DEPARTMENT OF PEDAGOGICAL CURRICULAR AND PROFESSIONAL STUDIES

GARDEN-BASED LEARNING IN TEACHER EDUCATION IN GERMANY

A MIXED-METHOD STUDY OF TEACHER STUDENTS' AND TEACHER EDUCATORS' VIEWS ON GARDEN-BASED EDUCATION

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Abstract

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Aim: This study focuses on achieving an in-depth understanding of teacher educators' and teacher students' perspectives on garden-based learning in the teacher education program in several universities in Germany.

Theory: The theoretical framework is based on three theories. Garden-based learning, as proposed by Gaylie (2009), focuses on the role of the garden in teacher education as environment, community, and transformation. As suggested by Meek and Tarlau (2016), critical food system education approaches food system change by helping students realise their potential in structurally transforming the food system through collective action. Actor network theory analyses the human-nature relationship by not privileging one over the other.

Method: A mixed method approach was applied, incorporating semi-structured interviews with eight teacher educators and an online survey with six teacher educators and 81 teacher students from five German universities. This methodological approach enabled an in-depth and holistic understanding of their perspectives of the learning garden and food system education to emerge. The collected data were thematically analysed, and codes were generated inductively and deductively.

Results: The results indicate that receiving support from various stakeholders is essential for teacher educators and that the motivation of the teacher educators is indispensable for initiating a learning garden in the teacher education programme. The teacher educators that started learning gardens mostly have previous experiences related to garden-based learning. The teacher students and teacher educators perceived the learning garden as a place for experiential learning, where the traditional student-teacher relationship can be challenged. According to teacher students, learning outcomes such as social competency, conscientiousness, self-efficacy, and action competency could be developed in the learning garden. It was found that teacher educators did not consider food system education in learning gardens to a great extent. Moreover, teacher students and teacher educators both perceive the learning garden as contributing to a more sustainable food system through a more sustainable diet and consumption pattern.

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List of Abbreviations

SD	Sustainable development
ESD	Education for sustainable development
TEfS	Teacher education for sustainability
CFSE	Critical food system education
ESE	Environmental and sustainability education
NCE	Nature conservation education
ANT	Actor network theory
GBL	Garden-based learning
NGO	Non-governmental organization
QCA	Qualitative content analysis

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1 Introduction

We have entered the 'age of humans', also known as the Anthropocene (Brennan, 2017). Scientific evidence such as the IPCC (2021) or IPBES (2019) report indicated the dimensions of climate change and the depletion of natural resources. The Anthropocene highlights the unprecedented scale, scope, and magnitude of humanity's environmental impact on Earth. The report Limits to Growth published by the Club of Rome clarified in 1972 that the supply of resources is finite (Meadows et al., 1972). Our food systems are depleting natural resources and contributing to biodiversity loss, environmental degradation, and greenhouse gas production (Fresán and Sabaté, 2019). Notably, the livestock sector leads to the transgression of three planetary boundaries: land-system change, climate change and biogeochemical flows (Bowles, Alexander and Hadjikakou, 2019). Hence the global operating food system can be described as highly unsustainable (Bowles, Alexander and Hadjikakou, 2019). Sustainability or sustainable development (SD) is often referred to as the intersection of three spheres: social-cultural, economic, and environmental. Seghezzo (2009) described how sustainability is generally perceived as *"a guide for economic and social policymaking in equilibrium with ecological condition".* Applying sustainability to the food system means that everybody simultaneously has optimal and equitable access to food and water, now and in the future. A sustainable food system should consider current issues such as high food loss and waste, global hunger and malnutrition, unequal economic access to nutritious food, and the long-term viability of the food system (Spiker et al., 2020). According to Spiker et al. (2020), a sustainable food system can be found at the midpoint of environmental stewardship, nutrition and health, social, cultural and ethical capital and economic validity.

Even though current educational institutions pose barriers to a transformation toward sustainability, education has a vital role in learning our way out of unsustainability (Wals, 2012). Education for sustainable development (ESD) is a contested, constantly evolving concept with a change-oriented nature (Reunamo and Pipere, 2011). ESD works at different levels - the whole institution, education system, and international scale. The roots of ESD can be traced back to nature conservation and Environmental Education (Wals, 2012). Regarding the role of education, two different vantage points of the instrumental and the emancipatory can be discussed. In comparison, the instrumental perspective emphasises changing human environmental behaviour in predetermined ways. Contrarily, the emancipatory perspective stands for developing the learners' capacities and confidence. The learner should be able to *"determine how to live together in ways that do not further undermine the carrying capacity of the earth"* (Wals, 2012, p.1). ESD needs a substantial commitment from teachers, teacher students and teacher educators as they are the ones who can integrate ESD into the education system. Regardless of the relative roles or significance of the instrumental or emancipatory vantage points, when it comes to shaping new generations, future educators must be taught those principles and methods first. The concept of teacher education for sustainability (TEfS) aims to prepare future educators for their role as leaders in social change by developing specific sustainability skills (Brandt et al., 2021). TEfS has been integrated into teacher education programmes in several countries. However, in Germany, Rieckmann and Holz (2019) described that the anchoring of ESD on a structural level in teacher training has so far been neglected. Given the potential of teacher education, teacher educators are central to TEfS. Teacher educators work in higher education institutions and are responsible for teaching teacher students. Teacher educators have not been given sufficient attention. Livingston (2014, p.219) even referred to teacher educators as *"hidden professionals".*

Education and the necessary changes that need to take place in our food system are deeply intertwined. As in the transition towards SD, teachers and teacher education both have an essential role in challenging the dominant narratives around food. Education about the food system means *"we can begin to overcome passivity, and the uncritical and dependent consumerism that characterises our*

society's relationship with food" (Rojas et al., 2011, p.766). Education is critical for the dietary transition toward a planetary health diet, as proposed by the EAT Lancet commission (Blackstone et al., 2018), or the increase in food and sustainability literacy (Valley et al., 2020). Education can also contribute to systemic changes that are necessary for a sustainable future.

Can learning gardens contribute to the transition toward a sustainable future and a sustainable food system? In the garden, learners are outdoors, become aware of their surroundings and learn to care for the natural world (Gaylie, 2009). They are learning to think systemically about the global interdependencies of their daily food choices and may also critically assess the food system (Gaylie, 2009). The mere production of food on their terms in the learning garden could provide learners with an opportunity to reconnect with food sources and understand the interconnected nature of food with all aspects of life (Rojas et al., 2011).

In a garden, teacher students can not only experience the entire food cycle from growing, harvesting, preparing, cooking, and eating to composting but also begin to reassess their educational assumptions, as described by Gaylie (2009), who worked with learning gardens in teacher education. Gaylie (2009), over the years of experience, witnessed how the opportunity to learn in connection with the land can lead the students to question their deeper attitudes towards learning and nature.

1.1 Research problem and statement of relevance

Learning gardens have been identified as a central component of the German National Action Plan on ESD, the German contribution to the World Action Program of UNESCO. The learning garden should be included in teaching as well as integrated into the whole school (BMBF, 2017). Therefore, garden-based teacher education is essential. Nevertheless, in Germany, training that enables teachers to employ learning gardens must either come to life or be improved (Benkowitz and Köhler, 2019).

Meek and Tarlau (2016) recognised that learning gardens have been de-politicised and even put the future of food system education at risk. They proposed critical food system education (CFSE). As established earlier, the current food system is unsustainable and needs to be transformed. Considering the deteriorating state of the world, there is an increasing need for teachers to integrate food system education into the learning garden because it could enable teacher students *"to teach as if the planet matters"* (Gaylie, 2009, p.9). Integrating food system education into the learning garden could enable the students to radically criticise the current state of global food production by connecting them to movements that are trying to transform the food system (Meek and Tarlau, 2016). Teacher educators play a central role in this process. They can either utilise education to reproduce the current food system or enable teacher students to transform the food system. Food system education in learning gardens can tackle food system problems, so profound changes in what and how it is taught are indispensable (Brekken et al., 2018; Galt, Clark and Parr, 2012; Gaylie, 2009). Hence, teachers must shift from emphasising knowledge and healthier practices at an individual level to encouraging a systemic change in which those consumer choices are considered (Meek and Tarlau, 2016). There is a need for integrating CFSE into teacher education in learning gardens. Teacher education in the learning garden focusing on CFSE would enhance food system literacy. Moreover, it would broaden critical and creative thinking skills and go beyond disciplinary boundaries, urgently needed. Gaylie (2009, p.6) describes how learning in a garden can

"promote a shift in education through teacher training, from single subject, decontextualised, methods-based approaches to interdisciplinary, ecoliterate learning with a focus on process, then learning in garden must unfold slowly, with care, sensitivity and deep awareness of one's surroundings".

Looking at the literature, several research gaps can be observed. First, there is a general lack of literature on incorporating CFSE into teacher education or into teaching in general. More specifically, there is a lack of research on structuring a garden-based course for teacher students that includes teaching around the food system. The existing literature has looked only at food system education concerning sustainable agriculture or interdisciplinary food system programmes at universities (Meek and Tarlau, 2016). In general, literature on teacher education in learning gardens is still scarce. Furthermore, it has not been reviewed whether food system education is a part of garden-based teacher education programmes. Most recent research on TEfS has emphasised teacher students' achievement of intended learning outcomes and the development of critical competencies (Brandt et al., 2021). Little focus regarding TefS has been given to teacher educators. More specifically, there is no research on how teacher educators perceive food system education and learning gardens in the university context. Finally, the available literature that is relevant to the context of German teacher educators is relatively scarce.

1.2 Research questions

This thesis aims to understand the potential and limitations of garden-based education of teacher students to terminate the reproduction of the current food system in learning gardens. The overarching question that is addressed in this thesis is: *How can the learning garden become a place for disrupting teacher students' and teacher educators' preconceived notions of food system education?*

The objective of this study is to answer the following research questions:

1. What challenges and facilitating factors do teacher educators view as significant for garden-based learning in teacher education in Germany?
2. What do teacher educators' and teacher students' views of teaching in the learning garden have in common?
    2.1 What are the implications for the development of future teaching in the learning garden?
3. How do teacher educators envision food system education in the learning garden?

Therefore, this research investigates the role of teacher educators in garden-based education that does not stop at disrupting the food system but, in the same breath, also disrupts preconceived notions of teaching in teacher students. Therefore, a deeper insight into the relationship of teacher educators and teacher students towards learning gardens and food system education is generated. The teacher educators' point of view is of great interest in examining the potential of instituting food system education and garden-based learning into teacher education in the learning garden. Critical aspects that have been researched are their motivation for teaching in a learning garden, their perception of the learning garden and the learning outcomes regarding competencies, knowledge, and values.

2 Literature review

What is essential for food system education from the perspective of ESD? Is food system education implemented into teacher education in learning gardens? These questions were relevant to this study and intended to address in this literature review. In the following chapter, previous studies on food systems, learning gardens and education for sustainable development are summarized to provide a basis for the research carried out in this study.

2.1 Food systems

2.1.1 Definition

Food systems are essential to humans and the planet but are harming both. The unsustainable trajectory of our food systems makes a sustainable transition of the food systems one of the most significant challenges of the 21st century (iPES Food, 2015). Food systems refer to a web of actors, interactions and processes from production to food consumption (Ericksen, 2008; iPES Food, 2015). Tracing the development of food systems allows for a broad categorization into traditional and modern food systems (Ericksen, 2008). Conventional food systems cater to local needs, and current food systems provide food to our globalized societies within a global market. Ericksen (2008) described four central challenges of our modern food system – (1) the intensification of food production, (2) the growth of processing and packaging of food products, (3) the distribution and retail and (4) the consumption. Food travels immense distances today and is increasingly concentrated on a vertical and horizontal scale (Ericksen, 2008). On a vertical scale, production becomes more and more concentrated, meaning that a single company engages with two or more stages of production. On a horizontal scale, companies at the same stage in the production process are consolidated.

2.1.2 Challenges

Applying a systemic lens to food means that the reinforcing and balancing feedback loops and the cyclical, multilayered and multi-scale interactions between the different components of a food system are considered (iPES Food, 2015). Understanding food system dynamics in the scientific community is still limited (Béné et al., 2019). These complex interactions require an integrative approach which becomes even more explicit by looking at the example of climate change. In this regard, Clapp, Newell and Brent (2018) referred to the two-way nature of the food system. On the one hand, the food system majorly advances climate change, as it has caused *"60% of global terrestrial biodiversity loss, around 24% of the global greenhouse gas emissions, 33% of degraded soils, the depletion of 61% of 'commercial' fish populations, and the overexploitation of 20% of the world's aquifers"* (UNEP, 2016, p.6).

On the other hand, the food system is highly vulnerable to the effects of climate change (Clapp, Newell and Brent, 2018). The IPCC (2021) reported how increasing temperatures, changing precipitation patterns, and greater frequency of extreme weather events related to climate change are already affecting food security and are projected to increase in the future. Food security refers to availability, access, utilization, and stability. Food security is at risk, considering the socio-economic drivers of population growth, food demand increases, and the recent COVID-19 pandemic (IPES, 2016; IPCC, 2021; FAO, 2021). The FAO (2021) measured that the COVID-19 pandemic increased the number of people that faced hunger. In 2020, about 800 million people were affected by hunger, and almost every third person did not have access to adequate food. People worldwide encounter a lack of access to affordable, healthy and fresh food on a daily basis.

Consequently, healthy diets were out of reach for 3 billion people as a report by the FAO from 2021 suggested. Since 1975, obesity and overweight have almost tripled (WHO, 2022). Strikingly, in terms

of consumption, the food systems are particularly unsustainable as certain areas of the world face malnutrition while other regions deal with obesity. Toussaint, Cabanelas and Muñoz-Dueñas (2021) described how the food system's social dimension was mainly neglected due to the inherent complexity and needed to incorporate insights from all actors at various levels of the value chain. They described how some actors in the food supply chain take advantage of the food system's complexity by hiding their actions and activities to avoid responsibility. An interviewee stated that *"In developing countries workers are being exploited and trampled by many people from developed countries, where all these situations are unseen."* (Toussaint, Cabanelas and Muñoz-Dueñas, (2021, p.15). Food production relies on the work of racially minoritized women and men and white working-class women (Swan and Flowers, 2015). These systemic pressures increase the need to change the food system fundamentally.

2.1.3 Approaches to change

Researchers agree on the need to transform the food systems (Haysom et al., 2019; Hinrichs, 2014; iPES Food, 2015). Changing the food system, its inherent power relations, systemic dynamics and lock-ins are complex, as each component of the food system is already challenging to reform (iPES Food, 2015). Béné et al. (2020) assessed what drives food system sustainability based on four dimensions: food security& nutrition environmental, economic and social. They found that the most statistically significant correlations between drivers and food system sustainability seem negative. Changes in values, cultures, practices, institutions, rules, technology and infrastructures are necessary (Hinrichs, 2014). It is still debatable what sustainability means for the food system, as sustainability, in general, is a highly contested concept. There are many viewpoints on the necessary changes to arrive at a sustainable food system (Haysom et al., 2019). These viewpoints are based on the different value positions highlighted by Haysom et al. (2019). From status quo to reform, these value positions are based on the views on SD by Hopwood et al. (2005). While some argue for place-based interventions or community-based work, others focus on the supportive meta-structures or the industrial food policy to facilitate change (Navarro, 2018; Blay-Palmer, Sonnino and Custot, 2015).

There is an ever-growing movement for re-localizing food systems, mainly in the industrial world, aiming to address the inherent problems and foster alternative food systems. Concerning the thematic focus of this thesis, delocalization and alternative food systems are essential keywords. Haysom et al. (2019) argued that a shift from dependence on the global food system toward local and regional food systems is required. Consequently, the producer-consumer relationship changes from 'Food from Nowhere' to 'Food from Somewhere' (Schermer, 2015). However, assuming that local food is inherently sustainable is a fallacy, as explained by Born and Purcell (2006). The so-called local trap should be avoided, as it was argued that not the scale of the food system but the content of that plan is responsible for favorable outcomes such as sustainability or justice. Cleveland, Carruth and Mazaroli (2015) argued that localization initiatives facilitate the maintenance of the status quo by mainstream players.

2.2 Education for sustainable development (ESD)

2.2.1 Problems of education

Orr (1994, p.5) criticised the conventional wisdom that all education is good by stating, *"The truth is that without significant precautions, education can equip people merely to be more effective vandals of the earth".* Education has not prevented humans from destroying the earth and heralding the new era of the Anthropocene. Sterling (2001) stated that education prepares us only for the world we know. The educational model in most parts of the world could still be described by what Freire (1996) calls banking education, where the learner is perceived as an object in which the teacher deposits information. Ultimately, this uncritical and obedient relationship results in oppression (Freire, 1996). Wals and Benavot (2017) argued that education could marginalise indigenous knowledge and

contribute to resource overconsumption and cultural homogenisation. It is well established that people with the highest degrees are destroying our planet the most (Gadotti, 2008, p.21). Essentially, the education system in most parts of the world aims to meet the needs of neoliberal capitalism by reproducing the roles of workers and consumers (Huckle and Wals, 2015).

2.1.2 Purpose of education

So, it could be argued that the global crisis is simultaneously a crisis in education. Nevertheless, it is vital to understand the term crisis in its original meaning in Greek, signifying a critical turning point that requests consideration and judgement, especially in these crucial times. It is essential to critically reflect on the purpose of education (Wals and Benavot, 2017). Education can, for instance, help learners to *"know, read and understand the world, both scientifically and emotionally, and above all, to intervene in an organised way"* (Gadotti, 2008, p.21).

Education can contribute to the transformation towards a more sustainable society and not only lead to the development of skills, competencies, tools, and concepts, but it also can shape behaviour, values, and worldviews (Wals and Benavot, 2017). This indicates that there are two main functions of schools in a social system: either supporting continuity or creating change in society by challenging the taken for granted (Poeck, Östman and Öhman, 2019). Biesta and Säfström (2011) proposed that staying in this tension between an ideal vision of society, the 'what is not' and the present 'what is' is essential. Concerning the role of education in creating a sustainable planet, Wals (2012) differentiated between instrumental and emancipatory perspectives. While instrumental education emphasizes the potential of education in changing behaviour in predestined ways, emancipatory education accentuates the potential of individuals to determine how to live and act sustainably. According to Freire (1996), emancipatory education is problem-posing education, where the teacher poses a problem to the class, and all collaborate and co-investigate in finding an answer. Generally speaking, instrumental education is favoured by environmentalists with immense worries about the accelerated loss of biodiversity and climate change (Wals, 2012). Emancipatory education is particularly encouraged by educators with a firm concern for agency, democracy, and self-determination (Wals, 2012). Emancipatory education promotes action-oriented, transformative, collaborative and participative learning (Wals and Benavot, 2017).

2.1.3 Principles of ESD

The concept of education for sustainable development (ESD) is also known under the terms education for sustainability or sustainability education, or environmental and sustainability education (ESE). On the one hand, the concept is grounded in the contested concept of SD and, on the other hand, in the practices of environmental education. SD emerged during the late 1960s and can nowadays be found on the political agendas on a global scale (Seghezzo, 2009). Nowadays, SD is interpreted in multiple ways to fit individual interests, which makes the polysemic use of the concept opportunistic and critical (Bolis et al., 2014). The Brundtland report states that development is only sustainable if it *"meets the needs of the present without compromising the ability of future generations to meet their own needs"* (Brundtland, 1987, p. 8). Besides, SD is often represented by the 'triple bottom line' of the social, environmental and economic pillars (Elkington, 1997). SD is defined as a tension between raising human well-being while at the same time limiting human activity by staying within the planetary boundaries (Hugé, 2013). The ideas of SD have been criticised for being anthropocentric because they imply that nature should be protected to safeguard the survival of humans (Seghezzo, 2009; Bolis et al., 2014). It is a contested concept with multiple definitions.

The practices of environmental education are not new. Wals and Benavot (2017) gave an overview of how education concerning people and the planet developed from nature conservation education (NCE) starting in the late 19th century to its present form of ESE. While the focus in NCE was awareness, knowledge and understanding of the natural world, the emphasis of ESE is on creating a society based

on sustainable values and structures with a relational way of being in the world (Wals and Benavot, 2017). To better understand the differences within the field of ESD, Poeck, Östman and Öhman (2019) discern three different teaching traditions: fact-based, normative, and pluralistic. They differ in their sustainability approach (sustainability problems and solutions), didactic approach (ideas about the role and purpose of schools in society), values and facts, and approach to education and democracy. While the fact-based tradition is most concerned with learning results related to knowledge, it is well established that there is no link between cognitive learning about concepts such as nature and relating to it in a caring way (Wals, 2012). The normative tradition focuses on the effects of sustainable attitudes and behaviours, highlighting that education is never value-free (Wals, 2010). According to Poeck, Östman and Öhman (2019), the pluralistic tradition is concerned with being a catalyst for processes. Pluralistic education means that democratic processes are situated *in* education and do not exclusively take place *after* education, like in normative education. Through critically discussing different alternatives and their consequences, students become democratic citizens in pluralistic education (Poeck, Östman and Öhman, 2019).

2.1.4 Teaching ESD

Wals (2020) argued for a relational pedagogy of hope based on three elements - (1) the critical, (2) the emancipatory and (3) the relational element. In his pedagogy of hope, the critical element is giving students space for disruptive questions about causes, effects and change strategies. At the same time, students should be able to understand and learn to overcome the systems and mechanisms that normalize and justify overconsumption, animal cruelty, exploitation and extraction (Wals, 2020). The emancipatory element of Wals (2020) relational pedagogy of hope refers to the students' autonomy and self-determination regarding raising and addressing their matters of concern. Lastly, the relational element, according to Wals (2020), is about connecting with the local environment, other humans and the more than human world. In sum, Wals (2020) argued for a more localized and existentially relevant curriculum. A curriculum that allows the learner to discover the complexities and interconnectedness of the world and to find their place and identity.

Wals and Benavot (2017) described the integration of diversity, cross-boundary learning and acquiring skills and competencies for life as the three ways education best supports sustainability. First, ESD promotes the importance of diversity and different viewpoints, particularly indigenous knowledge and practices (Wals and Benavot, 2017). So far, traditional knowledge has rarely been used to address environmental and societal issues (Brennan, 2019). Traditional knowledge is critical regarding sustainable agriculture, food preparation, conservation and socialization in indigenous communities (Wals and Benavot, 2017). This diversity of perspectives is precious in terms of our understanding of sustainability, as we cannot know the most sustainable way of living. Wals (2010) acknowledged difficulties as there are many confusing realities, which are moreover constantly evolving and shifting. Another central element of education is its interdisciplinarity, as it needs to draw on different sources and disciplines and involve learning across formal, non-formal, and informal settings (Wals and Benavot, 2017). Education should enable the learner to acquire new competencies to identify where change is needed. Wals and Benavot (2017, p.408-409) argued that education to support sustainability should encourage *"people in position of authority to seek critical information, embrace innovation and identify where change is needed—all with the well-being of people and planet in mind".*

2.1.5 Teacher education and ESD

To arrive at a sustainable future, teachers are essential in catalyzing the necessary changes in schools and society in general (Nousheen et al., 2020). Teacher quality and effectiveness have been the subject of scholarly discussion, and evidence indicated a strong link between students learning outcomes and teacher effectiveness (Nousheen et al., 2020). Teacher quality has been the target of criticism, especially after publications of standard-based, system-wide testing as the Program for International Student Assessment (PISA) (Nousheen et al., 2020). The education of teachers is not only a critical

lever for improving teaching quality and effectiveness but also for achieving a more sustainable future. Hence, the education of teachers is essential in the process of societal transformation and attaining SD, as it helps to professionalize the teaching field, promote ESD and enhance the learning of students (Nousheen et al., 2020). UNESCO advocated integrating ESD into teacher education through the Decade of ESD between 2005 and 2015 and the Global Action Program on ESD after 2015 (Evans et al., 2017).

Nevertheless, reviews of the achievements report limited progress (Evans et al., 2017) and no specific focus on ESD in teacher education (Brennan, 2019). Evans et al. (2017) conducted a systematic literature review on integrating sustainability into teacher education, including 28 studies. In 11 out of 28 publications, ESD was embedded into teacher education as a component of a core or compulsory subject, i.e. as a special workshop on ESD (Evans et al., 2017). Therefore, Evans et al. (2017) described the efforts to integrate sustainability into teacher education as mainly isolated activities instead of the necessary systemic approaches. The main reason for this is the standardized framework with tight timing, being primarily human-centered and oriented on delivering on the school curriculum, making it challenging to construct inter-disciplinary, flexible and integrated programs (Brennan, 2019). Integrating ESD into teacher education would mean a structural integration into organizational structures and policies, the content and curriculum and the teacher education pedagogy. Otherwise, changes are only symbolic and of short duration. A systemic approach would mean that sustainability would become a central part of the departmental policies, everyday pedagogical activities and core curriculum foci (Evans et al., 2017). Adomssent and Michelsen (2006) described the case of the German University of Lüneburg, where sustainability has been integrated into research, teaching, and everyday university activities.

An important role in mainstreaming sustainability into teacher education have teacher educators as they hold the potential to engage in collaborative action and have access to sites of education (Brennan, 2019). Teacher educators are mainly driven by government, university-level policies, the interests of student teachers and their interests (Brennan, 2019). The primary motivation of teacher educators for implementing ESD was their desire to enable student teachers to implement ESD in schools by developing knowledge, understanding, skills and values to embed ESD (Evans et al., 2017). Pedagogical strategies teacher educators used for teacher education were engaging student teachers in place-based, experiential and inquiry methods, as found in the study by Evans et al. (2017). Place-based outdoor experiences were one of the modelling strategies for teaching ESD that student teachers could apply in schools (Evans et al., 2017).

2.3 Learning gardens

2.3.1 Definition

Etymologically the word garden means enclosure or enclosed space (Ostertag, 2015). This thesis uses the term learning garden also to include used terms such as school garden and educational garden. A learning garden is a place for cultivating food crops and learning outdoors or garden-based education while offering a habitat for flora and fauna (Williams, 2018). The learning garden has a heterogenous nature, and its meaning is ever-changing, according to Ostertag (2015). The main reason for the revival of learning gardens is the necessity of outdoor spaces for children to experience their natural environment (Williams and Dixon, 2013). Tending to the plants offers learning opportunities that range from energy and materials to biological growth to cultural practices of extraction of seeds (Gray et al., 2019). The learning garden offers a resource for investigating food webs, interdependence, biodiversity, living and non-living things and life cycles (Johnson, 2012). As the influences of settler and Eurocentric human nature binary are ingrained in the learning garden some authors asked for reimagining the gardens. Ostertag (2018) critically discussed how the garden beds in rows all

surrounded by a fence represent a classification of nature while at the same time reproducing the order of indoor classrooms.

2.3.2 History

Learning gardens have an unsettling history of over 300 years and have served different purposes depending on their geographic location (Hellinger, 2021; Lochner, Rieckmann and Robischon, 2019). In the Global South, learning gardens serve for food production and vocational agricultural training (Lochner, Rieckmann and Robischon, 2019). In Costa Rica, learning gardens have improved children's nutrition and eating habits for decades (Lochner, Rieckmann and Robischon, 2019). In the Global North, they have served primarily as a science lab and have lately become a place to reconnect youth to their food's origin and nature (Lochner, Rieckmann and Robischon, 2019). The benefits of gardens as a source for outdoor investigations and scientific observations have already been recognized by Rousseau (1712-1778), Pestalozzi (1746-1827) and Montessori (1870-1952) (Johnson, 2012). Ostertag (2018) described the learning gardens' inherent anthropocentric and Eurocentric beliefs that humans have the right to control nature. Learning gardens have a complicated history in Germany, as they were essential in Nazi German education. The ministry obliged all schools in Germany to have learning gardens to build patriotism and the agricultural skills necessary for German territorial expansion (Ostertag, 2018). Pine (2010) recognized how learning gardens were a beneficial instrument for indoctrination and National Socialist pedagogy (Ostertag, 2018). In the German Democratic Republic, learning gardens were integrated into the curriculum. Since the 1990s, the learning gardens in Germany have been growing but are generally not anchored in the curriculum. In the late 1890s, in the Experimental School at the University of Chicago, featuring an experimental curriculum designed by Dewey (2008), students learned about economic principles, mathematics, food science and natural history by gardening and cooking the harvest (Ralston, 2011).

2.3.3 ESD in learning gardens

The learning garden intersects with educational movements such as outdoor, experiential, and place-based education, which has further intensified the attention of practitioners and scholars (Williams, 2018). Learning outdoors is a holistic educational method involving social engagement, outdoor activities, and environmental education. Therefore, the learning garden can accomplish many objectives and principles of ESD (Hellinger, 2021). The German National Action Plan on ESD (Nationaler Aktionsplan BNE) proposed that learning gardens contribute to the development of teaching and the school, referring to the whole-school approach (BMBF, 2017). Learning gardens can have a multitude of purposes, including:

(1) healthy eating habits and increased food literacy,

(2) positive environmental attitude and empathy,

(3) formation of community, school bonding and parental involvement,

(4) social, physical, personal and moral development related to motivation, self-esteem and self-concept (Williams and Dixon, 2013).

ESD should connect local action with global thinking (Lochner, Rieckmann and Robischon, 2019). There are many opportunities to integrate a global perspective into the school garden and *"make the interconnectedness of our realities tangible worldwide"* (Lochner, Rieckmann and Robischon, 2019, p.170). Yet, Lochner, Rieckmann and Robischon (2019) argued that school gardening often ends with composting and neglects connecting global challenges. The literature review by Lochner, Rieckmann and Robischon (2019) proposed the Virtual School Garden Exchange for forming global links through exchanges where participants from different parts of the world can engage with each other and share their knowledge about gardening and growing.

An essential way for education to foster sustainability is environmental stewardship (Orr, 2010; Wals and Benavot, 2017). According to Dewey (2008), gardening can channel a child's natural curiosity into a genuine appreciation and scientific interest in their environment (Ralston, 2011). Environmental stewardship focuses on the moral and ethical commitment to creating a more sustainable planet while encouraging empowerment, collaboration, transformation, and local ownership (Wals and Benavot, 2017). Hence, the learning garden can be a platform for ESD in the context of schools and universities or communities.

2.3.4 Rationales for learning gardens

Learning gardens provide both formal and informal learning experiences and offer an abundance of educational possibilities (van Dijk-Wesselius et al., 2020). The majority of scholarly research worldwide has focused on two main topics – (1) impact on academic outcomes and (2) impact on attitudes and knowledge toward vegetable and fruit consumption (Eugenio-Gozalbo, Pérez-López and Tójar-Hurtado, 2020).

(1) Impact on academic outcomes

The first concerns the impact on students' academic outcomes, emphasizing low-income schools (Eugenio-Gozalbo, Pérez-López and Tójar-Hurtado, 2020). Research on academic outcomes of garden-based learning in schools began in the 1990s (Williams and Dixon, 2013). Williams and Dixon (2013) argued that this type of research is essential for growing credibility within the wider educational community. Still, the studies they included in their synthesis lacked research rigour and focus. 83% of articles in their literature synthesis highlighted the positive impact on direct academic achievements, especially in science, math, and language arts (Williams and Dixon, 2013).

(2) Impact on attitudes and knowledge toward vegetable and fruit consumption

The second topic concerns the impact of garden-based nutrition programs on attitudes and knowledge toward vegetable and fruit consumption (Eugenio-Gozalbo, Pérez-López and Tójar-Hurtado, 2020). Berezowitz, Bontrager, Yoder and Schoeller (2015) reviewed 12 studies in learning gardens and found that all reported improvements in fruit and vegetable consumption. The systematic review of 40 articles, including quantitative (21), qualitative (16) and mixed methods studies (3), was conducted by Ohly et al. (2016). The researchers found limited evidence for changes in the intake of fruit and vegetables and noted limitations of the studies as they were solely based on self-report.

More recently, studies focused on well-being through learning outdoors (Malberg Dyg & Wistoft, 2018) along with improved levels of stress, interest, enjoyment in learning and self-discipline (Kuo, Barnes and Jordan, 2019), motivation to study science subjects (Passy, Morris and Reed, 2010). Moreover, contact with nature on an everyday basis may be a requisition for ecological behaviour and environmental concern (Dutcher et al., 2007). Fisher-Maltese's (2016) mixed-method study measured environmental attitudes among 236 sixth-grade students with an Eco literacy Survey. Although the survey data showed no significant shifts in environmental attitudes, the data from pre/post-test interviews and conversations showed an improvement in the learners' attitudes towards a more empathic view of nature. More systematic studies are required to examine this relationship between learning gardens and the impact on environmental attitudes and behaviour (Eugenio-Gozalbo, Pérez-López and Tójar-Hurtado, 2020). Gray et al. (2019) argue for the contribution of the gardens to a formulation of learning aesthetics. Learning in the garden centres on the body, connecting knowledge, actions and values (Gray et al., 2019).

Ralston (2011) reviewed the politics of gardening by comparing the work of John Dewey (2008) with the work of Mary Beth Pudup (2008). Her study highlighted that Dewey and Pudup argued in favour of a political reason for garden-based learning. For Pudup (2008), the focus of learning gardens should

be on *"discourse, in which citizen-subjects are constructed through social interaction and grassroots political activity"* (Ralston, p.17). Ralston (2011) described how garden projects could be a forum for political protests and opportunities for marginalized people to develop alternative discourses and join interested communities to form stronger push-backs against powerful interests. Guerilla gardening is such a form of political resistance. It is a grassroots movement that is reappropriating unused urban land for cultivating plants there (Ralston, 2011). Moore (2017) applied a political ecology lens to a case in rural Haiti, where farm school pedagogy's influence on the peasant movement of Papaye is explored. The study examines the role of movement pedagogy and movement-based agroecology in challenging the dominant rural governance (Moore, 2017). The movement's pedagogy challenges the hegemonic knowledge production and relation with nature, aiming to disrupt the *"continuity between histories of colonization and structures of hegemonic scientific knowledge"* (Moore, 2017, p.256).

2.3.5 Teaching in learning gardens

Teaching in a learning garden is quite different from traditional indoor classroom learning. The shift to outdoor learning involves a 'boundary crossing' proposed by Akkermann and Bakker (2011). Ostertag (2018, p.96) asked, *"What if we could decentre anthropocentric teaching practices and 'become teachers together' with other human and nonhuman teachers? Could a garden become a teacher? A plant? A spider?".* The notion of 'becoming' breaks with the perception of the self as stable, coherent, rational and autonomous and suggests instead that the process of becoming teachers together is one with *"unexpected loose end, openings and movement"* (Ostertag, 2018, p.112). She argued for abandoning the image of teaching as an individual act as the garden, and all nonhuman beings are present as co-teachers. The land as a teacher is prevalent in many indigenous teachings (Ostertag, 2018). Ostertag (2018, p.102) argued that this notion of the garden-as-teacher can become a romantic and picturesque metaphor and remain an *"exclusionary appropriations of land and culture".* Eurocentric thinking needs to be considered when thinking about the garden-as-teacher.

There is a shift in the physical reality of the learning environment and challenges regarding the purpose and practice of teaching in the learning garden (Hipkiss, Windsor and Sanders, 2020). Green and Rayner (2020) conducted a four-year place-based study with three teachers in the learning garden and 62 children aged 7 to 12 in an Australian public primary school. Their study's main finding is that the teacher's role changes in the learning garden. Teachers became a guide and facilitators of learning in the learning garden (Green and Rayner, 2020). Another study by Kapelari et al. (2007) highlighted the main content taught in learning gardens. The data collected from 52 teachers in learning gardens in Austria, Italy, Bulgaria and England showed that they taught mainly: plant function and form, seasons, food, native plants, environmental education and horticulture (Kapelari et al., 2007). Van Dijk-Wesselius et al. (2020) studied the main barriers and solutions related to teaching in a learning garden. Their participatory action research investigated 75 teachers at five primary schools in the Netherlands. Among the main barriers to teaching in a learning garden, the researchers identified the lack of a formal status of the learning garden in their educational practice, a lack of confidence in their outdoor teaching expertise, difficulties in getting started and physical constraints. As solutions to these barriers, the researchers summarized the following general recommendations: *"just do it, get educated and inspired, engage in real-life experiences, get an outdoor pedagogical mindset, and follow a tailored process"* (van Dijk-Wesselius et al., 2020, p.1).

McVittie et al. (2019) argued that learning gardens and place-based education must engage with the complicated history of a place and push towards decolonization. McVittie et al. (2019) applied indigenous educational approaches and described how relational learning is central to the learning garden. Relational learning can serve as a door opener for decolonization as it questions the hierarchical classroom-based learning that reinforces colonialism (McVittie et al., 2019).

To summarize, teaching in the learning garden requires the teacher to:

(1) take the role of a guide and facilitator of learning (Green and Rayner, 2020),

(2) have content knowledge about the plants and processes in the learning garden (Kapelari et al., 2007),

(3) overcome barriers such as the lack of formal status of the learning gardens (van Dijk-Wesselius et al., 2020),

(4) engage with the history of the learning garden and decolonisation (McVittie et al., 2019),

(5) not reproduce the human/nature binary (Ostertag, 2018)

2.3.6 Challenges of learning gardens

The learning garden faces different challenges that prevent institutions from installing learning gardens. Among the most common barriers are 1) high time expenditure for teachers, 2) existing curriculum pressure, 3) teachers' self-efficacy and confidence, and 4) difficulties in accessing training and resources (Burt et al., 2018). Installing, integrating and teaching in the learning garden requires a lot of work from teachers (Passy, Morris and Reed, 2010). The study of Burt et al. (2018) incorporated the answers from 99 teachers in learning gardens through an online survey. Of the respondents, 83.8% were female, and 62.6% were primary school teachers, which indicates where and by whom learning gardens are most frequently implemented. Furthermore, the study showed that 66% of respondents saw the necessary time for teaching in the learning garden as the biggest time-related challenge.

Barfod (2018) studied the teachers' perception of teaching outdoors in the 'udeskole', a school-based outdoor learning practiced in Denmark, through qualitative interviews. The study acknowledged that teachers struggled with teaching outdoors as the school setting was increasingly prescriptive and with narrow learning goals, quantifiable outcome measures and standardized tests. Moreover, teachers felt professionally isolated from their colleagues and characterized as strange, tree-hugging idealists. Barfod (2017) described the creative freedom to prepare and present subject-related knowledge as challenging and highlighted the importance of exercising mastery in being a teacher in the learning garden.

2.3.6 Food system education in learning gardens

Efforts to educate about food and the food system have intensified as noted by Swan and Flowers, (2015) and Koch (2016). In education, food has been used as the subject of investigation and as a pedagogical tool (Classens et al., 2021). We learn informally from the range of smells, textures and tastes of food whenever we eat. Nowadays, knowledge and skills related to a healthy diet or cooking are lacking. Food education aims at food literacy by providing skills and knowledge about nutritional, balanced and healthy eating (Meek and Tarlau, 2016). Beyond nutritional aspects of food, food education faces increasingly broader aims, such as sustainable food choices, reflected in the educational uptake of the planetary health diet by the EAT Lancet commission (Blackstone et al., 2018). The commodity fetish is one of the various reasons for the growing disconnection between our food and the food system. Harvey (1990) has defined the commodity fetish as the methods of markets to conceal social information and relations. Harvey (1990, p.423) wrote,*"The grapes that sit upon the supermarket shelves are mute; we cannot see the fingerprints of exploitation upon them or tell immediately what part of the world they are from."*. This refers to the "Food from Nowhere", where the consumer's knowledge about the food system is minimal (Schermer, 2014).

Food system education encourages understanding *"what processes comprise the food system, the problems inherent to it, and emerging sustainable alternatives"* (Meek and Tarlau, 2016, p.237). Food system education is a rapidly expanding area of pedagogy, scholarship, and curricular offerings. The food system can be a window of opportunity for education, as it connects overlapping justice,

citizenship, health and environmental science (Harper et al., 2017). Learning how food gets to our table represents an opportunity to learn about what structures prevented fair wages and labour conditions. Education about the food system means *"we can begin to overcome passivity, and the uncritical and dependent consumerism that characterizes our society's relationship with food"* (Rojas et al., 2011, p.766). Meek and Tarlau (2016) described three main directions of food system education (1) university-level courses, (2) activist-based education, and (3) de-politicized initiatives.

(1) University-level courses

Pérez-López et al. (2020) found that in higher education, the learning garden resulted in greater awareness of the environmental impact of agriculture. Even though food systems are inherently complex and interdisciplinary, Valley et al. (2018) described that university-level courses train future professionals in narrow disciplines such as food sciences, animal biology, nutrition, plant science and agronomy. Hence, they are often ill-prepared to face issues outside of their specialization and deal with complexities in the food system (Valley et al., 2018). To overcome the shortcomings of current food system courses in higher education, Valley et al. (2018) identified six themes in a thematic analysis of learning outcomes and guiding principles in four university programs on food systems. These are systems thinking, collective action, experiential learning, communication and collaboration skills, interdisciplinary and critical reflection, and research skills. On a similar note, Hilimire (2014) described that for building a food system curriculum, early exposure to the food system, case study learning, experience-based learning, and cooperative group learning is effective.

Galt et al. (2013) described in their phenomenological case study how food system education in an interdisciplinary undergraduate course at a land-grant college of agriculture applies student-centred inquiries. The course combines lectures, field trips, readings and the student's research. Students' engagement with course texts such as *Fast Food Nation* by Schlosser (2002) or field trips to food co-ops led to their engagement with the commodity fetish and tensions between their values and the realities of the food system. As Galt et al. (2013) described, writing a food diary can act as an inquiry into consumption related to the food system and its socio-economic and environmental repercussions. The researchers identified three routes of action among the students: (1) becoming "responsible eaters" by changing their food consumption, (2) bringing good food to others and (3) promoting and organising structural change (Galt et al., 2013). Guthman (2008) argued that adjusting dietary choices to eat more sustainably by, i.e. opting out of the capitalist food system, leads to devolving the responsibilities of the political and market mechanism.

On the contrary, the third route of action emphasised the importance of the politics behind the food system. Carter, Prado-Meza and Soulis (2016) described how programs in sustainable agriculture are governed by the hegemony of dominant agricultural systems and leave out questions of the injustice of the food system. For instance, concerning eating healthy, circumstances such as lack of money, lack of time, lack of transportation, lack of accessible shops etc. constrain the ability to choose nutritious food.

(2) Activist-based education

Activist-based education revolves around the terms of food justice and food sovereignty. Among food justice institutions Holt-Gimenez and Shattuck (2011) named alternative fair trade and slow food movements as well as the community food security movement. Among food sovereignty, they call Via Campesina and the international planning committee on food sovereignty. Meek et al. (2019) highlighted that their educational efforts range across various educational levels, from formal degree programs to political leadership training. Concerning activist-based food systems education, grassroots food justice organizations made a significant contribution *"such as their focus on experiential learning, agroecology, interdisciplinary curriculum, and politics"* (Meek and Tarlau, 2016, p.254). A critical element, particularly of the social movements in Latin America, is critical analysis and

reflection. For example, the deconstruction of media messages for food has been described by Meek et al. (2019). Food justice organizations educate local communities about food systems as part of their food justice campaigns through speaker series at organic farms, post-farmers markets workshops, courses on food sovereignty, or exchanges between different food justice organizations (Meek and Tarlau, 2016). Meek et al. (2019) argued that activist-based education relies on external funding and undermines more radical pedagogies. If philanthropic donors, the state or other actors that align with the dominant food system become involved, then transformative aims are sidelined or eroded (Sadegholvad et al., 2017).

(3) De-politicised initiatives

Sadegholvad et al. (2017) argued that some food system educational initiatives could be de-politicizing, apolitical or de-mobilizing when they do not strive to initiate social transformation and political consciousness. Farm-to-school initiatives connect schools with locally produced fruits and vegetables. Garden-based learning initiatives that focus on acquiring skills as an individual consumer are problematic, according to Sadegholvad et al. (2017). Meek and Tarlau (2016) emphasized the role of farm-to-school programs and garden-based learning throughout all educational levels. Those initiatives focus on the learner as an individual instead of a systemic analysis of political problems. Instead of radically breaking with the current food system, these initiatives often foster the food system by presenting superficial solutions for food security and health matters (Williams, 2018). Research on garden-based learning reflected this by delivering evidence of improved nutritional habits (Blair, 2009) and increased well-being and health (Dyment and Reid, 2005; Ozer, 2007; van Dijk-Wesselius et al., 2018). Critical scholars have debunked the underlying assumptions about sustainability, health, equity, and morality (Cairns, 2018).

2.3.7 Teacher education in learning gardens

Even though several studies engaged with the perspective of teacher students, there was no research on teacher educators' perspectives. Generally, studies such as Johnson (2012) indicated the relevance of learning gardens in teacher education programs. Johnson (2012) argued that if teachers are not trained in the learning garden, it will result in children planting beans yearly. From this argumentation, it could be concluded that the intention of teacher education is primarily to form knowledge and competencies concerning the cultivation of vegetables. The most relevant study to this thesis is the dissertation published by Hellinger (2021). His mixed-method study focused on German teacher students and their perception of the ESD-related learning potential in a learning garden. He argued that teacher students perceived opportunities of the learning garden for generating ESD-related competencies such as. Moreover, Hellinger (2021) found that teacher students rarely recognized the opportunities of global or intergenerational learning. It is described that teacher students rarely drew connections between the learning garden and the agricultural system (Hellinger, 2021).

McCarthy (2013) studied the REAL school garden program, setting up learning gardens in low-income areas. The program also provided teacher training to *"increase academic engagement among high-need students*" (McCarthy, 2013, p.1). The article described the overall interest of teachers in hands-on learning and how teachers in science, technology, engineering, and mathematics benefit most as they do not have the specialization for the learning garden. The article exemplifies the simplistic conceptualization of the learning garden as a "magic carrot" and lacks a critical perspective (Cairns, 2018). Furthermore, the author has stigmatized students in low-income areas by assuming that knowledge will contribute to healthy eating and thus masking the social justice aspects of food choices (Meek and Tarlau, 2016). Pérez-López et al. (2020) mixed method study explored the relationship between experiences in the learning garden and connectedness and conceptions of nature in teacher students. Specifically, the researchers studied the impact of organic gardens for teaching natural sciences at university on kindergarten teacher students. Overall, 74 kindergarten teacher students filled out questionnaires before and after the course related to their affected relationship with nature, pro-

environmental attitudes, and protective actions. The kindergarten teacher students were outside in the organic learning garden six times throughout the course (Pérez-López et al., 2020). The researchers found that kindergarten teacher students had a more cognitive than attitudinal or emotional relationship toward nature. They argued that a global, multidimensional and systemic conception of nature is necessary, especially for science educators.

Moreover, the conception that kindergarten teacher students had of nature was predominantly simplistic and has not been influenced by the me in the learning garden (Pérez-López et al., 2020). In Chiapas, Mexico, the LabVida program aims at scaling agroecology through existing structures of formal education to steer young people toward traditional agriculture and foodways (Ferguson et al., 2019). LabVida uses learning gardens to train teachers about local knowledge, respect for place and scientific thought (Ferguson et al., 2019). In their 120-hour continuing education program, they weave elements of food sovereignty, agroecology, and action research. A vital aspect of the program is integrating the school garden with various subjects within the official curriculum. The authors argued that the teachers and learning communities may become allies of the agroecological movement (Ferguson et al., 2019). Ostertag (2018) conducted arts-based research where she critiqued Eurocentric anthropocentrism in teacher education. She argued that the togetherness of plants, animals and nonhuman others, student teachers, the garden and teacher educators could be created through creative practices. Those non-anthropocentric encounters do not give space for demolition, domination and oppressive power (Ostertag, 2018).

3 Theoretical framework

3.1 Actor network theory

The actor network theory (ANT) first appeared in the 1980s. It is a toolkit of practices for addressing the complexities in the world (Fenwick and Edwards, 2010). ANT cannot be applied to a phenomenon but supports sensing and drawing the phenomenon. In particular, it enables tracing how things come together, act, hold together and become accepted. Providing a framework for this research, ANT examines human-nature relations by not privileging one over the other (Hipkiss, Windsor and Sanders, 2020).

Waltz (2006) claimed that non-human things are often treated merely as representative of a human end, obscuring the entity's quality in itself. Power (2010) described how gardens had been predominantly positioned as a passive object of human control that becomes ordered through gardening. Besides, Power (2010) argued that gardening entails an embodied engagement between non-human and human actors, creating a network. Pierce (2015) and Hipkiss, Windsor and Sanders (2020) applied ANT to the learning garden.

Pierce (2015) studied how knowledge of food and its link to bodies and communities can be developed through mapping genetically modified corn. Looking at the plant's origins and historical movement as well as now being a product in a highly complex food system. The perspective of food as an actor that can educate about the food system and draw connections to issues of food justice and food sovereignty is helpful concerning the objectives of this thesis. Hipkiss, Windsor and Sanders (2020) intended to reframe the school garden toward materiality and agency. ANT and social semiotics have been applied to analyse vignettes and photographs. In their study, ANT helped identify how a particular spatial arrangement facilitates or constrains a specific type of collaboration in a learning garden. The learning garden, where place and persons come together in the sense of ’throwntogetherness’ (Massey, 2005), facilitates imagination and inquiry (Hipkiss, Windsor and Sanders, 2020).

3.2 Critical food system education

Critical food system education (CFSE) aims to move beyond teaching about the food system by helping the students realise their potential to structurally transform it through collective action (Meek and Tarlau, 2015). Meek and Tarlau (2016) suggest that CFSE responds to the need to critique the global food system and link it to the movements to transform the system. Hence the ultimate goal of CFSE is a transformative change in the food system. The CFSE framework is theoretically grounded in critical pedagogy, food justice, agroecology and food sovereignty as cornerstones, as visible in Figure 1. That means CFSE is not a new theory, but it integrates the long history of social movements.

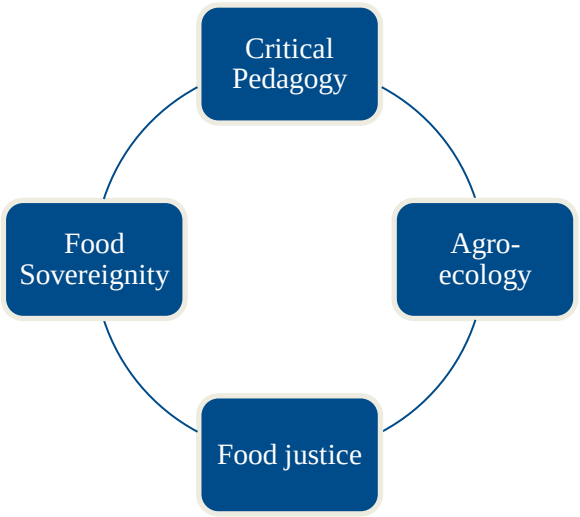

Figure 1: Four cornerstones of critical food systems education based on Meek and Tarlau (2016)

The first cornerstone of CFSE are the famous educational practices of social movements striving for social transformation. Movements such as the Brazilian Landless Workers' Movements, one of Latin America's most prominent social movements, have developed radical structures of food system education (Meek and Tarlau, 2015). In our class society, mental labour is privileged while manual labour is undervalued. The Brazilian Landless Workers' Movements oppose the view of "peasantry" as backwards and rejects the educational vision of producing "urban white modernity" (McCune and Sánchez, 2019; Meek and Tarlau, 2015). Critical pedagogy rests on the ideas of Paulo Freire (2002). For Freire (2002), education either actively maintains the status quo or tries to transform it. Meek and Tarlau (2016) highlighted the Freirean praxis as an essential move between learning and taking action. First, the reality of the local food system should be analysed, and then this should be linked with national and international structures that have constructed the local reality. Lastly, students should be helped to find solutions to reshape these realities. An avenue for this is participatory action research, where they apply what they learned to their rural communities.

The second cornerstone of CFSE is agroecology, which can be understood as the science of sustainable food systems (Meek and Tarlau, 2016; Moore, 2017). Agroecology comprises scientific inquiry, social movements and on-farm practices (Horner et al., 2021). Anderson, Maughan and Pimbert (2019) criticised the appropriation of agroecology by mainstream institutions reframed agroecology in the technocratic term. Agroecology highlights the importance of agroecological knowledge and its influence on agricultural practices and politics. Agroecology aims to strengthen the autonomy of food providers and emphasises farmers' knowledge (Anderson, Maughan and Pimbert, 2019).

Furthermore, it promotes an alternative economic and political model that counters the modern agricultural model. Agroecology is sometimes narrowly understood as focusing only on ecological and agronomic processes. The broader outlook of agroecology captures the entire agri-food system as a social-ecological system (López-García et al., 2019). Transformative agroecology is a critical concept integrating power, equity, agency and ecological renewal, put forward by authors such as Anderson and Anderson (2020) and Horner et al. (2021).

Another critical cornerstone is food justice. Food justice is a grassroots movement that connects food system issues with systemic race and class-based inequity. The food justice movement emerged in the 1960s and 1970s from the U.S. civil rights and environmental justice movements. Our food system often obscures violence, exploitation, poverty and profit. Meek and Tarlau (2015) criticized farm-to-school programs for centering primarily on white middle-class neighborhoods. They proposed that alternative food spaces and garden-based learning should be based on class and race dynamics and critically assess food access and individual choice.

The last cornerstone of CFSE is food sovereignty. Food sovereignty stresses that food systems need to be democratised. It means that those who produce, distribute and consume food have also control over food production and distribution (Meek and Tarlau, 2016). In that way, it challenges the dominance of NGOs, policymakers and scientists as the only protagonists in developing the food system. Food sovereignty is a global movement. Within CFSE, this cornerstone connects food system education to the more significant collective movements of food sovereignty.

Food systems are complex social-ecological systems marked by dynamic linkages between diverse topics such as justice, farm management, food consumption and federal policy (Hilimire et al., 2014). According to Meek and Tarlau (2016, p.241), CFSE has a threefold purpose: (1) theoretical framework, (2) pedagogies and pedagogical methods, and (3) a policy vision. CFSE highlights that food system education should not happen in a vacuum but within more extensive political and economic processes. CFSE was chosen because it offers a transformative perspective on how food system education could be taught in a critical way to the mainstream food system. Moreover, it doesn't leave out classism, racism and sexism questions. Instead, it understands changing the food system as part of the larger intersectional struggle of transforming class society, race relations and gender issues.

Even though there is no literature on the connection between ESD and CFSE, there are certain similarities. CFSE and ESD, how I came to understand them, both draw attention and try to challenge the dominant societal neoliberal narratives through collective action or real-world projects.

3.3 Garden-based learning

Garden-based learning (GBL) is a variant of place-based learning. It is commonly defined as an instructional strategy that uses the garden as a teaching tool. Desmond, Grieshop, and Subramanian (2004) warn that this definition may be too simplistic as it doesn't explain all the powerful elements of garden-based experiences. Narratives and pedagogies in the learning garden are based on outdoor and experiential learning (Gaylie, 2009). Ostertag (2015) described GBL as a highly Eurocentric pedagogical practice.

Gaylie (2009) established three metaphors for the learning garden in teacher education which are visualized in Figure 2. The garden as environment, garden as a community, and garden as transformation are explored throughout her book 'The Learning Garden: Ecology, Teaching, and Transformation'. The 'garden as environment' means that the learning garden is, at the same time, a physical space as it is an experiential learning process. Learning about responsible land management or ecological justice transforms the land and the learning (Gaylie, 2009). Gaylie (2009) described how

her students mindfully engage with the learning garden's surroundings and gradually understand the ecological damage caused by humans and that learning is an interactive process. Through the learning garden, Gaylie (2009) described how teacher students develop new perspectives on the role of themselves as teachers in the learning process.

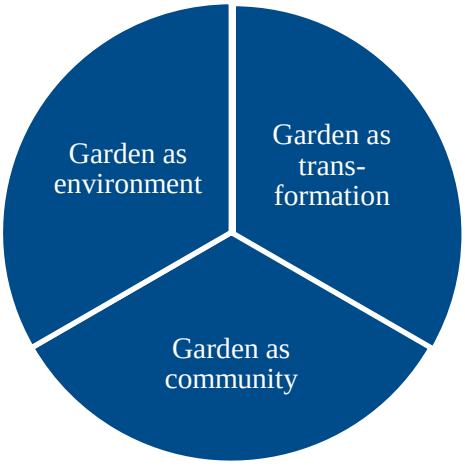

Figure 2: Three metaphors for garden-based learning based on Gaylie (2009)

According to Gaylie (2009), the ‘garden as community’ metaphor gives voice to the land and the community. It also means that the teacher students´ notions of teaching and learning are challenged as different actors than the teacher share their knowledge in the learning garden. The metaphor of the ‘garden as transformation’ acknowledged the change of the teacher students during the learning process. In becoming a teacher, the learning garden enables the teacher students to make new connections and shift their perspectives. These metaphors and GBL in teacher education require ”a certain slowness”, as proposed by Nielsen and Andersen (2010). Slowness is needed for teacher students to adapt to the new learning environment. Gaylie (2009, p.5) described the *“concept of slowness, simplicity and gratitude can become core principles of teaching and learning that bring depth, wonder and heart to teacher education”.*

4 Methodology

4.1 Case study

This research is based on a case study of a higher education programme for teacher students in Germany. The programme aims at teaching teacher students to establish and teach in a learning garden. A case study is defined as intensive research of a single unit to generalize the findings across a broader set of units (Gerring, 2004). The case study has generated in-depth results of different aspects regarding the teacher students and teacher educators that took part in this teacher training programme in 2022. As my main interest in conducting this research was to understand better the views and perspectives regarding garden-based learning and food system education of the participating teacher students and teacher educators, choosing a case study approach seemed the most appropriate. Since 2021 I have worked for a German non-governmental organization (NGO) that, in the past, has initiated different garden-based learning programmes for schools and pre-schools. From the idea of taking teacher education into focus, the NGO began with the first attempt in 2019. Back then, one university participated. Teacher education continuously expanded from three universities in 2021 to eleven universities in 2022. Every year a group of 15 to 25 teacher students learn how to establish a learning garden through on-site sessions with garden experts and additional sessions on the methodical didactic implementation with teacher educators. The case study focuses on the teacher education programme cycle that began in April 2022 and ended in July 2022.

The program is partly taught by a gardening expert trained by the NGO and partly by the teacher educators interviewed for this thesis. The gardening experts came to the garden nine times for 90 minutes, and each time, their lecture focused on a different topic, which correlated to the seasonal duties in the learning garden. The whole curriculum of the program and the learning outcomes for teacher students can be found in Appendix A. The curriculum shows that ecological sustainability is critical, as soil fertility or mulching is discussed. Besides, aspects related to the organization of a learning garden in the school and ESD are discussed. Including the curriculum in the Appendix is intended to give greater insight into what content is included in the programme and what specific learning outcomes are targeted. The insights of this case study could benefit the participating teacher educators and generally anyone interested in implementing garden-based learning in teacher education.

4.2 Mixed methods

Mixed method means collecting two independent forms of quantitative and qualitative data and connecting, integrating and linking them (Teddlie and Tashakkori, 2012). Even though there is an ongoing discussion about mixing the two paradigms, Teddlie and Tashakkori (2012) argued that the differences can lead to insightful tension. Hence, answering the research questions can be facilitated by mixed methods. Triangulation of different methods has enhanced the validity of this study.

The qualitative data was collected from teacher educators, and the quantitative data from the teacher students. A qualitative methodology was chosen as it can pay more attention to the authentic voices of the teacher educators and provides results that cannot be expressed in numbers (Lewis-Beck, Bryman and Liao, 2004). Qualitative research is applicable as teacher educators' perceptions of CSFE and GBL represent an under-researched field. Generally, priority was given to the qualitative data. In this research, the quantitative methodology helped to integrate the perspectives of the larger group of teacher students. The study was sequentially designed. The teacher educators' qualitative data were analysed and compared to teacher students' qualitative and quantitative findings. Hence, the quantitative data analysis was dependent on the qualitative data. Qualitative and quantitative data were integrated to determine whether qualitative and quantitative data would yield convergent results. The two different data collection instruments related to teacher educators found that in the interviews,

certain learning outcomes were described that were not present in the follow-up online survey. Triangulation was also helpful related to the two different target groups. Even though in the results section qualitative and quantitative data were presented separately as they were related to two target groups, certain commonalities were pointed out in particular in the section on teacher students. In the discussion section, the data is triangulated to a greater extent due to the nature of the research question. This was particularly necessary for answering research questions related to the commonalities of teacher educators' and teacher students' views of teaching in the learning garden.

In this research, mixed methods have been applied as qualitative and quantitative methods were appropriate for generating new insights. An advantage of applying mixed methodology was triangulation. Triangulation is defined by Cohen and Manion (2000, p.254) as an *"attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint"*. In this thesis the use of different target groups and data sources enabled finding commonalities and differences or even a deepened understanding of the case at hand. A drawback of the chosen mixed methods was the time investment necessary to analyse and compare a large amount of data.

4.3 Thesis length

The chosen research questions and methodology resulted in a large quantity of data. Due to this, the thesis length is in line with the guidelines for a degree project for the Masters in Education and Sustainability. The comprehensiveness of the data and length of the thesis match the studied phenomenon's complexity. Through a detailed analysis of the data, the research questions could be adequately investigated, thus enhancing the depth of the insights for an understudied research field.

4.4 Sampling

Two target groups were included in this research. Teacher educators have an essential role. They are considered to have experience with ESD and learning gardens. Teacher students' views were also essential, as they are not only the recipients of teacher educators' educational activities in the learning garden but also shape the future learning of many learners.

Eight teacher educators and 81 teacher students participated in this study. The eight teacher educators taught at five different universities. All teacher educators were purposefully selected, as only those who also participated in the teacher education programme were admitted to participate. For the teacher educators, specific criteria determined their inclusion in the study. They needed to teach teacher students in higher education institutions, implement a learning garden into their teaching, and have an academic background in education studies or an environmental-oriented field. These criteria were chosen to ensure that participants have the necessary experience to help answer the research questions. For a qualitative study, there are no rules for the sample size, as it largely depends on the purpose of the inquiry and the available time and resources (Lewis-Beck, Bryman and Liao, 2004). Since this study explores teacher educators' perceptions, a sample of eight seems feasible, valuable and credible. A questionnaire was sent to all participating students at the five universities. In total, the online survey was sent to 116 teacher students. Eighty-one responses were returned, which equals a response rate of 69,8%. Even though sampling errors would be reduced through a larger sample of teacher students, it is deemed sufficient for this research as valuable insights can be generated from this sample size.

4.5 Instruments

Two instruments were chosen for the data collection: semi-structured interviews and online surveys. The instruments were chosen based on a constructivist approach, as the primary objective was to understand participants' views.

The online survey with teacher students can be accessed in Appendix B. The interview guide for the semi-structured interviews with teacher educators can be found in Appendix C, and the online survey for teacher educators in Appendix D.

Interviews	Online surveys
•with teacher educators •semi-structured •audio recorded and transcribed	•with teacher educators and teacher students •mix of close-ended and open-ended question

Figure 3: Data collection instruments

(1) Semi-structured interviews

Semi-structured interviews (Appendix C) were conducted with teacher educators. The semi-structured interviews explored their views on GBL, ESD and CFSE. A semi-structured interview helps to obtain information from the interviewee efficiently (Lewis-Beck, Bryman and Liao, 2004). Semi-structured interviews were chosen because they allow follow-up questions to be asked and remain open to the unknown (Lewis-Beck, Bryman and Liao, 2004). In the concrete design of the interview guide, the questions were intentionally broad to ensure not to direct participants' responses unnecessarily. In developing the interview guide, the distinct cornerstones of CFSE, such as food sovereignty and justice issues related to the food system, could be probed. In the first part of the interview, teacher educators were asked for essential demographic information, namely gender, age, and years of teaching experience.

Participants answered questions related to GBL and CFSE. It was relevant to determine their understanding of the concepts and their relevance to their teaching practice. Questions evolved around the successes and challenges they experienced embedding GBL and CFSE in their teaching. Teacher educators needed to understand the questions of the interview guide. Therefore, its validity, precision, and reliability were tested. The internal validity was checked by discussing the interview guide with two colleagues with different backgrounds and expertise. One colleague worked for the studied programme and therefore had a lot of experience with garden-based teacher education. Another colleague worked for the impact assessment at the NGO. A joint briefing among the two colleagues ensured that they understood the purpose of the thesis. To check external validity and ensure respondents understood the questions in an intended way and answered thoughtfully, the interview guide was reviewed by teacher educators who were not participating in the study.

(2) Online survey

Teacher educators received an online survey (Appendix B) to obtain more detailed information regarding two main aspects. Firstly, it was relevant to deepen insights into their understanding of competencies, values, and knowledge in the context of the learning garden. The competencies, values and knowledge they would like teacher students to obtain were the second relevant aspect of the online survey. As Saleh and Bista (2017) described, the use of online surveys has been growing in educational research. The online survey format allowed me to easily access the answers standardised and straightforwardly. The questionnaire was composed of nine questions, a mix of one close-ended and eight open-ended questions. The open-ended questions offered more profound insights into teacher educators' perceptions. The close-ended question helped to understand how teacher educators rated the importance for the teacher students to be encouraged to consume food sustainably through the learning garden. The questionnaire was composed in Microsoft Teams and sent to the teacher educators via E-mail.

3) Online survey

One online survey (Appendix D) was sent to the teacher students before participating in garden-based learning for the first time in their studies. Besides providing data for this master's thesis, the survey was also intended to provide data for the development and evaluation of the teacher education programme. The entire online survey was composed of 27 questions but only 18 questions were useful for this research. An online survey was chosen as the suitable instrument for data collection among teacher students as they can be distributed to many people (Saleh and Bista, 2017). As for the teacher educators, the main aim of this online survey was to develop an understanding of the perspectives of teacher students regarding GBL, ESD and CFSE. On the other hand, it allowed a comparison of the teacher students and the teacher educators' answers. It is relevant for this thesis to determine whether the teacher students and the teacher educators' answers corresponded in specific ways or find areas of deviation.

The survey was structured into four sections: (A) environmental attitudes, (B) expectations for their participation, (C) previous experiences related to gardening and teaching in a learning garden, and (D) demographic information. In section D, demographic information was obtained related to the university they studied at, the specific course they were enrolled in, the year of their expected graduation, and their gender and age. The survey was composed of 22 open-ended and 15 close-ended questions. Some open-ended questions were similar to the interviews with the teacher educators. For instance, both were asked, ‘How do you understand a learning garden?’.

4.6 Data collection

The qualitative and quantitative data were collected from March until June 2022. The first data that was collected was the interviews. At the beginning of March 2022, potential teacher educators were contacted to participate in this study. Subsequently, the interviews were conducted via Microsoft Teams Calls, ensuring that the interviewees gave their consent and could withdraw at any time. The second data collection was started at the end of March 2022. The Microsoft Forms questionnaire was sent to the teacher students to discover their views before participating in the teacher education programme. The teacher students had four weeks to submit their answers. Teacher educators received a Microsoft Forms questionnaire in mid-May and the teacher educators had three weeks to submit their answers.

4.7 Data analysis

The qualitative data of the interviews were analysed using qualitative content analysis (QCA) in ATLASTi. The qualitative data of the online survey were analysed with thematic analysis in Microsoft Excel. The quantitative data of the online survey with teacher students were analysed with the help of the Microsoft Forms analytics tool and simple statistical tools such as calculating the mean.

The interviews with teacher educators were audiotaped and transcribed. By analysing each interview directly, the following data collection was influenced. For instance, the theme of regionality and seasonality emerged as shaping teacher educators' understanding of a sustainable food system. In the following interviews, particular attention was paid to whether these aspects were included, and if not, a follow-up question related to regionality and seasonality was posed. Using the qualitative research tool ATLASTi the data was coded by reading the interview transcripts multiple times. The QCA developed by Mayring (2015) was applied in this research to dissect subjective interpretation of the content. Therefore, a systematic process of classifying the data into codes, themes and patterns is recommended by authors such as Hsieh and Shannon (2005) or Gläser-Zikuda, Hagenauer and Stephan (2020). An essential element of QCA is the development and application of categories, which can be deductive and inductive (Gläser-Zikuda, Hagenauer and Stephan, 2020).

For analysing the qualitative data of this study (interviews with teacher educators and questionnaires with teacher students), a combination of inductive and deductive category development was applied as it takes advantage of the strengths of both. The first step involved deductive category development, where the theoretical background was used to develop categories for the analysis. For instance, deductive codes such as ‘food sovereignity’ or ‘sustainable food system’ were used to analyse the data. In the second step, inductive categories not addressed in the theories were created. The codes were descriptive and mostly consisted of single words that encapsulated the general idea. While in the beginning, the codes were very general, i.e., ‘teaching in the learning garden’, they became more specific throughout the process.

The answers related to each question were read separately and screened for common themes and red threads. When categories were identified, the data was reread and reviewed for correspondence to the categories. The analysis of teacher students' data was intended not to be biased by the interviews with teacher educators. Deductive coding meant focusing on answering the research questions, while inductive coding enabled thoroughly dissecting different aspects that were included in the analysis. Regarding the qualitative data of the questionnaire with teacher students, Microsoft Forms was used as it offered word clouds to all the open-ended questions. This was helpful due to the large amount of data.

For analysing the quantitative data, the Microsoft Forms analysis tool helped uncover statistically significant data for different questions. The use of statistical tools such as SPSS was refrained from due to the time-consuming analysis of the amount of data. Excel was used for the analysis of the collected quantitative data. Each question was analysed in a separate Excel sheet and the filter function helped to filter the data for different criteria. Furthermore, the average for a question or specific groups was easily calculated.

4.8 Ethical considerations

Ethics were essential throughout every stage of this study. Already in the selection of the research topic for this study, ethical considerations were relevant. As Guthman (2008) proposed, the food system and the learning garden are connected to ethical issues such as inequalities, injustice, and power. In the beginning, it was central to consider all the different ethically complex situations that the research process might involve to be prepared and able to react to them adequately.

This research follows the rules and regulations of ethical research at the university and therefore complies with the Data Protection Act and the guidelines issued by the Swedish Research Council. The ethical review is regulated in the Act (2003: 460) on ethical review of research concerning individuals.

This research adheres to the rules of ethical research practices by the University of Gothenburg. Therefore, the Swedish Research Council guidelines and the Data Protection Act were essential to follow. Since the research is geographically located in Germany, this research complies ‘The European Code of Conduct for Research Integrity’ (ALLEA, 2017). The participating teacher educators were informed about the research objectives, the data collection, and the documentation process and that their names and university were kept confidential (Lewis-Beck, Bryman and Liao, 2004). In the online surveys with teacher educators, their names were asked to relate the findings to the previously collected data. All teacher educators gave verbal consent. Written consent (Appendix E) was aimed at collecting from the interviewed teacher educators, but due to time limitations, it wasn’t fully achieved. In upcoming research, the researcher seeks to receive written consent during data collection. One exception from anonymity was made due to a special request by the interviewed teacher educators.

Nevertheless, the researcher is aware that this violates the followed ethical guidelines. In this thesis, the case of University Bonn is presented, where the teacher educators are named as this could benefit the awareness of the potential of learning gardens in teacher education. Other teacher educators might become motivated to contact them and become more familiar with their learning garden. The interviews were conducted via an online video conference tool. Thus, the participants were in a familiar environment for the interview and might feel more comfortable. The teacher educators' data were collected during the semester break, hence a time of the year when the teacher educators had less stress. Nevertheless, the online survey was sent during the semester, where two teacher educators reported being stressed and having little time to participate in the study.

Another vital ethical consideration was power dynamics related to the different positions of the teacher educators and me. For instance, the roles of the teacher educators in the university could influence the results. Concerning this, Reunamo and Pipere (2011) emphasized the element of agency influencing the ethical position of ESD researchers. Hence, they argue for maintaining a balance between the possibilities of environmental change and scientific rigour and validity prerequisites. Amundsen and Msoroka (2019) describe how teacher educators struggle between finding solutions for students and meeting government regulations and standards. Hence, it was essential to both open preconceived notions and integrate multiple perspectives during the data analysis.

4.9 Positionality statement

An essential component of how this thesis came to be is my personal story and perspective. While writing my thesis, I was working part-time on the project which I was researching for this master thesis. Since 2021 I have participated in the garden learning activities, evaluated the programme, and reworked the curriculum. Since teacher educators are like a “black box” for me, I thought that the most outstanding value would stem from bringing insights into their perspectives. My exposure to critical theory and political economy inspired me to challenge garden-based learning. By studying for the Master's in Education for Sustainable Development at the University of Gothenburg, I became interested in political issues within garden-based education. I’m driven by the vision of a *”world where how our food system works is common knowledge, instead of only in the hands of corporate executives.”* (Koch, 2016, p.55). Upholding the status quo in the food system through learning with plants is not what ESD means to me. Still, I must be aware of the potential influence this might have on the research outcome.

4.10 Limitations

The design of this research has several limitations. This case study research has been limited to Germany. Hence, it could be argued that no universal conclusions could be drawn (Yin, 2018). On the other hand, the interest in generalizing the results may be questioned as Yin (2018) saw the potential of case studies to expand and generalize the theories. A second limitation concerning case studies was lying in constructing validity and generalization. Using mixed methods, validity can be strengthened by different data sources and data triangulation (Preissle et al., 2015). Mixed method studies can be more complex and require more resources and expertise than using only a single method (Teddlie and Tashakkori, 2012). This study generated a large volume of data. Challenges were encountered in analyzing and disseminating this large quantity of data. Concerning the sampling of teacher educators, one limitation was the homogeneity of this target group, as 62,5% of the interviewees were teacher educators in biology didactics. This homogeneity could have potentially distorted the results.

Moreover, it is possible that those teacher educators who regard themselves as a good example may have participated in the study, which would affect the study's representativeness. The study also was restricted by the limited number of interviewed teacher educators and in the selection of teacher educators, addressing only experienced teacher educators. The online survey for teacher students was 27 long, which might have resulted in less accountability among the respondents. Moreover, the

teacher students and teacher educators understanding of the questions could not be clarified or checked. For example, in the case of the online survey for the teacher educators, one teacher educator answered, *"I don't understand this question".* Luckily this was not found in other answers by the teacher educators. Still, it was much easier for them to ask clarifying questions back in the personal interview conducted beforehand. The high number of answers in the online survey administered to teacher students ensured that the results represented the entire population.

5 Results

Setting the scene

The teacher educators participated in a programme where they were supported in setting up and teaching teacher students in a learning garden. The programme is open to students from different teacher education degree programmes and is mainly integrated as an elective module within teacher training. The programme is based on weekly sessions of 90-minutes on-site in the learning garden. While the teacher educators teach the future educators, they are supported by a gardening experts, who is particularly responsible for teaching the programme's curriculum. The curriculum consists of nine workshops which are described in detail in Appendix A. The session's content focuses on a particular topic or skill and ranges from biodiversity in the learning garden to planting techniques or care techniques for gardening. The format is open, where the participants can ask questions about substantial horticultural knowledge. The rest of the teaching in the learning garden during the spring semester is covered by teacher educators.

Structure of the results section

The results section is separated according to the two target groups of teacher educators and teacher students. First the results of the interviews and the questionnaire with teacher educators is presented. Second the data from the questionnaire with the teacher students is discussed.

In the beginning, after introducing some vital characteristics of the respondents, the teacher educators´ motivation for teaching in a learning garden is described. This is followed by an analysis of the teacher educators´ perceptions of the learning garden and the challenges and facilitating factors that teacher educators encountered in setting up a learning garden. Afterwards, learning outcomes, perceptions of ESD and around teaching ESD in the learning garden are described. The following chapters of the analysis of teacher educators focused on their understanding of a sustainable food system and food system education in the learning garden. First, their perceptions of a sustainable food system are analysed, followed by their ideas around sustainable food consumption in learning garden and food system education in the learning garden. In the last chapter, the learning garden at University Bonn and other universities is analysed.

The results of the questionnaires with teacher students are presented in the second part of this section. Introducing the respondent's profile is followed by the teacher students' perceptions of the learning garden and their expectations for participating in the module. Afterwards, data related to teacher students' perceptions of teaching in the learning garden and competencies that learners could develop in the learning garden is presented. Lastly, the results related to education for sustainable food consumption in the learning garden will provide insights into teacher students' understanding of food system education in the learning garden.

5.1 Teacher educators

5.1.1 Respondent's profile

Table 1: Overview of interviewed teacher educators

Teacher educator	University	Gender	Workplace within the university	The cycle of participation in the programme	Previous experience with learning gardens
Respondent 1	University A	Female	Institute of vocational education	Second Year	Planned a learning garden (school-context), taught in the learning garden for several years (teacher education programme)
Respondent 2	University B	Female	Institute of biology didactics	Second Year	None
Respondent 3	University C	Female	Institute of biology didactics	First Year	Taught seminars in the learning garden for four years (teacher education programme)
Respondent 4	University D	Female	Institute of biology didactics	First Year	Researched and taught in the learning garden for four years (school context),
Respondent 5	University D	Male	Institute of biology didactics	First Year	Focused on outdoor learning environments but not specifically on the learning garden (school context),
Respondent 6	University D	Female	Institute of biology didactics	First Year	Researched and taught in learning gardens for 20 years and with teacher students for five years
Respondent 7	University E	Male	Institute of primary school didactics	Second Year	Taught for four years in the learning garden in teacher education, researched about the learning garden for three years
Respondent 8	University A	Female	Institute of vocational education	Second Year	Taught in learning garden (school-context), conducted a seminar in a learning garden (raised plant beds) for several years (teacher education programme)

Table 1 shows that the interviewed teacher educators worked at different teacher education institutes. Five worked at the Institute of biology didactics, two at the Institute of vocational education (Institut für Berufliche Bildung und Arbeitslehre) and one at the Institute of primary school didactics. The teacher educators were selected for the study as they were involved in planning a module for teacher students that was set in a learning garden. Moreover, they had experience teaching in a learning garden, including raised planting beds. The learning gardens were already integrated into three teacher education programmes (University A, University B, and University E) in the previous year.

5.1.2 Motivation

The teacher educators expressed many factors that motivated them to teach in a learning garden which could be summarized as five motivational factors divided into three relational categories. The motivational factors and relational categories can be found in Table 2. On a personal level, both enjoyment of gardening and teaching possibilities are motivational factors directly related to teacher educators. On the level of the learner, which in this case refers to the teacher students, teacher educators were motivated by specific learning outcomes and by disrupting preconceived notions of teaching. In sum, the motivational factors highlighted that teacher educators were encouraged by the possible effects of teaching in a learning garden. The learning gardens' contribution to societal

challenges was acknowledged on the level of society. Teacher educators mentioned that the societal challenge that fewer and fewer people knew where their food came from was a motivator for them teaching in the learning garden. The motivational factors range from specific outcomes to more abstract and global problems.

Table 2: Five motivators for initiating a learning garden in the teacher education programme

Personal level	*Learner level*	*Society level*
1) Enjoyment of gardening	**3) Learning outcomes**	**5) Lost connection to food**
In the interviews, gardening is seen as a joyful hobby, where the respondents can get actively involved, try out and learn new things. The learning garden means an opportunity to be outside and relax.	After participating in the programme, teacher educators wish the teacher students could teach in the learning garden. Other earning outcomes were related to the curriculum.	Societal challenges refer to the many environmental and societal issues. The learning garden represented a potential solution to many pressing societal challenges, especially the distance of children from nature.
2) Possibilities for teaching	**4) Disrupting preconceived norms of education**	
Teacher educators are motivated by the different learning environments' educational opportunities. They value the possibility of teaching teacher students essential concepts, especially from an interdisciplinary point of view.	Critique of educational norms was expressed, and the learning garden represented opportunities for disrupting them. They were explicitly linked to the changing role of the teacher educator in the learning garden.	

(1) Enjoyment of gardening

Teacher educators were motivated to teach in the garden because they enjoy gardening. The coding yielded keywords such as 'gardening as a hobby', 'success stories' or 'emotion'. Descriptions of the activities in the garden with emotional and expressive language, such as the *"joy of harvesting"* (Respondent 1) or figurative language, such as *"making hands dirty"* (Respondent 5), further underlined their appreciation for gardening. Spending time in nature also represented a shift from the daily work routine of teacher educators, as it created *"a nice balance to the many hours in front of the computer"* (Respondent 3). Throughout the interview, most teacher educators mentioned some effects gardening has on them. For instance, Respondent 5 described to *"notice what it does to you on a psychological level. On your own physical level."* The different personal effects and sensations of being outside in the learning garden have been described as making them feel better or more balanced. For instance, Respondent 7 explained, "*I am outside, and I am balanced […] so a certain physical resonance aspect is in there. It feels good to have gardened".* In sum, teacher educators are motivated by teaching in the learning garden because it enables them to connect their hobby to their profession. This motivational factor which could be interpreted as only having a personal benefit for teacher educators was seen as slightly critical by Respondent 5, who stated having *"a completely egoistic goal".*

(2) Possibilities for teaching

The second motivating factor for teacher educators was the myriad educational opportunities of the learning garden. First and foremost, this is related to the significance of the learning garden for teaching their own subject and the teaching within the specific teacher education programme. For example, Respondent 6 described that she was *"dealing with the question of how to teach biology, […] in the area of teacher training"*. It can be assumed that teacher educators are particularly concerned with didactics in their educational practice. Therefore, they might have acknowledged the educational potential for teaching their subject. For example, Respondent 7 acknowledged that *"only the classroom is too boring".* Other teacher educators have highlighted the opportunities coming with the change of scenery as the learning garden is an outdoor learning environment. The code 'diversity of themes' reflects how various teacher educators saw the opportunities in the learning garden to create references to many relevant topics for the teacher students. Respondent 3 described that the learning garden offers a modular system. The modular design is based on the conditions of the learning garden and the goal that teacher educators have. The learning garden has the tools for teaching.

(3) Learning outcomes

The third motivational factor was the learning outcomes teacher educators envision for the teacher students. It was found that learning outcomes differed among teacher educators as they were tied to the learning outcomes in the teacher programme and the teacher training curriculum. For example, the teacher educators teaching at the Institute of biology didactics emphasized learning outcomes related to understanding the cycles of nature. Moreover, the learning garden enabled a *"connection of theoretical knowledge about the food system and can fill the theory with life"* (Respondent 1). A typical learning outcome among most teacher educators was that students should recognize the opportunities for teaching in the learning garden and learn to teach in the learning garden. In contrast, Respondent 5 pointed out that learning outcomes are up for debate as he *"can't make sure that they all eat sustainably afterwards"* but instead hoped that the learning garden gives teacher students a possibility to *"play around, and then we'll see what happens".* This general openness regarding the learning outcomes has been present in several interviews, which is picked up in the next motivational factor.

(4) Disrupting preconceived norms of education

At various points in the interview, the teacher educators express criticism of the educational norms within the school system to which the learning garden can present a counterpart. For instance, Respondent 1 describes that teaching tends to usually be very abstract and detached from reality, where the teacher stands in front of the class and holds a lecture on a topic. Interdisciplinary teaching has no tradition in schools. According to Respondent 8,*"in the past, was a lot of thinking within the boundaries of a subject"*. In contrast, the learning garden offered *"a different kind of learning"* (Respondent 7) that can provide real-life experiences and holistic learning. In the learning garden, teacher students can learn with their heads, hands and hearts, which is essential for them to raise questions around the standardized classroom learning setting, where in the learning, the mind captures the centre. Among a few teacher educators, a predominant motivation was a different relationship between teachers and learners. Respondent 7 summarized that the learning garden *"is not the classroom and the teacher is standing in front of it, but suddenly we are outside, but also manages not to reproduce this learning setting".* Representing a break from the usual form of instruction, respondent 7 highlighted the potential threat for teacher students to reproduce the same kind of frontal learning to which they are used. Hence, the changed role of the teacher in the learning garden is disrupting the educational norms, particularly the omnipresent frontal instruction.

(5) Lost connection to food

For most teacher educators, the fifth motivator was the societal challenge of the lost connection between humans, the natural environment, and food. They were personally concerned about the repercussions of this "lost connection". Respondent 5 captured his understanding of the problem as follows:

"That is what has been lost, that people no longer see themselves as part of nature, but as a cultural product. Students should realize that we are totally dependent on these cycles. Otherwise, it's finito."

Specifically, Respondents 1 and 8 lamented that children had lost the connection to nature and food. This motivator was exceptionally high when linked to a concrete experience. Respondent 8 referred to her experience of a child announcing that purple carrots must be poisonous and how this incident reminded her how children nowadays are only familiar with food from the supermarket and have no idea of the variety of fruits and vegetables that exist. In this light, the learning garden was seen to strengthen children's connection to nature.

5.1.3 Metaphoric perceptions of the learning garden

From the analysis of the teacher educators' perceptions about the learning garden, three central metaphors emerged. While the learning garden signified an island of hope, it represented a living lab of sustainability or even a playground for some. From these metaphors, it can be assumed that the learning garden is perceived chiefly positively. The metaphors can also help to conclude different aspects that teacher educators appreciate about the learning garden.

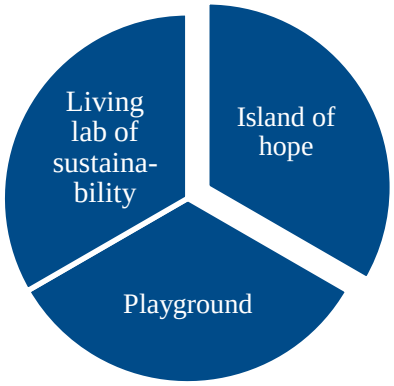

Figure 4: Three metaphoric perceptions of the learning garden by teacher educators

(1) Island of hope

Considering the global crisis and the often-felt inability to make a difference, the cultivation of plants in the learning garden can lead to the cultivation of hope by creating a positive self-image and a positive vision of the future. Being active and doing something with your own hands in the learning garden can help the teacher students and teacher educators alike to only focus on the present task and regulate feelings such as climate anxiety.

The learning garden can be a *"window of opportunity",* as Respondent 1 described it, where students could *"fade out horror scenarios and problems and remain capable of acting on a small scale".* The learning garden is an island of hope because *"numerous boats […] sail to the outside and connect."* This statement highlights how the learning garden can connect different initiatives, people or projects around similar ideas. As described by Respondent 1, this can bring hope. This idea of connecting people is picked up by Respondent 5, who clarified that the learning garden is an island of hope

because it shows different opportunities for becoming involved and being *"surrounded by people who have committed themselves to such an idea".*

(2) Living lab of sustainability

The analysis showed that the teacher educators viewed the learning garden as a living lab of sustainability for three groups. For the first group, the teacher educators, the learning garden represented not only a place for educating about sustainability but a place for personally practising sustainability, experimenting with organic farming and living more aligned with nature. Hence, the learning garden is understood as a place where they are not primarily teaching but also broadening their horizon and apprehending something new. By experimenting with a more sustainable form of living, the experience in the learning garden has repercussions on a very personal level. Secondly, for the group of teacher students, the teacher educators appreciated that the learning garden is a living ecosystem that the teacher students can use as a *"teaching tool"* (Respondent 8). Thirdly, the living lab of sustainability influences the larger community, such as students, lecturers, and staff within the university, but in particular, the schools. It was argued that teacher students could create living labs of sustainability in their future workplaces. Respondent 8 brought attention to the ripple effects of the living lab of sustainability by arguing that the learning garden can create a culture of sustainability if integrated into an educational institution.

(3) Playground

The third metaphor of the learning garden was that of a playground. Especially this metaphor has been surprising considering that the learning garden is situated within a formal university context. This metaphor represents a profound transformation, which can be challenging for teacher educators and teacher students. Respondent 7 saw the whole learning garden as creating a disorienting dilemma, which can lead to overall disconcertion based on the transformational learning theory as presented by Mezirow (2000). The openness in learning outcomes is reflected in the perspectives of Respondent 5, who intended to create *"a way for them to play around, and then we'll see what comes of it."*. The playground also represents a place of fun and experimentation, where the outcome isn't fixed, and knowledge can be co-developed.

Furthermore, in a playground, *"a different kind of encounter is possible"* (Respondent 7). In line with the playground metaphor, Respondent 2 described the learning garden as a space of non-consumption leisure, where you could relax, sit around and not be productive. Respondent 2 acknowledged that *"the learning garden questions the whole system."*

5.1.4 Challenges and facilitating factors

Teacher educators encountered various challenges and facilitating factors concerning the three stages: 1) setting up a learning garden, 2) initiating a teacher education program in the learning garden and 3) teaching in a learning garden. Table 3 offers an overview of what teacher educators encountered.

Table 3: Challenges and facilitating factors for teacher educators in the learning garden

Challenges	***Facilitating factors***
1) setting up and maintaining a learning garden	
• lacking support from university administration and colleagues • finding arable land and funding	• universities profile and strategy • specific teacher education programmes like biology • teacher educators' position within the university and connections to university administration • previous experiences and practical knowledge of teacher educators (i.e. applying for funds) • institutions within the university and beyond (i.e. green office, community-supported agriculture in the region)
2) initiating teacher education program in the learning garden	
• the novelty of learning garden (i.e. fit to academic requirements of a module examination)	• the specific degree or research profile of the teacher education programme matches the learning garden
3) teaching in a learning garden	
• lacking motivation from students in maintaining the learning garden during the semester break • the short duration of the semester • include their own (critical) perspectives and personal opinions • need to subordinate themselves concerning cooperation with the NGO	• support with teaching materials, the structure of the seminar, teaching, and expertise in horticulture concerning the cooperation with the NGO • integration of the learning garden into the everyday university life
4) in all three stages	
• high time expenditure (i.e. convincing authorities, teaching, applying for funds)	

(1) Setting up and maintaining a learning garden

In the most examined cases, the learning garden has not been structurally anchored yet, so the teacher educators had to overcome many hurdles in the initial stages. The analysis revealed two main interrelated challenges. The first challenge was related to the lack of support from the university administration and colleagues in setting up and maintaining a learning garden. The process of persuading multiple decision makers of the learning garden had been described as tedious and discouraging.

"You can't just set up a learning garden anywhere, not even on the university grounds. Everyone would be going crazy. There are 1000 different departments – the building department and the green maintenance department- and they all have a say, and it's not easy to fight your way through the bureaucratic jungle." (Respondent 5)

The data made clear that the lack of support from the side of the university administration was interrelated with the challenge of finding arable land and financial means for the learning garden. Obtaining sufficient financing to meet the expenditures for setting up the learning garden is another challenge for 37.5% of teacher educators. For instance, Respondent 7 stated that his funding application had been rejected. The headwind resulted in some teacher educators becoming demotivated. Teacher educators have described a further challenge related to funding in terms of maintaining the garden and lamented the learning garden's potential temporality. The lack of support from colleagues exacerbates the chances of keeping the learning garden. Similarly, Respondent 3 described, *"There is no one in our faculty who would immediately take over the project from me. It would be a challenge to find support among my colleagues."*

The analysis showed several facilitating factors concerning setting up and maintaining a learning garden. The strategic orientation and profile of the university are a prerequisite for acquiring support among the decision makers and ensuring a long-term commitment to the learning garden. For instance, at University A, sustainability has been anchored in the key objectives, facilitating the learning garden. 62.5% of the interviewed teacher educators were teacher educators in biology didactics. Hence, it could be argued that this group is much more likely to integrate a learning garden into the teacher training programs. In teacher training in subjects such as biology, the teacher students will be able to teach the content of their subjects in the learning garden.

Moreover, the position and connections of the teacher educator who initiates the learning garden are essential. For instance, one teacher educator was at the same time a prorector of sustainability at the university. Thus, it received greater support among the university administration and colleagues. Respondent 5 highlighted that *" we were lucky to have a very clever boss who knows exactly when to talk to whom and where, and who to ask.".* Another facilitating factor mentioned by one of the teacher educators was that teacher educators have previous experience with applying for funding. This experience was declared as a clear advantage compared to schoolteachers. Furthermore, it was mentioned that to ensure a permanent anchoring of the learning garden in the university. The learning garden must be integrated into everyday university life.

(2) Initiating teacher education programme in the learning garden

In the second stage, one problem has been prevalent among teacher educators. In particular, the academic requirements of a module examination and the fit into the curricula were mentioned. Even though it is possible to cover relevant content of teaching studies in the learning garden, Respondent 7 described that it is essential*"to think about how this fits in with the structure of the teacher training module."* Respondent 7 attributed the opposition to the learning garden to the *„teaching that doesn't correspond to the standard format".* The experiential and informal nature of the learning garden may have caused the experienced headwind from the faculty and university administration.

In contrast, what has been described as facilitating elements in initiating a teacher education program in the learning garden was often linked to the different profiles and research focus of the teacher training programs. According to teacher educators, they would determine whether the university management will support the establishment of a learning garden. For example, one university has a teacher education degree in nutrition science. Therefore, the learning garden is a good fit for the degree program's overall objectives. Respondent 8 described how *"the faculty found it good. It fits with raised beds and food processing. We have closed the loop as a discipline that we can show everything in food science in different variations."*

(3) Teaching in a learning garden

Concerning teaching in a learning garden, the analysis revealed three challenges. The first challenge concerns the participating teacher students' motivation to take care of the learning garden during the holidays. In the studied cases, the semester break preoccupied the teacher educators because teacher students would need to become motivated to spend extra time outside the official semester in the learning garden. As Respondent 1 indicated, *"keeping students coming in regularly, using semester breaks and their free time to do this"* is challenging. Another challenge for teaching in the learning garden reported by teacher educators was the short length of the semester. The limited time of approximately three months in the learning garden was perceived as too short for covering the relevant content.

Moreover, the semester break beginning in the middle of summer made it nearly impossible for the teacher students to observe the entire growing cycle, especially harvesting the produce. The third challenge was the issue of integrating own perceptions and personal opinions. Even though the garden is a place that is not bound by formality and rules, Respondent 2 commented that she finds it difficult to bring in her personal opinions. Respondent 2 expressed,*"one should not focus on one's political views".* This statement by Respondent 2 may indicate a conflict between her professional role as a teacher educator and her personal self. The fourth challenge related to the collaboration with the NGO. was that teacher educators must recalibrate their roles as teacher educators. It has been described that teacher educators need to take a step back. Respondent 5 stated, *"I have my ideas, but I can subordinate myself to the teacher education program. I want to see how they realize it [the teaching in the learning garden]."*. On the other side, teacher educators find themselves in a role conflict as they have to share the role of the teacher educator and take turns with the garden experts from the NGO. The collaboration with the NGO meant considerable communication expenditures for teacher educators. More positive aspects, like the different forms of support, were mentioned but what stood out the most related to the collaboration was the teaching support in the learning garden. Teacher educators also appreciated the gardening practices and horticulture expertise, the teaching materials and the prespecified structure and curriculum of the seminar.

Moreover, Respondent 4 mentioned that*"for the students, it is exciting to stand in the learning garden with you, it is a different experience"*, highlighting the motivational aspect of the meme. The collaboration has been commented on by Respondent 8: *"The fact that expertise is brought together is much more powerful than if you only try to do it alone. Through cooperation, you cross-fertilize each other. Not everyone has to work out a lot on their own, but by trying things out and working together, you can see what works well and what doesn't."*. Cross-fertilization related to different knowledge and expertise is essential to the teacher education program. The teacher educators contribute their didactic experience in educating teacher students. In turn, the garden experts from the NGO contribute their horticultural knowledge and expertise in cultivating plants. Co-teaching teacher students as a team, teacher educators, and teacher students complement each other well.

(4) In all three stages

Multiple teacher educators saw the main challenge for setting up and teaching in a learning garden as the high expenditure of time they describe as more demanding compared to what it would take to set up and conduct a usual lecture. Respondent 5 expressed his frustration by explaining how he had to go through the excessive and lumbering bureaucracy of the university for several weeks. In this regard, the high motivation from teacher educators is a facilitating factor. Respondent 2 acknowledged that she doesn't mind spending extra time in the learning garden and even goes to the learning garden on Sundays with her whole family or to prepare for the seminar. It was prevalent throughout the data that cooperation with the NGO helped the teacher educators to save a lot of time. It was also acknowledged in statements indicating that with the NGO's support, the likelihood of establishing a learning garden at the university is increased.

5.1.5 Learning outcomes

Appendix A gives an account of learning outcomes relevant for teacher students to learn in the learning garden. From identifying the most significant pests and beneficial insects to keep an ecological balance in the learning garden to the basic planting and seeding techniques, a lot of technical gardening knowledge is incorporated into the curriculum.

The interview data revealed disagreement among teacher educators regarding learning objectives in the learning garden. While one part of the answers indicated the significance of learning objectives for the education of student teachers, the opposite was evident in the other section of the answers. For some teacher educators, it was essential to measure learning objectives to advocate for integrating the learning garden into the curriculum. Other teacher educators like Respondent 7 argued that *"competency profiles and performance should not define the garden."* For this reason, a second data collection session was initiated to collect additional responses. Six of the eight teacher educators answered the questionnaire. The data collection provided insights into the teacher educator's understanding of competencies, values, and knowledge in the context of the learning garden.

(1) Competencies

The data suggested that for the teacher educators, the learning garden context didn't influence how they defined competencies for themselves. For instance, Respondent 2 argued competencies in the learning garden were *"not different than usual".* Two teacher educators mentioned that they understand competencies, as Weinert (2001). Weinerts (2001) defines competencies as transferable skills that help solve problems. Another teacher educator referred to Humboldts understanding of the definition and stated, *"the individual maturity is in the foreground"* (Respondent 5).

Moreover, it could be analysed that the understanding of competencies is quite individual, as teacher educators from the same university had an entirely different sense of what it meant. Regarding the concrete competencies that teacher students should learn in the learning garden, 4 (67%) of the teacher educators mentioned more abstract competencies such as self-efficacy. In comparison, 2 (33%) got very concrete and noted, for example, the competency of creating and maintaining a learning garden.

"The enthusiasm for the learning garden can be particularly encouraged during a teacher education programme. For instance, by allowing students to deal intensively with school gardening and to experience self-efficacy there. It also means gaining confidence that they are capable of running a learning garden, even if they are not necessarily biologists or farmers, of dealing with these issues and accompanying them at school." (Respondent 6)

As observable in this quote, for Respondent 6, competencies relate to qualifying teachers by equipping them with self-efficacy and confidence. Most (83%) teacher educators argued for the relevance of specific action competencies in the learning garden. For the teacher educators, action competencies

included self-efficacy, independence or planning and managing learning gardens as extracurricular learning spaces. Competencies were more connected to concrete action in the learning garden, as highlighted by Respondent 4. She stated that the essential competencies for teacher educators in the learning garden are *"skills and abilities to create, maintain and care for a school garden, as well as to become aware of botanical phenomena and to investigate them more closely".* Less essential but also mentioned were affective competency, such as *"care for the learning garden"* (Respondent 4) or didactic competency, such as*"Integrate/think about ESD in the classroom"* (Respondent 2).

The triangulation of the questionnaire data with the interview data displayed an exciting finding. In the questionnaire, systems thinking was not mentioned once. Systems thinking was found in 75% of the interview data, mainly related to the codes of 'natural cycles' and 'from the learning garden to the plate'. Particularly biology teacher educators saw the potential of the learning garden in teaching essential concepts around the ecosystem and different opportunities for interaction for teacher students. Cultivating vegetables, the various components in the natural cycle and a greater understanding of the learning garden as an ecosystem was directly linked in their descriptions.

(2) Knowledge

In terms of knowledge as a learning outcome in the learning garden, the group of teacher educators is divided. The results found mixed results regarding how teacher educators define knowledge in the context of the learning garden and what they declare essential knowledge that teacher students should obtain in the learning garden. Evidence was found that knowledge in the learning garden is generally considered vital for teacher educators. Still, it may not be their most important concern. A comparison of the definition of knowledge revealed that one group of teacher educators defined knowledge in the learning garden in the same terms as in the classroom. In contrast, for other teacher educators, more practical and applicable forms of knowledge were pointed out.

It is interesting to note that a connection between the teacher educators' definition of knowledge in the context of the learning garden and the knowledge that teacher students should learn was observed. For example, Respondent 6 understood knowledge as enabling teacher students to accompany students competently and joyfully in the learning garden. This practice-oriented definition of knowledge matches the focus on action competency described earlier. The focus on joy was consistent with teacher educators' earlier expressed personal motivation. Previously it was reported that gardening is a joyful hobby for teacher educators. It could be speculated that teacher educators responded to the question by how they would like to feel in the learning garden or what knowledge has been personally essential to them.

In terms of specific knowledge that teacher students should learn in the learning garden, Respondent 6 highlighted three forms of knowledge. Respondent 6 described that *"Technical knowledge (organic/agricultural), practical knowledge (cultivation techniques, harvesting, processing etc.) and methodological knowledge (didactics, pedagogy)"* would enable student teachers in the learning garden.

One response prompted conclusions about how the understanding of knowledge impacts teaching in the learning garden. Respondent 4 stated, *"there is also no lecture in which factual knowledge is imparted. Here, students are free to deal intensively with a botanical phenomenon of their choice and research it."* This implies that even though the specific knowledge is broadly defined, such as botanical phenomena, students are given the freedom to choose what exactly they want to learn in the learning garden. Interestingly, regarding the question of what knowledge is essential for teacher students to learn, their responses were much more concrete than the answers on competencies.

(3) Values

The analysis proved that values in the learning garden are essential for teacher educators. Nevertheless, some differences in how values in the context of the learning garden could be defined and what values were most vital were observed. For Respondent 6, the most important values were *"sustainability, appreciation, connectedness, perseverance, reliability, enthusiasm"*. For Respondent 1, values like *"protection of life, reverence for nature, wonder about biological relationships such as growth and reproduction"* were essential. At the same time, Respondent 2 mentioned *"understanding the self as part of nature"*. From these answers, it may be observed that environmental values were essential for teacher educators in the learning garden.

Again, a connection between the understanding of values and how these values are to be developed was found. Respondent 1 interpreted values as personal attitudes conveyed through *"targeted learning events by supervising teachers"* and argued that the learning garden thus has an influential role. More explicitly, the following statement clarifies Respondent 1 conceptualization of values.

"Therefore, the teaching/learning garden and the people working in it have an important role in the formation of personal attitudes of young people, which are strongly linked to ethical and ecological as well as future-oriented issues." (Respondent 1)

This description indicates that values can only be developed through teachers' intervention and not through being in the learning garden per se. In contrast, two teacher educators' statements indicated that values could not be learned; therefore, a critical and reflective approach to values and norms should be achieved in the learning garden. In Respondent 5 opinion, it is evident that the learners themselves hold a significant role in developing values in the learning garden. He replied that the learners should *"reflect on the meaning of the learning garden for themselves as a person"*. The next chapter of perceptions of ESD in the learning garden is connected to teacher educators' perception of the learning outcomes and values in particular.

5.1.6 Perception of ESD

This chapter aims to highlight the connection between the teacher educators' views on learning outcomes and ESD in the context of the learning garden. The analysis showed some commonalities, such as that teacher educators were personally invested in sustainability and environmental issues and were familiar with teaching ESD to teacher students. They viewed the role of teachers as essential in multiplying ESD. For instance, Respondent 6 stated that it is imperative that teacher students *"bring this into the schools"*. Therefore, they wished that teachers would indicate ways to personally support and become involved in sustainability and show the learner the significance of their own life. Relating to this point, Respondent 6 stated

"So really learning what sustainability issues are, what does sustainability affect? Which areas of life and how can I personally support it? How can I get involved? What does it mean for my life?".

In sum, the learning garden has been described as a *"good access route to sustainability"* (Respondent 7) and thus able to provide an answer or a potential solution on a small scale to societal challenges. Moreover, it was argued that the learning garden enables teacher students to understand ESD better. They mostly agreed that ESD could not be taught in a lecture but through concrete activities like gardening. It was mostly agreed that necessary competencies for teaching ESD could be developed in the learning garden. Respondent 2 stated, *"ESD competency is much better developed in practical seminars, which are non-hierarchical, picking up collaborative work, letting people observe themselves"*. ESD should acknowledge the dimensions of the global challenges and be engaged in a constructive and forward-thinking way. Likewise, Respondent 7 acknowledged, *"ESD should be positive and seen as something nice and not that you say after the garden sessions, now I feel totally*

exhausted and frustrated". This finding could be related to the metaphoric perception of the learning garden as an island of hope.

The analysis found that understanding values, knowledge and competencies in the context of the learning garden, described in the previous chapter, dramatically impacts the teacher educators´ perceptions of ESD. Especially Respondent 7 responses were interesting in that regard. In the interviews, he stated that values shouldn't be taught. At the same time, for Respondent 7, ESD as a concept could and should not be defined or standardized. Hence for Respondent 7, teaching ESD is difficult as *"no one knows what sustainability and ESD mean".* He proposed that ESD should be challenged as a concept and critically discussed with teacher students.

5.1.7 Teaching ESD

Based on the analysis, four distinct elements were crucial for teacher educators to teach ESD to teacher students in the learning garden. Generally, it has been observed that their understanding of ESD described in the previous chapter greatly influenced their teaching in the learning garden.

Table 4: Key aspects for teaching Education for Sustainable Development to teacher students in the learning garden

1) changed role of teacher educators and teacher students	**2) local-global nexus**
• culture of exchange that honours diverse competencies • everybody learns and makes mistakes • learning facilitator instead of a knowledge transmitter • non-hierarchical	• tying global topics to the concrete and local example of the learning garden and teacher students´ personal life • diversity of themes with global dimensions attached to learning gardens
3) interdisciplinary teaching	**4) experiential learning**
• learning from each other (when different teacher education programmes come together) • possibility for integrating diverse perspectives • based on a concrete example • ripple effects for universities and schools	• practical hands-on learning • engaging all the senses • reduce the complexity of global topics • relate concrete experiences to discussions

(1) changed role of teacher educators and teacher students in the learning garden

The analysis revealed that teaching ESD in the learning garden begins with exploring new roles for teacher students and teacher educators alike. Teacher educators attribute this shift to the mutual learning process that acknowledges diverse competencies, allows for making mistakes and repudiates power imbalance. Diverse and versatile knowledge and skills are fundamental to the process of gardening together in the learning garden. For Respondent 8, this meant encouraging exchange, especially among students in the learning garden. For Respondent 8, teacher students can fully use their competencies *"because in the learning garden all competencies are important and needed.".* Respondent 7 related to the teacher's changed role a different learning culture as observable in the following statement

"This is also one of the advantages of the school garden, that it can bring about a relatively big change in the learning culture with relatively little."

The teacher educator must engage with a new learning culture as described by Respondent 7, who argued that the learning garden enables more *"discourse, of weighing things up, and also of standing up there and saying, I don't know either".* A new learning culture would mean, on the one hand, that the teacher educator has to ask critical and controversial questions, as proposed by Respondent 2. On the other hand, teacher educators have to establish a so-called error culture that promotes dealing with errors actively and openly. At the same time, teacher educators have a similar level of knowledge as teacher students. For instance, in terms of horticultural expertise, both teacher students and teacher educators learn from each other. Respondent 3 said she doesn't see herself *"in the role of a knowledge transmitter but as a learning facilitator"*. Accompanying the changed role of the teacher educator, the role of teacher students also changed. In several of the university gardens, the students learned on their own, without a teacher educator. Respondent 4 acknowledged that it is crucial for teaching in a learning garden to give the learners a lot of freedom but also support students when they need help or be there to answer questions. The described changes in the role of the teacher educator, according to Respondent 7, broke the hierarchical positions of the lecturer as a learning person.

(2) Local-global nexus in the learning garden

The local-global nexus is the second aspect for teacher educators in teaching ESD in the learning garden. It has been observed that whether global topics are integrated into the learning garden is also related to understanding how sustainability could be reached – either through individual action or more structural and global activities. The global-local nexus in the learning garden relates to teaching relevant global and political topics related to the concrete example of the learning garden. The main reason is that the learning garden can unite the local and the global perspectives through the diversity of themes encountered in the learning garden. On a local scale, the learning garden presents a concrete example that is an alternative to the global food system. On a global scale, the learning garden connects to many themes. Respondent 2 summarized the global aspects found in the learning garden in the following way

"global resource cycles, imports, fertilization, global player, agricultural businesses which prepare their seed profitably however seed propagation is no longer possible, biodiversity, Fairtrade, cultivation conditions in different countries, culture, because people from different cultures use different cultivation techniques which contributes to international understanding, water, not only agricultural but also food companies, regionally and seasonally nourish, how we become all full."

Generally, the data indicated two approaches to teaching the local-global nexus in the learning garden. With regards to the first approach, it was argued by teacher educators that it is possible to begin with the global perspectives and relate them to different learning situations in the garden. Secondly, the learning started locally and connected to relevant global issues. According to most teacher educators, the learning garden offers an opportunity to move from a local to a global perspective because the learning garden can be understood as a model of the bigger picture. Respondent 8 stated, " *before you get to the big picture, you have to understand it on a small scale. Once you think about it locally, then you can tackle it globally."*

(3) Interdisciplinary teaching

The third reoccurring theme within the interviews has been the potential for interdisciplinary teaching in the learning garden. It has been acknowledged by Respondent 8 that for teaching ESD in the learning garden, it is crucial *"to tackle problems from in an interdisciplinary way. Otherwise, it's too much for one subject".* At the same time, it has been acknowledged that teaching in the learning garden about topics such as the global food system is quite complex due to the interconnectedness of issues. The learning garden offers a concrete example to illustrate and break down the entangledness of the learning garden with related themes.

"I think it's super exciting when these different perspectives come together on a real example, which is what it's all about. The advantage is that I have something very concrete to talk about. Of course, that's much easier than finding a topic where you try to bring different perspectives together artificially. Here in the learning garden, that happens automatically." (Respondent 6)

Teacher educators mentioned two main aspects concerning how interdisciplinary teaching could look in the learning garden. First, teaching in the learning garden should integrate multiple and diverse perspectives to create a holistic view of the problem. Secondly, teacher educators proposed that the teacher students' interdisciplinary backgrounds could be engaged in the learning garden. For example, in University A, teacher students enrolled in different teacher education specializations learn together. Respondent 8 argued that *"through the second subjects of the students, the knowledge that you have from other areas complements each other. This creates the big picture because you can include interdisciplinary subjects".* Teacher educators recognized that through interdisciplinarity, teacher students' plurality of thinking could be developed. It was mentioned that the interdisciplinarity practiced through learning in the learning garden should be carried further and reach the rest of the university and even the schools. Therefore, teacher educators put forward the need for support from teacher educators of different teacher education programs. This support is, according to Respondent 4, not a given. She argued, *"we have to show other subjects why this is also exciting."* The interdisciplinary teaching in the learning garden could influence the teachers' perception of education within the bounds of a single subject. This idea has also been developed by Gaylie (2009), who argued that the thinking within subject barriers is still predominant among teacher students. Teacher educators' motivation to break preconceived notions of education could be related to the importance of interdisciplinary teaching in the learning garden.

(4) Experiential learning

The fourth key aspect of teaching ESD in the garden is experiential learning. Teacher educators highlighted the practical hands-on experiences happening in the learning garden. The importance for teacher students to develop their ability and motivation for teaching ESD could be related to the preponderance of the motivational aspect in educating teacher students. The code of 'motivation' was most frequently used in the analysis, assigned 56 times. Respondent 3 highlighted this through her statement:

"When I say that I want to promote a closeness to nature, then that would be through emotional access, through the fact that it is simply fun. In the university, this is, in general, a problem because when it comes to promoting closeness to nature, it is much too cognitive. From a neurobiological perspective, if we want to change the behaviour of the human being, this is actually not achieved through knowledge but through action or the fact that the limbic system is activated, and these are just emotions, which I can achieve through the work in the learning garden." (Respondent 3)

Respondent 3 proposition reflects the discussed importance of values for teaching ESD to teacher students. In her explanation, the learning garden through providing experiences a change in behaviour is more probable than through lecturing about the importance of it. It could be argued that, according to Respondent 3, through experiential learning teacher students developed values related to closeness to the natural world. The importance of experiential learning was also included in Respondent 5 description:

"A learning garden is a place where I can try something out and learn something myself and not where I sit and listen to what someone tells me, and I know it afterwards but that I do it myself, that the experience is in the foreground."

It could be argued that through experiential learning, every activity in the learning garden teaches the teacher students something. Teacher educators described the experiential learning opportunities as getting your hands dirty and engaging all the senses by touching, smelling and tasting the vegetables. The opportunity to create something in the learning garden, according to Respondent 1, not only teaches life experience and self-competence.

5.1.8 Perception of a sustainable food system

Most teacher educators had not earlier explored the food system. Some had difficulties in answering the question of defining what a sustainable food system conveys to them. The responses ranged from *"I haven't given it much thought yet"* (Respondent 4) to *"Books are being written about it"* (Respondent 1) or *"I'm not an expert in the field"* (Respondent 6). Their responses hint at the complicated nature of the food system. It could be analysed that, in a way, the teacher educators, through their statements, distanced themselves from the food system by making it a topic of experts discussed in scientific books and nothing concerned about. The analysis resulted in three principal vantage points of a sustainable food system which are 1) sustainable consumption, 2) complex global system, and 3) localization.

(1) sustainable consumption

Almost all teacher educators mentioned the need for conscious consumers to follow a sustainable diet regarding a sustainable food system. The most common denominator among the interviewees was a local and seasonal diet that is healthy for humans and the environment. Respondent 3 said in this context,

"you eat locally and seasonally - then you have implemented a lot of what you want from your own scope of action."

The teacher educators' explanations also included how they try to eat more sustainably. Respondent 4 exclaimed that she tries to eat more consciously. Respondent 5 argued that organic production is mandatory for him. Respondent 2 saw the necessity of a plant-based diet with little dependence on global markets. Only one teacher educator related sustainable consumption to a more global perspective. Respondent 2 expressed that, in particular, the global north should drive the consumption of animal products down. For the majority, sustainable consumption was something local and seasonal. The global implications were underrepresented in the data.

(2) complex global system

The second reoccurring perception was that the sustainable food system is compounded and has various ramifications on the political system. Teacher educators related the food system's complexity to the multiple stakeholders involved in the value chain. Respondent 1 noted the value chain includes the *"production, transport and processing of food up to the use of leftovers"*. As described earlier, few teacher educators highlighted the global interdependence of the food system. The food system's interrelatedness also corresponds to the entirety of decision-makers. Only two teacher educators acknowledged the need for political interference in transforming the food system. For instance, Respondent 2 expressed that it is essential to keep an eye on *"who determines what we eat, […] connecting to the topic of agribusiness, global trade and global economy".* Similarly, Respondent 7 argued that even though following a sustainable diet is essential, the *"influence of the individual is relatively small".* Hence, according to him, the responsibility for a sustainable food system should *"not be passed on to consumers because there are very, very, very complex global political aspects involved".*

(3) localization

As already discussed, localization was a vital part of sustainable consumption for teacher educators. Most of the interviewed group saw a more local food system as sustainable. In the analysis, the theme

of localization was also related to a circular economy and ecological sustainability. Localization was often associated with other environmental motives, such as moving away from chemical fertilizers and long transport routes. Culturing regional food would result in a renunciation of global trade, which, for Respondent 6, "*would be such an economic-ecological idea* ". Almost all teacher educators neglected aspects of social sustainability associated with a sustainable food system. Instead, aspects of ecological and economic sustainability were mentioned with increased incidence. In particular, organic agriculture was deemed ecologically sustainable. Paired mostly with *"as little use of pesticides as possible"* (Respondent 6), or as Respondent 2 described *"promote biodiversity on my farmland".* Regarding the farming in the learning garden, Respondent 8 shared how the owners had asked them of the land where their learning garden was situated and whether they were interested in fertilizing the learning garden, to which they responded, *"absolutely not".* Besides, the recirculation of inputs was propagated, and a circular economy was mentioned repeatedly by teacher educators.

5.1.9 Sustainable food consumption

Based on this thesis's analysis and theoretical framework, the first three perceptions of a sustainable food system have been explored further. The topic of sustainable food consumption is fascinating as it was a central part of a sustainable food system but at the same time critiqued by some teacher educators. As indicated by teacher educators, sustainable food consumption was the most central contribution of the learning garden concerning food system education. In the analysis, it became apparent that the sustainable food system was most frequently mentioned. This notion was further explored in the online survey sent to teacher educators with the question 'How important is it that student teachers through the learning garden consume food sustainably?' (Appendix D).

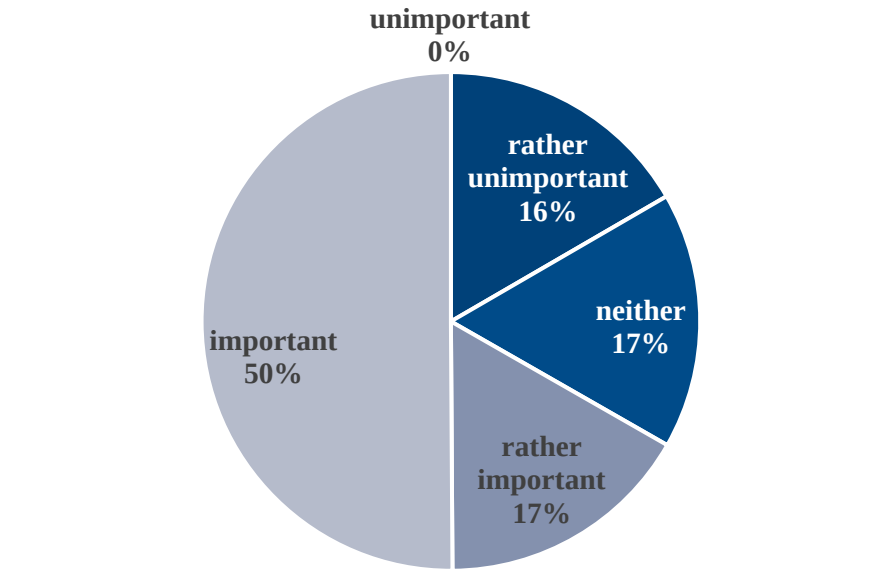

Figure 5: Importance of sustainable food consumption through the learning garden for teacher educators

The results visualized in Figure 5 showed that sustainable consumption is essential for 50% of the teacher educators and rather important for 17% of teacher educators. None of the teacher educators thought it is unimportant to encourage sustainable food consumption. This focus on sustainable food consumption has at the same time been critiqued by some teacher educators as being too narrow in focus and anthropocentric. For instance, Respondent 2 explained, *"For me, it's bigger. It's not just about nutrition."* Another critical element was the anthropocentrism mentioned by Respondent 3, who

argued that teaching in the learning garden is overly concerned with consuming food and neglecting the perspective of non-human others.

"Humans are very anthropocentric in their perspective, which means that the added value that you can generate for yourself in the school garden is primarily the food that you can consume." (Respondent 3)

5.1.10 Food system education

Various vantage points were covered when the teacher educators were asked how food system education in the learning garden could look. Generally, the analysis showed that the broad area of food system education is not a central concern of teacher educators. The data showed that teacher educators were either still preparing the content or thought other issues were more important. For instance, Respondent 5 admitted that *"We are still completely blank"* regarding what topics concerning food system education they want to touch upon.

For example, in teaching the global food system, the pathway of teacher educators was the direct, first-hand experience of cultivation in the learning garden. Teacher students experience what produce is growing in the learning garden, and teacher educators related this to discussions around global food production.

(1) being a part of the food system

Being a part of the food system is the first contribution of the learning garden for more sustainable food consumption. The teacher students can realize that they are an active part of the food system and have what it takes to influence the food system. In that sense, Respondent 1 highlighted that understanding the food system results from being actively involved in the food system.

"The important thing about the learning garden is that you see yourself as part of the food system and that you can also practically intervene in the food system. You can't understand that with texts about the food system." (Respondent 1)

Besides being actively involved in the gardening activities, a few teacher educators described that the learning garden opens a space for critical conversation around their involvement and contribution toward changing the food system. Discussions around conventional food, cooking and utilising fresh vegetables from the garden were central for some teacher educators. Some teacher educators, like Respondent 2, highlighted political aspects related to food choices by discussing where the products we usually consume come from is crucial. Others remained on an individual consumer level. For instance, Respondent 6 highlighted that students need to learn what to pay attention to when storing different types of vegetables. Overall, it was described that experiencing being a part of the food system through gardening gives the teacher students knowledge about the growth of different species and a greater appreciation for food.

(2) example of a sustainable food system

Secondly, teacher educators indicated that the learning garden could highlight aspects of a sustainable food system. Teacher educators intended for teacher students to be confronted by different examples and components of the food system. Then the teacher students should discern whether these are sustainable in their opinion. The learning garden in and of itself is an example of a sustainable food system or, as Respondent 1 expressed,*"a facilitator of a changed view of the food system"*. Several excursions were carried out within the teacher education programme at University D. They visited an organic farmer and a conventional dairy farmer. Both were looked at objectively so that the students could debate whether they see them as sustainable. Respondent 5 narrated from an excursion,*" visiting a massive greenhouse with tomatoes [...] the students realize the insane proportions of the work that goes into such a big greenhouse"*. He argued that through this excursion to an organic farm, students

understood what they have to pay attention to in terms of sustainable food consumption and can make up their minds. From his experience, these excursions enabled students to make new connections and perspectives on the global food system.

(3) following the entire value chain

Realizing the efforts of growing food by following the entire value chain is the third contribution of the learning garden for more sustainable food consumption. 75% of the interviewed teacher educators perceived that following the whole value chain from planting until harvesting will make the teacher students realize *"how much work it takes to grow a carrot like this"* (Respondent 5). Hence, harvesting and cooking something is essential to generate an appreciation from experience. Teacher educators argued that through the learning garden, the value of food becomes more tangible as the teacher students experience all the time and expenses necessary for the cultivation. According to Respondent 4, this could lead to reflections about the prizes in the supermarket. She 4 argued,

"I believe that by making everyone aware of how much work is involved, how many hours, days and months of work go into it, you start to wonder how some products can be so cheap." (Respondent 4)

Respondent 8 highlighted the potential to discuss that the climate conditions in the learning garden limit what can be grown *"there you can discuss on a small scale […] that we only have a variety because it is grown globally"*.

5.1.11 University of Bonn

The example of the learning gardens at the University of Bonn aims to illustrate the previously presented findings. Moreover, it provides an inspiring example. This chapter first presents the general idea behind the learning garden, its particularities, and the didactical approach.

The University of Bonn has two learning gardens. In 2019, the didactic garden ('Didaktische Garten') was inaugurated for teacher education at the University of Bonn. The second learning garden was planted in 2022 and is a part of the teacher education programme described in this thesis. While the didactic garden is only for biology teacher students, the newly built learning garden unites teacher students and enables interdisciplinary teaching. The teacher educators Amélie Tessartz and Jonathan Hense were responsible for both learning gardens at the University of Bonn. Both requested to be named so that interested parties could contact them.

The motivation and intention behind the didactic garden are interesting to observe. The focus of the didactic garden is to promote interest in plants, as interest theory is also one of the major theoretical frameworks for the research carried out by the teacher educators at the biology faculty of the University of Bonn. The focus of the didactic garden on interest theory came from the biology faculty and Amélie Tessartz's doctoral thesis called 'Interesse an Pflanzen fördern - Eine Design Based Research-Studie mit Kindern und Jugendlichen', published in 2022. Tessartz (2022) investigated the interest in plants, reasons for interest in plants and what factors can facilitate greater interest in plants. One outcome of her research was that first-hand experiences and research-based activities could positively affect interest (Tessartz, 2022).

The didactic garden is part of the botanical gardens and has an area of about 200 m². It is located next to the university and thus allows *"that you can also water between two lectures, you don't have to take the bus somewhere."* (Jonathan Hense, University of Bonn). In the other cases presented in this study, the distance between the learning garden and the university has been different. Only in one other case the learning garden is directly on the university campus. In all the other cases, the learning garden is further away from the university. It could be argued that the possibility of spontaneously visiting the learning garden, even for a short break, could create a stronger bond between the teacher educators and the learning garden.

Figure 6: Impressions of the Didactic Garden at University Bonn (provided by University of Bonn)

The ground plan illustrated in Figure 6 shows that the didactic garden has planter boxes, various planting beds, a tool shed and compost. It offers habitats like fruit and wild meadows for microorganisms (Hense and Scheersoi, 2022). The didactic garden also has a seminar room, a toilet, a research room, a library for rainy days, and a seating area for the students to spend their free time in the didactic garden. As the images show, the didactic garden holds many opportunities to experiment with food cultivation and conservation for the teacher students: a nesting aid for bees, a hydroponic system for growing plants without soil, a steam juicer, a dehydrator serves for preserving foodstuff like apples from the garden. Some of the possibilities the learning garden offers can be observed in the pictures of teacher students are visualized in Figure 6. The learning garden also has a greenhouse for plants' propagation. Compared to other universities, the facilities found in the didactic garden are pretty impressive. In some universities, there are only planting beds available. Because of this, the learning garden may not be seen as a place where student teachers like to linger for a prolonged time.

"We want them to try it out and experience themselves in the garden and create a space for them that they can make their own. […] so that you can sit down and read a book, but also have the opportunity to work with plants in the garden." (Amélie Tessartz, University of Bonn)

Teacher students can either come to the didactic garden on their terms or choose an elective module, which is only open to teacher students in biology. There are no lectures taking place in the didactic garden. Instead, teacher students can come to the didactic garden during the so-called 'open garden hours'. In the didactic garden, the teacher students are given the space to learn about growing, caring for, and harvesting plants. The following statement highlights the differences between the didactical

garden and the programme focused on in this case study (Appendix A), where a uniform curriculum is promoted can be observed.

"We do not follow a uniform curriculum in the didactic garden, nor is there a lecture in which factual knowledge is taught. The students are given the freedom to deal intensively with a botanical phenomenon of their choice and to research it. They, therefore, acquire a wide variety of knowledge in the field of botany." (Amélie Tessartz, University of Bonn)

As observable from this statement, for the examination of this elective module, teacher students have to deal with a botanical phenomenon of their choice and examine it more closely. Students are encouraged to look at fascinating phenomena of plants, such as the fact that flowers turn in the direction of sunlight, although they are always considered immobile (Hense and Scheersoi, 2022). Based on the phenomenon, teacher students are required to write two pages where they document their observations and how to accomplish the phenomenon horticulturally, to be reproduced by other teachers. The teacher students' elaborations are planned to be compiled into a publication, which will be made available to teachers, parents and other institutions as a handbook with instructions for experiments.

The student teachers receive a lot of freedom and space, promoting their autonomy in the didactic garden. For some teacher students, this autonomy is overwhelming, as described by Amélie Tessartz in the following statement:

"Students are totally overwhelmed with freedom at the beginning. They can't believe that it's really like that, that we don't control when they come […] Some also need a joint tour of the garden to find the topic they want to work on. Suddenly they [teacher students] notice many things they want to look at more. When we give freedom, someone must be there to see how much support the person needs, or at least be there to answer questions." (Amélie Tessartz, University of Bonn)

It was highlighted how some teacher students face difficulties recognizing what biological phenomenon fascinates them. The interviewed teacher educators explained how they deal with this response by teacher students. They take the teacher students on a ten-minute walk through the didactic garden. Jonathan Hense explained how he then encourages them to reflect on what they find fascinating. By listening closely to the words that teacher students use in describing the different phenomena, he can tell what fascinated the teacher students. University E, self-organized learning is practised which mirrors the didactical approach of giving the teacher students a lot of freedom. At University E, the teacher students are mostly on their terms in the learning garden. Respondent 7 at University E only guides the teacher students through virtual lectures into a reflection process. In comparison, the learning is more structured and predetermined at the other three universities.

Another vital cornerstone of the didactic garden are regular visits by school children. The school children can carry out their small research projects on themes related to plants' growth over several months while they are supported and supervised by student teachers. Hence, the student teachers gain garden-based teaching practice. The approach of regular visits is unique compared to other cases included in this study. The importance of teaching practice has been recognized by Respondent 1: *"Students should also think about how they can convey this to students in teaching practice, that they can take the step from teacher training in the future."* Only at University B, the teaching practice has also been a component of the teacher training in learning garden. Here the teacher students had to perform one garden-based session in a group at a school.

According to teacher educators in the didactic garden, field trips are another essential and relevant cornerstone of the teaching taking place in teacher education at the University of Bonn. Even though these field trips are not directly connected to the instruction in the learning garden, field trips came up in the data concerning food system education. These field trips are integrated into other modules in the institute. These field trips aim to get to know different food system actors and understand their living reality. Field trips are mainly carried out to farms of different scales and orientations. The diversity of the food system is shown through organic and conventional farms, as shown in the statement of Jonathan Hense.

"That's so important to me that I never do conventional bashing. I think you must immerse yourself in the reality of the farmer's lives. That happens super well with dairy farming because it's so crazy what they have to deal with, with breeding consequences, etc.. It's so complex. And you have to keep all that in mind when you pull something off the shelf." (Jonathan Hense, University of Bonn)

5.1.12 Other universities

The results casted light on learning gardens at other universities. Three of the remaining four universities had another type of learning garden. The teacher educators at universities A and C taught a learning garden module with raised planting beds. Respondent 3 described that the raised planting beds are more practical since they are faster planted and closer to the university, allowing for spontaneously visiting the learning garden. University C's learning garden is four kilometres from the university. Hence, being in the learning garden needs to be pre-planned and more time must be granted for a visit.

Another interesting case is University E, where teacher students learn in a self-organised format during two semesters in the learning garden. Respondent 7 aimed for students to be able to not only learn about how to plant but also to experience the organization of the learning garden. He stated that students need to coordinate themselves, set priorities and make decisions, which frequently led to irritation. He described that the teacher students *„expect that everything will be pre-structured, that their tasks will be clearly outlined and that they will have to work through them."*.

5.2 Teacher students

5.2.1 Respondent's profile

This section presents the results of the data of teacher students in more detail. A concise overview of the second target group of teacher students can be found in Table 5. In terms of the distribution of questionnaire responses, about a quarter came from University A, 22% came from University D, 20% came from University C, 17% came from University E, and 15% came from University B. Of those surveyed were 68% female, 28% male and 4% diverse.

Regarding the age of the teacher students surveyed, the great majority (62%) were under 25 years old, followed by 22% between 25 and 30 and 16% older than 30. Upon closer analysis, it became clear that there were significant differences in the age distribution between the universities. At university B, for example, 92% of the teacher students surveyed were under 25. In contrast, at university A, only 24% of students were under 25, and a large proportion (43%) of enrolled students were over 30. The participating teacher students were equally distributed among elementary school education (48%) and secondary school education (52%).

Regarding the pedagogical experience with garden-based learning, as visualized in Figure 7. 26% of teacher students had zero experience, 65% had little experience, and only 9% had a lot of experience. A significant difference was observed between the universities regarding garden-based pedagogical expertise.

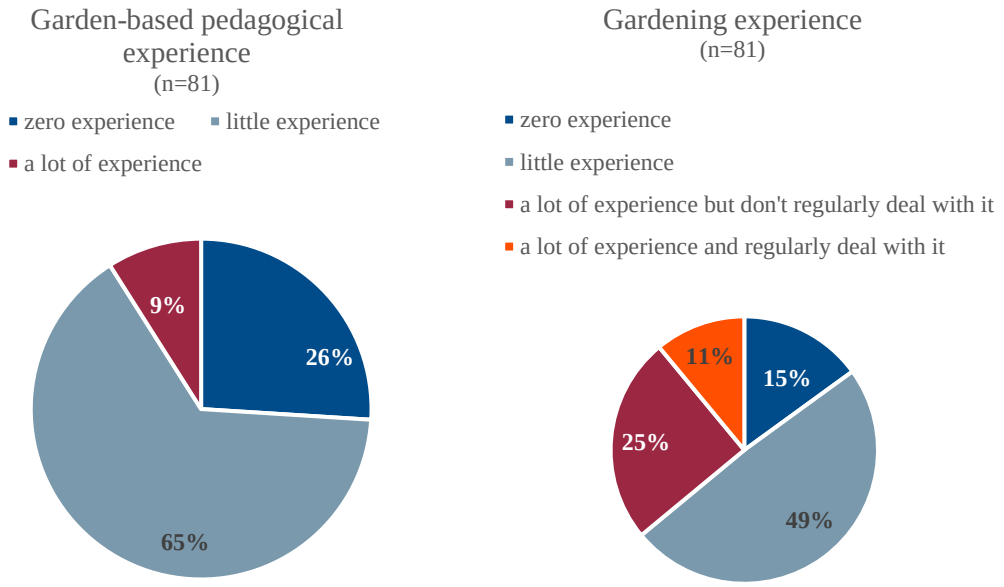

Figure 7: Pie chart of teacher students' garden-based pedagogical and gardening experience

44% of the students with a lot of experience were studying at University A. At University E, there was no student with a lot of experience. In terms of the teacher students' experience with gardening, 15% of all 81 respondents had zero experience yet, 49% had a little expertise, 25% had a lot of experience but didn’t spend a lot of time with gardening, and 11% had a lot of experience and regularly dealt with gardening. A remarkable difference was observed between the universities concerning the expertise in horticultural practice.

Table 5: Overview of teacher students included in this study

University	**Answers received (% of total group)**	**Age of teacher students**	**Degree programme of students**	**Gardening experience**	**Garden-based pedagogical experience**
A	21 (26%)	24% - <25 33% - 25-30 43% - >30	All studied secondary school education but with different subject combinations The majority studied home economics The second subject varied (i.e. Biology, history, ethics, physical education, geography, nutrition and food science and special education)	10% have zero experience; 52% have little experience; 38% have a lot of experience but don't regularly deal with it;	10% have zero experience; 71% have little experience; 19% have a lot of experience
B	12 (15%)	92% - <25 8% - 25-30	Elementary school education	33% have zero experience; 42% have little experience; 8% have a lot of experience but don't regularly deal with it; 17% have a lot of experience and regularly deal with it	50% have zero experience; 42% have little experience; 8% have a lot of experience
C	16 (20%)	56% - <25 31% - 25-30 13% - >30	The majority studied Elementary school education Few studied Secondary school education	6% have zero experience; 56% have little experience; 25% have a lot of experience but don't regularly deal with it; 13% have a lot of experience and regularly deal with it	25% have zero experience; 69% have little experience; 6% have a lot of experience
D	18 (22%)	73% - <25 22% - 25-30 5% - >30	All studied secondary school education but with different subject combinations Most studied for a Bachelor's degree The majority studied biology but also English, German, vocational training etc.	17% have zero experience; 50% have little experience; 11% have a lot of experience but don't regularly deal with it; 22% have a lot of experience and regularly deal with it	33% have zero experience; 61% have little experience; 6% have a lot of experience
E	14 (17%)	86% <25 7% - 25-30 7% >30	Elementary school education	14% have zero experience; 43% have little experience; 36% have a lot of experience but don't regularly deal with it; 7% have a lot of experience and regularly deal with it	21% have zero experience; 79% have little experience

5.2.2 Perceptions of the learning garden

This chapter presents the results of the question 'What do you understand by a learning garden?'. The word cloud, visualized in Figure 8, highlights the most common words to answer this question. The teacher students frequently used terms related to cultivation, plants and vegetables to describe their perception of learning gardens. Learning gardens were omnipresent in the teacher students' understandings as 14% of the teacher students related the learning garden to the school. For example, one student describes that a learning garden in a school is a *" jointly created and maintained garden with useful plants (vegetables, fruits, herbs, ...)."* as a teacher student from University D stated (S. U. - D). The wording of "useful" plants is interesting as it mirrors the critique of the anthropocentrism voiced by Respondent 3. Portraying plants as useful might be a tool for future teachers' teaching practice. Another interesting perception was that students understood the garden as a place controlled and beautified through human actions. One student described that *"by means of joint actions and activities can make the environment blossom and become a more beautiful environment"* (S. U. - B).

Figure 8: Word cloud composed of the survey data (size of the word represents the times the word was mentioned in the data)

Another essential element in the perception of the teacher students is the experience of cultivation, teaching, and other terms in the word cloud in a practical way. For instance, one student recognized that the garden encouraged her to try new ideas and learn about growing vegetables. For this student, a learning garden includes other elements like trees or space to build your things (Like an insect hotel). This student came from the University of Bonn, where the didactic garden provides many described aspects. Hence it could be argued that how the teacher students experience the learning garden at their own university frames how they perceive learning gardens in general.

Another portion of students described the learning garden as a place to meet and learn from and with each other. The reflections of one student of University A illustrated this notion. A learning garden is *"A garden where I can marvel at the wonders of nature with other gardening friends and learn new things about gardening together"* (S. U. – A).

5.2.3 Expectations for learning

This chapter illustrates what teacher students wanted to learn in the learning garden and the university-level course. Different questions helped to gain an understanding of the teacher students learning objectives, such as:

- What do you want to take away from this seminar?
- What should not be missing from the seminar in terms of hands-on experience?
- What topics and content should not be missing from the seminar?'.

The qualitative data were coded and resulted in seven different expectations that teacher students had for the seminar in the learning garden. The results are visualized in Figure 9. The number of times these categories appeared varied greatly

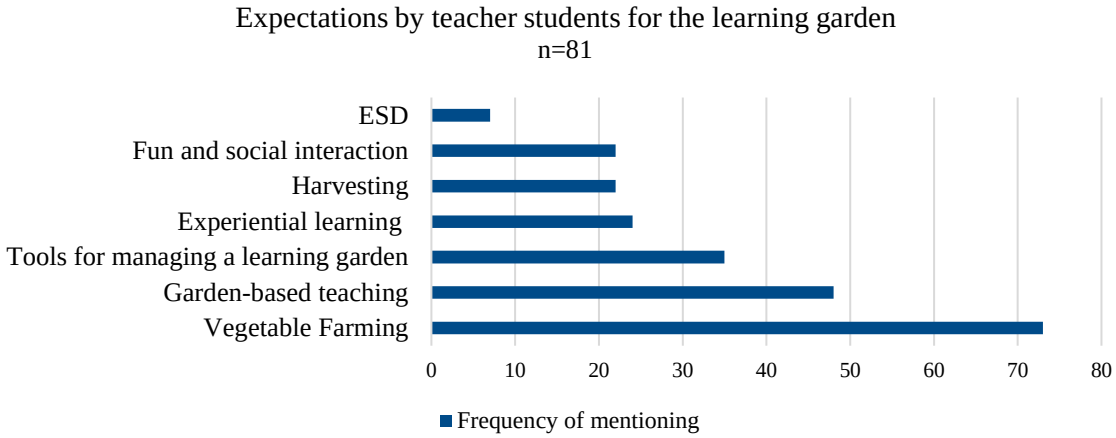

Figure 9: Teacher students' expectations for the learning garden

(1) Vegetable farming

73 (90%) of the surveyed teacher students were interested in learning the nuts and bolts of vegetable farming, as farming was perceived as essential for teaching in the learning garden. Based on the belief that vegetable farming would be the most valuable for the teaching practice, one student described: *"Above all, I would like to take away from the seminar a wide range of information on vegetable cultivation that I can draw on both in my teaching activities later on (e.g. working group school garden) and in my private life."* (S. U. - E). As indicated in this statement, applying the knowledge of cultivation is also useful for their private life, i.e., in their own garden. This intention was also found in other answers by student teachers.

Within vegetable farming, a lot of different subthemes emerged from the data. One was related to sustainable farming methods such as resource-saving irrigation or natural pest control. The teacher students mentioned concrete questions that occupied them, such as:

- Which plants can grow well together and which rather not?
- Which soil is suitable for which plants?

Sustainable farming was primarily related to natural and ecological ways of dealing with pests in the learning garden. Surprisingly, many teacher students mentioned they wanted to learn the right way to farm or correct planting techniques. Related to the cultivation of vegetables was also the term of success. Teacher students mentioned that they wanted to learn how to plant vegetables successfully. Closely tied to success were also mistakes. As one teacher student said, she wished to make mistakes to learn from them and later in the school be able to address the most common errors that learners make. 27% of teacher students mentioned the importance of harvesting for them. It was noted that the teacher students highlighted feeling proud, joy and pleasure through the harvest.

(2) Garden-based teaching

6 out of 10 teacher students wished to learn garden-based teaching methods. Different aspects of teaching methodology and didactics were mentioned. For some teacher students, it was essential to learn *"how to divide tasks amongst several children so that each child does something they enjoy and yet you, as the teacher, don't lose track of everything."* (S. U. - A). For others, the interdisciplinary possibilities were essential to learn. Another student wrote, "*I want to learn how to infect other people with my enthusiasm"* (S. U. - D). Interestingly, those teaching methods were not only garden-based, as a lot of students wanted to know how to follow up on the experience in the school garden in the classroom setting, i.e. *"I would like to learn how a project like a school garden can be theoretically accompanied in the classroom"* (S. U. - A). Teacher students also wanted to experience garden-based teaching in practice with children.

(3) Tools for managing a learning garden

Almost every second teacher student (43%) wanted to learn the tools for managing a learning garden. One student said, *"As a future teacher, I hope for impulses and tools that I can use later on to start a similar project at school."* (S. U. - A). Similarly, another student stated, *"I would like to learn how to approach such a school garden project with children and everything that you have to consider."* (S. U. - B). From these quotations, the strong motivation to create a learning garden in the future and the corresponding desire to be adequately prepared for it emerged.

(4) Experiential learning

30% wished for experiential learning to happen in the learning garden. While some teacher students recognized that through the learning garden, they would *"learn more and more intensively than through books"* (S. U. - B), at the same time, the lack of experiential learning in the often theoretical teacher training was recognized. Experiences, fun and social engagement were also crucial for the student teachers.

(5) Harvesting

27% of students said they expected to experience and learn about harvesting in the learning garden. Related to harvesting was also a social kind of experience, as one student stated that *"eating part of the harvest together"* (S. U. - D) is vital for her.

(6) ESD

It was striking that only 7 of the 81 respondents expected to learn about ESD in the learning garden. Similarly, in my own experiences, many teacher students weren't interested in learning about ESD. Teacher educators described that ESD so far hasn't been integrated into teacher education; therefore, some might have heard of ESD in the questionnaire for the first time. This became particularly apparent when an interactive online lecture about ESD in the learning garden was hosted during the module in 2022. In the end, only five teacher students showed up.

5.2.4 Teaching

One important finding that was represented in both the teacher educators and the teacher students' view on teaching in the learning garden was the teacher's changed role. It has been described by teacher students that based on the learning garden being an extracurricular place of learning, the typical pupil-teacher division of roles is abolished. The teacher's role is more of a facilitator to be available to answer questions, provide new knowledge and support the learners. Nevertheless, the data emphasised expert knowledge and correctly performing gardening activities, which could be interpreted as teachers' more traditionally oriented role in the learning garden. As for the teacher educators, the data also highlighted a dissonance between two opposing poles. One pole, where most teacher students were situated, reflected the focus on knowledge and correct techniques delivered by experts. For instance, one student intended to receive *"information about the plants".* In contrast,

another teacher student stated, *"you are shown there by real experts how to plant and harvest fruits/vegetables successfully".*

Respondent 2 conceptualised the learning garden as a place of non-performance and non-consumption. This idea reappeared in the response of one teacher student, who argued that a learning garden is a place that is *"separated from pressure to perform, work quietly and patiently on a collaborative and engaging project."* (S. U. - D). This idea of working in the learning garden either together or individually and thereby learning something stands in contrast to other students´ emphasis on "learning" in the sense of gaining new information about gardening: *"every step in the learning garden is explained in an age-appropriate way."* (S. U. - C). Some students acknowledged that they could also learn from the garden. For instance, one student understood the learning garden as *"A garden, from whom, with whom you learn."* (S. U. - B)

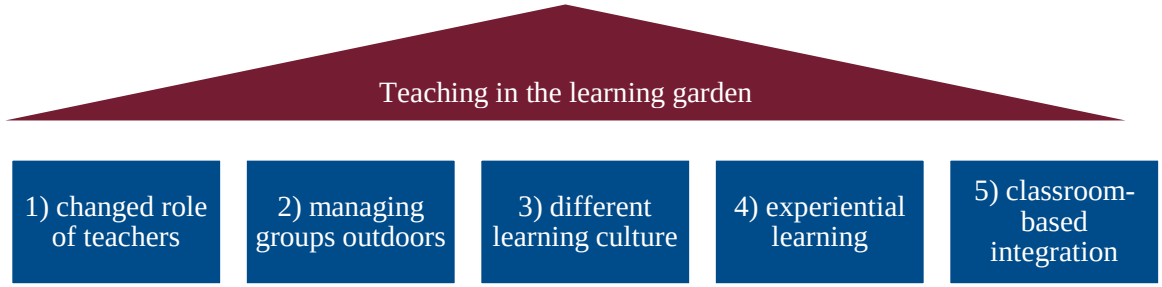

Figure 10: Key aspects for teacher students with regards to teaching in the learning garden

The data suggested that teacher students relate the teaching in the learning garden to experiential learning. They described that the instruction should focus on hands-on work, from sowing to harvesting vegetables and plants. Working with their hands on the ground was essential. Hence, according to teacher students, the most important for a successful implementation of the learning garden was hands-on garden work, as 76.6% said it is essential for them, as shown in Figure 10. Another important finding is related to motivation. 27% of teacher students mentioned wanting fun and social interactions in the learning garden. In the learning garden, the role of managing big groups and keeping control of the lecture was described. Methods for teaching and managing groups outdoors were also related to classroom-based instruction. Hence, embedding the learning garden within a general discipline-based and interdisciplinary curriculum was a significant concern among teacher students.

5.2.5 Competencies

An important question related to teaching in the learning garden that teacher students were asked 'What do you think are the most important competencies that students can develop through teaching and learning in the learning garden?'. Based on this open-ended question, the results were clustered, and four main categories emerged.

(1) Social competency

Social competency was the most critical competency. It was named by 31% of teacher students. Social competency had been related to teamwork and togetherness in the learning garden. Teacher students argued that different people come together in the learning garden, resulting in a new social mix. Teacher students saw the learners' potential to work together and learn from each other. One student described the importance of *"planning and realizing joint projects, reflecting on them"* (S. U. - E). The following quotation also shows the learning garden is an intergenerational learning space.

"By a learning garden, I mean a place out in nature that allows many people to work together and learn from each other, no matter their age. So everyone can plant something in this garden and pass on their knowledge to the others." (S. U. - C)

(2) Conscientiousness

The second most crucial competency mentioned by 25% of the teacher students was conscientiousness. For teacher students, their future students need to learn to take responsibility through the learning garden. Conscientiousness was strongly related to an appreciation for nature, plants and food. The competency of conscientiousness could be related to the teacher educators learning outcomes related to values. One student explained that she wished for students to *"develop mindfulness towards nature and their fellow human beings"* (S. U. - C). Another aspect that was valued by a lot of teacher students was patience. One student described that learners could practice patience from sowing to harvesting.

On the other hand, it was important for teacher students that learners would develop responsibility not only for the plants in the learning garden but also related to different aspects of sustainability. For most students, this responsibility for sustainability encapsulated consumer-based individual decisions. For example, one student described that learners should develop a *"sustainable lifestyle and sustainable consume decisions"* (S. U. - C) through the learning garden. Similarly, another student mentioned that learners should form an *"understanding of sustainability and implementation in everyday life"* (S. U. - B). The concern for more sustainable consumption decisions has also been related to the food system. For instance, critically reflecting on the food system was mentioned by students. Likewise, one student described that learners should *"critically question their own nutritional behaviour"* (S. U. - D).

(3) Self-efficacy

According to teacher students, the third competency that is vital to form in the learning garden is self-efficacy. Teacher students related this to the learner's ability to create something with their own hands. One student acknowledged that *"harvesting something that you have grown yourself makes proud"* (S. U. - A). Self-efficacy in the learning garden was associated with the physical activities that form *"an alternative to sitting quietly in class"* (S. U. - A). Teacher students described that their work results are directly visible in the learning garden. Hence, one student acknowledged that learners could understand the consequences of their actions *"good care means rich harvest"* (S. U. - C). According to teacher students, directly seeing tangible results in the learning garden was a clear advantage to the classroom. One student described, *"the pupils can observe the growing process of what they have grown themselves and enjoy the final product"* (S. U. - D). In the learning garden, the children learn through *"taking responsibility for one's own projects/areas, contributing one's own ideas, being active oneself."* (S. U. - E). Another aspect is that the students often face challenges in the learning garden, where there is no single solution to approach it. As one student acknowledged in the learning garden, *"not everything runs smoothly",* so the children learn to *"deal with precipitation"* (S. U. - D)

(4) Action competence

Action competence is the fourth competence that 17% of teacher students mentioned. Action competence was related to different aspects of the learning garden in the descriptions of teacher students. Teacher students related action competence to acting and implementing what was learned in the learning garden. One student described that she understood action competence *"in the sense of the independent application of the acquired knowledge and sustainable consumption."* (S. U. - D). Other students related action competence to *"experiencing "proper" work"* (S. U. - A) and that they are getting to know *"the most important gardening techniques and can apply them professionally".* Some other students related action competence more to sustainable development.

5.2.6 Sustainable food consumption

Even though no question in the questionnaire directly related to the food system. In a way, food and sustainable food consumption were omnipresent in the data. As showcased in the chapter on teacher students' expectations, harvesting was the number one experience teacher students hoped to have in the learning garden. Harvesting fresh vegetables in the learning garden was important for 27% of teacher students. For example, one teacher student expressed the wish to *"feel pride, joy and pleasure in the things you grow yourself"* (S. U. - A).

The most common denominator, similarly to what the results of the teacher educators indicated, was the contribution of the learning garden to more sustainable consumption of food. Related to the question 'Name three goals you have with teaching in the learning garden.', the most frequent answer mentioned by 35% of teacher students was a sustainable consumption of food. Teacher students hoped that the learners would consume more vegetables through the learning garden and live healthily.

"Positive experiences in connection with the learning object provide positive connotations for the child (vegetables and co. are presumably viewed with new eyes and, i.e.. are also eaten more readily)" (S. U. – E)

Like the teacher educators, teacher students also wished that the learners would develop more appreciation of food. One student explained that more significant appreciation of food was achieved through an *"awareness for the necessary resources for growing food"* (S. U. - C). It was also explained that learners would appreciate food more by learning about different food system aspects. One student described that the learning garden could *"change the perspective of the learner from the cultivation over the purchase to the waste of food"* (S. U. - C). Similarly, it was stated that the cultivation in the learning garden should be *"framed in the context of "normal" agriculture."* (S. U. - D).

Figure 11 visualizes the answers by teacher students: 'How do you rate the importance of the following aspects to the successful implementation of a learning garden?'. Surprisingly, the knowledge of interrelated global topics or cooperation with different food system actors was significantly less important than the other aspects. Only 8.8% of teacher students rated cooperating with different food system actors as necessary. 23,4% of teacher students viewed linking the learning garden to different food system actors as relatively unimportant or extremely unimportant. Compared to that, 76,6% of teacher students viewed horticultural background knowledge as extremely important and only 6,5% as relatively or extremely unimportant. Still, teacher students rated knowledge of interrelated global topics and ESD implementation as necessary. Hence, it could be concluded that the teacher students regarded food system education as less important than education for sustainable food consumption. This finding could be related to the teacher educators' results. The data suggested that sustainable food consumption was a primary aim of teacher educators.

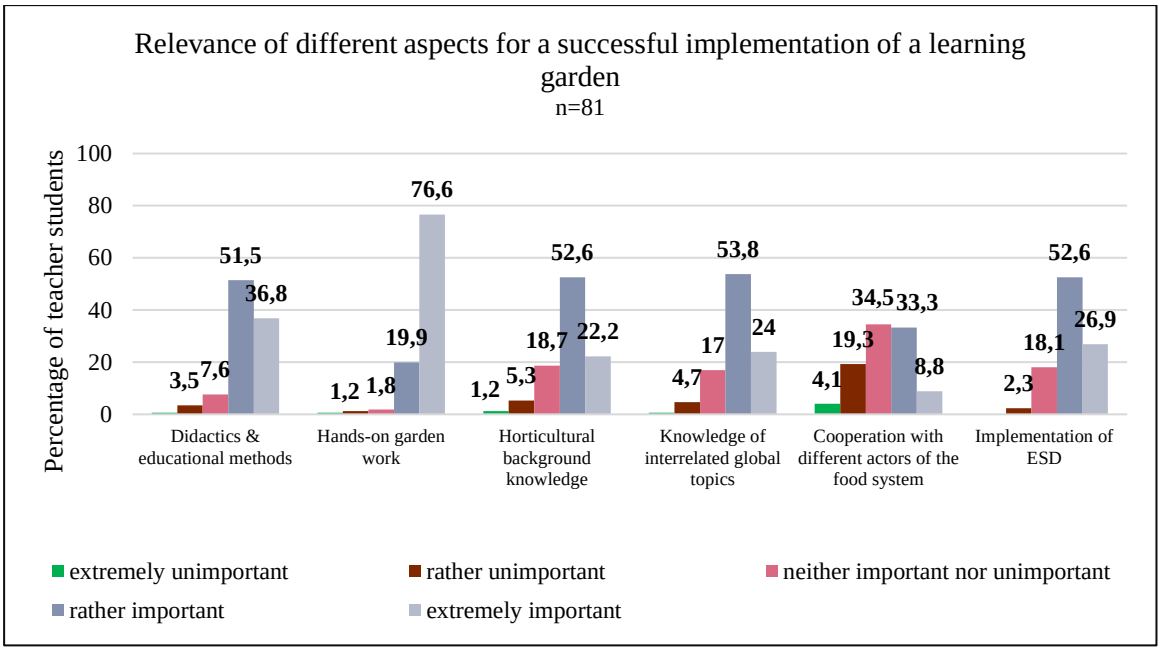

Figure 11: Importance of different aspects for the successful implementation of a learning garden

6 Discussion

The primary aim of this discussion is to answer the research questions and not only describe the findings but suggest approaches to challenge and change reality. Since there are two different target groups, the findings are compared, and conclusions are drawn for the respective target group.

What challenges and facilitating factors do teacher educators view as significant for garden-based learning in teacher education in Germany?

The results indicated that for all teacher educators setting up a learning garden was related to specific challenges. On the one hand, the teacher educators had to find arable land, support from colleagues, support from the university administration and funding to cover all the costs of a learning garden. Hence, teacher educators depended on help from various stakeholders, especially in the early stages of the learning garden. Whether the universities supported the learning garden depended on factors such as the research profile and the profile of the teacher education programme. The literature somewhat mirrors the challenges experienced by teacher educators. For instance, Van Dijk-Wesselius et al. (2020) argued that the barriers were caused by the lack of formal status of the learning garden, which has been acknowledged by Respondent 1 as well.

Even though all teacher educators overcame the hurdles of initiating a learning garden, there was general frustration about the time-consuming process, which they managed due to their intrinsic motivation to teach in a learning garden. The analysis indicated that teacher educators were mainly motivated by five factors – (1) enjoyment of gardening, (2) possibilities for teaching, (3) learning outcomes, (4) disrupting preconceived norms of education and (5) lost connection to food. The findings by Barfod (2017), to some extent, have validated the results of this study. Barfod (2017) studied the intrinsic motivation to perform ‘udeskole’ amongst experienced teachers and found that teaching with its unforeseen possibilities that forced teachers to think outside the box was intended. Disrupting the norms of isolating the school from the living world and the narrow educational goals put forward by Barfod (2017) reappeared in the motivational factor of disrupting preconceived notions of education.

In the second phase, teacher educators tried integrating the learning garden into the existing teacher education curriculum. They encountered the headwind associated with the learning garden's experimental approach and new learning culture. This resistance was not the case at universities where a teaching and research orientation conducive to the learning garden was already in place, such as at the University of Bonn, where interest theory shaped the direction of biology didactic teacher training.

In the third teaching phase in the learning garden, the teacher educators generally faced more challenges than facilitating factors. In addition to the conditions, such as the short duration of the semester or the need to subordinate themselves to the standards of the NGO, it was difficult for the teacher educators to motivate the students for the maintenance also beyond the semester. It was beneficial for the teacher educators to be provided with teaching materials, structure, and expertise in garden-related topics by the NGO. This finding indicated that teaching in the learning garden in general also plays a challenging role for teacher educators due to its novelty, especially for teacher educators without prior experiences, such as Respondent 2. However, compared to the literature (cf. van Dijk-Wesselius et al., 2020), this challenge is minor, mainly because the teacher educators have mostly gained prior experience with different forms of learning gardens. In comparison, the data of teacher students indicate a great deal of uncertainty concerning teaching in the learning garden as 48% of the students wanted to learn about garden-based education in the seminar.

What do teacher educators and teacher students view of teaching in the learning garden have in common?

The previous chapters highlighted various essential aspects related to teacher students and teacher educators understanding of teaching and learning outcomes in the learning garden. Three common elements were found in both target groups' data to answer this research question. The first part of the answer to this research question is related to the (1) changed role of the teacher. The second part of this chapter is related to (2) experiential learning. The third part aims to connect both parts by proposing (3) role of the learning garden. These three views are strongly interrelated and mutually dependent, as shown in Figure 12.

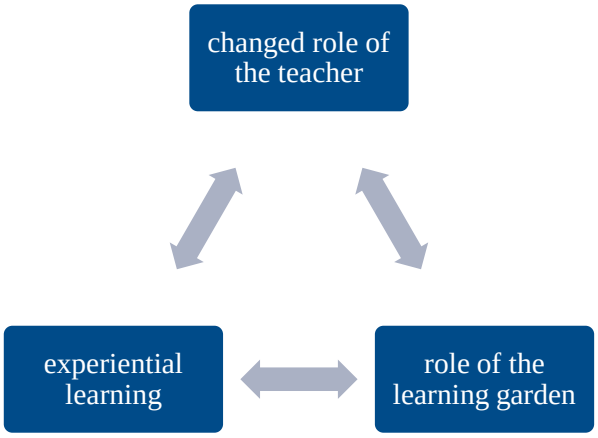

Figure 12: Common views of teaching in the learning garden

Changed role of the teacher

The teacher's changed role appeared in both target groups' data. In the learning garden, the teacher educators became role models of the different ways of relating with their students. Teacher students and teacher educators became learners together. This finding could be in particular linked to the studied teacher education programme. The teacher educators were also learning in the programme and were supported by the garden experts.

The changed role of the teacher and the critical role of teacher educators in the learning garden was also present in the case study of the University of Bonn. Even though teacher educators gave their students a lot of freedom, it was also acknowledged that *"someone must be there to see how much support the person needs, or at least be there to answer questions."* (Amélie Tessartz, University Bonn). This finding fits well with A Manifesto for Education by Biesta and Säfström (2018, p.540), who argued that *"educational freedom is not about the absence of authority but about the authority that carries an orientation towards freedom with it."*

In contrast to this changed role of the learner is a finding that highlights that, in particular, teacher students saw the importance of gardening correctly. Some teacher students intended to become experts in the garden to correct their future students. As the questionnaires were sent to students before the seminar even began, these findings can most probably be linked to the teacher students prior learning experience either in the teacher education or the school. This idea might be further encouraged by the garden expert that educates teacher students in the learning garden teacher education programme. This notion of the 'correct way' to gardening and expertise knowledge may represent a eurocentric perspective among teacher students. To transform this perception of gardening correctly, it might be essential for teacher educators to encourage students to make mistakes in the learning garden and react positively to any errors.

This finding of a changed role of teachers in the learning garden could be related to garden-based learning theory, described by Gaylie (2009). Gaylies' (2009) metaphor of the 'garden as transformation' explicitly highlights the change of the teacher students during the learning process in the learning garden. Through learning with their hands, heads and hearts, Gaylie (2009) described that students preconceived notions of teaching are challenged.

Respondent 7 summarized that the learning garden *"is not the classroom and the teacher is standing in front of it, but suddenly we are outside, but also manages not to reproduce this learning setting".* Therefore, the learning garden represents a break from the usual form of instruction. Respondent 7 acknowledged that there might be a potential threat for the learning garden if teacher students would reproduce the same kind of frontal learning to which they are used to. Hence, the changed role of the teacher in the learning garden is disrupting the educational norms. Another part of the teacher students emphasised the new relationship between teachers and pupils in the learning garden. It has been described that everyone can share their knowledge and ideas in the learning garden. Gaylie (2009, p.6) explained that learning in the garden *" must unfold slowly, with care, sensitivity and deep awareness of one's surroundings".*

Teaching and learning in the learning garden could be understood as the tension of 'what is' and 'what is not'. To not reproduce the education and not dream of an unattainable ideal version of education, Biesta and Säfström (2018) argued that challenging the status quo and taking responsibility for the present is only possible by staying in this tension.

Experiential learning

The second aspect essential in the learning garden is experiential learning. Both teacher educators and teacher students emphasised hands-on practical learning opportunities in the learning garden. The teacher educators emphasised the aspect of ESD concerning experiential learning. Experiential learning as a pedagogical strategy combined with place-based and inquiry methods was described by Evans et al. (2017) as being employed by teacher educators for embedding sustainability into teacher training.

Teacher educator's metaphoric perceptions of the learning garden as an island of hope, a living lab of sustainability and a playground come to mind when discussing the importance of experiential learning

for teacher educators. The learning gardens enabled experiential learning for the teacher educators, as their primary motivation was to experience the joy of gardening when teacher educators shared and modeled their joy of gardening as co-learners with their teacher students, as described by Grant and Littlejohn (2004).

For teacher educators, the learning garden was a living lab of sustainability as it covers different aspects and issues of sustainability and thus could help to educate teacher students about sustainable practices for their life and teaching practices for ESD at the same time. Respondent 6 acknowledged that through the learning garden, teacher students can experience different aspects of sustainability and recognize the importance of their engagement for a sustainable future. In the learning garden, teacher students are simultaneously exposed to experiential learning and learn how to incorporate experiential learning into the learning garden. As described in the University of Bonn case study for some teacher students, this new form of instruction and freedom was overwhelming. Experiential learning related to the changed role of the teacher created a new learning culture which caused initial irritation. The different learning culture could be related to the finding that teacher students were looking for ways to manage groups outdoors and thus keep control over the learning happening. This difficulty with the open and free form of experiential learning in the learning garden was reflected in the study by Barfod (2017), who found that teaching implied a loss of perceived control, which the teachers had to become accustomed to.

Experiential learning might better equip teacher students to teach in the learning garden. Teacher students in the learning garden according to Gaylie (2009) learn to teach by learning to learn. By trying to cultivate vegetables and teaching in the learning garden, teacher students become confident and motivated to teach in the learning garden. Teacher students often missed hands-on and practical learning in the teacher training programme. 76.6% of teacher students rated experiences such as hands-on garden work as extremely important for successfully integrating the learning garden.

Role of the learning garden

Another promising finding of this thesis was that the learning garden inhibited a central role that guided teacher educators' and teacher students' learning. The results proved that teacher students and teacher educators viewed experiential learning as inseparable from the learning garden.

Experiential learning in the learning garden forms the conditions for the coming together of humans and the more-than-human world, which can, at the same time, be a basis for food system education. Wals's (2020) relational pedagogy of hope is present in the learning garden as teacher students and teacher educators related to the local environment and treating another human, nonhuman beings and non-living matter with more care. Gaylie (2009) argued for viewing the teaching process in the learning garden in terms of gift giving. The teacher students give to the land and the gift of shared knowledge to each other.

Respondent 8 described that the teacher students were worried when it snowed or hailed about how the plants were doing but that they were also frustrated when the plants were not growing, as Respondent 1 mentioned. From these statements, it can be assumed that teacher students were emotionally connected to the plants in the learning garden. As described, the usual perspective of humans as consumers of food changes to growing food and caring for plants not as a commodity but as living beings. Respondent 4 argued that she wished for teacher students to take ownership of the learning garden and not only come there for the lecture but also to read a book in the learning garden or just marvel at plants. This aspect of ownership and agency for the learning garden might be created through participative creation of the garden, i.e. deciding on the cultivated crops and the design of the learning garden.

More care and emphasis on the needs of the garden were developed through the self-exploratory walks through the garden without teacher-centred instruction. When teacher students arrived at the learning garden, they walked through the garden and took in the plants' growth and everything that had happened since the last time they were there. Free exploration of the garden and discovering it for themselves is a central part of the studied programme. At the beginning of every seminar, students take a self-guided walk and think about the needs of the garden and what they should do to get those needs met. Through this process in which teacher students and teacher educators experience the garden with its needs and developments, the garden becomes a teacher and an actor.

Among teacher students, some challenging views were found related to the role of the learning garden. While some teacher students referred to plants as 'useful', which was related to using plants as a tool for teaching about the cultivation of food, others perceived the learning garden as a place that could be made more beautiful through their gardening activities. In that sense, Ostertag (2018) critiqued the anthropocentric and Eurocentric nature of these beliefs that humans have the right to control nature. The garden has been positioned as a passive object subject to human control as proposed by actor network theory (Power, 2010). In the context of this thesis, actor network theory in the learning garden can be used to problematize the interactions of humans with inanimate objects (Power, 2010).

How do teacher educators envision food system education in the learning garden?

Critical food system education by Meek and Tarlau (2016) has been a point of reference for answering this question. This thesis's findings supported the unpolitical nature of food system education in learning gardens.

One important finding is that many teacher educators were intrinsically motivated to teach in the learning garden by the so-called "lost connection to food". This finding is in line with how learning gardens have been portrayed in the literature. Cairns (2017) pointed out that the learning garden is often constituted as a place that could reinstall the lost connection to nature and the modern food system (Cairns, 2017). Malone (2015) described that the perception of our current lifestyle as being distanced from nature as being highly anthropocentric. The notion that proximity to nature would be a question of learning and teaching was criticized by Malone (2015).

Another essential finding relates to teacher educators' understanding of a sustainable food system centered around local and regional food consumption. Most teacher educators neglected the global repercussions of local and regional food choices. Born et al. (2006) have described the fallacy of the local trap. Thus, perceiving the learning garden as a solution to the food system's problems could be problematic as it neglects to point toward transforming the centralized mainstream food system's structural, large spatial, and economic scale. It is argued that not the scale of the food system but the content of that agenda is vital for achieving a sustainable food system (Born et al., 2006).

Another important finding was that it was essential for 4 out of 6 teacher educators to motivate the students to eat more sustainably. This finding is in line with the results by Williams and Dixon (2013), who indicated teachers' focus on increased fruit and vegetable consumption among children. In the article 'Critical food systems education (CFSE): educating for food sovereignty' the authors highlighted that education in the learning garden has over-emphasized knowledge and healthier eating habits (Meek and Tarlau, 2016). In the literature, as well as in the data, a controversy related to the necessary route to transformation was found. Meek and Tarlau (2016) argued that this form of learning gardens would reproduce the current food system instead of transforming it. On the contrary, Galt et al. (2013) argued that the notion of educating the learners to become "responsible eaters" would be one way to approach food system change. Soulis (2016) criticized how questioning the dominant food system, and its inherent injustice constraining people's ability to eat healthily is often not discussed.

Critically examining the restricted ability of certain groups to eat sustainably with teacher students could benefit their training and enhance their capacity for CFSE in the learning garden.

On the other hand, Meek and Tarlau (2016) argued for encouraging a systemic change in which those consumer choices are taken, which was also present in the data. This was related to whether teacher educators perceived the learning garden as a place of political education. A group of teacher educators highlighted the importance of the politics behind the food system. Respondent 2 expressed that it is essential to incorporate *"who determines what we eat"* into the learning garden by connecting to the topic of agribusiness, global trade and economy. Respondent 5 argued that the learning garden is a political space, where questions around societal context should be posed. Gaylie (2009) described the learning garden as a paradox because it is a small-scale and simple local solution to the much larger complex global environmental problems and how teacher students need to engage in this dichotomy to understand the actual contribution of the learning garden. Here, the critical element of Wals (2020) pedagogy of hope is noteworthy, as he argued that learners should be encouraged to raise provocative questions. Respondent 7 claimed that he discusses aspects of the learning garden from different perspectives. He stated, *"It's much more than saying this is good because it's regional, and we eat our nice vegetables and you go to the organic store and that's all good, but also to critically question these things and weigh different positions."* As the literature review of this thesis presented different approaches to food system change, those need to be integrated into teacher education by putting them up for discussion. Students in the learning garden could ponder whether their efforts in the learning garden are sustainable and through this discussion understand the complexity of the food system and sustainability while practicing a critical reflection process.

Similarly, Respondent 7 explained that even though following a sustainable diet is essential, the *"influence of the individual is relatively small".* Hence, according to him, the responsibility for a sustainable food system should *"not be passed on to consumers because there are very, very, very complex global political aspects involved".* What can lead to a change in the food system and what keeps it from changing should be discussed, according to Wals (2020). Thus, promoting and organizing structural changes is also facilitated by CFSE, i.e., connecting them to movements that are trying to transform the food system (Meek and Tarlau, 2016).

Food system education might be possible as the learning garden can enable the learner to understand the bigger picture of the food system. This is only feasible with a critical discussion around the four cornerstones of CFSE. Critical discussions engage with contrasting ideas within civil discourse (Piro and Anderson, 2015). In teacher training, critical discussions are essential for encouraging critical discussion with learners. Even though most teacher educators mentioned discussions, these discussions were mainly linked to personal consumption decisions instead of the politics behind the food system. According to Poeck, Östman and Öhman (2019), critical discussion is a catalyst for change and represents a pluralistic form of ESD. Critical discussions around the food system lead to democratic citizens. Hence, discussing different aspects of the learning garden and their relation to the food system could lead teacher students to become democratic citizens (Poeck, Östman and Öhman, 2019). In turn, they might enhance their future student's democratic capacities through the learning garden.

Another finding that this thesis made was that every fourth teacher student believed cooperation with different food system actors would not be necessary to implement a learning garden successfully.

This thesis found that teacher educators argued that through the learning garden, teacher students become an active part of the food system. It is possible that through this experience, the learners realize their capacity to transform the food system. Usually, in our food system, the role of the consumer is powerless. Wals (2020, p.826) argued that possibilities for action should be created to

avoid a *"doom-and-gloom education",* where existing structures are merely problematized but not transformed. Valley et al. (2018) suggested a signature pedagogy for sustainable food systems education for higher education consisting of (1) collective action, (2) systems thinking, (3) experiential learning and; (4) interdisciplinarity. They argued that providing sustainability content focused on food systems complements ESD.

Recommendations for future research

To better understand the implications of the results of this research, future studies should further address teacher educators' perceptions of learning gardens, their motivation to teach in a learning garden, and their perspectives on learning outcomes in the learning garden to strengthen the results of this study. It would be interesting to compare the results from Germany with those of other countries and circumstances. It could be intriguing to compare the findings with contexts where the teacher educators are not participating in a program like the one investigated here, as it has been touched on in the case of the University of Bonn. It is undecided which approach may work better and also to determine what a 'better' would mean, especially in light of enabling teacher students to teach education for sustainable development in their future careers. This study found a connection between the teacher educators' perspective of education for sustainable development and the learning garden. For future investigations, this link could be explored more thoroughly. As the garden-based critical food system education, particularly in university settings, is scarce, developing more insights would be highly beneficial for food system education. For instance, looking at case studies where Universities have already implemented critical food system education into the teacher education programme would be very valuable to the field.

7 Conclusion

Food systems can nurture human health and support environmental sustainability (Hilimire et al., 2014). The food systems threaten human health and nature, so they need to be transformed. It is widely acknowledged that learning gardens offer a direct experience of the cultivation of plants and can also be a platform for critical discussions around the food system. Teacher education is often seen as resistant to change and often reinforces problematic views of education and the natural world that contradict education for sustainable development. As Orr (1994) noted, education can equip humans to be vandals of the earth.

Teacher education in learning gardens is an important area to focus on, as they can become venues for education for sustainable development and food system education. Thus, learning gardens can contribute to the transition towards a sustainable future if teacher students become equipped to lead that change process. Learning outdoors can accomplish many objectives and principles of education for sustainable development (Hellinger, 2021) and challenge the current food system as proposed in critical food system education by Meek and Tarlau (2016). If the learning garden only prepares the learner for the neoliberal market-oriented world, as we know it today, unsustainability in the food system and education is reproduced. Studying teacher educators' and teacher students' attitudes towards teaching and learning in the learning garden is necessary for designing garden-based teacher training conducive to education for sustainable development and a sustainable food system.

This research aimed to identify the potential and limitations of garden-based teacher education incorporating food system education. Therefore, this study has combined three complementary theories. Garden-based learning, as proposed by Gaylie (2009), focuses on the role of the garden in teacher education as environment, community, and transformation. As Meek and Tarlau (2016) presented, critical food system education approaches food system change by helping students realize their potential in structurally transforming the food system through collective action. Actor network theory analyses the human-nature relationship by not privileging one over the other.

Overall, it was found that the educational opportunities of the learning garden in teacher education depend significantly on the teacher educator. Factors that influence whether and how the learning garden is implemented into teacher education rely on the teacher educator's expertise in the learning garden. Their previous experiences in the learning garden, motivation, connections to different stakeholders and perceptions of the learning garden and teaching are essential premises.

This research indicated the following challenges and facilitating factors concerning integrating garden-based learning into teacher education in Germany:

- Support from various stakeholders is essential, especially in the early stages of the learning garden.
- The intrinsic motivation of teacher educators is a critical facilitating factor.
- The novelty of the learning garden in the university setting was a critical barrier to the integration into the curriculum of the teacher education programme.
- The role of learning gardens needs to be promoted, and awareness amongst decision-makers and the wider public should be raised.
- Previous experiences of teacher educators facilitated the teaching in the learning garden.

Concerning common views among teacher educators and teacher students of teaching in a learning garden, three commonalities can be concluded. These are the changed role of the teacher, experiential learning and the role of the learning garden.

- Teacher students and teacher educators both perceived the learning garden as a place for experiential learning, where the traditional student-teacher relationship could be challenged.
- The learning garden itself became a "teacher" that stimulated action in the teacher students and teacher educators.
- Teacher students found it necessary to learn the 'correct' and 'expert' ways of cultivating vegetables.
- Even though teaching was connected to enjoyment, especially among the teacher educators, the majority of teacher educators perceived particular learning outcomes as essential.
- Both for one group of teacher educators and teacher students, learning outcomes were seen as essential. In contrast, for the other group of teacher educators and teacher students, they were less critical.
- Teacher students focused on four competencies: social competency, conscientiousness, self-efficacy and action competency.

To answer the subquestion related to the implication for the development of future teaching in the learning garden, it was found that:

- Experiential learning should be prioritized over learning outcomes in the learning garden.
- Anthropocentric thinking should be challenged by giving a voice to the land and community, as suggested by Gaylie (2009).
- Dealing with mistakes in a positive way to overcome the perceptions of a "correct" way of gardening should be implemented by teacher educators.
- Moments of irritation among teacher students are favourable to strengthen their perception of a changed role of the teacher and the learning garden.
- Debriefing and critical discussion can be helpful for teacher students to deliberate their own teaching practice in the learning garden.
- Integrating opportunities for teacher students to practice teaching in learning gardens can strengthen their learning in terms of experiential learning and the changed role of the teacher and the garden.

With regards to how food system education is envisioned in the learning garden, it can be concluded that:

- Teacher educators haven't thought about food system education in the learning garden.
- The teacher students and teacher educators perceived the learning garden as contributing to a more sustainable food system through a more sustainable diet and consumption.
- Teacher educators perceive a sustainable food system mainly as being local and regional.
- The learning garden was an excellent example of a sustainable food system for teacher educators.
- Teacher educators conceptualized the food system in the learning garden, that the learner is becoming a part of the food system and can follow the entire value chain.

Overall, the learning garden provided both teacher educators and teacher students with experiences of growing food. Nevertheless, utilizing the learning garden for critical food system education means re-envisioning how garden-based learning should occur. Garden-based teacher education for critical food system education needs to equip teachers to critique and transform the food system radically. The learning garden can challenge teacher students' *"assumptions about land, learning and 'successful' academic progress"* (Gaylie, 2009, p.75). Finally, this thesis suggests not overemphasising technical

and expert knowledge and healthier individual choices in teacher-based learning in teacher education. Instead, the learning garden could equip teacher students with the necessary understanding and competencies to transform the food system.

For ESD, the learning garden can guide insights for teacher educators, and teacher students alike as the complex theory of sustainability is reduced and understood through experiential learning. This is pointed out by Respondent 6, who described *"Sustainability" is being pasted on everything - it's very chic right now. Still, it's important to really get to grips with what it actually means and how you can contribute to transforming the university, but then also your own everyday life, society and especially teachers, who have a multiplier function, who bring this into the schools."* The learning garden with its potential to bring people together and learn with the more than human world is essential to integrate it into teacher training as it gives opportunities for experiential learning and transforming the role of the teacher as well as the anthropocentric perceptions of the garden. Changed perspectives among teacher educators and teacher students alike, as Respondent 6 described, can transform the educational sector and have multiplying effects on other aspects of society.

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Appendices

Appendix A: Curriculum of the studied garden-based teacher training programme

Seminar	Description of the seminar	Learning outcomes
1. Introduction and setting up the learning garden	During the first seminar in the learning garden, we get to know each other, clarify prior experiences, create a shared vision, and establish beds and pathways.	- Teacher students know what to expect in the seminar and know the team. - Teacher students know the vision journey method and have developed a vision for the programme - Teacher students know what is important in setting up the learning garden. - Teacher students know how to create beds and paths and how they can create them with learners.
2. Planting workshop I	In the second seminar in the learning garden, different planting techniques (young plant, seedling), sowing techniques (mark seeding, row seeding, broad seeding, etc.) and rules and freedoms of the learner in the learning garden are covered.	- Teacher students know the basic planting and sowing techniques and can apply them with learners. - Teacher students know rules and freedoms of the learner in the learning garden.
3. Garden maintenance I	In the third seminar in the learning garden, we cover ESD in the learning garden, as well as basic techniques (hoeing, raking, watering, weeding) and weekly to-dos.	- Teacher students know the basic care techniques and can apply them with the learners. - Teacher students know why we use these techniques - Teacher students can relate the principles of ESD to the learning garden
4. Soil fertility	In the fourth seminar in the learning garden, we cover the basics of soil fertility and the use of experiments in the learning garden.	- Teacher students know the functions of the soil and the main types of soil - Teacher students have basic knowledge of soil fertility in the learning garden. - Teacher students understand techniques to increase soil fertility and can apply them in the learning garden.
5. Planting workshop II	In the fifth seminar in the learning garden, we cover the topics of plants that are strong uptakers and mulching.	- Teacher students learn planting techniques for tomato, squash, zucchini, cucumber and corn - Teacher students know the background for mulching - Teacher students know which material is suitable for mulching

		- Teacher students can implement mulching independently
6. Organisation of the learning garden	In the sixth seminar in the learning garden, we deal with topics such as the organisation of the learning garden and challenges in the implementation (such as finding supporters or vacation care).	- Teacher students can name the challenges of organizing a learning garden and develop application-oriented, pragmatic solutions. - Teacher students can communicate advantages, benefits and needs for a network around the learning garden.
7. Garden maintenance II	In the seventh seminar in the learning garden, we cover the topics of water as a resource in the field and harvesting techniques.	- Teacher students know that water is a precious resource. - Teacher students understand the consequences of water shortage and surplus. - Teacher students know how to water efficiently, how to check if watering is needed, and how to water correctly. - Teacher students will be able to sprout tomatoes. - Teacher students know different harvesting techniques.
8. Ecological balance in the learning garden	In the eighth seminar in the learning garden, we treat the importance of ecological balance, liquid manure, and broths	- Teacher students recognize the most important pests and beneficial insects on the field and can deal with them to maintain the ecological balance. - Teacher students know which liquid manures and broths are available in the field and can create a liquid manure.
9. Evaluation workshop and completion	In the last seminar in the learning garden we celebrate the harvest, the students share their motivation to create a learning garden. In addition, the seminar is evaluated, and the students receive their certificate and appreciation for their participation.	- Teacher students reflect on the seminar. - Teacher students master harvesting techniques and recognize vegetables ready for harvesting. - Teacher students reflect on their motivation for teaching in the learning garden.

Appendix B: Online survey for teacher students

1) What do you understand by a learning garden?
2) What do you want to take away from this seminar?
3) What topics should not be missing from the seminar?
4) What should not be missing from the seminar in terms of experience?
5) How would you rate your current experience growing vegetables?
   a) I have no experience at all.
   b) I have little experience.
   c) I have a lot of experience, but I do not deal with it regularly.
   d) I have a lot of experience and deal with gardening regularly.
6) What factors do you think are most significant for the successful integration of a learning garden into an educational institution?
7) How do you rate your current pedagogical-didactic experience, to teach in the learning garden?
   a) I have no experience.
   b) I have little experience.
   c) I have a lot of experience.
   d) I have a lot of experience.
8) Do you think that by working in the learning garden, children can develop a greater appreciation for nature and food?

0	1	2	3	4	5	6	7	8	9	10

No, absolutely not! Yes, definitely!

9) What do you understand by education for sustainable development (ESD)?
10) What are three advantages of experiential learning in the learning garden compared to teaching and learning in the classroom?
11) In your opinion, what are the most important competencies that students can develop through teaching and learning in the learning garden?
12) List three goals you associate with teaching in a learning garden.
13) How important do you think the following aspects are for the successful implementation of a learning garden?

	extremely unimportant	rather unimportant	neither important nor unimportant	rather important	extremely important
a) didactics & methods for implementation with the children in the learning garden					
b) practical activities in the learning garden					
c) horticultural background knowledge (e.g. life cycle assessment)					
d) practical implementation of ESD					
e) working together with actors of the food system					
f) knowledge of global topics, that are related to the learning garden					

14) Where do you study?

15) What do you study?

16) When will you graduate? Please list the highest degree you are aiming for (Bachelor, Master, etc.)

    a) 2022
    b) 2023
    c) 2024
    d) 2025
    e) 2026
    f) after 2027

17) How old are you?

    a) <25
    b) 25-30
    c) >30

18) Which gender do you identify with?

    a) male
    b) female
    c) diverse

Appendix C: Semi structured interview guide for teacher educators

1) What is your position at the university?
2) Have you worked at a school or taught at another institution before?
3) If yes, did the school or institution have a learning garden?
4) How many teacher students are enrolled in the teacher education programme?
5) What is the distance between the learning garden and the university?
6) How do you understand a learning garden?
7) What is the current role of education in a learning garden in the teacher education?
8) Why did you wanted to integrate a learning garden into teacher education?
9) What challenges and opportunities have you encountered in integrating a learning garden into teacher education?
10) What global perspectives can be integrated into the teacher training in the learning garden?
11) Is the learning garden a place of political education?
12) What is your understanding of a sustainable food system?
13) What is the role of education in a learning garden to achieve a sustainable food system?
14) What role do teachers play in getting to a sustainable food system?
15) To what extent does the learning garden contribute to food system education in teacher education?
16) What do you think about integrating the perspective of social movements concerned with food system change, such as ‘Solidarische Landwirtschaft’ (SoLaWi), into teacher education?
17) How can food system teacher education in the learning garden look like?
18) Is there anything else I haven't asked you about that you would like to tell me about?

Appendix D: Online survey for teacher educators

1) What is your name?
2) What are the most significant learning outcomes that student teachers should achieve in the learning garden?
3) How do you define competencies in the context of the learning garden?
4) What competencies should student teachers develop in the learning garden?
5) How do you define knowledge in the context of the learning garden?
6) What knowledge should student teachers acquire in the learning garden?
7) How do you define values in the context of the learning garden?
8) What values should student teachers learn in the learning garden?
9) How important is it that student teachers through the learning garden consume food sustainably?
    a) unimportant
    b) rather unimportant
    c) neither nor
    d) rather important
    e) important

Appendix E: Consent form for teacher educators

Consent form for *(name of teacher educator)*

RESEARCH TITLE:	GARDEN-BASED LEARNING IN TEACHER EDUCATION IN GERMANY - A MIXED-METHOD STUDY OF TEACHER STUDENTS' AND TEACHER EDUCATORS' VIEWS ON GARDEN-BASED EDUCATION
RESEARCHER:	LENA ROTHE

I have been given information about *"Garden-based learning in teacher education in Germany - A mixed-method study of teacher students' and teacher educators' views on garden-based education"* and discussed the research project with Lena Rothe who is conducting this research as part of a master's degree in Education for Sustainable Development, supervised by Dawn Sanders and Håkan Pleijel at the University of Gothenburg.

I have been informed of the potential burdens and risks associated with my involvement in this research. I was given the opportunity to ask Lena Rothe any questions about the research and my participation. I understand that my involvement in this research is voluntary. I am free to reject to participate and I am free to withdraw at any time. My refusal to participate or withdrawal of consent will not affect my treatment or my relationship with the University of Gothenburg in any way. If I have any enquiries about the research, I can contact Lena Rothe and contact phone number *(phone number of researcher)* or if I have any concerns or complaints regarding the way the research is or has been conducted.

By signing below, I am indicating my consent to (please tick):

- ☐ Be interviewed with a semi-structured interview guide

I understand that the data collected from my participation will be used for the purpose of a master thesis and potential further publications and I consent for it to be used in that manner.

Signed	Date
……..	……/ ……/ ……

Name

……..