Fluorescent tubes (E)	Waste sorting bin
Frying pan	

E = Electrified artefacts, 16 %

Tables 1–3 show two consistent features in the data. First, participants represented technology predominantly through artefacts across all phases. Second, the share of electrified artefacts remained high in Phases 1 and 2 (both 52%) but decreased markedly in Phase 3 (16%), indicating a shift toward noticing non-electrified, everyday technologies after the book-based, reflective work.

4.1 Analysis

The images share a common emphasis on artefacts embedded in everyday routines and social relations. They depict essential objects that enable individuals to perform tasks more quickly and ease daily life. The variation lies in the types of functionalities and efficiency highlighted by the participants. One participant directs attention toward domestic chores such as shopping, cooking, and cleaning, while the other photographed objects like a coffee cup, a drum set, and a crocheted blanket, items associated with pleasure and enjoyment in everyday life. The participant who photographed household technology describes technology as something that saves time and enables tasks to be carried out more easily and efficiently; technology is thus framed as both functional and efficiency-enhancing. In contrast, the participant who photographed other everyday objects associated with enjoyment argues that technology not only provides comfort but also serves to make life more enjoyable and accessible. Technology is understood as fulfilling needs while simultaneously generating desires.

When the participants were asked a second time to photograph what they associate with technology (Phase 3), the most notable shift occurred in the participant who had previously focused solely on electrical devices. Instead of coffee makers, hand blenders, and computers, the new set of images includes a garlic press, a cheese slicer, a screwdriver, and a key. The participant explains that the book and discussions about the nature of technology contributed to a transformed, expanded understanding of what technology can be. Becoming attentive to the broader concept of technology was described as a novel experience that shifted the focus from exclusively electrical devices to analogue tools. What remains consistent is the interpretation of technology as something that supports everyday life by making tasks easier. What becomes more explicitly articulated in Phase 2, however, is that technology is also a form of convenience we become acutely aware of and feel a need for when it is not available. One participant noted that simply posing the question, "What is technology?" directs attention in a particular way and sharpens one's "technical gaze." This participant already had a strong interest in technology and therefore did not rely on the literature to broaden their perspective; instead, the question itself stimulated reflection and discussion.

4.2 Disclosure

The authors used generative AI tools for language-level support during drafting (e.g., translation and suggestions to improve grammar and clarity). The authors conducted, verified, and take full responsibility for all data extraction, analyses, and interpretations.

5 DISCUSSION AND IMPLICATIONS

This pilot study explored what pre-service teachers count as "technology" when they engage with children's literature through an iterative, aesthetically oriented task. The data points to what we have chosen to call technical blindness. Technical blindness in this context refers to participants most often identifying technology as visible artefacts and, less often, describing the knowledge, processes, or socio-ethical dimensions that shape artefacts and their use. Such starting points matter because they influence what future teachers are likely to prioritise in classroom talk, task design, and assessment. Nordlöf et al.'s (2022) framework and the A in STEAM helped us interpret our data. Participants' responses largely reflected "use" of technology. They rarely mobilised technological scientific knowledge or socio-ethical technical understanding, which aligns with prior research showing wide variation in teachers' conceptions of technological knowledge (Norström, 2014). One plausible explanation is that everyday life supports functional use, running on electricity, without requiring explanations of construction, mechanisms, standards, or consequences, leaving students with limited conceptual tools for noticing technology beyond objects. The task also created moments of dilation. When participants needed to justify their selections, some moved from naming artefacts to reasoning about function, constraints, and alternatives. This supports the view that technological knowledge becomes visible through explanatory and design-oriented reasoning rather than through the artefact itself (de Vries, 2016). In these cases, the STEAM-infused, dialogic structure helped expose assumptions and opened space for more developed interpretations.

Narrative and aesthetic experience mainly served as a shared entry point. The story world supported engagement and provided a common reference for discussion, but it could also reinforce artefact seeing if participants treated the book as a set of "props." Broader conceptions emerged more reliably when instructions directed attention to disciplinary questions, how something works, which systems it depends on, what trade-offs it involves, and what consequences follow. This suggests that aesthetic materials can support "technology beyond artefacts" only when teacher educators explicitly connect interpretation to technological knowledge practices and contextual judgement. The findings point to using artefact identification as a first step that requires explanation and context; otherwise, it risks leading students to focus only on the artefacts. Technology educators can counter technical blindness by assessing breadth across technical, analytic, and socio-ethical dimensions. Many learners know how to use artefacts, but lessons in technology education must also help them learn how to explain, reconstruct, and evaluate them.

This pilot has several limitations: a small sample, a single institutional context, and a short time frame, all of which affect transferability. The analysis could also have examined why deeper conceptual shifts (e.g., socio-ethical or systemic thinking) did not emerge despite the STEAM-based design. It remains unclear whether photographs of technology can capture more than artefacts. Although children's literature might support broader conceptual understandings, participants still documented only artefacts despite narrative prompts and seminars. This reinforces the central finding: students most readily identify technology as artefacts. Future research should scale the design, compare contexts, vary genres and media (e.g., film, games, multimodal texts), and use longitudinal approaches to assess whether broader conceptions persist and influence teaching practice.

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