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Subject Student Teachers' Perceptions of Key Environmental Problems and Their Own Role as Environmental Problem Solvers

Eija Yli-Panula [1,*], Eila Jeronen [2], Sofia Vesterkvist [1] and Laura Mulari [1]

[1] Department of Teacher Education, University of Turku, 20014 Turku, Finland; sofia.vesterkvist@edu.vaasa.fi (S.V.); lauraelisamulari@gmail.com (L.M.)
[2] Faculty of Education and Psychology, University of Oulu, 90570 Oulu, Finland; eila.jeronen@oulu.fi
* Correspondence: eija.yli-panula@utu.fi; Tel.: +358-50-3391216

Abstract: Teachers play a crucial role in supporting the development of students' environmental knowledge and skills for responding to environmental change, but previous research has not sufficiently explored teachers' perceptions of this matter. The article reports on a survey aimed at studying subject student teachers' (SSTs, n = 113) perceptions of environmental problems, their interest in sustainable development (SD) and their own role as environmental problem solvers. The material was gathered using a questionnaire and analysis by quantitative methods. Urban environment and infrastructure problems were the most frequently mentioned. Problems of ecosystems and indifference and a lack of information were also mentioned often, while the least noted were problems of human wellbeing. The majority of SSTs were interested in SD, but interest in SD was dependent on the discipline studied and gender. Two-thirds of women and one-third of men were very interested, and more than half of biology and geography SSTs were very interested. Over half of SSTs reported that environmental problems had to be solved by someone else; only about one-seventh perceived themselves to be solvers. The SSTs felt that they could influence the solutions to environmental problems more often on a local than on a regional or global level.

Keywords: climate change; environmental issues; subject student teachers; sustainable development

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1. Introduction

The role of human beings in environmental problems and sustainability, such as climate change and the reduction in biodiversity, has been reported as increasing [1]. As the world's population has grown, the effects of these changes have expanded from the local to the regional and global levels. The formation of global ecological, social and economic challenges cannot be addressed by individuals working alone or solely using local efforts [2]. With the help of global development guiding the sustainable development (SD) paradigm, the aim is to find ways to overcome threats to ecology and human health by looking for new forms of interactions between society and nature [3]. Effectively combating environmental problems requires people to acquire new knowledge, skills and ways of thinking and acting. The education system must respond to this need with appropriate teaching content and teaching methods [4].

Education for sustainable development (ESD) involves holistic, transformational and lifelong learning processes that aim to enhance the cognitive, social, emotional and behavioural dimensions of learning [5]. ESD seeks to balance human and economic wellbeing while taking into account cultural traditions and the sustainable use of the earth's natural resources [6]. It emphasizes the expansion of social learning and responsibility thinking from the individual level to communities and social institutions [7]. Key issues in ESD include globalization, the rise of the information society and the knowledge society, the use of diversity and the need for the inclusion of marginalized groups and perspectives [6,8].

The main goal is to educate students to be cooperative, active members of society who see environmental problems as solvable, know how to draw up plans to promote SD and are ready to act in accordance with those plans [5,9]. This goal is also noted in the curricula of Finnish basic and upper secondary education [10,11]. Comprehensive knowledge and socio-emotional and practical skills serve as the basis for promoting SD [5,12].

In general, students entering teacher training programs already have some sense of the subjects they are studying. However, their knowledge can be partial, illogical or simply wrong; these "alternative conceptions", as the field describes them, make it difficult to learn new concepts and theories for several reasons [13]. First, students usually do not know that their information is wrong. In addition, they interpret new experiences through these incorrect understandings, with their old "knowledge" interfering with the better understanding offered by new knowledge. Misconceptions can also take root in the students' thinking and make learning difficult because learning requires replacing or reshaping their old knowledge [13]. Learning requires a conceptual change, without which a student cannot effectively learn new knowledge and skills. In order for teachers to support learning, they must know their students' alternative conceptions. Thus, in order to teach SD, they must know their students' previous perceptions of SD and environmental challenges, their interest in adopting new ideas about SD and their desire to act on behalf of the environment.

Many studies have been published on teachers' and university students' perceptions of environmental problems e.g., [14–19], but specifically, SSTs' perceptions of environmental problems and especially their own role as environmental problem solvers have been examined less often. Some researchers, e.g., [20], have considered the interests of secondary school students in relation to environmental issues in school education. Durant et al. [21] have argued that the more people know, the more they will be interested in and concerned about their environment. Interest is important because it is related to a positive attitude towards environmental responsibility [20], and a more positive environmental attitude has been shown to be related to both higher work performance and proactive environmental friendliness at work [22].

Today, the idea of SDG 4 is that students gain knowledge and skills to promote sustainable development [7,14,23] and that teaching supports this. Educating SSTs as future teachers on issues concerning sustainability and the environment is particularly critical because teachers are largely responsible for the development of future generations' environmental knowledge and skills [24,25]. In the context of Romanian teachers [26], the importance of a wide subject knowledge in order to be a good teacher of environmental issues pointed out. The good knowledge of teachers was valued, especially in connection with the usefulness of the ability to adapt subject content to be accessible to students. Based on relevant knowledge and skills, the SSTs were able to raise awareness of primarily local sustainability issues but also of regional and global problems to some extent. Therefore, this study pays special attention both to SSTs' knowledge of environmental problems and their interest in SD related to local, regional and global environmental problems.

2. Theoretical Background

2.1. The Environment and Environmental Problems

The meaning of the term "environment" has changed significantly over the last few decades. Previously, it was associated with the natural environment and the pollution thereof. Today, it covers the full range of living environments and activities. Thus, it is often presented in accordance with the concept of SD as three-dimensional in two ways, with environmental, social and economic dimensions on the one hand and the three transverse dimensions of needs, long-term consideration or future generations and institutional aspects or governance on the other hand [27]. In the present study, this more nuanced concept of "environment" is applied.

The state of the environment and environmental problems have been extensively studied in recent years. According to the Intergovernmental Panel on Climate Change

(IPCC), the most urgent environmental problem is climate change. Human-caused climate change has already been connected with extreme weather events across the globe. This has adversely affected food and water security, human health, economies and whole societies, leading to damage to nature and economic losses [28]. In Finland, as elsewhere, climate change is one of the most serious environmental problems affecting humanity. It is linked to the impoverishment of biodiversity and unsustainable consumption and production methods [29]. The IPCC has set the goal of shifting development pathways to increase sustainability and mitigate climate change [2]. A climate-neutral Europe by 2050 is the goal of the European Union (EU). Particular attention is being paid to the development of the circular economy, the central functions of which are waste reduction, reuse and recycling to promote economic wellbeing and environmental protection [30].

From the perspective of environmental protection, the enormous diversity and sheer scale of the environment poses challenges, as the environment is seen as the indirect responsibility of everyone but the direct responsibility of no one [1]. The socially constructed nature of environmental problems also poses challenges. Although statistically verifiable data are used to identify environmental problems, the selection and definition of those data are socially constructed. This can lead to disagreements about environmental problems, as some may feel that a given definition conflicts with their interests [31]. Due to the multidimensional nature of the environment and environmental problems, it is challenging to find an objective truth to define these terms, to assess the severity of environmental problems and to identify cause-and-effect relationships [1,31]. Based on the multidimensional nature of environmental issues and the diffuse responsibility for the environment, local, regional and global environmental problems and who is expected to solve them are the focus of the present study.

The results and conclusions of environmental reports have been based mainly on information provided by decision makers' [32] and citizens' perceptions of environmental problems and behaviours [33]. By interviewing local decision makers and environmental experts, Rousval [34] and Rousval and Maurin [35] created a hierarchy of the environment and related goals that were based on environmental problems (Table 1).

Table 1. Hierarchy of objectives in the environmental field [34,35].

Objectives on Global Levels	Objectives on Local Levels
Preserving the environment for human life	*Concerning the natural environment*
Limit the greenhouse effect	Limit the degeneration
Limit climate change	Protect fauna
Protect the ozone layer	Protect flora
	Preserve landscapes
Preserving natural resources	Limit excessive use of concrete
Limit the extinction of natural species	
Limit the extinction of the natural environment	*Concerning the human environment*
Limit energy consumption	*Concerning public health*
Limit the maritime pollution	Limit the effects of air pollution
Limit the production of non-recyclable waste	Limit the health impacts of noise
	Concerning quality of life
	Limit disturbing noises
	Limit disturbing fumes
	Limit disturbing odours
	Improve townscapes
	Preserving cultural legacies
	Respect an area's villages
	Prevent habitats from being spoiled

Studies have shown that, regardless of discipline, most students regard the environment [36] and environmental issues [16] as important for their future teaching work.

2.2. Students' Perceptions of Environmental Problems

Finnish university students have been shown to regard climate change to be the most serious environmental problem, with decreasing biodiversity second and the lack of clean water third [15]. The main goals in teaching climate change, according to the perceptions of Finnish university students, are increasing and structuring knowledge, developing thinking skills and encouraging action, with raising hope and triggering emotions regarded as less important [37]. Kukkonen et al.'s [15] findings support earlier research [16] in which teacher candidates were reported to consider the most important environmental problem to be global warming, with climate change coming second. Salïte et al. [38] found that student teachers did note the serious effects of climate change but regarded other issues as more serious, especially pollution. That finding partially diverges from Elshof's report [39] that technology teachers perceived biodiversity and global warming as the least important sustainability issues. Kukkonen et al. [15] found that arts, social sciences, mathematics and natural sciences students considered the lack of clean water to be a serious environmental problem more often than education students, with female students regarding climate change as the most serious environmental problem more than male students. This finding is in line with those of Svetina et al. [40] about a gender difference in appreciating sustainability. Some international studies conducted at universities have mapped students' awareness of waste minimization, collection, reuse and recycling problems [41–43]. These studies and others [32,44] show that environmental issues are very important for students.

Finnish university students have also been shown to be aware of the existence of local, regional and global ecological, economic and environmental problems [44]. Of local problems, they consider air pollution, private motor vehicles and littering to be big issues in particular. Regional problems included ineffective local transportation, overconsumption and the use of energy. Globally, they showed awareness of climate change, deterioration in water quality and low levels of recycling. However, they did not consider social disadvantage to be a SD issue. This finding differs from another study [14], where Spanish student teachers rated social problems as more important than other environmental problems.

2.3. Sustainability, SD and Environmental Issues

The heart of sustainability lies in ethical issues related to three concepts: continuity, orientation and relationships [45]. From the perspective of continuity, the concept of sustainability involves stability over time and the inherent ability of systems (e.g., ecosystems, economic systems), entities (e.g., species, buildings, capitals) and processes (e.g., evolution, activities) to survive, with or without human intervention, in a context of rapid change. The concept of "orientation" refers to the idea that sustainability is the main goal that should guide the actions of individuals and communities [44], while "relationship" is the core idea in the Brundtland Report [46], which clearly emphasizes the link between the environment and development and the importance of the human dimension in all decisions concerning environmentally sound development [47]. Thus, sustainability has often been divided into weak and strong forms [48]. The former emphasizes the quantitative aspect of growth [49]; the idea is that weakening one dimension of SD could be mitigated by strengthening another [48]. For example, a lack of ecological sustainability could be managed by technological advances. In this case, the danger is an overestimation of nature's carrying capacity and an inability to recognize the need to protect nature and change our current behaviours. From a strong sustainability perspective, the dimensions of sustainability complement one another [50], and the importance of the green economy and environmental protection is emphasized [48].

Sachs [51] (p. xiii) has stated that SD "is both a way of looking at the world, with a focus on the interlinkages of economic, social, and environmental change, and a way of describing our shared aspirations for a decent life, combining economic development, social inclusion, and environmental sustainability. It is in short both an analytic theory and a 'normative' or ethical framework". Thus, SD is a socio-economic issue that not only helps meet short-term human needs but also contributes to long-term progress towards

wellbeing and a better quality of life within realistic environmental constraints [52]. At its core, it has three principles: eco-efficiency, inter- and intra-generational social justice and participation in decision making [46]. Eco-efficiency strives to create more goods and services with fewer resources and creating less waste and pollution in the process. Inter- and intra-generational social justice and the possibility of participating in decision making depend on different aspects, including inter- and intra-generational equity, the distribution of power and resources, education and freedom [53].

The concept of SD derives from the triple bottom line framework, which implies a balance between the three dimensions of sustainability: ecological, social and economic SD [54]. The broad perspective of the concept of environment, where cause-and-effect relationships of phenomena related to the environment are also examined socially and culturally, is also clearly visible in the SD concept [55].

Ecological SD focuses on maintaining the level of environmental protection necessary for carrying out economic activities and enhancing people's quality of life [48]. Human–environment interactions and their impacts belong to the ecological dimension. Social SD strives to ensure human rights and equality, the preservation of cultural identities and respect for cultural diversity, race and religion [56]. At the core of the social dimension are social equity and the sustainability of communities. Economic SD involves creating and maintaining the natural, social and human capital required for income and living standards [57]. It concerns organizations' impacts on the economic conditions of their stakeholders and on economic systems at the local, national and global levels. These three dimensions are also integrated in a complex manner: for example, the political aspect is mainly a part of the economic dimension but also affects the other two dimensions [47].

The importance of ecological SD lies in the fact that society and the economy depend on the integrity of the biosphere and the ecological processes taking place within it. Consequently, people should maintain their social, cultural and economic wellbeing without overly depleting natural resources or overloading nature's delicate balance. SD cannot be achieved solely with technical solutions, political regulation or financial instruments; it also requires high-quality education and learning for SD [5].

In the early years of environmental education, teaching was often based on a resource-oriented and reductionist approach that avoided social, environmental and political issues. Instead, it emphasized protecting fauna, flora and natural resources. It was often also connected with the idea of the ability of science and technology to find solutions to environmental problems. Later, the focus shifted to the responsibility of the authorities and of every citizen to protect, revitalize and improve the environment not only in the ecological but also in the social and economic areas [58]. These perspectives are reflected in the environmental knowledge and skills of today's university students.

According to Khalid [17], prospective American science teachers had several misconceptions about the causes, consequences and interactions of the greenhouse effect, ozone depletion and acid rain. Teksoz et al. [59] concluded that Turkish pre-service teachers did not possess an acceptable degree of knowledge; they could barely identify, analyse, investigate and evaluate environmental problems and issues or the interrelationships between natural and social systems. Kopnina and Cocis [60] showed that Dutch higher education students discussed social and economic SD as the cornerstones of SD without realizing that human wellbeing and economic stability depend on the availability of natural resources. For some students, social justice and economic equality were even more important than environmental issues. Yavetz et al. [36] reported that attitudes of future teachers in Israel did not necessarily translate into environmentally responsible behaviours. These examples show that environmental problems are intricately related not only to ecological but also to economic and social issues and that teaching them using interdisciplinary approaches that integrate ecological science with social and economic issues and in-depth knowledge are necessary.

Environmental knowledge can be classified into system knowledge, action knowledge and effective knowledge [61]. System knowledge refers to the natural characteristics of

environmental and ecological systems regarding the relationship between organisms and ecosystem functions. Understanding the causes of environmental problems requires system knowledge and thinking concerning, for example, why carbon dioxide is a problem, where groundwater comes from, why the ozone layer is important and how long it would take for the ozone layer to completely regenerate [62].

Moreover, according to Díaz-Siefer et al. [63], the knowledge of the local environment in relation to global environmental problems supports students' pro-environmental behaviour. Kollmuss and Agyeman [64] (p. 240) defined pro-environmental behaviour as consciously seeking "to minimize the negative effects of one's own actions on the natural and built environment (e.g., minimizing resource and energy consumption, using non-toxic substances, reducing waste production)". Action information is needed when selecting activities and minimizing and eliminating environmental problems [64]. Effective knowledge supports the kind of environmental activity or behaviour that can achieve the greatest environmental benefit [61]. According to Barber et al. [65], in-depth information about the environment and the causes of environmental problems increases people's motivation and actions to confront environmental problems; conversely, insufficient or contradictory information limits participation in environmental activities [66]. However, information on the relationship between environmental knowledge and pro-environmental behaviour is conflicting. Laroche et al. [67] found no significant relationship between environmental knowledge and pro-environmental behaviour. One reason for these conflicting results is that having an environmental understanding is not easily transformed into a feeling that generates action. Kollmuss and Agyeman [64] list several obstacles to the transformation of knowledge into feeling. The first is the "non-immediacy of many ecological problems" (p. 253), the second is that the deterioration or even destruction of the environment occurs gradually, and the third is the complexity of environmental problems.

2.4. ESD in Teacher Education and Teachers' Attitudes towards ESD

ESD is a transformative and holistic education that addresses learning objectives, content and outcomes and pedagogy and the learning environment [6]. The goal of ESD is to provide learners with the information they need to undertake responsible environmental action by supporting the values, knowledge, understanding and multidisciplinary practical, cognitive and socio-emotional skills needed for sustainable environmental management, the promotion of social justice and the eradication of poverty [5]. ESD is also useful in encouraging people to participate in SD actions to promote social, economic and political change and to modify their own behaviours. ESD aims to develop competence so that individuals are able to look at their own actions, taking into account current and future social, cultural, economic and environmental impacts from both local and global perspectives [6]. Individuals should also be empowered to act sustainably in complex situations, which may require them to participate in socio-political processes and help direct their societies towards SD [68]. In this case, the ability to work with actors with different value systems and to find meaningful compromises to resolve conflicts between stakeholder goals are essential. Environmental problems and their solutions are a key part of SD, so being aware of them and understanding their interactions can also be considered SD skills [69].

The problems faced when integrating SD into teacher education are the conflict between the multidisciplinary nature of SD and the differentiation of university disciplines, a lack of time and a shortage of competent staff [47,70].

The attitudes of both teachers and student teachers towards teaching SD and their experiences of their own competence vary, and research on the subject is partly contradictory. Previous studies have found that teachers have a positive attitude towards SD and perceive their own SD competence to be moderately good [71,72]. Student teachers have also been found to consider teaching SD as part of teacher training important, but they feel that the amount of teaching is insufficient [73]. On the other hand, teachers and student teachers have also been shown to have indifferent or even negative attitudes towards SD and to feel

that SD content does not belong in their teaching, even though it has been included in basic education curricula since the beginning of the millennium [74].

3. The Aim of the Study and Research Questions

This study aims to clarify Finnish SSTs' perceptions of environmental problems and SD, their own role as environmental problem solvers and their interest in SD. The results can be used for developing SD education curricula and guidelines at both the basic and general teacher education levels.

The study is guided by the following research questions:

- Research question 1. What are the issues that subject student teachers consider to be environmental problems?
- Research question 2. How do local, regional and global environmental problems relate to subject student teachers' interest in sustainable development?
- Research question 3. How do environmental problems mentioned by the subject student teachers refer to the ecological, social and economic dimensions of sustainable development?
- Research question 4. How do subject student teachers perceive their own role as problem solvers?

4. Materials and Methods

This study is part of a project in which Finnish SSTs' competencies in SD education were studied. All Finnish language universities with SST education programs were called to take part in this study by sending the link to the SSTs of that year; the total number of respondents accounted for 12% of all SSTs. Altogether, 138 SSTs voluntarily participated in this survey, and 113 SSTs answered all three questions (Q1–Q3) concerning urgent environmental problems. The SSTs were students from six subject groups: biology and geography (15%); mathematical subjects (15%); Finnish language and literature (22%); non-Finnish languages (24%); and humanities (23%).

The pre-tested questionnaire contained 17 questions from which the following three open-ended questions were included in this study: What environmental problems do you consider to be essential, how do you propose to solve them, and with whom do you solve them (a) locally (b) regionally and (c) globally (Q1–3)? In addition, Q4 (How interested are you in SD?) was included in the study. The SSTs were asked to respond to this question on a 10-point Likert scale (1 = not at all; 10 = extremely). Later on, for statistical purposes the answers concerning interest levels were grouped into three categories: *very interested* (9–10), *interested* (6–8) and *not interested* (1–5).

The answers of the SSTs were analysed quantitatively. The SAS/STAT GLIMMIX procedure was used for general linear mixed (GLMs) models. As a response variable environmental problem (mentioned/not mentioned), categories were used. Each environmental problem category was used separately. The response variable followed a binomial distribution in two-category responses and Poisson's distribution in numbered responses.

The class variables in content-based analyses were defined in order to study research questions 1, 2 and 3. The analytical process was as follows: underlining environmental problems and proposed solutions, reducing underlined expressions to their core elements (e.g., the decline of plant and animal species, or the situation in the Baltic Sea), looking for similarities and differences in the reduced expressions to create general groups (e.g., the decline of biodiversity), forming subcategories (e.g., the state of the seas, nature conservation) and grouping them and combining into main categories (e.g., problems in ecosystems). The class variables were based on the answers when SSTs were asked to name environmental problems and propose solutions to them. In investigating SSTs' own roles as solvers of environmental problems (research question 4), three categories were formed: the respondent, someone else and no solver.

The participating students in this study represented SSTs from all Finnish universities providing SST education, and students of all Finnish subject groups were present.

Respecting and ensuring the anonymity of the respondents was important so that they were able to freely answer to the questions [75]. The qualitative content analysis related to the perceptions always include the potential risk of misinterpreting answers as well as the inherent subjectivity of classification [76]. To judge the methodology, the original categories were discussed during the analysis process and re-evaluated by two researchers who did not take part in the original categorisation. Researcher triangulation was a part of our analysis process.

5. Results

5.1. Research Question 1: SSTs' Perceptions of Environmental Problems

Seven environmental problem categories with a total of 28 subcategories were identified in SSTs' answers relative to research question 1 (Table 2): urban environment and infrastructure problems (21% of all mentions), problems in ecosystems (19%), consumption and production problems (17%), indifference and lack of information (17%), climate change (12%), problems in cooperation and decision-making (11%) and problems of human wellbeing (3%). The most often identified single issue was climate change, with 92 mentions. At the other end of the scale, ozone depletion was mentioned only once.

Table 2. Local, regional and global environmental problems mentioned in the SSTs' (n = 113) written answers (n = 339).

Main Category	Subcategories	Number of Mentions
Urban environment and infrastructure problems	Built environment and functional infrastructure, health care, waste disposal, air quality, transportation	168
Problems in ecosystems	Seas/oceans, forests, waters, natural environments, biodiversity, nature conversation	154
Indifference and lack of information	Indifference, lack of knowledge, education, climate-friendly choices	138
Consumption and production problems	Consumption habits, production methods, economy, emissions	135
Climate change	Climate change, climate-related problems	97
Problems of cooperation and decision making	Collaboration, decision making	87
Problems of human wellbeing	Health, population growth, inequality, refugee, natural disasters	23

5.2. Research Question 2: Interest of SSTs in SD and Local, Regional and Global Problems

The majority of SSTs were interested in SD, with nearly half of them classified as very interested. These SSTs mentioned carbon sinks or other forms of climate change in their responses more often than those who did not express interest in SD. Those who were interested identified themselves as potential solvers and listed more solvers in general than those not interested in SD. All SSTs who mentioned biodiversity were interested in SD; it was discussed, among other things, as a threat to species, the impoverishment of rainforest biodiversity and the general decline of biodiversity.

Only one in ten respondents were not interested in SD, and none of them mentioned biodiversity. Interest in SD varied with an SSTs' disciplines and gender but not with age. Two-thirds of female participants and one-third of male participants were very interested. SSTs in biology and geography displayed the most interest at 63%, while the number among other SST disciplines was 37%.

The SSTs considered the issues of the urban environment and infrastructure problems (F_2, 334 = 17.15, $p < 0.0001$) and indifference and lack of information (F_2, 334 = 7.56, $p = 0.0006$) to be more local than global or regional. Climate change (F_2, 334 = 29.90, $p < 0.0001$) and problems of human wellbeing (F_2, 333 = 3.51, $p = 0.031$) were statistically more frequently mentioned at the global level than locally or regionally. Problems of cooperation and decision making were perceived to be more central at the regional and

global levels than at the local level (F_2, 334 = 14.99, $p < 0.0001$). At the regional level, there was no statistically significant relationship between the categories of consumption and production method problems (F_2, 334 = 2.26, $p = 0.106$) and the problems of ecosystems (F_2, 334 = 1.44, $p = 0.239$).

SSTs who were very interested in SD were more likely to mention problems in the climate change category (F_2, 131.1 = 3.23, $p = 0.043$) than SSTs who were not interested in SD. They also more often mentioned problems belonging to the indifference and lack of information category (F_2, 107.7 = 3.41, $p = 0.037$) than students with little interest in SD.

5.3. Research Question 3: Environmental Problems and the Three Dimensions of SD

Environmental problems concerning social and cultural sustainability were mentioned most often by the SSTs (41%); the least cited problems related to economic sustainability (28%). Problems related to ecological sustainability appeared in 31% of answers. The majority of SSTs mentioned two of the three dimensions in their answers. There was no statistically significant difference between subject group (F_2, 108 = 0.13, $p = 0.932$) or interest in SD (F_2, 104 = 0.16, $p = 0.856$) regarding how many aspects of the three dimensions of SD were mentioned by respondents.

Neither SST subject group nor interest in SD had any statistically significant relationship with whether a student mentioned problems related to economic, ecological or social and cultural SD.

5.4. Research Question 4: SSTs' Own Roles as Solvers of Environmental Problems

In the majority of responses (52%), the solver was somebody else than the SST. Around one-third of the responses (32%) did not mention a solver at all, and only 15% of answers identified the respondent as a solver. The students felt that they could contribute to solving environmental problems more often on the local than on the regional or global levels. The SSTs' teaching discipline had no statistically significant relationship with whether a student identified themselves as a solver, named someone else as the solver or did not indicate any solver. There was no statistically significant relationship between mentions of the local, regional and global levels or any of the three solver categories.

6. Discussion and Conclusions

In previous research, student teachers have been found to justify their perceptions of environmental problems through their own experiences [77]. In the present study, the SSTs most often mentioned issues from the urban environment and infrastructure, and the indifference and lack of information categories are presumably based on their actual personal experiences in their own local and regional environment, such as problems in the Baltic sea and other worries. Both categories highlighted environmental problems whose effects were locally perceptible and were likely to be present in the SSTs' own daily lives, such as traffic, indifference and waste management.

Of the seven environmental problem categories, four were related to social and cultural SD, as were most of the environmental problems mentioned. This result departs from previous research, where teachers have more often been found to use an ecological approach in teaching SD [78–80]. This is partly because over time teachers of subjects other than science have started to pay attention to sustainability issues; for example, social science teachers emphasize social dimensions, and science teachers also focus on areas other than ecological dimensions due to the holistic view of sustainability education [78].

Most SSTs referred to environmental problems from only one or two aspects of SD. This result is in line with previous research and emphasises that teachers have difficulties using a holistic approach in teaching SD [9,78,81]. However, the environmental problems mentioned by the SSTs do not make it possible to directly infer their SD competence; according to Summers et al. [82], some student teachers do not fully understand the cause-and-effect relationships of environmental problems. The SSTs' awareness of different

environmental problems reflected what they considered to be an environmental problem and how broadly they understood SD.

Like the preschool student teachers in Doğan and Simsar's study [83], the SSTs mentioned climate change significantly more often than other environmental problems. The result supports previous findings that university students consider climate change to be a serious and very important environmental problem [15,16]. This reflects both the attention paid to climate change in media and paints a picture of how the SSTs value global environmental issues. Unlike previous studies (e.g., [83]), SSTs did not consider ozone depletion to be a major problem, with only one SST mentioning it. None of the SSTs mentioned water security, unlike university students a decade ago [15], who considered it the third most important environmental issue. Every era has its own environmental problems that are sought to be prevented, minimized and solved. The depletion of the ozone layer was a key problem in the early 2000s, but international action has been taken to restrict the causes, and people were more worried about it in that time than today. No mentions of the water security may be due to the fact that, today, Finland has abundant, high-quality water resources and is completely self-sufficient in terms of groundwater [84]. However, water security is not bound by borders; it is one of the most important global environmental issues, as the IPCC stated in its most recent report [17].

According to Yli-Panula et al.'s earlier research [37], the SSTs regard climate change as a particularly global challenge, along with deterioration of water quality and low levels of recycling. Meanwhile, Salìte et al. [38] found that students noted climate change but regarded other issues as more serious, especially pollution. In the category of urban environment and infrastructure problems in the present study, the SSTs mentioned waste disposal and transportation's effect on air pollution. The fact that the student teachers mentioned these issues is important, because reducing waste and air pollution are considered as important goals from the local level to the global level [34,35]. They are also important issues in a circular economy, and waste reuse and recycling have been reported to promote economic wellbeing and environmental quality [30]. In Finland and the EU, unsustainable consumption and production methods [29] have led to special attention being paid to the development of the circular economy. Thus, these issues should also be emphasized far more in teacher education than is currently the case.

As mentioned above, the SSTs did not consider issues related to the ozone layer, water safety and similar environmental issues as significant environmental issues. One reason is maybe also that understanding of these kinds of complex issues are based on systems knowledge and thinking [60]. Previous research has found that the knowledge of teachers [85], students [86] and student teachers [59,87] regarding these issues is incomplete, fragmented and narrow, with many misunderstandings. According to Palmberg et al. [88], no kind of systems thinking had developed for the majority of Finnish, Swedish and Norwegian student teachers during their previous education. Systems thinking should be included in teacher education, because educational programs should give individuals information about how different actions and choices can affect society as a whole. In other words, teacher education programs must include critical thinking and systems thinking based on negotiation and action skills, for example by offering learners the opportunity to think about and solve the problems they encounter at school. This is necessary, as sustainability cannot be taught without systems thinking [89].

The majority of the SSTs were interested in SD, which promoted the perceptions of their own roles as SD actors, and this result has been reported in other research [43]. However, more than half of the students surveyed here did not consider their own roles as solvers of environmental problems to be significant. One reason may be that local, regional and global environmental objectives have not been included explicitly enough in teacher education curricula, even though several researchers have published on these issues over the last 20 years (cf. [34,35]). Salas-Zapatas et al. [68] also observed contradictions in teachers' knowledge, attitudes and actions of SD. In the present study, the SSTs felt that they could best influence local environmental problems themselves. Local environmental problems

were identified as problems of the urban environment and infrastructure and a lack of information and indifference. The experience of locality could be explained by the fact that the above-mentioned problems are encountered in everyday life and can be seen with one's own eyes. The position of the SSTs as future teachers could also explain the fact that many felt that they could influence the problems in the lack of knowledge and indifference category. This result agrees with Yli-Panula et al.'s study [37], in which Finnish university students considered their own ability to deal with different aspects of climate change to be good, especially in terms of developing thinking skills and encouraging climate change action at the local level. This approach runs counter to the view of climate change as a global problem related to decision making. These problems may be perceived to be so extensive that the SSTs do not feel that they can influence the solution or even the ability to increase hope and trigger emotions.

Most of the SSTs were interested in SD. This group mentioned carbon sinks and other climate change issues in their responses. They discussed biodiversity in terms of issues like threats to species, the impoverishment of rainforest biodiversity and a general decline in biodiversity. This decrease in biodiversity was also mentioned by the university students who participated in Kukkonen et al.'s study [15], but it runs counter to the technology teachers' perceptions who considered biodiversity to be the least important issue in SD [38]. Since the protection of fauna and flora is considered the main environmental goal concerning the natural environment at the local to the global level [34,35], it would be good to emphasize issues related to the natural environment and the protection of natural resources more than has been done at present in teacher education. The answers of the SSTs, as a subset of that larger university student group, reflect a good knowledge and understanding of environmental problems. The reason for this may be that all topics, including the foundations of environmental issues, is taught along a continuum from basic through upper secondary education. In basic education, climate change is addressed from the perspective of building a sustainable future by looking at one's own activities [10]. In upper secondary education, environmental issues are part of the transverse competence themes and are mentioned in both the common goals and guidelines for upper secondary education and in connection to subject-specific aims and objectives [90,91]. For teachers, two models are designed to facilitate the planning of environmental-related teaching: the bicycle model [92] and the problem-centred process model [92]. In both, knowledge and thinking skills form the basis for teaching and learning environmental issues.

Interestingly, taken as a whole, the SSTs' answers show, on the one hand, that although they have quite a good understanding of environmental issues, there are many shortcomings in the SSTs' environmental content knowledge and recognition of their own roles in environmental action, which is why teacher education should pay more attention not only to goals and content information but also to student teachers' action competence in environmental issues. According to Sass et al. [93], the term action competence entails the willingness, commitment, knowledge, skills and confidence to engage in finding solutions to controversial problems or issues. On the other hand, the SSTs' answers also reflect their positive attitudes towards SD, as is the case with teachers and students in general, according to previous studies [18,19,71,94–97]. Thus, in this study, the action-competent person in relation to SD is seen as "committed and passionate about solving a societal issue, [he/she] has the relevant knowledge about the issue at stake as well as about the democratic processes involved, takes a critical but positive stance toward different ways for solving it, and has confidence in their own skills and capacities for changing the conditions for the better" [93]. Consequently, during teacher education, student teachers should be encouraged to be interested in environmental issues and related topics, especially local ones. The feeling of being able to act as a solver of ecological, social and cultural environmental issues should also be supported by using different approaches to environmental issues, such as paying attention to systems thinking and integrated problem solving. Useful didactic strategies in different areas of education and environmental sciences for promoting sustainability are, e.g., first-hand experiences, locality- and place-based education [98,99],

problem-based learning, project-oriented learning, service learning, simulations and case studies [100]. These issues will be the focus of future studies.

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