



## Talking About Sustainability in Teacher Education in Finland and the United States

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### Abstract

This article reports on empirical research findings from a case study of teacher education in Finland and the United States. A sociological perspective was deployed for investigating how the concept of sustainability was addressed in two teacher education programs. One of the programs was located in Finland and the other in the US. The study was carried out in 2015 and 2016. Seventeen semi-structured, open-ended, audio-recorded interviews form the core of the research materials. A thematic analysis of interviews was conducted for identifying articulations related to sustainability in subject-matter specialized teacher preparation. Findings from this study contribute to research on teacher preparation. Notably, by articulating how context-specific culture and social norms contribute to local models of teacher education. Findings from this study indicate that teacher training practices in Finland have encouraged students to articulate sustainability in relation to critical thinking, whereas in the US, sustainability has been articulated in relation to social justice. The key point supported by the evidence is that sustainability was by teachers and teacher educators conceptualized as being about the popularization of knowledge about ecology and biodiversity. The kind of communication that was by teachers and teacher educators described as effective for popularizing knowledge about scientific phenomena were forms of teaching that expanded on content-specific knowledge by connecting it to ethical and civic frameworks of the societies in which students live.

**Keywords:** Teacher education, professional training, popularization of scientific concepts, science teacher preparation, mathematics teacher preparation, sustainability, Finland, United States

### Introduction

A number of different practices and fields of inquiry can be referred to when discussing sustainability in teacher education. The approach depends on the specialization and normative views of the researcher. A discourse in education that has been around since the 1970s has promoted environmental education in schools (Raabs, 2010; cf. examples from Norway and Thailand described in (Wiksten, 2017)). In this perspective, sustainability in

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teacher education is about raising popular awareness about human interaction with the natural world, and about the maintenance of diverse biospheres. Awareness of the importance of such phenomena has in the political life of societies across the globe been promoted by green movements such as Greenpeace as well as governance efforts and scholarly efforts both large and small (cf. example from Mexico in Wiksten, 2017). International policy think-tanks in education, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) are currently promoting education within an agenda of sustainable development goals (UN, 2015; Bexell & Jönsson, 2017). An important early push for the popularization of scientific knowledge about sustainability was provided by Rachel Carson (1962, 1955). In this paper, I draw on outcomes from a comparative study for supporting the thesis that one of the important roles education holds for the promotion of sustainability, is the popularization of scientific knowledge. Specifically, this paper reports on a study that sheds light on some of the ways in which sustainability as a concept has been engaged in mathematics and science teacher education in the United States and in Finland.

The research question on which this paper reports is: How was the concept of sustainability addressed in the context of mathematics teacher education in Finland and the US, as documented in the interviews carried out in this case study? The initial research question of the case study was broader and sought to map what was perceived as important knowledge and skills for teachers specializing to become mathematics teachers in two programs, and what characterized the cultures of teacher preparation in the observed programs.

This paper is structured as follows. The first part describes the theoretical perspective, participants, research procedures and methods. The second part of the paper presents research materials and findings. Three assertions regarding similarities and differences in explanations provided by research participants are presented. The final part of the paper discusses some of the ways in which research participants drew on ethical frameworks in their explanations of how teachers implement teaching about sustainability in classroom practices.

## **Theoretical framework and methods**

Scholarship on social and cultural dimensions of education is particularly interesting for a practitioner field such as teacher education. Valuable work for understanding educational practices has been advanced by anthropologists of education (Erickson, 1986), sociologists who have directed attention to discourse analysis in education (Bernstein, 1977), political scientists who have directed attention to speech act theory (Skinner, 2002), as well as sociologists who have furthered an understanding of the relationship of human agency and social structures in societies (Giddens, 1986; Archer, 1996).

Structuration theory proposes that individuals make strategic decisions in everyday situations in which they build on prior experience and what they know about structural

constraints and resources. “[...] *everything which actors know or believe about the circumstances of their action [...], including tacit as well as discursively available knowledge*” (Giddens 1986 p. 375). Human agency in socially situated practices, such as classroom instruction, is connected to social structures by a reciprocal relationship (cf. Spillane, 2005; Burrige et al., 2010). Social and institutional structures are understood both as a medium and an outcome of human activity. In this perspective, student outcomes are not only an outcome of specific interventions but also of the social interaction in class to which students and instructors contribute. I have used structuration theory as a theoretical framework for designing the research. This is expressed, for example, by the selection of participants that was not limited to a specific social category but included as broad of a range of participants as possible.

Giddens rejects, in contrast to an older school of sociology (Durkheim, 1919), the idea that social phenomena are governed by rules akin to natural laws (Giddens, p. 179). He calls for a methodological approach that is sensitive to “[...] *multiple meanings that constraint must be recognized as having in social analysis.*” (Giddens, p. 179). Following structuration theory, it is futile to search to identify generalizable causal relationships operating independently from human behavior and practices (cf. Giddens, pp. xix, xx.). In this vein, I propose an effort to examine the strategies chosen by individual actors and groups of people as a fruitful approach for research in teacher education. Strategies are in this approach understood as limited by what individual actors and groups of people know and by the options present in specific circumstances that vary across time and space (Giddens, p. 173).

What is known in a local context and what resources individuals have at hand for constructing meaning when working with concepts such as sustainability include locally established discourses. Applying Giddens’ structuration theory in analyzing my research findings, I provide one example of how a spontaneous respondent narrative on sustainability was constructed in Finland in a form that echoed older, pre-Christian narrative traditions.

## Methods

The research materials on which this paper reports consist of open-ended semi-structured interviews conducted in 2015 and 2016 in the US and in Finland. Among the themes that emerged from the interviews, were reflections on social norms and ethical underpinnings that bear on the work of teachers. These were reflections that connected the role that mathematics teachers and science teachers hold, to different conceptualizations of what is meant by sustainability.

I am a native speaker of Finnish and have lived the first half of my life in Finland. I have worked for more than fifteen years, in professional and research environments internationally, with the translation of Finnish cultural and societal concepts and terminology into Swedish, Danish, French, and English (cf. Wiksten, 2013). I am a permanent

resident in the US where I teach research methods. My professional and educational experience in the US and Finland contributes to my ability to document, translate and analyze the interviews that I have conducted in the US and Finland.

This paper reports on parts of a larger qualitative case study that was conducted with the approval of the Institutional Review Board of the University of California, Los Angeles (UCLA). The study was conducted with the consent of all interview participants and with the consent of the research university that served as a second field research site in Finland.

Research participants were students, teacher educators, and administrators at two programs preparing mathematics teachers for upper secondary schools. Four of the initially documented interviews were conducted in the US and the rest of the interviews were carried out in Finland (for a detailed description of participants, see Table 1.). Participants at both sites included student-teachers and teacher educators from a Graduate School of Education, Faculty of Education and in the case of Finland also from the Department of Mathematics and Statistics, as well as one field-practice school. Articulations presented by participants in Finland are in this paper contrasted with articulations from participants in the US. Both research settings are leading schools of teacher education located at renowned research universities.

Following Giddens (1986), I propose that a relevant methodological approach for examining social phenomena such as social institutions, is the identification and description of varieties of social phenomena. My research did not from the outset assume teacher preparation as a practice that is fundamentally the same across contexts and time. Instead, I have sought to outline and characterize varieties of teacher preparation. This approach has allowed me to highlight nuances and differences in the ways in which the meaning of a concept such as sustainability was constructed in two different contexts.

I have used ethnographic methods and reflexive writing strategies in order to produce a rich study material of field notes and interview notes. (cf. Howe, 2003, p. 144; Emerson et. al. 2011, p.101; Olson 2011, p.17). Observation and interview guides as well as initial grounded coding aimed at capturing *the local meanings that happenings have for the people involved in them* (Erickson 1986, p. 120-121). Initial codes were grouped into categories using structuration theory in that I sought to identify what study participants identified as resources, constraints or as neutral factors, i.e. neither resources nor constraints, for teacher development (Giddens 1986). Early on in the study, I noticed that narratives were frequently used as an aid for explaining meaning by study participants at both sites. Narratives of this type were systematically identified and documented (cf. Seidman 2005, p.7) (Table 2). Following principles of grounded coding, and as the research advanced, I have used coding as support for documenting themes that were identified as meaningful by research participants (Saldaña 2013, pp. 175-179; Bazeley 2013, p. 146-147). Decisions to group initial codes into themes were documented systematically throughout the study in interview notes, field notes, research memos, interview transcripts and interview syntheses (cf. Wiksten, 2018).

English and Finnish versions of the same interview guides were used in the US and Finland. Separate interview guides were articulated for student-teachers, teacher educators and administrators. Out of seventeen documented interviews, seven were carried out with student-teachers, eight with teacher educators and two with administrators. The initial interview guides and selection of themes was narrowed down in consultation with research participants. I have encouraged research participants to discuss the relevance of interview questions, to provide feedback to interview syntheses, to describe a participant demographic profile in an open-ended manner and to elaborate on themes that participants found interesting or relevant. My analysis has focused on the themes that respondents found to be relevant and the themes where respondents had the most to say. Explications that I had not anticipated to emerge as markedly as documented in the interviews were ethical frameworks and humor. These topics were raised by research participants, at both research sites, in connection to discussions on critical thinking and what it meant to be a good teacher. Research participants discussed sustainability as a concept related to ethical frameworks. The development of interview guides and themes is described in greater detail in Wiksten (2018).

The six themes that participants showed the greatest interest to discuss in relation to their experiences in teacher education or as teacher educators were (1) the goals of teacher education; (2) the role of collaborative practices in teacher education; (3) the role of research in teacher education; (4) the role of critical thinking in teacher education; (5) the knowledge areas of a teacher; and (6) articulations of what it means to be a good teacher. In all seventeen semi-structured open-ended audio-recorded interviews ranging from 28 minutes to 3 hours were documented. Syntheses of each interview were written, coded and subsequently structured by themes. Parts of the interviews were transcribed, coded and subsequently structured by themes. Interviews were anonymized. All of the participant names used in this paper are pseudonyms. Feedback from member checking showed that syntheses were perceived as accurate descriptions of the interviews. In order to strengthen my familiarity with the research sites and in order to triangulate my findings, I carried out participant observations at both of the research sites (25 hours of documented lectures, seminars and meetings). The case study contributed to Ph.D. research completed in 2018 (Wiksten, 2018).

### **Research participants**

Participants were student-teachers, teacher educators and administrators in two graduate-level programs preparing subject-matter specialized teachers for upper secondary schools (for a detailed list of participants see Table 1). The approach to participant recruitment followed a combination of (1) snowball technique (teacher educator referral of colleagues), (2) open calls for instructor and student volunteers for interviews at lectures and (3) individual requests over e-mail and in person.

My initial contact at both of the research universities that served as research sites was to the Director of the program that prepares subject-matter specialized teachers, i.e. high-

school teachers. As I was in my initial research question interested in inquiring into the relationship of subject-matter expertise and teacher preparation, I decided to interview students and faculty (including instructors, professors, and lecturers, hereafter referred to as *teacher educators*) involved in the preparation of subject-matter specialized teachers. Narrowing down to a specific subject-matter was for the initial interviews conducted in the US-guided by the scheduling of classes. Having tested my interview instruments with teacher educators preparing mathematics teachers and student-teachers preparing to become mathematics teachers, I decided for the sake of consistency to carry out the remaining interviews with students and teacher educators in a comparable program in Finland.

Often, the researchers of mathematics education have previously worked as mathematics teachers. Having a background in Comparative and International Education, the Humanities and having worked professionally with credential evaluation, I am in a conventional sense an outsider-observer of teacher preparation. The agenda that motivates my research is not, as often is the case in the field of education, to study and evaluate an individual program for the purpose of promoting it as an example of what works, or for the practical purpose of trying to improve said program. Instead, I have been interested in trying to outline some of the characteristics of context-specific social norms and local cultures without which a translation and understanding of the goals and practices manifested in the seventeen interviews analyzed in this case study would not make sense. I am motivated by an interest to contribute to basic research that is informed by a sociological approach to understanding how institutions function and the local practices that manifest constraints and resources available to local actors. The idea of contributing to a locally and internationally relevant, as well as culturally sensitive translation (cf. De Sousa Santos, 2014), was a complex challenge that appealed to me as I have grown up in Finland and have spent most of my adult life working with education and culture in an international context (Denmark, France, Sweden, and the US).

I do not view the choice of studying the preparation of mathematics teachers as an arbitrary point, even though in this case study I might have chosen another subject-matter specialization to focus on. The preparation of mathematics teachers is interesting as it brings together two fields of research that conventional academic discourses identify as very different, namely the ‘hard’ natural sciences and the ‘soft’ social sciences. It is also a subject matter the teaching of which in schools is conventionally perceived to reflect social norms by a privileged participation along intersectional lines of social positionality defined by social categorizations such as race, ethnicity, nationality, socio-economic status, first language and gender (cf. Bullock, 2017; Civil & Planas, 2009; Norén, 2011; Tan, 2011; Lightbody & Durndell, 2006.)

A case study with seventeen interviews does not necessitate the use of pre-determined racial, gender and age categories such as is required by large-scale statistical surveys. For developing a demographic profile of research participants, I have used self-identification. Having used semi-structured open-ended interviews as method, I had the possibility to allot additional time for allowing research participants to provide a self-identification that

made sense to my research participants as individuals. Table 1 provides an overview of the demographic self-identification provided by research participants.

The preparation of teachers for high-schools is structured in Finland in a manner in which each teacher-student prepares to become a teacher in two subject-matters. In addition to studying to become mathematics teachers, two of the students interviewed in this case study in Finland were specializing in physics, one in chemistry, one in Buddhism and one of the students in Finland had not decided on a second subject of specialization at the time of the interviews. The preparation of teachers for high-schools in the US manifests a greater diversity in terms of qualifying programs and certification practices that differ by state. Comparing teacher education practices in Finland to an individual US state comes across as a relevant comparison from this perspective. In Finland, universities confer teacher certification at the completion of teacher education programs. In the US, teacher certification is governed by teacher certification entities, such as state boards that are separate entities from teacher education program providers. The territorial expanse of Finland is comparable to the US state of Montana, whereas the population size of Finland is comparable to the US state of Minnesota. Using the units of state (Finland) and federal state (US) in a comparative analysis, as is the practice in comparative and international education research, is limited by such differences.

Both of the programs at which interviews were conducted were graduate-level programs that required the full-time commitment of students to studies at the Education Department, over the course of two years. A difference with the programs was that the students in Finland were taking mathematics courses at the Department of Mathematics and Statistics in parallel with their studies at the Education Department. All of the students in the US program had applied to the graduate teacher education program after having completed a separate undergraduate program at another department, often at another university or college. Students at both interview sites (US, Finland) were studying to become mathematics teachers for secondary schools.

The teacher educators and administrators interviewed in Finland were involved in the training of subject-matter specialized teachers, however, some of the teacher educators taught didactics for other subject areas in addition to mathematics. For example, one of the lecturers taught Mathematics Didactics but also the Didactics of Information Technologies. In the US, I interviewed an instructor for a graduate level program that prepared mathematics teachers and the Director of the teacher education programs. In brief, both programs observed in this study prepare STEM teachers for secondary schools (Science, Technology, and Mathematics oriented subjects).

## Findings

Discussions about sustainability emerged in the interviews in connection to student reflections about the purposes and goals of teaching. The following story was offered voluntarily by one of the student-teachers in Finland as a narrative about what it meant to be a good teacher. The narrative outlines the role of responsibility for scientists, both for the

environment but also for society. This both humoristic and purpose describing narrative is an explicit articulation of how teaching practices support sustainability. Namely, by helping students to understand how the work of a professional in science is linked to both environmental and societal sustainability. What is notable is that the narrative is not a narrative about sustainability and ethics as abstract concepts but rather as expressions of the purposes and goals of research and development efforts of everyday work undertaken by professionals. Efforts for which the outcomes are in the narrative described as directly and concretely impacting local communities.

A chemist is someone who first studies the qualities of natural phenomena and then formulates knowledge. After this, he/she [fi. hän]. spends a lot of time and effort to come up with applications of this knowledge, such as chemical compounds, for which the chemist invents uses for. After this, the chemist studies the use and the effects of the chemicals he or she has contributed to getting out into the use of societies. He/she studies the effects on human beings, plants, and animals. The chemist registers the damage that the chemicals produce. Finally, the chemist tries to figure out some ways of dealing with the problems he/she has caused. (Matti, interview September 2<sup>nd</sup>, 2016).

All of the interviews were analyzed using structuration theory and six themes (goals; collaborative practices; research; critical thinking; knowledge areas of a teacher; the good teacher). One of the themes is exemplified by the above excerpt. That is, articulations on the role of critical thought in mathematics and science teaching and in the preparation of teachers.

I have formulated three assertions regarding the characteristics of the discourse on teacher preparation in this case study. The first assertion identifies an overall characteristic of how sustainability was discussed in Finland and the US. The second assertion describes similarities in how sustainability was discussed at both of the research sites. The third assertion highlights differences in how sustainability was discussed in Finland and the US. The following section provides an elaboration on each of these assertions.

### **How sustainability was discussed reflected respondent positionality**

An important overall observation from having analyzed the interviews was that respondent positionality manifested itself in different priorities and in the degree of elaboration of responses. At both of the research sites, I observed that student-teacher responses tended to be shorter and less elaborate when compared to the responses from teacher educators. While gender differences were observable for other themes in the overall study, I have not observed such differences in articulations that related to sustainability. The interviews conducted illustrate some differences associated with ethnic or cultural identity, notably across sites but also within sites. These differences were notable in ethical frameworks articulated along postmodern lines by teacher educators in the US and along Christian lines by a Taiwanese American student in the US. Ethical frameworks articulated along modern lines were, in this case study, prominent among teacher educators in Finland and along pre-Christian (animist) lines as articulated by a student in Finland who self-identified as ethically and environmentally conscious.



Almost identical articulations for concrete examples for the instruction of sustainability were provided by two student-teachers in Finland (Matti, Arno). Both Matti and Arno proposed that critical thinking could be engaged in classroom teaching for supporting students' understanding of questions pertinent to the concept of sustainability. The teacher could, for example, select a piece of information about environmental deterioration. Subsequently, the teacher could inquire together with students into different sources of information in order to see how the claim was supported. After this, the teacher and students could try out ways of verifying the claim.

### **Shared characteristics in how sustainability was discussed in the two programs**

Shared articulations among respondents recognized the importance of understanding the social context in which education is carried out. Both respondents in Finland and the US made a point of connecting mathematics instruction to an inquiry and understanding of the local community and society at large. A connection to critical thinking was also made by respondents at both sites.

As already noted in the above, the positionality of respondents in the interviews was marked in both Finland and the US by similar answers among students, such as the above example of instructional practice described by Arno and Matti. Another shared characteristic of how sustainability was discussed were connections made to ethical frameworks. The narrative provided by Matti in Finland about the responsibilities of a scientist (see quote above) connects like the reflections of one of the students in the US (Samuel) to ethical frameworks, and to personal interpretations of normative frameworks. The following provides Samuel's take on differences and similarities between the ethical framework of the teacher education program and his personal beliefs.

Excerpt from an interview with Samuel on February 25<sup>th</sup>, 2015:

P.I.: [...] What kind of knowledge and/or skills do you expect this course will strengthen? What would it ideally support you with?

Samuel: This program in general, has a big emphasis on integrating social justice into your teaching. I literally never thought about this before, however, it does give me a different way of looking at it. It'll take a lot of creativity. For me, social justice may mean something a bit different than for the program.

My understanding of being socially just in general is to try to understand those you are serving. I get a lot of my teaching philosophy from Jesus, he would learn what is important for them [students] and frame the teaching in that way. If I were to teach under-privileged students without understanding them, they would not be motivated to learn. This school [in which he is currently teaching] is an art school, doing something that has to do with the arts would be appealing to them [students]. My goal is for you [students] to learn to see the beauties and intricacies of math. My job is not to expose them to the world. That is not possible if they do not have the motivation.

At [this university] some people try to create the diversity requirement, I view it in a way that for each person it's a different journey, you cannot force it on people, if they are required to take [a] class on diversity, that's human [if they are not motivated].

It's the same in professional development, in professional development meetings the teachers are not motivated to be there. [...]

In the above interview, Samuel related program goals to a historical normative framework that is Christian doctrine. I have proposed in my Ph.D. dissertation (Wiksten, 2018) that the narrative of Matti similarly as Samuel's reflections is connected to another historical normative framework, that derives from the Finnish oral tradition of pre-Christian animist beliefs (Lönnrot, 1995). Specifically, I have proposed a comparison with an older documented narrative from the *Kalevala* about the origin and uses of iron (Lönnrot, song 9, verses 29 - 416). Matti and the Professor of Chemistry who had related the narrative of the responsibilities of a chemist to Matti and his peers likely did not intend the story as a parallel to the ninth song in *Kalevala*. I am making the connection as I see the narrative structure of the ninth song providing a parallel narrative in form and function. A similar feature of the story about the contemporary scientist and the story about the origin of iron is that both are descriptions of how new technologies may impact societies negatively. In the modern variant, scientists are presented as responsible parties whereas the animist tradition proposes that iron (the sword) is responsible for problems caused to society by technological development. Both stories identify parties in society who are responsible for restoring societal damages. In summary, I have observed respondents at both sites engaging with historical normative frameworks (Christian and animist) and contemporary program-specific efforts to outline normative frameworks (modern and postmodern).

The normative framework that I associate here to a modern outlook relates to the ways in which the teacher educators I interviewed in Finland and the US underscored the connection of critical thinking in the sciences to community membership. On one hand, this is reflected in Timo's stance that the role of the mathematics teacher is to popularize scientific knowledge, (interview, September 7<sup>th</sup>, 2016). To make knowledge available in a form that is relevant and meaningful for the local community.

Excerpt from an interview with Timo on September 7<sup>th</sup>, 2016:

Timo: [...] In a way, all teaching in school is about popularizing knowledge. Fundamentally, it's about scientific knowledge that the teacher has to be familiar with, so that the teacher by her or his understanding, which hopefully is continuously developing, plus all sorts of teaching materials textbooks and so on, that the teacher from all of this makes a filtered version that is appropriate to the level or stage of students that she or he is teaching. However, if the teacher is talking about atoms and does not understand anything about the Physics concepts about atoms, the description will soon become an absurd depiction of ping-pong balls [...].

The above comment by Timo reflected his view that teachers need to have an advanced understanding of the subject matter. This was a view that he shared with teacher educators in the US. Aina similarly underscored that teachers cannot be social justice teachers only, but need to have advanced skills in the subject matter as well (interview, February 13<sup>th</sup>, 2015).

### Differences in how sustainability was discussed in the two programs

Sustainability was discussed differently at the two research sites in ways that highlight different emphases on critical thought. Respondents in Finland emphasized the connection between sustainability, responsibility, scientific methods, and critical thinking. Respondents in the US emphasized the connection between sustainability and social justice.

A comparable feature that emerged from the interviews was that students in both Finland and the US provided somewhat different stances from teacher educators, either as described above by simply providing shorter answers, or by expressing different reference frameworks. This difference was marked in the US where teacher educators identified and described a social justice agenda as the driving idea of teacher preparation and teaching practices (Aina, Mary Lou) whereas student-teachers provided alternative personal interpretations of normative or ethical frameworks that for them underpinned their view of good teaching practices. For example, Hye described the professional teacher as someone who cares for students and understands students in a holistic way. In concrete classroom practices, this meant for her the use of humanizing school practices. (Hye, interview February 25<sup>th</sup>, 2015). Samuel similarly as Hye provided his own interpretation of an ethical framework, as described above.

The eight teacher educators interviewed in Finland demonstrated a greater inter-group divergence when compared to the five student-teacher respondents interviewed in Finland. In the US this relationship was inverse, where the two teacher educator respondents demonstrated a greater convergence in interviews than did the two student-teachers. The following two excerpts from interviews with the teacher education program director Mary Lou and instructor Aina articulate a closely related concept of social justice.

Excerpt from an interview with Mary Lou on February 23<sup>rd</sup>, 2015:

Mary Lou: [...] This program is about that, how does your understanding of justice and equity and race and oppression drive your thinking is key for how you implement.

P.I.: Is critical thinking more relevant for another course than this one?

Mary Lou: Understanding social justice is key, understanding everything in a lens of critical race and social justice and equity and race and what does that mean in your practice. Critical thinking the way I think about is, in literature and history and science, is taking a critical stance in how you think about texts, and in the field [teaching practices] it's different.

P.I.: So critical thinking is different from social justice and critical race theory?

Mary Lou: Critical thinking would be analytic thinking, more cognitive, not as relevant for social justice work. If you google critical thinking you won't get hits on social justice.

P.I.: What kind of qualities do you appreciate in a teacher, if you don't primarily think about yourself but other teachers?

Mary Lou: Absolute commitment to students and families and their communities and understanding of the context, that a child exists in a context, teachers need to be responsive to that context, an effective teacher uses this and builds on the assets of students, community in classroom, inclusive. A person who is committed to always reflect on practice, a practice that develops through experience. [...]

The following excerpt similarly to the one above, provides a comparable articulation of social justice as a key concept in teacher training.

Excerpt from an interview with Aina on February 13<sup>th</sup>, 2015:

P.I: [...] Critical thinking. How significant is this skill? For teachers, what does it mean in practice?

Aina: Using the content to address political issues, social justice issues. Right now, we are discussing albinism in Tanzania, this works with the concept of recessive genes while at the same time giving them [student teachers] agency. [Another example is that we use] ratios to liquor stores to people. Socio-economic status [that shows] less wealth [goes with] more fast food, higher rates of addiction. [There's] too much out there that leaves individuals at fault. Rico Gutstein's book "Reading the world through math", this is an example of a critical approach. We did the other week analysis on world wealth assessment, the wealth of the world. Concrete examples with candy bars per world region, followed by questions such as "why do you think it is this way". Students have very interesting responses and what they ask e.g. "I'm surprised that China does not have more wealth".

P.I.: Is critical thinking more relevant for another course than this one?

Aina: [It's an] important part of all courses, it's emphasized in their [student teachers] methods courses as well.

P.I.: Teacher's role as actors in advancing their field, or as professionals. What does this mean?

Aina: Changing what it looks like for a student in a classroom, we want teachers to advocate for their students, this program was born out of historical riots. We need schools [in our communities] to support students, [name of city] students deserve [teachers] who fight for things they would like to have in schools. Breakfast and lunch, after school activities and care and wellness and all of that, reaching out to communities. [...]

I observed a somewhat different stance that was represented by several teacher educators in Finland. This was the idea that in order for teachers to make good pedagogical decisions in their teaching practice and in the changing contexts in which they work, teachers need to draw on an ability to discern among relevant research, and teachers need to have a strong theoretical foundation both in education and in mathematics didactics. Approximately six out of eight of the teacher educator respondents in Finland discussed these aspects in concrete terms. I paraphrase in the following two variations of similar articulation to this end provided by three teacher educators in Finland (Erik, Jukka, and

Taimi, interviews, September 2016): (1) *Teachers are able to function with greater strength if they have the capacity to be researchers of their own work;* (2) *Teachers make better pedagogical decisions when they have a strong theoretical foundation.* What is meant here by a strong theoretical foundation is reflected in statements by a teacher-student and five teacher educators in Finland who underscored that teachers need to understand different types of research, both research in the hard sciences and research in the social sciences.

## Conclusion

This paper reports on how sustainability and related concepts were talked about in two mathematics teacher education programs, one in Finland and one in the US. The results of the study present a coherent conceptual model in which respondents at both research sites connected the concept of sustainability to critical thinking and ways in which mathematics instruction needs to engage with practices of inquiry that are relevant for local communities. The latter was presented as important on one hand for the sake of successfully popularizing and thereby communicating scientific knowledge, and on the other hand for the sake of promoting social justice. The work of Gutstein was identified by Aina as a concrete example of mathematics teaching in this vein (interview with Aina, February 13<sup>th</sup>, 2015; Gutstein, 2013; 2006).

### Characteristics of how sustainability was addressed in teacher education

The excerpts and examples provided in the section on findings illustrate sustainability as a concept that was articulated by three practices in classroom teaching: (1) by connecting mathematics and science instruction to societal and environmental inquiry in the classroom; (2) engaging students and teachers in critical thinking; (3) by connecting to social norms in the form of ethical frameworks.

The articulations and purposes of engaging with both critical thinking and social justice issues varied among the respondents. Respondents in Finland articulated critical thinking as part of scholarly and academic expertise that takes into consideration societal, historical, philosophical, political, human development specific as well as subject-matter specific areas of knowledge. An approach in which critical thinking is defined as the proactive questioning of the occurrence of bias in teaching practices. The latter goal was articulated also by respondents in the US, while framed by drawing on normative frameworks that were articulated in a different manner. I observed Christian and postmodern normative frameworks in the interviews in the US whereas I observed modern and animist normative frameworks in the interviews in Finland.

Analysis of frequent themes evoked by research participants in the interviews documented in this study has in light of structuration theory allowed me to identify similarities and differences in how sustainability was talked about in teacher education in Finland and the US.

Characteristics observed in both US and Finland were: (a) hierarchy associated to formal research experience and expertise; (b) a pro-active effort to question bias and prejudices in teaching practices; (c) a pro-active effort to support the development of teachers able to work with groups of students that are diverse in terms of socio-economic status, gender and language or ethnic background (cultural/racial/economic differences); (d) A pro-active effort to develop teaching practices (i.e. not to reproduce existing practices).

Characteristics observed in the US were: (e) a unified social justice agenda articulated among teacher educators. Characteristics observed in Finland were: (f) an emphasis on theoretical plurality and understanding of different types of research in the hard sciences and the social sciences, as a foundation for making decisions in science teaching practices.

## Discussion

This case study does not allow me to comment to what extent another teacher education program at another university in Finland or in the US is guided by the approaches outlined in this case study. However, the teacher educators interviewed in Finland had previously held positions at other universities in different parts of Finland. This indicates that some degree of overlap with other teacher preparation programs in Finland is likely. Contrasting the interviews conducted in Finland with the interviews conducted in the US, my impression is that critical thinking, which at both sites was associated with questions of sustainability, was in the US associated with hopes that teachers would play a role in political activism and in *changing society*. The stance on critical thinking that I encountered in my interviews in Finland, seemed to emphasize instead a hope that mathematics and science teacher students would learn to *change teaching practices* by making well-reasoned pedagogical decisions in their everyday teaching. Yet, the political aspect of the work of teachers was not downplayed in the interviews that I conducted in Finland. An example of this was a response from Erik, the Director of subject-matter specialized teacher preparation. Erik said that teachers “[...] *need to have a strong theoretical foundation and to be well-versed in research practices in order to withstand the crossfire of sometimes unreasonable expectations under which teachers work in their day-to-day* [...]” (interview, September 19<sup>th</sup>, 2016).

The ways in which the two programs observed in this case study connect to sustainability do not come across as distinct models or conceptualizations for teaching and learning about sustainability. What becomes clear however is that similar values and goals, such as the mitigation of bias in instruction are pursued in both contexts by using a variety of normative frameworks (animist, Christian, modern, postmodern) for articulating how to best reach said goals.

The concrete examples provided by research participants regarding the teaching practices for locally relevant ways for engaging a concept such as sustainability in mathematics and science teaching allow us to identify some of the characteristics of two culturally and normatively different approaches to the preparation of mathematics and science

teachers. I propose that the scientific significance of outlining social norms that contribute to our understanding of how a concept such as sustainability is understood in a local context is crucial for a deeper and more meaningful understanding of locally relevant teaching practices. Large scale surveys of student outcomes provide important information but do not shed light on the reasoning and motives that drive locally relevant teaching practices.

The set-up, history, and constellation of stakeholder roles in social institutions such as education vary from one context to another. When the motivation of teachers in different contexts is assumed without inquiry, research efforts can be understood to contribute to a form of globalizing pressure to homogenize the ways in which we understand the purposes and motivations at play in education (Andrews, Atkinson, Ball, & et al., 2014; Dale, 2005). The value of complementing what we know from larger surveys with efforts to discern local discourses in teacher preparation is that such efforts allow us to consider what motivates teachers as they contribute to local practices in the day-to-day. I propose that this case study is significant in identifying how different normative frameworks are deployed for local adaptations of what is meant by sustainability in teacher preparation.

The Finnish approach documented in this case study was characterized by a view according to which the primary role of mathematics and science teachers with regard to sustainability is to popularize scientific knowledge. The contrasting articulations from student-teachers and teacher educators in the US identified social justice as the foundation for sustainable futures and professional excellence. Interestingly, both discourses encountered in teacher education programs in Finland and the US connected the premises of teaching sustainability in the hard sciences with critical thinking and local histories. The interviews documented in this case study underscored the importance of teachers' understanding of the social world in which teachers function. Understanding the local communities and society in which teachers work was articulated as important for teachers' ability to effectively popularize knowledge that can support sustainable development.

The findings are significant in that connections between teaching practices and language practices regarding societal purposes and what is meant by sustainability in two different locations are outlined. I explain these differences using a sociological framework. Both in designing the case study on which I report and in analyzing the findings of this study, I have drawn on structuration theory (Giddens, 1986). The findings highlight resources such as shared narratives and some of the ways in which language practices limit perceptions about relevant teaching practices; notably, differences between conceptualization and explication. These are differences that describe variations in cultural contexts and social norms.

One of the unexpected findings in this study was that a respondent in Finland shared a contemporary narrative that bears a distinct resemblance to a narrative in Finnish oral history (Lönnrot, 1995). The narrative provides, in its older as well as in its more recent articulation a local explication of sustainability in technological development. The variant that draws on historical oral traditions (Lönnrot, 1995), and the variant documented in

2016, both underscore the societal purposes and risks associated with the adoption of new technologies. In the historical version, in relation to the use of iron, and in the more recent variant in relation to chemical industries.

As mentioned in the introduction, Carson contributed by her scholarship to the popularization of an understanding of the natural world. Notably, she contributed to a popularization of the concept of ecology and an understanding of human interaction with ecologies. In some of her early work in the 1950s, she used the term *economy* of the sea as a synonym for the term *ecology* of the sea (Carson, 1998, p. xvi). To a contemporary reader, the term *economy* of the sea comes across as odd. However, the usage was not specific to Carson but dates back to an earlier interdisciplinary conceptualization of ecology. The zoologist Heckel coined the term ecology in the late 19<sup>th</sup> century in his efforts to describe the interdependent and inter-relational existence of life forms (Carson, 1998, p. xvi). In constructing the term *ecology* he drew on the term *economy* to describe a system of interdependence. As modernization in the sciences has advanced and favored disciplinary and technical specialization, the original reference to economies has fallen out of practice.

However, environmental education projects such as the *Ospreys flyways linking communities* international collaboration of schools and experts at wildlife centers (cf. Wiksten, 2017), as well as efforts to study the environment by participatory action approaches (Pain, Finn, Bouveng, & Ngobe, 2013) are breathing new life and new meaning into this link as such efforts highlight the inter-relationship of human economic interests, human governance, civic practices and the world of natural forms of life. The osprey is a migratory bird that is affected on its migration route by changes in the environment, changes that have been brought about by human societies, economic interests, and political economies.

The method of comparing open-ended semi-structured interviews of teacher educators and student-teachers in mathematics teacher education in the US and Finland has in this study highlighted the ways in which sustainability as a concept in teaching practices is about much more than subject matter content. The interviews I have documented highlight through participant narratives that the ways in which sustainability as a concept is present (and is absent) in teacher training and the ways in which student-teachers think of how to implement teaching about sustainability in classroom practices, is closely linked to ethical frameworks. Ethical frameworks that were in this study articulated following established discourses representing somewhat different traditions (Christian, post-modern, animist and modern).

Sustainability as a concept was, in the two teacher education programs observed, approached as a question of *how teachers are prepared to popularize knowledge about ecologies and biodiversity*. I propose in line with teacher educators interviewed in this case study, that a stronger more balanced approach to teaching about sustainability is achieved by addressing the popularization of knowledge about ecologies and biodiversity as topics that are connected with the popularization of knowledge about economies and civic life.



In this perspective, teacher education curricula need to include approaches for communicating about sustainable human societies from a holistic perspective. One example of efforts in this direction is provided by the ecopedagogical social justice teaching and learning framework proposed by Misiaszek (2018). An interdisciplinary approach to communicating about sustainable societies in teacher education curricula presents itself as a more persuasive approach than conventional approaches in which biology, culture, political life and economy have been treated as disconnected fields of inquiry and practice.

Findings from this study indicate that the advancement of practices in teaching about sustainable development would benefit from further comparative research on the ways in which teacher education programs incorporate two concepts into teacher education curricula: (1) social justice and (2) critical thinking. Recent scholarship in the field of Global Citizenship Education and Education for Sustainable Development provide relevant contributions to this end (Bamber et al., 2019; Sant et al., 2018; Diemer et al., 2014).

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*Table 1. Demographic profile of research participants by participant self-identification.*

<b>Pseudonym</b>	<b>Position</b>	<b>Ethnicity, race or culture</b>	<b>Age</b>	<b>Gender</b>
Aina	<b>Instructor in mathematics education</b> , Education. US	First generation Indian-American, born in California	36	Woman
Mary Lou	<b>Director, Teacher Education Program</b> , Education. US	Bilingual Spanish English	60	Woman
Samuel	<b>Student</b> US	Taiwanese American	23	Man
Hye	<b>Student</b> US	Korean	28	Woman
Arno	<b>Student</b> FIN	Human being	22	Man
Matti	<b>Student</b> FIN	Environmentally conscious, ethically oriented	40	Man
Paavo	<b>Student</b> FIN	Swedish ethnic minority	32	Man
Anna	<b>Student</b> FIN	Not Finnish origin	31	Woman
Antti	<b>Student</b> FIN	Finnish	49	Man
Kirsi	<b>Instructor</b> , Mathematics and Statistics. FIN	Finnish	35	Woman
Marianne	<b>University Lecturer in Mathematics</b> , Mathematics and Statistics. FIN	Finnish	35	Woman
Timo	<b>Professor of Mathematics</b> , Mathematics and Statistics. FIN	Finnish	64	Man
Natalya	<b>Teacher at the Normal School</b> . FIN	Russian	44	Woman
Taimi	<b>University Lecturer in Mathematics Education</b> , Education. FIN	Third generation teacher	56	Woman
Jukka	<b>Professor of Mathematics Education</b> , Education. FIN	Not a member of any minority	52	Man
Tarja	<b>Program coordinator</b> , Education. FIN	Finnish	36	Woman
Erik	<b>Director</b> of subject-matter specialized teacher preparation, Education. FIN	Swedish ethnic minority	53	Man

Source: Wiksten, 2018.

*Table 2. Characteristics of explanatory narratives*

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1. An intentional articulated communication in a setting of social interaction.
  2. Actors are explicitly identified in the narrative.
  3. A narrative that recounts for lived experience.
  4. The story serves as an explanation for how something came about, or how something is.
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