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Technological literacy in Finnish craft

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Abstract

The research task is to ask, "How do craft teachers and student craft teachers perceive technological literacy (TL) in craft for comprehensive school in grades 1-9?". TL in craft includes the conceptual and functional levels in this study. The conceptual level comprises general learning goals. The functional level comprises learning objectives, content, and methods. Empirical data were collected from Finnish student craft teachers (n=23) and craft teachers (n=56). Respondents perceived TL's general goals and learning objectives to be very necessary, and a quite strong positive correlation was found. They perceived learning content and methods as somewhat necessary, and there were no significant connections between general learning goals and learning content and methods. There were no significant differences between the respondents' different educational backgrounds. Overall, the respondents had a good perception of TL in craft. The question of how TL could connect to the learning of learning content and learning methods more deeply arises as a research and development target for the craft subject as in technology education worldwide.

Keywords

Technological literacy, craft, technology education

Introduction

In Finland, technology is specifically taught in technical work in comprehensive schools in grades 1-9 under "Craft, technical work, and textile work" (Kananoja, 2009; Niiranen et al., 2022). In the 1994 curriculum reform, technical work and textile work formed the subject group called craft, and later it was included as a craft subject in the Finnish Basic Education Act (628/1998). Nowadays, technical and textile work are called working methods in the newest national curriculum (2014), albeit without specialised information on what technologies relate to teaching those methods. Craft is a compulsory subject until the seventh grade in Finland, after which it is an optional subject in the eighth and ninth grades. Finnish schools do not have a technology education (TE) subject for comprehensive school grades 1-9, but craft is a subject corresponding to it. The cross-curricular theme "Human being and technology" was the closest to addressing TE in the 2004 national curriculum (Rasinen et al., 2011), but it is not mentioned in the most recent (2014) national curriculum.

The general goals of craft in the most recent Finnish national curriculum basics (2014) relate to the learning content areas. In grades 7-9, this refers to innovation, design, experimentation, documentation and evaluation, making, occupational safety, entrepreneurial learning, awareness, and participation. Technology is connected to four content areas in grades 7-9. The student is guided to:

1. Become familiar with cultural and technological development in design learning;
2. Apply programming to design and make products in experimentation;
3. Utilise information and communication technology in process documentation; and
4. Use the necessary work tools, machines, and devices appropriately and in a versatile manner in their making.

Teachers are permitted to decide what the technologies and their values in their craft curricula in their own city or municipality are, and the specialised technologies in students' product design and other technological learning. In countries where craft or similar subjects have been developed in TE, there has been a wider examination of how technology is defined, how it should be specified for teaching and learning, and how to teach students to understand certain technologies according to the needs of society. In addition, other subjects' information that supports TE has sometimes been planned for teachers in TE, unlike in Finnish craft, such as guidance in mathematics and science that are applied in design and technology in England (GCSE, 2015).

The obvious difference between craft and TE is technological literacy (TL). The TL target is for students to understand and apply the technological method through which technology is developed to satisfy human needs, and they develop technology through experiences with tools, equipment, ideas, processes, and materials (Pucel, 1995). Standards for TL (ITEEA, 2000) showed the direction and emphasised comprehension of the elements that go into any technology, which can determine the product's success or failure, such as the design process, development, production, and use and maintenance of the product. Students should be able to evaluate the effects of technology, understanding that technology is used to solve problems and that it may create new ones. Later, technological and engineering literacy was published to articulate the components of that literacy and their role in STEM education. Literacy is a fluid construct, meaning that knowledge, skills, and abilities in any given field will change over time (ITEEA, 2020).

TL is an essential (Ritz, 2009), a universal (Rasinen, 2003), and an end goal (Walach, 2015) of TE, and developing TL (Rossouw et al., 2011) is the main purpose of TE. These goals and purpose have not been considered important in craft, or 'Sloyd' (Hallström, 2017), a term commonly used in the Nordic countries (Finland, Sweden, Norway, Denmark, and Iceland).

However, TL began to be discussed in craft in Finnish technical work since the 1990s. Kankare (1997) explored technical work and its learning environment for implementing TL. He concluded that TL could be one of the main goals of technical work. Another Finnish seminal research aim was to clarify the meaning of technology, of TL, and of TE, as an educational objective in comprehensive and upper secondary school (Parikka, 1998). Parikka created the structure of technological competence for TL, presented in the next section. Other studies specifically focussed on TL and related to school craft have not been conducted after that research in Finland. However, defining and aligning TL with craft teaching has been seen as important, especially within technical work, so that alongside the teaching of traditional technologies such as wood, plastic, metal, mechanical and electrical technologies, and technical drawing, the wider meanings of the aims and content of technology teaching would be better highlighted. The greatest inspiration for TL and its discussions have been the ITEEA standards (2000) which were translated into Finnish by Kantola et al. (2002), and later ITEEA standards have been taken into discussions by teachers teaching technical work content.

Niiranen et al. (2022), have researched the current and future trends and issues facing TE in Finland. In the study, TE stakeholders (n=19/n=24) agreed with the statement, "The requirements and phenomena of TL have changed" (p. 5). Many stated that TL must change because complex digital technological systems are part of daily life and because complex technological systems have an increasing role in people's daily life. The study does not reveal what kind of TL respondents desired to change for those reasons. Probably, the answers can provide an interpretation by referring to the nature of TE change worldwide: TE has gradually evolved from focusing on skills to focusing on TL (Rossouw et al., 2011).

The research question answered by this study is: "How do craft teachers and student craft teachers perceive TL in craft?" Due to the vagueness of TL in craft, it was not clear how important teachers or student teachers consider it to be in the subject.

Conceptual and Functional Level of Technological Literacy

TL relates to developing teaching for students who can operate in a technological world and understand the opportunities and adverse effects of a range of technologies. TL emphasises knowledge that a student can use to survive in a technological environment, understand and manage technology, make judgements on technology, and act with technologies. According to Avsec and Jamsˇek (2018), "the main goal of TE curricula is to develop students' TL so that they can understand, manage and assess the technology used to consciously and rationally reshape the natural world" (p. 148) without forgetting the needs of sustainable development. They have expanded Eisenkraft's (2010) definition, adding that the development supports students' technological competence by enabling them to create and implement certain technologies and to repair artefacts encountered in their TE. Teaching derived from the more conceptual learning goals supports the student's achievement of more specific learning goals as functional learning and vice versa.

The conceptual challenge is that teachers should teach TL because the goals and information are needed not only by engineers, industrial technologists, or craft workers, but by all students (Ritz, 2009). It is important to make judgements about various aspects and phases of technological developments (de Vries, 2017), for example, aspects of the development of vehicle engines and their effects on sustainable development. From functional perspectives, it is more important to make judgements about how TL is involved in design (Williams, 2017) such as in students' own design of a miniature vehicle. The functional challenge is to guide students' learning for design and creative problem solving, not just product development or problem-solving according to given instructions (Wells, 2013). So, TL means not merely knowing how to acquire skills, but also understanding that learning skills in the student production process will be severely limited without understanding the knowledge meaning outside the school learning environment (Moore, 2011).

Parikka (1998) developed a conceptual level of TE on the literature, and he researched the functional information from experts of technologies with a structured questionnaire related to the three areas: 1) Learning objectives, 2) learning content, and 3) learning methods. The main results are crystallised under the three functional level areas in Figure 1.

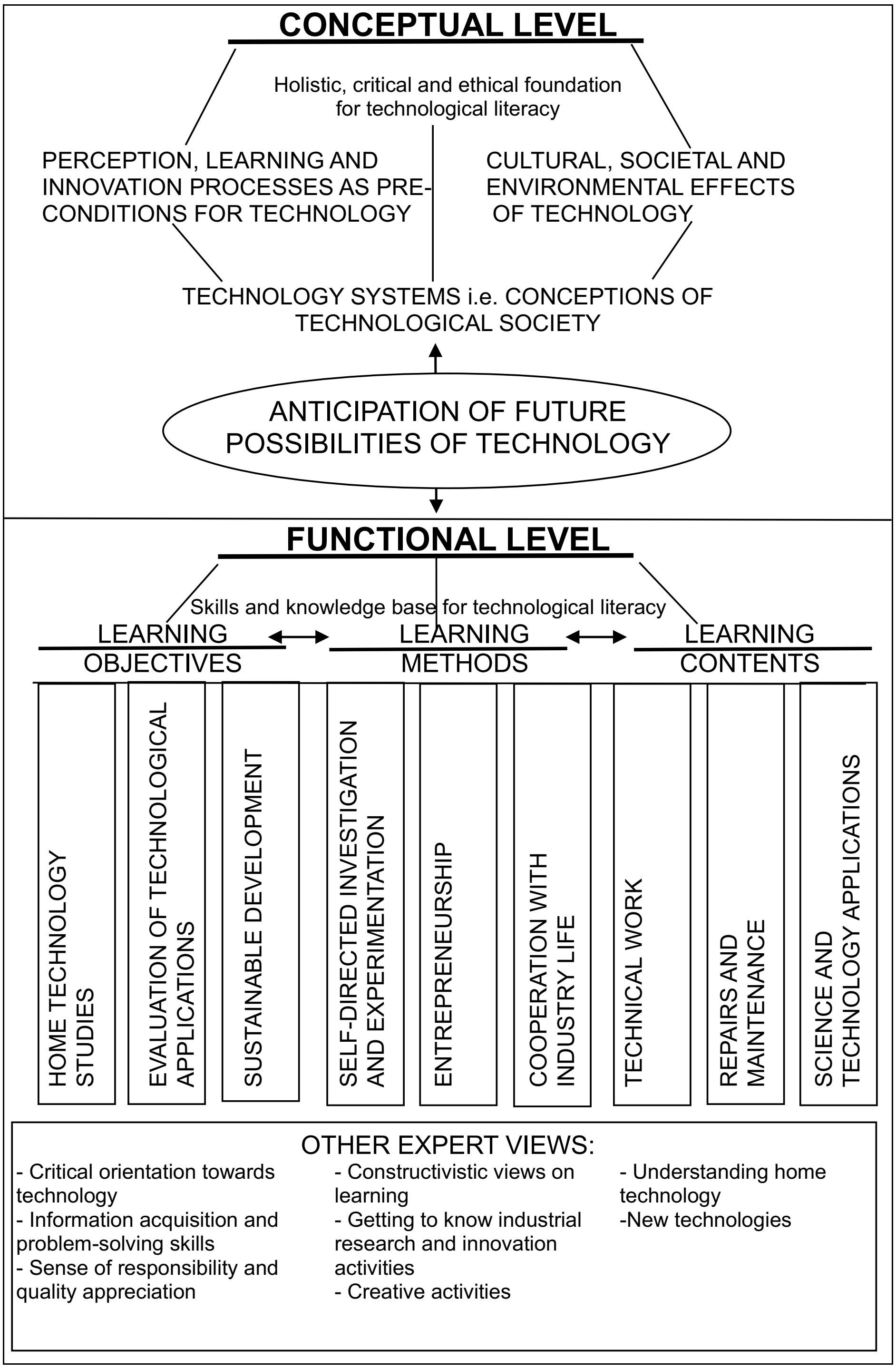

Figure 1.
The Structure of Technological Competence (Parikka, 1998, p. 160).

Conceptual Level

Parikka's conceptual level theory was developed from Blandow (1991), Layton (1993), and Dyrenfurth's (1991) research, later extended on by Kolehmainen (1998). The conceptual level forms the holistic, critical, and ethical foundation of TL for the teacher to teach the student to understand technologies and their anticipation of future possibilities of technologies.

Technology systems shape a conception of technological society in which teaching broadens learners' awareness, enabling them to identification technologies, understand their purposes and applications, and recognise their limitations. This links to learners' ability to recognise technology, acknowledge the opportunities it provides (Layton, 1993) and understand its operating principles. Such learning involves identifying, recognising, and understanding technology as well as realising its purpose in life and in design. In this respect, understanding the relationships between technology concepts and technology hierarchies is essential (Blandow, 1991).

The purpose of teaching cultural, societal, and environmental effects of technology is to enable learners to judge the worth of a technological development in the light of personal values and its wider implications, and to step outside their usual 'mental set' to evaluate what that development is doing to us (Layton, 1993). Guiding the learner's evaluation of technologies relates to considering the value base of the individual learner, the community, and natural world. The learning also relates to evaluating trends and future development ideas affected by technology and comparing them with contemporary decisions.

Teaching technological perception, learning, and innovation processes establishes the preconditions for the learner to create their own technological processes. The prerequisites for envisioning exploratory production and creative learning require consideration of technological processes, applying analytical thinking, and formulating technological needs and aims. The learning relates to using, planning, and implementing technologies, without being limited to a single or specific product or device. This also connects students to the broader range of technological activities and processes outside school to which their learning can relate.

The Conceptual Level with the Functional Level

The teacher's and students' joint reflections on understanding technology systems, evaluating the effects of technologies, and outlining technological activities outside the school context provide a foundation for learners to consider why they should learn about technology. This is an important question —not just about what to do and how to do it—because according to Järvinen & Rasinen (2015), 90 percent of Finnish students in ninth grade (n=1181) regarded technology and manual skills as interrelated. Meaning, a student can use and apply their preliminary knowledge and their own envisionment to set their own functional learning objectives. Envisionment means the student's thoughts and images and defines what kind of object productive learning could meaningfully relate to before starting the ideation of the product, which the teacher guides with the help of the conceptual technological knowledge. In Finnish craft in grades 7-9, one of the main goals is to guide the student to set their own learning goals, carry out the entire production process based on them, and evaluate the learning (POPS, 2014).

The main functional learning objective is usually directed to creating a product which has sub-objectives such as students planning and implementing the product with as much quality as possible and learning to have safe work attitudes when using machines in the learning environment. The objectives may also include requirements such as performing peer reviews or using certain information such as using ICT in process evaluation. When the main goal is not related to students' technological activities, the goal is to understand a task and technological system outside the school environment.

Finnish craft teachers have planned and taught the technological learning content of metal, plastics, wood, surface treatment techniques, electricity, mechatronics, engine and mechanical engineering, and some information and communication technologies, technical drawing by hand and computer (2D and 3D modelling), CNC-machine programming and robotics, and textile work such as sewing techniques, making clothing and maintenance. Home economics does not belong in craft, because it is own discipline in home economics teacher education in universities, and it is compulsory school subject in the seventh grade and an elective subject in grades 8-9 (optional 10 level) in Finland.

Technological teaching and learning methods direct students' learning to communicate their thoughts and ideas, enhancing their ability with project work and problem-solving (Blomdahl & Rogala, 2008).

Learning processes comprise the learning topic, object, and related functional learning objects, such as doing material experiments and understanding the signs and symbols of technological concepts. Finnish craft pedagogy has been focused on guiding students between the traditional model-based instructions, and design and making processes that are student-led. The student is guided gradually to have more freedom to plan their own learning, and the pedagogical models are focused on developing the guidance and learning of processes that require self-initiated learning and differentiation.

Method

Research Question and Measurement

The research question that informed this study was ‘How do craft teachers and student craft teachers perceive TL in Finnish comprehensive school craft?’ The sub-questions are 'How do respondents perceive TL according to the subscales of general learning goals, learning objectives, content, and methods?’ and ‘How do the results of these sub-areas differ depending on the craft education received by respondents?’ The connection between general learning goals and functional learning objectives, content, and methods is also examined.

This study elaborates on a Finnish master’s thesis data (Tupasela & Hjelt, 2020). The measurement and the subscales in the theses and this research are based on Parikka’s (1998) conceptual and functional level structures for TL. The general learning goals subscale was drawn up from Parikka’s conceptual level structure. Parikka’s empirical research part dealt only with the functional level structure, which is applied in this study. Therefore, it was interesting to examine the connection between general learning goals and other functional subscales.

The question to be answered regarding general learning goals was, ‘What is central in teaching TL to students?’ This question had 12 items. The questions related to the area of ‘perception, learning and innovation processes as preconditions for technology’ had five items. Questions of ‘cultural, societal and environmental effects’ had four items and questions on ‘technology systems i.e. conception of technological society’ had three items. The main question in the other three functional level subscales were the same: ‘Evaluate the necessity and usefulness of the following learning objectives or content or methods in terms of TL’. Learning objectives had 21 items, learning content had 18 items, and learning methods had 16 items. The Likert scale descriptors were “not at all necessary and useful”, “a little necessary and useful”, “somewhat necessary and useful”, “very necessary and useful”, and “completely necessary and useful”. There was space for open-ended responses next to each question.

Parikka (1998) prepared the questions for TE, not just for teaching technical work. Despite this, they were mostly well suited to the study of today’s TL in craft. At the time of Parikka’s research, technical work was a comprehensive school subject, which, in 2008 was officially combined with textile work in school education. So, in accordance with the current national craft curriculum (2014), attributes dealing with textile work were added to these functional measurement subscales. Some items in the functional sections are combined in contrast to Parikka’s measure, so that TL questions would not be linked to overly detailed techniques and how to teach craft in such a way that students not only become skilled in a craft but also become technologically literate in a 21st-century sense. For example, metal technology was described in Parikka’s study as forging, MIG-MAG welding, and metal turning. In this study, this learning content was treated as a single item, ‘Evaluate the necessity of metal technology’. In addition, some of Parikka’s questions were omitted, as they related to material no longer generally taught in Finnish craft. These relate to handicraft hobbies and some electrical work.

Sample

The acquisition of the data was carried out using a Webropol survey. The survey was distributed to the email lists of student craft teachers' organisations, the craft teachers' organisations, and their social media pages. Respondents were granted two months to respond. There is no certainty that all these organisations shared the survey with their members, as some of the responses were not received from the contacts. The balanced ratio between teachers and students, as well as the balanced ratio between the previous education background of craft teachers in either technical work or textile work education, remained quite weak. The processing of the research material started by removing from the sample (n=93) those respondents who did not give permission to use their answers for research purposes (n=5). In addition, nine respondents were removed from the data due to the lack of craft studies.

According to the Education Statistics Finland (Vipunen, 2019), the main target group of the study, i.e., subject teachers of crafts, consisted of more than 4,000 teachers. In addition to this, the views of class teachers teaching crafts and those studying crafts were also considered, which made it almost impossible to collect the views of all respondents representing the population. For this reason, an open questionnaire aimed at the target group was used in the study.

The sample in this study (n=79) comprised 56 craft teachers and 23 student craft teachers. There were 47 men and 32 women. In Finland, a master's degree is required by those wishing to qualify as a craft teacher at a comprehensive school. Most teachers obtained a qualification in technical work or textile work either because they had completed it as part of their own teacher education before the 2005 decree that redefined Finnish universities' educational responsibilities, or afterwards, as it took about ten years to reorganise the universities' craft education programmes. Today, students majoring in craft (craft science or craft education as a main subject at universities) study both technical and textile craft. Thirty-six of the participants were technical work teachers (technical educated) and 13 were textile work teachers (textile educated). Thirty participants had studied both technical and textile craft content (craft educated). Nine of the teachers did not report on their training. There were 21 primary schoolteachers and 33 craft subject teachers in grades 7-9. Most of the students had studied both sets of craft content (n=17).

Analyses

The Cronbach Alphas of the whole instrument (.929) and the subscales were reasonably good (.815-.859), although the number of respondents was too small to state it more broadly. The distribution of the subscales was normal. Only in the general learning goals subscale was the skewness a little too high.

The data were analysed by presenting the means and standard deviations of the answers. The main purpose was to present the phenomenon under study only as it appeared from the results of the measurement and four subscales. These results were examined by describing the differences between teachers and student teachers, and between the different types of craft education. The differences between groups were tested with a T-test. Respondents had the opportunity to supplement their responses by writing their open-ended thoughts. The respondents wrote a few short thoughts, and those that added value to the answer have been presented in the results section. The connection between the general goals subscale and the functional subscales were tested using a Pearson correlation coefficient.

Results

Main Results

The result of the measurement of all respondents (M=4.0) and subscales of the general learning goals (M=4.4) and the functional learning objectives (M=4.1) showed that respondents perceived the learning goals to be very necessary. The mean of all items in the general learning goals exceeded 4.0. In the functional learning objectives, eight of the 21 items were perceived as being quite necessary (M 3-4). The result of all respondents of subscales of the learning content (M=3.7) and methods (M=3.8) were weaker than these and their mean value variation was higher (M between 2.5-4.5).

Table 1.

Main Results (M, [CI], (SD))

	Total (N=79)	Teachers (n=56)	Students (n=23)	Textile educated (n=13)	Technical educated (n=36)	Craft educated (n=30)
Measurement	4.0 [3.9,4.1] (.39)	4.0 [3.9,4.1] (.39)	4.0 [3.9,4.2] (.37)	4.0 [3.7,4.3] (.48)	4.0 [3.9,4.1] (.37)	4.0 [3.9,4.2] (.38)
General learning goals	4.4 [4.3,4.5] (.49)	4.4 [4.3,4.5] (.53)	4.4 [4.2,4.5] (.37)	4.2 [3.9,4.5] (.54)	4.5 [4.3,4.7] (.49)	4.3 [4.2,4.5] (.45)
Functional learning objectives	4.1 [4.1,4.2] (.42)	4.1 [4.0,4.2] (.43)	4.2 [4.0,4.4] (.39)	4.1 [3.7,4.4] (.55)	4.2 [4.0,4.3] (.40)	4.2 [4.0,4.3] (.38)
Learning content	3.7 [3.6,3.9] (.52)	3.7 [3.6,3.9] (.48)	3.7 [3.5,4.0] (.62)	3.8 [3.5,4.2] (.62)	3.6 [3.5,3.8] (.42)	3.8 [3.6,4.0] (.58)
Learning methods	3.8 [3.7,3.9] (.50)	3.7 [3.6,3.9] (.53)	3.9 [3.7,4.0] (.41)	3.9 [3.6,4.2] (.48)	3.7 [3.5,3.9] (.56)	3.8 [3.6,4.0] (.43)

As can be seen in Table 1, the results of student teachers and teachers can be considered to be similar, taking all subscales into the backgrounds of the total scale (M=4.0), and T-tests revealed no statistically significant differences. Also, according to the respondents' education the general learning goals and the functional learning objectives, subscales of M > 4 have better results than the learning content and methods subscales (M<4). Regardless of education, everyone's result was the same (M=4.0). There were small differences between the educational backgrounds in the subscales, which are described in the following sections.

The connection between the general learning goals and the functional learning objectives (.597, p=.001, CI [.433, .723]) was quite strong. However, the connection between general learning goals and learning content (.367, p=.001, CI [.159, .544]) and methods (.413, p=.001, CI [.211, .581]) were moderate.

The measurement results and subscale results answer to the main research question "How do craft teachers and student craft teachers perceive TL in Finnish comprehensive school craft?" is considered next. Respondents perceived TL general goals and learning objectives to be very necessary, and their connections were quite good. They perceived learning content and learning methods to be somewhat necessary, and general leaning goals did not have a significant relationship with them.

The Results of the Subscales and the Differences in the Respondents' Educational Backgrounds

General Learning Goals

In Figure 2, the means between different educational backgrounds (M=4.2-4.5) were very high in the general learning goals. The biggest difference was between the textile educated (M=3.7) and the technical educated (M=4.5) concerning the item to be active in the technological world. In this item, the craft educated mean value (M=4.0) was between them. The mean value of the item use technology in your everyday life was also clearly higher within the technical educated (M=4.6) than the textile educated (M=4.0).

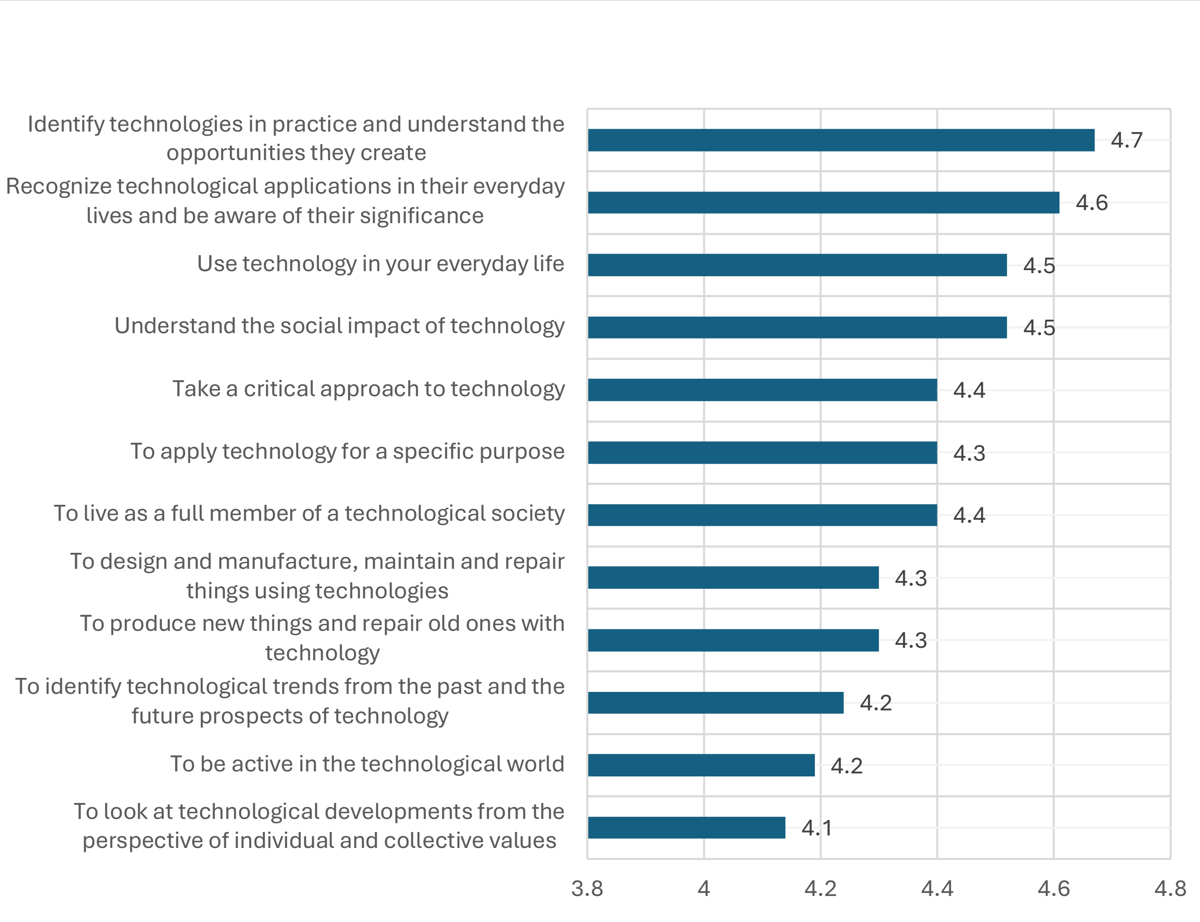

Figure 2.
General Learning Goals

Functional Learning Objectives

As can be seen in Figure 3, concerning the functional learning objectives, the results between the various educational backgrounds were very good (M=4.1-4.2), and almost the same as in the general learning goals (M=4.2-4.5). The mean value of the craft educated (M=3.8) and the textile educated (M=3.8) concerning document the craft process and practice were higher than the technical educated (M=3.0). The craft educated had a more positive result when answering using information and communication technologies as part of the craft process (M= 4.1) than the textile educated (M=3.9) and the technical educated (M=3.9). The textile educated had lower mean values in answers to experimenting with materials using traditional, new and recycled materials (M=3.9) than the technical educated (M=4.7) and the craft educated (M=4.6)

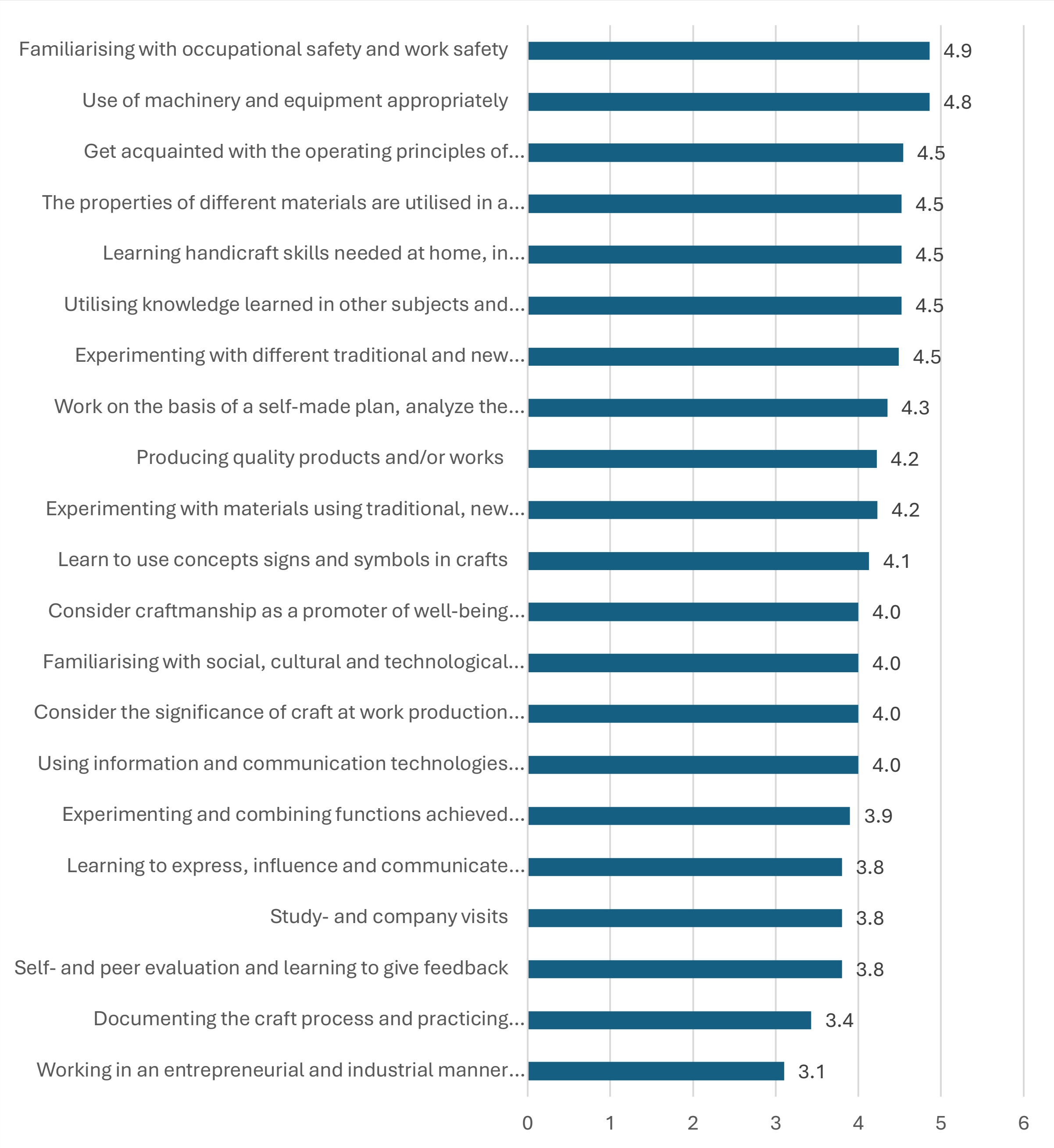

Figure 3.
Functional Learning Objectives

Learning Content

As shown in Figure 4, the technical educated found all the learning content (M=3.6) and textile craft content (M=2.0-3.3) less necessary than the textile educated (all content M=3.8 and textile content M=3.00-4.17) and the craft educated (all content M=3.8 and textile content M=3.03-3.70). The textile educated found the content related to technical craft clearly to be less necessary (M=3.8-4.2) than the technical educated (M=3.7-4.4) and the craft educated (M=3.7-4.2). However, the textile educated found programming (M=4.0) and renovation and decoration (M=3.9) to be slightly more necessary than the technical educated teachers did (programming M=3.8 and renovation and interior design M=3.7). The biggest difference was in metal technology. The technical educated found metal technology to be more necessary (M=4.4) than the textile educated (M=3.8) and the craft educated (M=3.9). Regardless of educational background, the respondents considered the content related to textile work, excluding felting, fabric printing and dyeing, wire technology, sewing technology and maintenance of clothing and equipment to be the least necessary content (M=2.6-3.6). The results of the three items mentioned above were only slightly necessary (M<3).

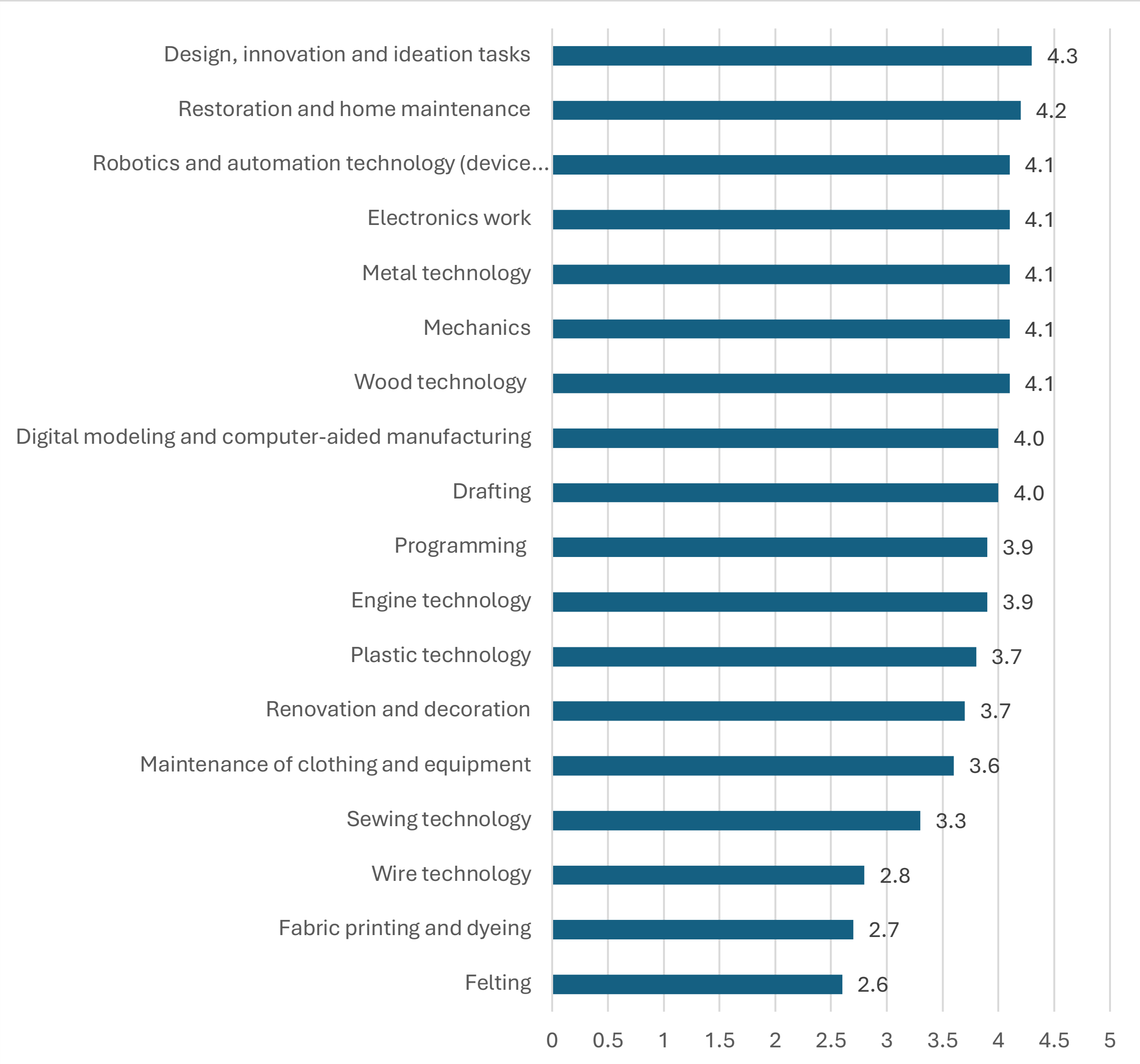

Figure 4.

Learning Content

Learning Methods

As can be seen in Figure 5, regardless of educational background, respondents perceived that learning methods are somewhat necessary (M=3.7-3.8). The textile educated found working within a given phenomenon/theme using specific materials and/or techniques (M=4.3), working within a given phenomenon/theme without any other restrictions (M=3.9) and working in phases in a teacher-led manner (M=3.9) to be more necessary than the technical educated (M=3.7, 3.3 and 3.7) and the craft educated (M=4.2, 3.3 and 3.3).

Figure 5.

Learning Methods

Discussion

The original purpose of craft—teaching and learning the hand skills and use of machines needed to produce products—is generally considered important in Finland. Therefore, the very strong results for broader conceptual TL goals, and their positive alignment with the learning objectives, were unexpected. There were only slight differences related to educational background in the individual questions of the subscales, so the following discussion considers the results of all respondents across all subscales.

The most positive results (M=4.5-4.7) in the general learning goals were in the questions *identify technologies in practice* and *understand the opportunities they create, recognise technological applications in their everyday lives,* and *be aware of their significance* and *understand the social impact of technology.* They cover Parikka's (1998) theorised notions of understanding and evaluating technology, but only one of them referred to the student's doing, which was use technology in your everyday life. Answers with a mean lower than these contained more goals related to doing as *to design and manufacture…, to apply technology…, to produce new things… and to be active…*. Answers for understanding and evaluation of technology, such as *to look at technological developments from the perspective of individual and collective values* (M=4.1; SD .90), *to identify technological trends from the past and the prospects of technology* (M=4.2; SD .80) refer to a broad reflection on technology. It is a little surprising that these questions related to value choices in technology received slightly lower means, considering all questions in the subscale. This may be because the respondents do not consider the broader social examination of technology to be particularly important. However, the teaching community's needs and demands for technology relate to cultural, ethical, religious, environmental and economic global technological challenges. No matter how the link between teaching certain technologies and global technological worldviews were perceived, their goals reflect the teacher and students' own culture (Natarajan, 2007).

In functional learning objectives, respondents perceived objectives related to skills learning, such as *occupational safety, machinery and equipment, materials, manufacturing techniques,* and *necessary craft in everyday lives* to be highly necessary (M=4.5–5). The two most necessary objectives stand out from the others: *to become familiar with occupational safety* and *work safely* (M=4.9, SD .46), and *use of machinery and equipment appropriately* (M=4.8, SD .43). The open-ended comments showed that these objectives connected to understanding technological systems, such as "Many of devices utilise a rotating shaft", and "Understanding physics supports operating many machines".

The respondents perceived learning objectives to be very necessary for the student production process (M=4–4.5), such as *work based on the self-made plan…* and *learn to use concepts signs and symbols in crafts*. Another factor related to meanings of craft as *well-being* and *technological development*. The open-ended responses highlighted mostly process and materials learning as "The process is more important", "A by-product of a good process is a quality product", "Use of recycled materials in schools should increase due to climate change and sustainable development".

The respondents considered the following learning objectives to be important or somewhat important (M = 3.5–4): *Using information and communication technologies as part of the craft process; expressing, influencing, and communicating through crafts; undertaking study and company visits;* and *engaging in self-evaluation, peer evaluation, and learning to give feedback.* In the open-ended responses, these objectives related to the future needs of the workforce. "The Finnish technology industry needs thousands of experts in the near future, and we must dare, even in our current doctrine, to talk about coaching students for vocational training also — but saying it out loud these days is almost shameful". However, respondents perceived *documentation of the craft process* and *learning entrepreneurship and industrially learning from the point of series production* as being only somewhat necessary (M=3–3.5). Open-ended responses support that, because "I do not think documentation adds value to the subject" and "Series production is not bad either, but I do not think it is the most important thing to learn".

Overall, *specific skills* and *safety-based technical design and learning* were to be slightly more important than the associated objectives like *communication learning* and *learning entrepreneurship*. This may relate to the teaching time allotted to school craft at Finnish schools. It is only two hours per week on average. The time is generally divided into half for technical and textile craft. Therefore, acquiring *basic skills and occupational safety* is seen as being very important in technical craft within a short period of time, that something can be designed and made by hand. Based on that, the respondents did not see that the role of craft would be further diminished, which is what expert opinion in the Netherlands and Flanders has suggested (for example, Ardies & de Vries, 2022). Instead, the brake on the development of the subject has been the combination of technical and textile craft, instead of trying to renew the subject (Niiranen et al., 2022).

The connection of general learning goals to learning objectives was quite strong. This gives a very positive direction for developing craft and TL future learning objectives. Instead, the general goals had only a moderate statistical connection with the learning content. In part, this may be because the individual learning content is quite well established in terms of knowledge in craft, in which case TL is not considered to be as important as in the context of setting goals and orientation to learning. In addition, a wide range of special contents has been traditionally taught in school craft, so not enough time has been available for broader TL teaching. If TL is to be promoted, then the craft subject could focus on the needs of modern technology learning, more specifically, on whether there is content in the craft that could be reduced or even left untaught.

In the learning content subscale, the respondents perceived these to be very necessary (M>4): *Design, innovation and ideation tasks, restoration and home maintenance, robotics and automation technology, electronics work, mechanics, and wood- and metal technology.* They perceived others to be well or somewhat necessary (M=3.5–4.0): content related to *digital modelling and computer-aided manufacturing, engine and plastic technologies, renovation and decoration, and maintenance of clothing and equipment.* The respondents perceived as somewhat necessary (M<3.5) textile learning content, which includes *yarn technology, fabric printing, dyeing, and felting*. Open-ended responses were mainly given in this content section mainly for or against textile work as "It is crazy to equate them with, for example, wire technology and metal technology or mechanics", "The extent of the subject areas is completely different, and spinning should be taught to everyone!" and "Material understanding would increase!" Open-ended responses also related to a wider context, such as "By felting, no one is employed in Finland, by welding thousands" and "Learning dyeing helps, you can make choices when shopping clothes". When considering the textile results, it must be noted that regardless of respondents' education, they were perceived as being the least necessary content.

The content of technology in craft is not defined in the latest Finnish national curriculum (2014). Teachers have a great deal of freedom in choosing what to teach. Despite this, the teaching time for the content of technical and textile craft at school is usually divided, so that both types of content receive the same amount of teaching time. According to Autio (2022), at the beginning, every student should be given the basic skills in everyday life situations in both traditional craft and TE, but later, every student must be given an opportunity to focus more seriously on the area in which they are the most interested. The difference between boys and girls in technological knowledge and attitude must also be considered, which should not be influenced by the teacher's own views. It seems that in terms of subject development and means of learning TL in the subject, the time allocated to the subject by schools should be able to change.

Respondents perceived as being very necessary (M>4) learning methods aimed at developing student *problem–solving work, their own design-based materials and techniques*, *choices about hand tools* as well as *learning the craft techniques and the instructions*. Open responses comprised limiting factors related to the use of these teaching methods, such as time resources in the subject and students' skills. Several respondents argued that before using these teaching methods, students must have the basic abilities and skills, because before that, "You need to know what to do with the tools and how", and "First you must learn to use tools to understand what you can do with them".

Respondents perceived the following to be well or somewhat necessary and necessary (M=3.5-4): *Exploratory and experimental work, working within a given phenomenon / theme using specific materials and / or techniques, work focused on learning craft techniques, teamwork and working in phases in a teacher-led manner and functional study visits.* Regarding open learning methods as exploratory work, negative aspects were seen in the adequacy of time resources in the subject and the students' ability to work as it "Requires more hours" and is "Too difficult for some students", "Disappointing" and "There is not enough time". Working within a given phenomenon with the help of prescribed materials and techniques gives more positive answers, because "It also makes it easier for the pupil when the teacher sets limitations to succeed within a given time". There were two sides, being for or against teamwork, in which it is fruitful if "One student does, or if the rest of the pupils stand back and brainstorm".

Respondents perceived the following as being somewhat necessary (M=3-3.5): *Fully open learning assignments according to the pupil's interest, working within a given phenomenon / theme without any other restrictions* and its complete opposite *working with model crafts.* Open-ended answers revealed that "Only a few can work this way independently". According *to work within the phenomenon / theme without other limitations*, answers were that "More freedom is given, the more subject management is required of the pupil and the teacher". On the other hand, *teacher-led training* was perceived as being important "In the early stages of learning" and even later in demanding projects". Open-ended responses about *competition and exhibition activities* consisted of positive perceptions, as "The exhibitions are good at times", and "It is important that the pupils' products will be seen". *Industry and professional and serial work* were perceived as being the least necessary learning methods (M=2.7) and in the open-ended responses, because "Repetition does not make sense" supports the results.

The perceptions of the methods were not surprising from a craft perspective, but they were surprising from a craft in terms of TL perspective. An assumption in the learning results of the methods, that TL would also focus more on methods that give information outside school processes and more open learning task methods and not so much on the choices and techniques connected to the student's process. Moreover, the general learning goals had no good statistical connection with the learning methods.

Considerable care was taken to ensure the validity and reliability of this study. The validity of the questions was examined and discussed with ten student teachers before they were measured. However, several limitations must be acknowledged. Firstly, the sample size (n=79) was relatively small compared to the total number of craft subject teachers in Finland. Additionally, the sample's regional representativeness was not sufficiently broad, limiting the ability to make wider generalisations. Furthermore, due to the voluntary nature of the survey, it is possible that the respondents were among the more competent, independent, and conscientious teachers and students, potentially skewing the results. Secondly, the validity of survey data can be compromised by socially desirable responses, which are common in self-reported surveys. While this risk can be mitigated by crafting clear, non-leading survey questions and placing only essential personal background inquiries at the end of the questionnaire (as recommended by Braun et al., 2012), the possibility of socially desirable responses having been provided cannot be eliminated. Lastly, the measures used in this study have been validated within the Finnish context, and are widely recognised in various countries, but the specific cultural context may still influence the findings. However, the measure used in this study could be interesting when comparing TE in Finland and other countries.

Conclusion

The results showed that both craft teachers and student craft teachers perceived the general learning goals and the functional learning objectives of TL in craft particularly well. There was also a clear connection between the learning goals and the learning objectives. However, the learning goals were not well-connected to the learning content and methods. In addition, respondents perceived the content and methods as slightly less important than the learning goals and functional learning objectives.

Overall, the results about TL in craft can be considered positive. When the results about the functional learning objectives, content and methods are compared with the results collected by Parikka in 1998, Finnish school craft can be considered to have developed in the way for TE. Parikka acquired information from experts for the development of TE across subject boundaries, and this wide-ranging structure of TE by means of TL was perceived as being comprehensively positive in craft in this study. However, it must be noted critically that the sample size, especially student teachers, in this study was relatively small. How student teachers perceive TL in craft and by means of the craft, developing for TE should be researched in more detail.

A conclusion can be made according to the relationship of the connection between TL general learning goals and the learning content and the learning methods—that should be critically examined in the Finnish craft subject. Different teaching and learning processes have been extensively studied in Finnish craft, but they have not been examined enough to see how and what kind of TL is required for teaching and learning in different learning content and methods of craft.

In the future, it is essential to research and develop what conceptual knowledge should be taught to provide students with TL and why, instead of learning TL focused only on the guidance in design and making processes (Dakers, 2007). In this regard, the questions asked in this study about the content with the TL of learning should be developed for the future, because they relate closely to craft processes. Learning broader content than that which is directly associated with the craft learning process should be examined in more detail in the future. For example, digital learning has been used to search for product ideas and in documenting the student's process in craft, but teachers could pay more attention to planning and using such digital learning materials for students that promote their understanding of products and devices, the technological principles of their operation, and the materials required.

In craft, the general goals of education have been at the centre—handwork has been seen like a device of education such as the way craft education strengthens self-esteem, increases self-expression and provides pleasurable experiences. These educational goals are very rarely planned to be connected to TL in craft, even if TL is associated in many ways with students' life beyond school and their needs and activities. From this point of view, TE should define and study which scholarly knowledge can be meaningfully connected to educational craft goals like those mentioned above by using TL. This should also be considered for planning the next Finnish national craft curriculum. General learning goals could direct teaching and learning to use and construct wider multidisciplinary subject knowledge than the process knowledge of craft. Through this, TL should be considered in planning learning methods to ensure students' enhanced survival in the technological world, providing them with skills to face and learn ever-changing new technologies for studying later and in their own life.

Craft could also take into account how, and to what extent, knowledge from STEAM subjects and engineering content (e.g. ITEEA, 2020; National Research Council, 2010; National Academy of Engineering and National Research Council, 2009) as well as learning methods (e.g. Connor et al., 2015) can be used and renewed. This does not mean that precise standards should be drawn up for all students; rather, the content within craft learning processes could be examined and considered in relation to broader TL contexts and students' need to learn TL. It must also be recognised that TL cannot be prescribed in advance, given its multi-literacy and ever-changing nature. As Dakers (2018) notes, "TL is something that one never actually becomes" (p. 23), but the general learning goals and objectives of TL could be associated more meaningfully with learning specific content, learning methods, and their combined application.

References

Avsec, S. & Jamsˇek, J. (2018). A path model of factors affecting secondary school students' technological literacy. *International Journal of Technology and Design Education, 28*(1), 145-168. https://eric.ed.gov/?id=EJ1170035

Ardies, J. & de Vries, M. (2022). A Delphi study on the future of technology education. *Australasian Journal of Technology Education, 9*. https://ajte.org/index.php/AJTE/article/view/95/53

Autio, O. (2022). Development of students' technical abilities between 1993-2022 in Finnish comprehensive schools. *Design and Technology Education: An International Journal, 27*(3), 76-93. https://ojs.lboro.ac.uk/DATE/issue/view/237

Blandow, D. (1991). *Integrative education and technological literacy.* Loughborough University.

Blomdahl, E. & Rogala, W. (2008). Technology in compulsory school – Why? What? How? *Design and Technology Education: An International Journal, 13*(1), 19-28.

Braun, E., Woodley, A., Richardson, T. E., & Leidner, B. (2012). Self-rated competences questionnaires from a design perspective. *Educational Research Review, 7*, 1–18. https://doi.org/10.1016/j.edurev.2011.11.005

Connor, A. M., Karmokar, S. & Whittington, C. (2015). From STEM to STEAM: Strategies for enhancing Engineering & Technology education. *International Journal of Engineering Pedagogy, 2*(2), 37-47. https://doi.org/10.3991/ijep.v5i2.4458

Dakers, J. R. (2007). Incorporating Technological Literacy into classroom practice. In M. de Vries, R. Custer, J. Dakers & G. Martin (Eds.), *Analyzing Best Practices in Technology Education International Technology Education Series* (pp. 125-137). Sense Publishers.

Dakers, J. R. (2018). Nomadology: A lens to explore the concept of Technological Literacy. In M. J de Vries (Ed.) *Handbook of Technology Education* (pp. 17-32). Springer International Publishing.

Dyrenfurth, M. J. (1991). Key competencies central to technology literacy. In *Proceedings of The Sixth Annual Technological Literacy Conference: National Association for Science, Technology and Society* [Conference Proceedings].

Eisenkraft, A. (2010). Retrospective analysis of technological literacy of K-12 students in the USA. International Journal of Technology and Design Education, 20(3), 277–303.

Finnish Basic Education Act (628/1998).
https://natlex.ilo.org/dyn/natlex2/r/natlex/fe/details?p3_isn=73915

GCSE Design and Technology (2015). *General Certificate of Secondary Education Design and Technology Education. Subject, content, aims and objectives for GCSE in design and technology for teaching from 2017.* Department for Education. Government of the United Kingdom. https://www.gov.uk/government/publications/gcse-design-and-technology

Hallström, J. (2018). Exploring the relationship between Technology Education and Educational Sloyd. In M. J de Vries (Ed.), *Handbook of Technology Education* (pp. 205-218). Springer International Publishing.

ITEEA (International Technology and Engineering Education Association). (2000). Standards for technological literacy: Content for the study of technology.

ITEEA. (2020). *Standards for technological and engineering literacy: The role of technology and engineering in STEM education.* https://www.iteea.org/stel

Järvinen, E-M. & Rasinen, A. (2015). Implementing technology education in Finnish general education schools: Studying the cross-curriculum theme “Human being and technology”. *International Journal of Technology and Design Education, 25*(1), 67-84. DOI?
Kananoja, T. (2009). Technology Education in general education in Finland. In A. Jones & M. de Vries (Eds.), *International Handbook of Research and Development in Technology Education* (pp. 41–50). Sense.

Kankare, P. (1997). Teknologian lukutaidon toteutuskonteksti peruskoulun teknisessä työssä. [The context of Technology Education (Technical Work) in schools]. [Doctoral dissertation, University of Turku]. *Annales Universitatis Turkeunsis, Ser. C – Tom. 139*.

Kantola, J., Rasinen, A., Kananoja, T., & Liuha, J. (2002). *Teknologisen perussivistyksen standardit. Teknologiakasvatuksen sisällöt luokille 0-12 Yhdysvalloissa. International Technology Education Association julkaisu Standards for technological Literacy; Content for the Study of Technology* (2000). Teknistieteelliset Akatemiat FACTE, Koulutusryhmä. https://converis.jyu.fi/converis/portal/detail/Publication/29036446?lang=fi_FI

Kolehmainen, V. (1998). Teknologiakasvatus käsityökasvatuksen osana. Teknisen työn aineenopettajan koulutusohjelman kehittämisen teoreettisia perusteita. In T. Kananoja, J. Kari & M. Parikka (Eds.), *Teknologiakasvatuksen tulevaisuuden näköaloja. Jyväskylän yliopisto. Opettajankoulutuslaitos. Opetuksen perusteita ja käytänteitä 30* (pp. 69–76). Springer.

Layton, D. (1993). *Technology's challenge to science education*. Open University Press.

Metsärinne, M. & Kallio, M. (2017). Instructional theories of exploratory production. *Australasian Journal of Technology Education, 4.* http://ajte.org/index.php/AJTE/article/view/49

Moore, D. R. (2011). Technology literacy: The extension of cognition. *International Journal of Technology and Design Education, 21*(2), 185–193. https://eric.ed.gov/?id=EJ921250

Natarajan, C. (2007). Culture and Technology Education. In M. de Vries, R., Dakers & G. Martin (Eds.), *Analyzing best practices in Technology Education. International Technology Education Series* (pp.153-168). Sense Publishers.

National Academy of Engineering and National Research Council. (2009). *Engineering in K-12 Education: Understanding the status and improving the prospects.* The National Academies Press. https://doi.org/10.17226/12635.

National Research Council. (2010). *Standards for K-12 Engineering Education?* The National Academies Press. https://doi.org/10.17226/12990.

Niiranen, S., Ikonen, P., Rissanen, T & Rasinen, A. (2022). Current and future trends and issues facing technology education in Finland—Taking part in an international Delphi study. *Australasian Journal of Technology Education, 8*. https://ajte.org/index.php/AJTE/article/view/88/45

Parikka, M. (1998). Teknologiakompetenssi: Teknologiakasvatuksen uudistamishaasteita peruskoulussa ja lukiossa. [Technological competence; Challenges of reforming technology education in Finnish comprehensive and upper secondary school] University of Jyväskylä. *Jyväskylä studies in education, psychology and social research 141*. https://urn.fi/URN:ISBN:978-951-39-4625-8

POPS (2014). Peruskoulun opetussuunnitelman perusteet 2014. [National Core Curriculum for Basic Education]. Kouluhallitus [Finnish National Agency for Education]. https://www.oph.fi/sites/default/files/documents/perusopetuksen_opetussuunnitelman_perusteet_2014.pdf

Pucel, D. J. (1995). Developing Technology Literacy. A Goal for Technology Education. *The Technology Teacher, 55*(3), 35-43. https://eric.ed.gov/?id=EJ513026

Rasinen, A. (2003). An Analysis of the Technology Education Curriculum of Six Countries. *Journal of Technology Education, 15*(1), 31-47. https://files.eric.ed.gov/fulltext/EJ678548.pdf

Rasinen, A., Ikonen, P. & Rissanen, T. (2011). Technology Education in Finnish Comprehensive Schools. In C. Benson. & J. Lunt (Eds.), *International Handbook of Primary Technology Education Reviewing the Past Twenty Years. International technology education studies vol. 7*. Sense Publishers.

Ritz, J. (2009). A new generation of goals for technology education. *Journal of Technology Education, 20*(2), 50-64. https://jte-journal.org/articles/10.21061/jte.v20i2.a.4/

Rossouw, A., Hacker, M. & de Vries, M. J. (2011). Concepts and contexts in engineering and technology education: An international and interdisciplinary Delphi study. *International Journal of Technology and Design Education 21*(4), 409–424.

Tupasela, A. & Hjelt, J. (2020). Teknologian lukutaito käsityön opetuksessa: Käsityön opettajien ja opiskelijoiden näkemyksiä teknologian lukutaidon keskeisistä osaamisalueista, oppimistavoitteista, oppisisällöistä ja opetusmenetelmistä. Master's thesis in craft education. University of Turku, Faculty of Education, Teacher Education. https://urn.fi/URN:NBN:fi-fe202003249112

de Vries, M. J. (2017). Philosophy as Critique. In P. J. Williams & K. Stables (Eds.) *Critique in Design and Technology Education. Contemporary Issues in Technology Education* (pp. 15-30). Springer.

Vipunen. Opetushallinnon tilastopalvelu. (2019). [Educational statistics]. https://vipunen.fi/fi-fi

Walach, M. (2015). Measuring the influences that affect Technological Literacy in Rhode Island high schools. *Journal of Technology Education, 27*(1), 56-77. https://jte-journal.org/articles/10.21061/jte.v27i1.a.4

Williams, P. J. (2017). Critique as a disposition. In P. J. Williams & K. Stables (Eds.), *Critique in Design and Technology Education. Contemporary Issues in Technology Education* (pp.135-152). Springer.