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Reflective Tool for Sustainability Thinking – Craft, Design and Technology Student Teachers' Narratives

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Abstract

Teacher education is key for education in sustainability and sustainable development. In the Finnish education system, the subject of Craft, Design, and Technology (CDT) is considered an effective platform for teaching sustainability. The view of sustainability, from environmental, economic, and socio-cultural dimensions, has shifted to a more holistic perspective in which all dimensions are regarded as intertwined. This study combines theoretical aspects of sustainability and its inclusion in the subject of CDT. The aim is to investigate CDT student teachers' meanings of sustainable development in their individual lives and their CDT teaching. The narratives of student teachers (N=47) in survey responses were analyzed to gain insight into their meanings. The analysis resulted in four descriptive subcategories, each reflecting different meanings shaping CDT student teachers' sustainability thinking. In conclusion, a reflective tool for sustainability thinking in teacher education was created within this study.

Keywords: Craft, design and technology education, meanings, sustainability thinking, sustainable development, teacher education.

Introduction

Higher education is responsible for preparing future teachers to deliver education for sustainable development at all school levels. In education for sustainability, teachers must connect broader aspects of sustainability holistically. According to Hofverberg et al. (2017), Craft, Design, and Technology (CDT) education is regarded as a pathway toward a sustainable future. Teachers play a key role, and education is a powerful

societal instrument for enhancing citizen awareness of sustainable development (Gavinolla et al., 2022; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2016, 2021; Vesterinen et al., 2016). Additionally, teachers’ individual values for sustainability are recognized as important (Hofverberg et al., 2017), and their meanings vary from person to person (Goller & Rieckmann, 2022). Teaching sustainability requires a combination of attitude, knowledge, and suitable pedagogy (Esa, 2010; González-Salamanca et al., 2020). The challenge is that while sustainable development is everyone’s responsibility, people often do not feel personally accountable (Berglund & Gericke, 2015).

A broad understanding of sustainability covers several aspects, including environmental, economic, and socio-cultural dimensions (Aminpour et al., 2020; Koskela & Kärkkäinen, 2021; Maurer & Bogner, 2019). Holistic sustainability is essential, as social and cultural factors often lead to environmental problems (Borg et al., 2014). Sustainability and environmental background are recognized as relevant topics for discussion in teacher education (Maurer & Bogner, 2019; Sihvonen et al., 2023) and higher education (Žalėnienė & Pereira, 2021). Local and global levels of sustainability should be recognized in teacher education (Nousheen et al., 2020). In-service teachers already consider sustainability-related issues in their teaching but do not approach sustainability holistically (Uitto & Saloranta, 2017). In teacher education, sustainability is often linked to environmental education (e.g., Wanchana et al., 2020). The multidimensional and fragmented nature of sustainability challenges teacher education, and student teachers find the concept of sustainability relative (Maurer & Bogner, 2019). However, teacher education can improve student teachers’ awareness, attitudes, and skills for teaching sustainability (Nousheen et al., 2020; Thomas, 2009).

In Finnish basic education, CDT is viewed as a holistic process where the maker individually or collaboratively designs, produces, and evaluates the entire process and final product (Finnish National Board of Education [FNBE], 2014, 270, 430; Pöllänen, 2009). The crafts maker is an essential agent in the process, from ideation to evaluation of the outcome (Porko-Hudd et al., 2018), and must possess sufficient knowledge, skills, and attitudes to complete the process (Lindfors & Hilmola, 2016). CDT fosters students’ growth into responsible, participatory, and enterprising citizens (Häsänen et al., 2018), provides a framework for integrating different subjects and digital skills into learning (Hakkarainen & Seitamaa-Hakkarainen, 2017), and offers a natural learning environment where well-being is promoted through crafting (Veeber et al., 2015). Such a holistic approach to CDT education offers a way to integrate sustainable development into schools.

In the Finnish National curriculum for basic education, sustainable development and sustainable living are considered a holistic entity that recognizes environmental, economic, social, and cultural sustainability (FNBE, 2014, p. 16). The United Nations’ (UN) 2015 declaration, Agenda 2030, comprised goals for sustainable development to be achieved by the end of 2030. From the CDT perspective, Agenda 2030’s key aspects are the following:

1. development-oriented practices aiming to support productive activities, creativity, entrepreneurship, and innovation;

2. sustainable consumption at both the production and the consumer levels, including sustainable and efficient use of natural resources, prevention of waste, and recycling and reusing material (UN, 2015).

This study investigates sustainable development and sustainability from the perspective of CDT student teachers. CDT is an inventive and experimental activity that involves implementing visual and technical solutions along with various material choices and production methods (FNBE, 2014, p. 270; 430). CDT has the potential to combine different subjects and content (Räisänen, 2014), offer multifaceted learning experiences and environments (Rönkkö & Aerila, 2015), and enhance innovation (Karppinen et al., 2019). In the crafting profession, the ethics of sustainability are seen as holistic, including raising awareness of sustainable values (Kane, 2017), understanding how things are made, knowing the skills and materials to create them, and being a responsible producer and consumer (Weinberg, 2012). Because of CDT's multifaceted approach, this study views sustainable development as a holistic entity encompassing environmental, economic, and socio-cultural aspects of sustainability (Berglund & Gericke, 2015; Väänänen & Pöllänen, 2020). The lack of a holistic perspective in sustainability education is recognized in higher education institutes (Findler et al., 2019). To deepen the understanding of sustainability and its role in education, this study explores CDT student teachers' meanings of sustainable development, both in their personal lives and as part of CDT education.

Theoretical Framework

The well-known definition of sustainable development in educational policy and research describes it as a human activity that ensures both current and future generations can meet their needs and have the opportunity for a good life (Brundtland, 1987). Traditionally, sustainable development has been divided into the categories of environmental, economic, and social sustainability (Goodland, 1995; Ruggerio, 2021; Søråa & Fyhn, 2017), also known as the three pillars of sustainability (UN, 2002, 2005). According to Hofverberg et al. (2017), economic, social, and ecological processes together create a multi-level entity that supports a resilient socio-ecological system. Therefore, the idea of sustainable development is to link economic and social development with nature and support its carrying capacity (Berglund & Gericke, 2015). Criticism of the concept of sustainable development has arisen due to its focus on separate dimensions rather than a holistic view that extends globally and even to the planetary level (Salonen et al., 2023). Living in a sustainable way pressures humans to view life as part of a larger entity and to see the world holistically (Ferraro et al., 2011).

In this study, sustainability is considered part of the definition of sustainable development (cf. Aminpour et al., 2020). The authors recognize the distinction between defining sustainability and sustainable development in earlier research (cf. Ehrenfeld, 2008, p. 5–6). Sustainability originally referred to an ecosystem's potential to subsist over time, but when the idea of development was added, the concept shifted to focus on society and the economy instead of the environment (Jabareen, 2008). Sustainability involves the persistence, maintenance, or endurance of different systems, environments, facilities, and cultures (Zeeshan et al., 2022). These systems have a certain capacity to

maintain their vitality, but humankind's current lifestyle cannot sustainably support this (Loukomies et al., 2023). Sustainability has been seen as an environmental trademark and development as an economic one, easing the paradox between sustainability and sustainable development (Jabareen, 2008).

Environmental or ecological sustainability has received the most attention in public discourse within sustainable development (Sørraa & Fyhn, 2017). There is also a scientific consensus that many environmental threats are human-related, such as overconsumption of natural resources, ecosystem destruction, unsustainable land use, and pollution (Burns, 2012; Lehtonen et al., 2019; Loukomies et al., 2023). These human activities should be a key focus in education (Ogunyemi et al., 2023; Timoštšuk & Lumi, 2022). A key aspect of environmental sustainability is living sustainably within the limits provided by ecosystems (Ferraro et al., 2011; Goodland, 1995). Environmental sustainability is defined as a state in which society and nature exist in balance (Cogut et al., 2019). It has been suggested that establishing a personal relationship with nature and materials could increase respect and care towards the environment (Andić & Mažar, 2023; Haukeland & Sæterhaug, 2020). In environmental education, methods such as outdoor learning, engagement, and experience-based teaching are implemented (Ronen & Kerret, 2020).

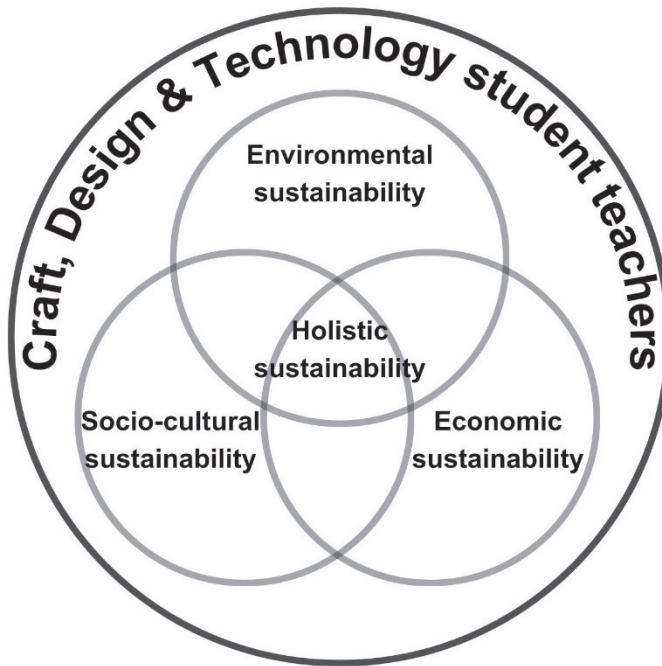
Economic sustainability is complex (Jouzi et al., 2024), as consumption increases waste and the use of natural resources, but it also increases employment (Väänänen, 2020, p. 45). Therefore, consumption practices should be structured around sustainability (Laine, 2016). Economic sustainability ensures stable economic activity and promotes societal development while considering environmental demands (Timofti et al., 2020). It seeks to integrate environmental and social aspects of sustainability through economic means (Soini & Birkeland, 2014). According to Bofylatos (2017), the current model of economic growth, which aims to reduce environmental and societal impacts, can never lead to sustainability. However, highlighting the UN's sustainable development goals in policymaking has created new business opportunities, such as promoting the circular economy and sustainable entrepreneurship (Crecente et al., 2021). Due to the human economic subsystem, education for sustainable development has been regarded as critical in research (Maurer & Bogner, 2019). In both the Finnish CDT basic education curriculum and the teacher education curriculum, entrepreneurship is recognized (FNBE, 2014; Seikkula-Leino et al., 2021).

Social sustainability is understood to encompass sustainable capacities produced for society's own benefit, such as well-being (Izidio et al., 2018; Salonen & Konkka, 2015), health, security, equity, and equality (Jabareen, 2008; Laine, 2016). Current research also recognizes cultural sustainability as a fourth dimension of sustainable development (Pop et al., 2019; Soini & Birkeland, 2014). At the same time, crafts and CDT education integrate cultural heritage and socio-cultural sustainability (Aytekin & Rızvanoğlu, 2019; Väänänen & Pöllänen, 2020; Walker et al., 2019). Although the distinction between social sustainability and cultural sustainability is recognized in research (Laine, 2016; Soini & Birkeland, 2014), this study combines the two dimensions as socio-cultural sustainability (cf. Axon, 2020; Huang & Cheng, 2022). The Finnish basic education curriculum recognizes cultural sustainability as part of sustainable development and living sustainably (FNBE, 2014, p. 16). Holistic sustainability is considered a perspective where

environmental, economic, and socio-cultural dimensions of sustainable development are integrated (Figure 1).

Figure 1

Sustainability in CDT Student Teachers' Meanings



Proponents of the STEAM (science, technology, engineering, arts, and mathematics) approach, an integrated pedagogical approach to education, acknowledge the potential of integrating sustainability education (Deák & Kumar, 2024; Horvath et al., 2023; Yang et al., 2024). In an international context, STEAM education closely aligns with the Finnish CDT subject (cf. Aerila & Rönkkö, 2024; Karppinen et al., 2019) and Nordic technology and sloyd education (cf. Hallström, 2018). While STEAM education fosters future innovators, its link to sustainable innovations has been recognized in research (Deák & Kumar, 2024). Finnish CDT education and its infrastructure support learning through innovation and invention (Riikonen et al., 2020). UNESCO (2020) emphasized the importance of education for sustainable development, focusing on innovative pedagogies in technology-driven learning environments. Innovation, ideation, and problem-solving are at the heart of CDT, especially in the design process (Lindfors & Hilmola, 2016).

Systems thinking, critical thinking, and normative competences are treated as key sustainability skills (Lozano et al., 2021; Wiek et al., 2011). Awareness of scientific, conceptual, metacognitive, and procedural knowledge is crucial for improving transformative science education for sustainability (Jeronen et al., 2024). The most recognized competencies among student teachers in sustainability education are

collaboration, integrated problem-solving, and strategic thinking (Yli-Panula et al., 2021). These skills are considered 21st century skills, which are also highlighted in CDT and STEAM education (Bano et al., 2023; Deák & Kumar, 2024; González-Salamanca, 2020). Earlier research shows that student teachers’ understanding and learning of sustainability improve through practical experiences and modeling with available materials (Timoštšuk & Lumi, 2022). In this sense, CDT education, with its practical nature and inherent relationship to materials (Horvath et al., 2023; Mehto & Kangas, 2023), is well-suited for sustainability education.

Globally, teachers and education are seen as crucial agents in promoting sustainable development goals (Gavinolla et al., 2022; UNESCO, 2021). The challenge in pre-service and in-service teacher education is to comprehend sustainability’s multidimensional and complex nature. For example, teaching climate change in an interdisciplinary and holistic way has proven beneficial (Beasy et al., 2023). Promoting sustainability in education requires teachers’ commitment (Esa, 2010; Waltner et al., 2018). Teachers must understand the science behind technology to pass this knowledge to students and support a sustainable future (Schnittka, 2023). The importance of understanding the value of technology when developing education is crucial (Gavinolla et al., 2022). Hence, higher education can promote the innovation of technologies that form the basis of sustainability (Žalėnienė & Pereira, 2021).

Method

This study investigates how CDT student teachers perceive sustainable development and its meanings in their lives and CDT in school. To investigate meanings, the data collection was conducted through an online Webropol survey distributed by the university to N=47 CDT student teachers (Table 1).

Table 1
Background of the CDT Student Teachers

Participants (N=47)	f (n)
CDT Studies	
Bachelor’s level (major student)	23
Master’s degree (major student)	17
Basic studies (minor student)	1
Intermediate studies (minor student)	6
Gender	
Female	33
Male	14
Working Experience in School Community	
At least one school year	14

See next page for continuation of table

Continuation of Table 1

Occasional substitutions	13
No working experience	20
Work Experience as a Craft Professional or Qualification for Crafts	
Yes	12
No	35

This study uses a narrative approach to understand student teachers' meanings of sustainable development (Chase, 2008, p. 64; Polkinghorne, 2007). Narrative analysis reveals student teachers' meanings (Riessmann, 2008). Narrative analysis addresses subjectivity and individual endeavors in theory building (Andrews et al., 2007). The analysis included students' responses to two open-ended questions: *What does sustainable development mean to you?* and *Give at least one example of how you would include sustainable development in your own CDT teaching?* A question allowing respondents to freely share their perceptions of sustainable development was also included. Sustainable development is recognized as an ideological concept with an inherent ethical paradox (Jabareen, 2008). Research in higher education has found that sustainable development is often generalized to cover institutions rather than focusing on detailed sustainability concepts (Findler et al., 2019). To avoid these generalizations and highlight individual meanings, the questions were designed to be "storyworthy in the narrators' social settings" (Chase, 2008, p. 71). In this study, social settings refer to participants' individual lives and thoughts on teaching CDT.

Student teachers' answers formed narratives of their individual meanings of sustainable development. A brief account of personal experience is considered a narrative in which the speaker shares their thoughts (Watson, 2006). Narratives reflect both personal identity and everyday life practices (Freeman, 2015). When participants reflect on sustainable development in their narratives, their experiences and surroundings are revealed. Narratives reflect individual lives and interpretations of experiences without a definitive conclusion (Freeman, 2015; Polkinghorne, 2007; Riessmann, 2008). This study recognizes the shift in participants' roles from survey respondents to reflectors of individual meanings. These meanings were further interpreted by the researchers.

The analysis was conducted in two phases. In the first phase, the data was classified into three dimensions – environmental, economic, and socio-cultural sustainability – based on the theoretical framework (Figure 1). The units of analysis (n=257) ranged from single words to multiple sentences, reflecting how student teachers emphasized different dimensions of sustainability. In the second phase, each participant was analyzed individually. The units identified in the first phase categorized N=47 student teachers into four subcategories based on their meanings of sustainability. Each subcategory emphasized one or more dimensions of sustainability. If students' meanings highlighted all three dimensions evenly, they were considered holistic, as outlined in the theoretical framework (Figure 1).

Results

Based on the narratives, descriptive features for each subcategory were recognized, and names were assigned to clarify each group. The identified subcategories included those who are:

- aware of sustainability,
- endeavoring towards sustainability,
- responsible consumers, and
- craftsmen.

The subcategories reflected CDT student teachers' meanings of sustainability and sustainable development. The meanings emphasized students' individual actions regarding sustainability and their meanings of teaching sustainability in relation to CDT education.

Those Who are Aware of Sustainability

In the “aware students” subcategory, there were 12 CDT student teachers. The aware students recognize the importance of sustainable development, but their daily practices do not fully align with their understanding. For example, their consumption habits differ from their understanding, as they only sometimes purchase recycled clothing and occasionally make their own necessary items. However, they prefer local products over foreign ones, even when the local product is more expensive. Their understanding of sustainable development is somewhat vague or ambiguous:

“Sustainable development is a contemporary issue, and everyone must contribute to advancing the mindset of sustainable development”.

They particularly stress environmental sustainability in their meanings. Eleven of the twelve aware students described sustainable development from an environmental or environmental-economic perspective, while one student took a holistic view:

“Ecological aspects, environmental friendliness, aiming for a sustainable future, and making sustainability choices”.

A recurring theme in CDT education is that aware students discussed sustainable development abstractly, often noting its importance but struggling to provide specific examples. However, they were able to provide specific examples of implementing sustainable development in CDT teaching, primarily related to environmental or economic sustainability:

“Utilizing recycled materials, such as fabrics from old and worn-out clothing”.

Those Who are Endeavoring Towards Sustainability

There were 12 CDT student teachers recognized in the “endeavoring students”

category. The conjunctive element of the category was that the students were striving to live by sustainable principles, though they did not always succeed. The main difference between aware and endeavoring students was their effort to live sustainably:

“It [sustainability] is something I try to incorporate into my daily life. I want to help to protect the environment with my own contribution”.

They understand the importance of sustainable development, but their actions reflect uncertainty. Sustainable development is significant to them, but they are highly aware of the challenges of living sustainably. Endeavoring students recognize that they do not always live according to principles of sustainable development:

“However, sometimes I crumble and act in a way that does not promote it [sustainable development]. But I want to help the progress of sustainable development quite a lot”.

Endeavoring students understand sustainable development from either an ecological (four students) or economic (five students) sustainability perspective. Three of them also understand sustainable development from a holistic sustainability perspective. In CDT education, endeavoring students view sustainable development through practical aspects of teaching. This is evident in their consideration of available resources, such as money and time:

“As a teacher, I would certainly think about the origin of the material. However, the budget must of course be considered as well. I would also strive to teach students about sustainable development within the constraints of the schedule”.

Those Who are Responsible Consumers

The “*responsible consumers*” category included 11 CDT student teachers. Responsible consumers believe their actions can impact the state of the planet. This is evident in both their daily lives and their approach to CDT education. They highlight consumption habits that serve or benefit nature and its carrying capacity. They strive to avoid disposable culture and consider environmental factors when making purchase decisions:

“We need to make ecologically good choices so that products last longer and harm nature as little as possible”.

Their critical examination of individual consumption habits and the avoidance of unnecessary purchases are central to their sustainability thinking. This is reflected in their understanding of sustainable development:

“Making adequate purchases, using products until they are ‘spent’ and avoiding unnecessary acquisitions”.

Although economic sustainability is emphasized in the perceptions of responsible consumers, environmental sustainability is an underlying element in their thinking. This is evident in their meanings: eight students understand sustainable development

from an environmental-economic perspective, and three view it from an economic perspective. Their meanings also emphasize product repair, and they rarely discard broken items, opting to repair them instead. Repairing is recognized as a key element of their sustainability practices in craft education:

“Teaching how to repair and recognize a quality product”.

Those Who are Craftsmen

The “*craftsmen*” category included 12 CDT student teachers. They emphasized either the practice of craftsmanship or the teaching of crafts in relation to sustainability. Guided by craftsmanship, all twelve students understand sustainable development holistically, covering environmental, economic, and socio-cultural sustainability:

“Using and selecting product, process, and materials in a way that burdens the environment as little as possible, both ecologically and socially”.

When their meanings are guided by craftsmanship, the principles of sustainable development are almost automatically emphasized:

“By extending the product’s lifecycle as long as possible (excluding, for example, motor vehicles), sustainable development values are promoted”.

As seen in the example above, certain realities are considered in craftsmen’s meanings, such as teaching motor technology, which is included in CDT teacher education, may not necessarily advance sustainability. They were capable of comprehending sustainability from the perspective of craft education and recognized their individual responsibility and role as teachers of sustainable development:

“In technical crafts [woodwork], for example, growing and using of hardwood nowadays; could the same result be achieved with domestic birch and stain?”

“Sustainable development, recycling, and repairing products are particularly strongly the responsibility of the crafts teacher. If they are not interested in the matter, it will not be implemented in the teaching either”.

As responsible consumers, craftsmen emphasized repairing and maintaining products. Repairing broken products also occurred in their concepts of teaching sustainable development. Thinking through craftsmanship helped them understand, for example, the environmental harm of mass production in the clothing industry and the importance of product quality and durability.

Among the craftsmen, there is a small group (three students) who could be called “*lifestyle sustainers*”. Lifestyle sustainers’ everyday actions reflect sustainable development, and they consider sustainability comprehensively in their lives. This includes understanding the perspectives of ecological, economic, and socio-cultural sustainability, making sustainable development a self-evident principle. For them, living sustainably is not just a way of acting but rather a continuous state of being that guides everyday choices:

“Placing the nature at the center of all actions, rather than as a constraint of action”.

Discussion and Conclusions

This study strove to broaden the understanding of CDT student teachers' meanings of sustainability and sustainable development. To promote sustainability education for CDT student teachers, the study identified subcategories that reflect students' meanings. The meanings highlighted the students' individual actions of sustainability and their understanding of teaching sustainability in the CDT school subject. The four resulting subcategories – aware students, endeavoring students, responsible consumers, and craftsmen – formed narrative descriptions of CDT student teachers' interpretations of sustainable development. To tackle real-world sustainability challenges, the focus should be on teaching students how to think rather than what to think (Brundiers et al., 2010; Lander, 2017; Thomas, 2009). This study recommends a self-reflective tool for teachers, especially CDT student teachers, to assess their sustainability thinking, individual actions, and teaching in the CDT subjects (Figure 2). The development of different approaches to thinking sustainably has also been explored in earlier research (cf. Risopoulos-Pichler et al., 2020). To promote reflective sustainability thinking, models and tools such as those shown in Figure 2 can be integrated into broader teacher education, not just for CDT student teachers.

Figure 2

Reflective Tool for Sustainability Thinking

The Aware Students

- Sustainable development is abstract term for me.
 - I emphasize environmental or environmental and economic perspectives in my thinking.
 - I recognize the importance of sustainable development but I don't always apply sustainability to my everyday choices, such as my consumption habits.
 - I sometimes buy recycled clothes.
 - I prefer local products, even if they cost more than other.
- In CDT teaching, I can give concrete examples of sustainability, such as using recycled materials.

The Endeavouring Students

- Sustainable development is environmental and economic term for me but I also recognise sociocultural aspect of it.
 - I strive to live sustainable way but I often face challenges doing so (for example over consumption).
 - I understand the importance of sustainable development and I try to contribute to protect the environment.
 - I want to remain committed to support sustainability more in the future.
- In CDT teaching, I am able to consider sustainability within the practical resources such as time, budget, and available materials.

The Responsible Consumer

- Sustainable development is environmental and economic term for me.
- I believe my actions impact the state of the planet.
- I avoid disposable culture and use products until they are worn out.
- I critically examine my individual consumption habits (for example I avoid unnecessary acquisitions and purchases).

- In CDT teaching, I value repairing products and recognizing quality and long-lasting products.

The Craftsmen

- Sustainable development is holistic term for me that includes environmental, economic, and socio-cultural sustainability.
- Living sustainable way is almost automatic for me, such as extending a product's lifecycle by repairing it, or choosing sustainable and long-lasting materials.
- I recognize my responsibility as a teacher of sustainable development (for example teaching the importance of repairing, recycling, and using sustainable materials).
- I understand the human impact to the planet (for example mass production, fast fashion and technology).

- In CDT teaching, sustainability is starting point of the whole CDT process.

Current research suggests a multifaceted and holistic approach to sustainability education, encompassing environmental, economic, and socio-cultural dimensions of sustainable development (Berglund & Gericke, 2015, Deák & Kumar, 2024; Väänänen & Pöllänen, 2020). Earlier research shows that CDT teachers often consider two or three dimensions of sustainability but are less active in holistically teaching sustainability (Uitto & Saloranta, 2017). Current study findings differ by distinguishing students focusing on one or two dimensions of sustainability (aware students, endeavoring students, and responsible consumers) and students with a holistic view including all three dimensions (craftsmen). This result may be explained by the CDT subject and its material context, which may lead student teachers' meanings towards concrete aspects of sustainability, such as using recycled materials and repairing broken products. Similar findings were noted in Väänänen et al.'s (2018) research on CDT teachers' conceptualization of sustainable craft, where product orientation and materiality were highlighted. In the current study, craftsmen had experience or qualifications in crafting, which might have affected their meanings, leading them to see a bigger picture – to see sustainability as a holistic entity – including the socio-cultural dimension. Interestingly, earlier research emphasized the social dimension of sustainability (Koskela & Kärkkäinen, 2021), a view recognized only in the craftsmen's meanings in this study. However, research also indicates that both in-service teachers and students struggle to connect socio-cultural sustainability to their teaching (Huang & Cheng, 2022).

Higher education is estimated to impact adult life 50 to 60 years after graduation (Bowen, 2018). Hence, education can contribute significantly to graduates, for instance, enabling to secure well-paid jobs that help build sustainable societies (Žalėnienė & Pereira,

2021). A positive relationship has also been found between parents' socioeconomic status and student teachers' environmental knowledge (Pe'er et al., 2007). To promote future sustainability, adequate and multifaceted education for sustainability in higher education may positively shape individual perspectives and increase sustainable values in societies. Sustainability thinking could enrich CDT education, and vice versa, CDT's multifaceted, interdisciplinary nature could enhance sustainable development education. Future teachers are in a key position to adopt sustainability principles and consider them holistically. As the Berlin Declaration (UNESCO, 2021) states, teachers and teacher education programs are key agents and a platform for delivering education for sustainable development goals. All in all, the aim of education for sustainable development and sustainability is to integrate the values and practices of sustainable development into all aspects of education (Uitto & Saloranta, 2017). For that reason, the need to promote sustainability thinking in teacher education is increasingly relevant.

In the context of primary education, creating generalizations of sustainability concepts and models is recognized as an important skill (Timošćuk & Lumi, 2022). Holistic sustainability thinking is needed to generalize sustainability concepts and convey this understanding to students. A holistic approach to sustainability has also been recognized as multidisciplinary in current research. For example, research on well-being suggests that the concept should be considered holistically, including sustainability (Ronen & Kerret, 2020). When combining sustainable development with CDT, product repair should be further investigated. König (2013) introduces the concept of mending, which includes various motivations for repairing products, such as environmental sustainability, personal and cultural relationships, and economic interests. Interestingly, themes of mending and repair were included in the previous Finnish CDT curriculum (FNBE, 2004) but are absent in the current version (FNBE, 2014). In today's technological era, crafts are no longer valued as they once were (Marjanen & Metsärinne, 2019; Pöllänen, 2009). According to Niedderer and Townsend (2014), traditional crafts have gained a retro image, remaining stuck in tradition. As a result, craft development has been slow, treated as outdated and irrelevant to modern society and 21st-century skills. To promote CDT education, wicked problems such as sustainability should be investigated more in the teaching practices of CDT.

In today's technology-driven world, research on sustainability education has recognized digitalization and technology as key components in teaching sustainability. Modern technologies, such as the Internet of Things (Zeeshan et al., 2022), digital immersive technology (Tang, 2024), educational robotics (Román-Graván et al., 2020; Yang et al., 2022), artificial intelligence (Abulibdeh et al., 2024; Goralski & Tan, 2020), and information and communications technology (González-Salamanca et al., 2020; González-Zamar et al., 2020), have been examined from various sustainability perspectives. Harnessing new technologies to enhance education is seen as a way to provide quality education for sustainable development (Zeeshan et al., 2022). Also, digital learning and modern technologies have been considered an essential future research field of sustainability in teacher education (Gavinolla et al., 2022). Modern technologies – such as digital modelling and educational robotics – have been integrated into CDT education to enhance learning and thinking. From a sustainable development perspective, the

relationship between modern technologies and sustainability should be further explored in the context of CDT and teacher education. Schools that utilize advanced technology can add value to sustainability education and produce a competent future workforce (Zeeshan et al., 2022).

Sustainable development is recognized as inherently ideological, with ethical paradoxes constituting a fundamental aspect of its conceptual framework (Jabareen, 2008). Emotions are found to be relevant in understanding sustainability-related aspects (cf. Anđić & Mažar, 2023; Pihkala, 2018; Schnittka, 2023), such as in the teaching of climate change (Beasy et al., 2023). Understanding sustainability also influences individual decision-making, particularly in areas like consumption (Bengtsson et al., 2018). This study investigated meanings closely connected to experience (Wenger, 1998, p. 51–52). When investigating meanings, it is essential to examine not only what happened, but also the relationships between events and experiences (Freeman, 2015). In this study, the reasons and relations behind students' meanings were not specifically investigated. Only the respondents' backgrounds (Table 1) were collected but not used for qualitative purposes in this study.

Collaborative environments and teamwork are recognized as crucial for promoting sustainability education by setting common goals and fostering shared responsibility (Tang, 2024), as well as enhancing key sustainability competencies (Pacis & Van Wynsberghe, 2020). Collaboration and teamwork should also be considered when integrating sustainability into CDT education. Maker culture, where craft and technology projects rely on teamwork and knowledge sharing (Hsu et al., 2017), provides a suitable platform for sustainability education. This action-oriented pedagogy linking formal and informal learning has been emphasized in education for sustainable development (González-Salamanca et al., 2020). So-called hackathons or green hackathons, which use innovative and collaborative approaches to promote sustainability and solve environmental problems (cf. Medina Angarita & Nolte, 2020; Zapico Lamela et al., 2013), could be included in future CDT teacher education.

The study findings and the reflective tool for sustainability thinking may promote education for sustainable development in teacher education. According to Vukelić et al. (2025), student teachers' values, beliefs, attitudes, and self-efficacy are positively affecting their intention to implement the teaching of sustainability. Hence, a reflective tool for sustainability thinking aims to trigger student teachers' minds and ease the process of finding intrinsic values and attitudes toward sustainable development. In the CDT context, this thinking is integrated into a tangible, hands-on approach where different materials provide a concrete possibility to promote thinking in a sustainable manner. This hands-on minds-on ethos added in the social context of teacher education, where collaboration takes place with peers and teacher educators with multiple and varied views of sustainable development, may promote sustainability thinking. Knowledge gained through hands-on exploration and interpretive discussions is recognized as essential for sustainability education (Glasser & Hirsch, 2016; Maurer & Bogner, 2019; Schnittka, 2023). To promote holistic sustainability thinking, including different aspects of the phenomenon, the current study suggests an integrative approach combining sustainability thinking and hands-on making in collaborative activities with peers. This

combination of thinking, making, and sharing needs further investigation in the future to tackle wicked global problems.

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