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Current and future trends and issues facing technology education in Finland—Taking part in an international Delphi study

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Abstract

This study is part of an international research collaboration aimed at identifying current and future trends and issues in technology education in Belgium, Finland, Japan and the USA. The three-round Delphi method was utilised to solicit information from technology education stakeholders in Finland from November 2019 to April 2020. The panel of experts (N=31) comprised technology education teacher educators, researchers and experts of the national LUMA (STEM) 2020 programme and technology education developers. During the Delphi process both quantitative and qualitative approaches were utilized in gathering information and analysing the findings. In this article the focus is on comparing the most relevant trends and issues identified by craft and technology education professionals after Round 3. The data were analysed using qualitative content analysis. These findings reveal the unclear role of technology education in Finland and the need for a clear definition for it on the national curriculum level.

Keywords

Strategic planning; trends; issues; technology education; Delphi method

Introduction

Technology education has been developed to help students with technology by providing them with the tools and skills needed to understand and utilise it. Studies have been interested in defining technology education (what it is) and how it can uniquely contribute to developing young people by providing them with versed knowledge and skills, i.e., technological literacy (Banks & Barlex, 2014; Dakers, 2018a; de Vries, 2005; Moye et al., 2020; Ritz & Fan, 2015; Rossouw et al., 2011; Williams, 2018). Though some countries have national standards for technological literacy and technology education at all educational levels, their subject status varies, and there is no common framework for teaching technology around the world (Cross, 2011; de Vries, 2005). Technology education is a complex domain with several interrelationships between discourses surrounding technology and social, economic, political, cultural, religious and philosophical perspectives (Dakers, 2018b). The precise identity or definition of technology education is still unclear, with many varying orientations towards its teaching in schools worldwide (de Vries, 2018; Williams, 2009).

To understand technology education in Finnish basic education, it is necessary to consider it within the subject of craft. Technology education is not an independent subject in basic education; rather, technological topics are decentralised and taught through various subjects (The National Core Curriculum for Basic Education 2014, hereinafter NCCBE 2014). Craft education, especially technical craft, can support technology education because as early as 1866, Uno Cygnaeus described "technological" content as an important aspect of craft education (Rasinen et al., 2006). Internationally, during the past 40 years, the position of technology education at various levels of education has been varyingly challenging, and this trend seems to continue in the future (de Vries, 2018). As the role of technology education is still undefined in Finland, strategic planning, and research to develop the necessary procedures and operations to achieve improvements in the future is needed. Thus, the purpose of this research was to identify present and future trends and issues in technology education in Finland. A modified Delphi study was conducted by investigating the most relevant trends and issues identified through technology education professionals and stakeholders. During this process both quantitative and qualitative approaches were utilised in gathering information and analysing the findings. In this article the focus is on comparing the most relevant trends and issues identified by craft and technology education professionals after Round 3 of the Delphi study in Finland.

Development of craft and technology education in Finnish basic education

In Finnish general education schools, there has never been a school subject called "technique" or "technology". When observing the five curricula from the past 50 years, one finds the concepts of technique or technology mainly under craft subjects, particularly in "technical work" contents. In 1970, the Ministry of Education published two memorandums to guide teachers in transitioning from the old parallel school system to the comprehensive school system. Before the 1970 reform, pupils continued their schooling after grade four either in more "academic" or more "practical" schools. The 1970 curriculum stated the objectives and contents for different school subjects, and craft education was divided into two sub-areas: technical and textile craft. Technology as a concept is not found in the 1970 curriculum. Consequently, concept of technique can be found under "technical craft". (POPS, 1970a; POPS, 1970b.)

The concept of "technology" can be found (but is undefined) in the 1985 Framework Curriculum for Comprehensive Schools, only under "Craft, technical work, and textile work". The reason for the concept of technology not being mentioned in earlier curricula may be that it was not publicly used. Instead, technique was a more common expression. Technology is the beginning of technical abilities, planning and implementation. During technical work lessons, pupils should also learn to manage technology. (POPS, 1985.) Technology is clearly stated in the general objectives of the 1994 curriculum. The national guidelines state that the technical development of society makes it necessary for all citizens to have a new kind of readiness to use technical adaptations and to influence the direction of technical development. Furthermore, it stated that students, regardless of their gender, must have the opportunity to acquaint themselves with technology and learn to understand and avail themselves of it. What is important is to critically consider the effects of technology on the interaction between human beings and nature and the ability to utilise the possibilities it offers and understand its consequences.

(POPS, 1994.) However, the document does not provide any operational instructions on how to study technology.

Finland's National Core Curriculum for Basic Education 2004 (NCCBE, 2004) introduced seven cross-curricular themes in Finnish education, one of them is "Human being and technology", addressing technology education. The objectives of this theme stated that basic education should offer pupils fundamental knowledge of technology, its development and impacts to guide them towards sensible choices and lead them to consider the ethical, moral and equality issues associated with technology (NCCBE, 2004). These themes should have a central emphasis on education and should be included in studies of various subjects. Though technology education remained undefined in any depth, it appeared that much of the technological content of the "Human being and technology" theme was studied during technical craft lessons. In a study of technology education implementation in Finnish basic education it appeared that 90 percent of students in ninth grade (N=1181) regarded manual skills and technology as interrelated (Järvinen & Rasinen, 2015).

In NCCBE 2004, technology education was focused particularly in the objectives and contents of technical craft, while in NCCBE 2014, technology education seems to be emphasised in science studies. Also, current NCCBE 2014 describes seven transversal competence areas. These competences should be studied from the point of view of various subjects. One transversal competence area is "Taking care of oneself and managing daily life". It addresses students' need to receive basic information about technology, its advancement and impact on various areas of life and the students' environment (NCCBE, 2014.)

Research design

This study is part of an international research collaboration aimed at identifying current and future trends and issues in technology education in Belgium, Finland, Japan and the USA, replicating Wicklein's 1993 study "Identifying Critical Issues and Problems in Technology Education Using a Modified-Delphi Technique". The Delphi method was chosen as the research method, due to its suitability for studying complex and still open future alternatives (Clayton, 1997; Rossouw et al., 2011). It was also suitable for gathering data from stakeholders who were geographically dispersed and provided sufficient time for participants to reflect and comment using electronic questionnaires (Moye et al., 2020). Traditionally, Delphi studies have aimed at reaching expert consensus; however, one application of Delphi, namely Disaggregative Delphi, is based on the assumption that expert communication will not lead to consensus but rather to various schools of thought (Tapio et al., 2011). The aim of this study, on the other hand, was to obtain the most reliable consensus of opinion of a group through a series of questionnaires but also to examine varying viewpoints in relation to technology education. To gather empirical data, a three-round Delphi process ascertaining and prioritising the critical trends and issues in technology education was conducted between December 2019 and April 2020 in Finland. During this process both quantitative and qualitative approaches were utilised in gathering information and analysing the findings. First and second phases were distributed by conventional questionnaires and analysed by use of quantitative methods to find out the topics which reached consensus among the panellists. In Round 2, data were analysed by observing means, standard deviations and using a boxplot analysis for each of the statements. Due to a rather small panel for a quantitative approach, the third round of the Delphi process, which is reported in this article, was organised by use of a qualitative approach to capture the full spectrum expert opinions.

A trend was defined as societal phenomena affecting technology education or a general direction in which technology education is developing. An issue was defined as viewpoints debatable in technology education. The term current was defined as the present conditions regarding technology education. The term future was defined as a projected period of time, 3–5 years, in the future. (see Moye et al., 2020.) The following research questions were developed for investigation:

1. What are the trends currently impacting the technology education discipline?
2. What are the trends that will most probably impact the technology education discipline in the future (3–5 years)?
3. What are the issues currently impacting the technology education profession?
4. What are the issues that will most probably impact the technology education profession in the future (3–5 years)?

One crucial step in the Delphi method is the selection of an expert panel (Clayton, 1997). As the research is part of international cooperation, and Finland does not have such a clear established technology education community, the panellists were chosen by involving technology education experts according to Wicklein's (1993) criteria, adapting them to the Finnish context. An invitation was emailed to 52 individuals, and 31 agreed to participate in the study (see Table 1). The invitation described the research with its objectives and highlighted the importance, anonymity and reliability of participation in the research; the voluntary nature of participation in the research; the possibility of refusing at any time; and the opportunity to enquire about the research. Because the success of the Delphi technique relies on the use of informed opinion, random selection was disregarded when selecting the Delphi participants in Finland. The selected participants were considered well-informed and leading authorities in technology education by their position, experience and research. The criteria used in selecting the participants were based on their involvement in professional associations (teaching, research, developing) representing technology education. The following preliminary qualifying criteria were used: (1) Currently teaching technology education in higher education, (2) Has teaching experience as a technology education teacher, (3) Prior experience developing curriculum materials for technology education, (4) Creative and innovative thinkers in technology education, (5) Competent in their assigned teaching area, and/or (6) Actively participates in national professional associations relating to technology education (Wicklein, 1993). The participants represented technology education through two distinct groups: 68 percent were educators and/or researchers at the universities (professors, university lecturers and university teachers in craft, particularly technical craft and technology education), and 32 percent were researchers, developers or project workers in the field of craft, technology education or LUMA (STEM) education outside of the university (see Table 1).

Table 1. ***Panellists***

Panellists	The number of invited panelists and how many joined the study
Educators and/or researchers at the university	33 (21)
Researchers, developers or project workers outside of the university	19 (10)

In Round 1, participants were asked to exhaustively identify the trends and issues facing technology education in Finland using four open-ended guiding questions (questions 1–4) between December 11 and 20, 2019. After the first round, researchers formulated 49 key descriptors as statements based on questions 1–4. Round 2 was designed to prioritise the identified trends and issues and begin the process of consensus. Panellists were asked to mark their degree of agreement on a Likert scale (1=I fully disagree to 5=I fully agree). Panellists (n=28) answered the survey between January 29 and February 19, 2020. After the second round, consensus was reached with 27 statements by 70 percent of the panellists who agreed or fully agreed/disagreed with the statement.

Round 3 sought to improve the levels of consensus by asking participants to argue about those 22 statements without consensus after Round 2 (Table 2). Unlike Round 1 and 2 questionnaires, the last open-ended questionnaire was answered anonymously by the panellists. Hence, the statements were submitted to the online questionnaire as open-ended questions and were supplemented with more specific questions based on the Round 2 analysis. Panellists were asked to comment on and justify either all the allegations or only those they found interesting or necessary. Twenty-six of the panellists responded to the Round 3 questionnaire between April 2 and 23, 2020.

Table 2. ***Round 3 Statements***

Round 3 statements
RQ 1 and 2 3. The capacity of multidisciplinary entities/overarching themes responsible for technology education is weak. 4. The requirements and phenomena of technological literacy have changed. 6. The role of technology education as part of a multi-material craft subject is unclear and challenging. 7. The development of multi-material crafts requires more research. 8. Large-scale technology education should be taught in multidisciplinary collaborative teams. 9. The definition of technology education is missing from the basic education curriculum and should therefore be more closely defined among technical craft. 10. Digitalisation is an opportunity for technology education to be an integrator of learning. 13. The increase in the number of STE(A)M schools will improve technology education in primary education. 16. Working with new and easy materials should be a stronger part of technology education in the future. 17. With urbanisation, the focus of technology education should change. 18. A new Technical Craft and Technology (TCT) subject would bring concreteness to technology education. 22. The technological skills of children and young people have decreased with digitalisation, and the understanding of technology education has gotten narrower. 27. The new challenges posed by occupational safety legislation affect technology education. 29. Changing teacher education curricula to match multi-material craft is the right change. RQ 3 and 4 32. Combining the crafts (textile and technical) and the resulting cuts in teaching hours threaten to weaken teachers’ motivation and resilience. 33. Implementing a new craft curriculum is difficult when practice and theory do not meet. 35. The development of technology education becomes clearer when teachers who have studied multi-material crafts enter working life.

38. Multidisciplinary subject management (STEAM) and pedagogical sensitivity to enabling student-centred activities will be strengthened through renewed teacher education. 39. The proliferation of multidisciplinary learning entities/overarching themes is an opportunity for technology education. 43. Municipal and school solutions for elective subjects undermine the implementation of technology education. 44. After the combination of crafts (into multi-material crafts), contact teaching in universities does not enable students to have sufficient skills in technology education. 48. The cost of in-service training is currently high for the municipalities.

For Round 3 analysis, a qualitative content analysis was chosen because it enables the illumination of patterns in a content (Braun & Clarke, 2006). The study's analysis was based on making sense of and interpreting the panellists' responses. First, all responses to a single item were read through, and meaningful descriptions or manifest content were chosen as the analysis units. During this coding process, the data were organised manually (e.g., colour-coding the significant excerpts in the data) in relation to each statement. For such content analysis to be reliable, the coder should understand the context, i.e., how to identify the representative samples denoting the construct (Rourke & Anderson, 2004). In this study, coding was performed by researchers who understood the study's context well. After coding, the analysis units within the statements were grouped and categorised according to the higher order headings and they were further divided into sub-themes, which emerged from the data. The identified themes and sub-themes within each statement (22) are shown in the results section (see Table 3).

Findings from Round 3

Table 3 presents all identified themes and sub-themes. (Numbers refer to the original statements in the questionnaire).

Table 3. ***Sub-Themes and Statements***

Themes	**Included sub-themes and statements**
The role of technology education in basic education	• The role of technology education in multi-material craft (6, 7, 32 and 33) • Who is responsible for technology education (3, 8, 13, 18, 39 and 43)
Definition of technology education	Technology education is not defined in basic education curriculum (4 and 9) • The nature of technology education and what technology education should be (10, 16, 17, 22 and 27)

Teacher education	• Crafts teacher education (29, 35, 38 and 44)
Statements that panellists did not provide an opinion	• "The cost of in-service training is currently high for the municipalities"

The role of technology education in basic education

When observing panellists' responses to the statement, "The role of technology education as part of a multi-material craft subject is unclear and challenging" (6), most (23/25) of the panellists reported that the challenge is that technology education is undefined as a concept and lacks a curriculum in basic education. Additionally, the role of technology education as part of multi-material crafts was seen as ambiguous. Many (14/18) of the panellists thought that implementation of a new national craft curriculum has been challenging when practice and theory do not meet (33). They argued that this is mostly because it is difficult to change the long national tradition of having technical and textile crafts as rather separate content areas, and most of the subject teachers working in schools presently have been trained to teach mainly textile or technical crafts. The majority (18/23) of the panellists agreed with the statement, "The development of multi-material crafts requires more research" (7). However, their suggestions on what should be studied varied widely, some (5/23) of them thought there was no need for further research, or their comments did not provide any perspectives to this question. Regarding this new situation in crafts, almost all (19/21) agreed with the statement, "Combining the crafts (textile and technical) and the resulting cuts in teaching hours threaten to weaken teachers' motivation and resilience" (32). Panellists' argumentation regarding this statement varied. They explained that from the teacher's perspective, cutting teaching hours will weaken their job motivation and reduce their well-being. Also, combining the crafts (i.e., demand of broader subject related skills [of technical and textile]), weakens their resilience and motivation. From the student's perspective, some panellists reflected that new multi-material craft will lower motivation and students' insufficient craft skills when they are both unable to concentrate and choose one specific subject matter.

Almost all (25/26) of the panellists agreed that "Large-scale technology education should be taught in multidisciplinary collaborative teams" (8) and many (15/20) also agreed that "The proliferation of transversal competence areas is an opportunity for technology education" (39). They considered technology education suitable for a wide range of phenomenon-driven projects and thought that collaboration between disciplines was important in bringing out different perspectives of technology on a broad scale. Over one-third stated that someone or one subject area should have a designated responsibility and an overall picture of implementing technology education so activities would not only be shortly dealt with, and that more resources should be allocated to the implementation of multidisciplinary activities. Just over half (14/23) of the panellists agreed with the statement, "The capacity of transversal competence areas to be responsible for technology education is weak" (3). With no separate resource for these, a common understanding of technology education is weak and, being undefined at the curriculum level, is practically no one's responsibility. Also, half (10/18) of the panellists agreed with the statement, "Municipal and school solutions for elective subjects undermine the implementation of technology education" (43). They stated that when the curriculum is loose, municipalities and schools interpret it in different ways, affecting the implementation of technology education.

In Finland, there has been discussion that instead of one multi-material craft subject, there should be a new subject "Technical Craft and Technology" (TCT) parallel to Textile craft. Regarding the statement, "A new Technical Craft and Technology (TCT) subject would bring concreteness to technology education" (18) more than half (12/22) of those panellists who responded considered the idea of having a new subject of TCT appropriate. They argued that this would clarify and boost the status of technology education in Finnish basic education. Almost half (10/22) of the panellists were against this idea because it would restrict the concept of technology education and divide the new multi-material craft subject. Also, almost half (10/22) of the respondents observed that "The increase in the number of STE(A)M schools will improve technology education in primary education" (13). However, about one-third (6/22) observed that it was about our understanding of STEAM schools.

Definition of technology education

Regarding the status of technology education, half (13/25) of the panellists clearly agreed with the statement, "The definition of technology education is missing from the basic education curriculum and should therefore be more closely defined among technical craft" (9). In their arguments, they highlighted how technical craft and its learning contents and operating culture provide a natural and effective learning environment and a framework for technology education. In addition, some panellists called for instructions on how technology should be dealt with in various subject areas and that the objectives and contents of technical craft should be defined from the point of view of technology education. The majority (19/24) of the panellists agreed with the statement, "The requirements and phenomena of technological literacy have changed" (4); how this change affects the demands of technological literacy varies. Many (15/24) stated that technological literacy must change because complex technological systems due to digitalisation are part of daily life. Some (4/24) emphasised the importance of "basic technologies" that should remain part of technology education despite the change. With these basic technologies, respondents meant the traditional contents of technical craft, such as tools, materials and machinery.

In regard to what technology education should be, i.e., defining it in basic education, half (11/22) of the panellists thought that "Working with new and easy materials should be a stronger part of technology education in the future" (16). However, they suggested that new and traditional materials should be used in parallel, complementing each other and making full use of the opportunities they offer. Also, almost half (9/20) of the panellists agreed with statement 10: "Digitalisation is an opportunity for technology education to be an integrator of learning". Some of them pointed out how digitalisation is fundamental in daily life. Others argued that digital tools and applications offer versatile opportunities to integrate learning. Another half (8/20) thought that digitalisation does not affect technology education either way. Moreover, regarding digitalisation, half (11/21) of the panellists agreed that digitalisation has decreased children's technological know-how and narrowed their understanding of technology education (22) by reflecting that technology and technology education are mostly understood as ICT. The majority (9/15) of those who answered statement 17 "With urbanisation, the focus of technology education should change" disagreed with the statement and pointed out that urbanisation does not have an effect on how technology should be taught. Also, half (10/18) of the panellists disagreed with the statement, "The new challenges posed by occupational safety legislation affect technology education" (27) because changes in safety legislation are insignificant and do not target technology education.

Teacher education

When observing the panellists' responses to the statement, "Changing teacher education curricula to match multi-material crafts is the right change" (29), many (17/26) of them agreed with the statement. In their explanations, most of them reported how, with a wide range of craft skills, teachers can better help students understand the world around them and that teacher education cannot be separate from national curriculum guidelines. However, some panellists saw the importance of providing students with good knowledge and skills about different techniques (both in terms of technical work and textile craft) or of allowing students to choose which craft they would study more according to their interests and their own learning goals. These panellists pointed out that this would require more resources and collaborative development of craft teaching. Over half (13/22) of the panellists disagreed with the statement, "The development of technology education becomes clearer when teachers who have studied multi-material crafts enter working life" (35). Panellists raised concerns that the narrow material management and reduced resources for teacher education undermine teachers' professional skills. The same number (14/23) agreed with the statement, "After the combination of crafts (into multi-material crafts), contact teaching in universities does not enable students to have sufficient skills in technology education" (44). They argued that with lessons being at the minimum, students' skills depend a lot on their own interest and their possible hobbies in relation to crafts. Half (10/20) of the panellists disagreed with the statement, "Multidisciplinary subject management (STEAM) and pedagogical sensitivity enabling student-centred activities will be strengthened through renewed teacher education" (38), mostly because graduated students from renewed teacher education do not have sufficient subject-related skills in craft and technology education. Those who agreed with the statement did not argue in detail.

Discussion

The purpose of this study was to increase understanding of the present and future trends and issues in technology education in Finland. In relation to what the trends impacting the technology education discipline are (research questions 1 and 2), and what the issues impacting the technology education profession are (research questions 3 and 4), panellists reported that the role of technology education as part of a multi-material craft subject is unclear, as technology education is undefined as a concept and lacks a curriculum in basic education. Additionally, they expressed that the implementation of a new national craft curriculum is challenging and that developing multi-material crafts requires more research. Finland's current National Core Curriculum for Basic Education 2014 brought many changes to craft subject and technology education by combining two content areas of craft entities, technical and textile crafts, under one new concept of multi-material crafts. There is evidence that this change in crafts caused confusion among pupils, especially in their interest in studying crafts, and among craft teachers (Hilmola & Kallio, 2019). Based on this study, it was noteworthy how the shift from two separate content areas to one multi-material craft can generate strong, emotional reactions. Though panellists considered technology education to be suitable for a wide range of phenomenon-driven projects and thought that collaboration between disciplines is important, they stated that someone or a subject area should have a designated responsibility and an overall picture of implementing technology education. Also, many stated that the capacity of transversal competence areas handling technology education is weak and argued that the TCT subject would clarify and boost the status of technology education in Finnish basic education. However, all panellists do not share this view, as in their opinion, it would restrict the concept of technology education and divide the new multi-material craft subject. These findings reveal the unclear role of technology education and underline the need for clarifying it in basic education. If stakeholders have disharmonious understanding of the role of technology education or who is responsible for it, this will not promote the development.

Regarding the trends impacting the technology education discipline (research questions 1 and 2) panellists argued that concerning the missing definition of technology education in the basic educational curriculum, it should be more closely defined as part of technical craft. In their arguments, they highlighted how technical craft, its learning contents and operating culture provide a natural and effective learning environment and a framework for technology education. They also felt that the requirements and phenomena of technological literacy have changed. However, their opinions on how this change affects the demands of technological literacy and technology education varied. Many stated that technological literacy must change because complex technological systems have an increasing role in people's daily life. For the first time in the Finnish national curriculum, the concept "technology" can be found (but undefined) in the 1985 Framework Curriculum for Comprehensive Schools under "Craft, technical work and textile work". During technical work lessons, pupils should also learn to manage technology (POPS 1985). Also, as evidenced in the comparative analysis of technology education in national curricula, it seemed to be well represented in the National Core Curriculum for Basic Education 2004: craft curriculum. However, in the 2014 curriculum, technology education was more represented in science, as if many objectives were transferred from the 2004 craft curriculum to the 2014 science curriculum (Niiranen et al., 2021). To guarantee high quality technology education in basic education, a clear definition is needed on the national curriculum level.

In relation to what the trends are impacting the technology education discipline (research questions 1 and 2), and also what the issues are impacting the technology education profession (research questions 3 and 4), panellists saw that the revised teacher education curricula better matched multi-material crafts. However, they emphasised the importance of providing students with good knowledge and subject-related skills on different techniques and pedagogy. They felt that graduate students from renewed teacher education lack sufficient subject-related skills. Unfortunately, it seems that the lack of professional development of highly qualified technology teacher education is an international and continuous concern as experts in technology education have expressed concerns for over 30 years (Engelbrecht & Ankiewicz, 2016; Compton & Jones, 1998; Moye et al., 2020; Wicklein, 1993).

Conclusion

This study made the voices of technology educational experts in Finland heard and examined their views on current and future developments in the field. The selection of an expert panel is one of the crucial stages of the Delphi study. This study decided to invite experts to the panel according to Wicklein's (1993) criteria, mainly from university teaching and research staff. This can be seen as a limitation of the study. Future research should also consider the views of those who teach technology education in grades 1–9 of basic education. Additionally, it would be important to hear the views of the experts in more depth, which would be better made possible by interviewing them. Hopefully, our research will enrich the ongoing debate by bringing in the perspectives of teacher educators, researchers and developers.

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