5-17-2023 11:00 AM

Exploring Pre-service Teachers' Perceptions about the Use of School Gardens in Education for Sustainability

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A thesis submitted in partial fulfillment of the requirements for the Master of Arts degree in Education

Abstract

This study examines pre-service teachers' attitudes, interests, and views about the use of school gardens in education for sustainability, as well as pre-service teachers' range of understanding about the use of school gardens in education for sustainability and how they think school gardens impact students' cognitive, affective, and psychomotor learning for sustainability. To answer the main research questions, a mixed-methods research approach was used in the study. Parajuli's Partnership Model of Sustainability was used as the conceptual framework for this research, which emphasizes four main aspects of sustainability: ecology, economy, equity/social justice, and bio-cultural diversity. The research findings revealed that the majority of pre-service teachers have overall positive attitudes, interests, and views about the use of school gardens in education for sustainability. Also, there was no statistically significant difference in the overall attitude, interests, and views between different demographic data of pre-service teachers, such as their age, sex, year of study, and teachable subjects. As well, results showed that the majority of pre-service teachers do not have a suitable understanding of the concept of "education for sustainability," and their understanding of the use of school gardens in education for sustainability aligns with only certain aspects of sustainability. Furthermore, the study revealed particular learning outcomes of school gardens suggested by pre-service teachers that address students' knowledge, skills, and attitudes toward sustainability. The study also provided insight into pre-service teachers' future tendencies to use school gardens in education as well.

Keywords: Education for Sustainability (EfS), sustainability, school gardens, garden-based learning, pre-service teachers

Summary for Lay Audience

The main objective of this study was to examine pre-service teachers' perceptions about the use of school gardens in education for sustainability. The study explored three main research questions, focusing on pre-service teachers' attitudes, interests, and views about the use of school gardens in education for sustainability, as well as pre-service teachers' range of understanding of the use of school gardens in education for sustainability and how they think school gardens impact students' cognitive, affective, and psychomotor learning for sustainability. Parajuli's Partnership Model of Sustainability, which emphasizes four main aspects of sustainability: ecology, economy, equity/social justice, and bio-cultural diversity, was used as the conceptual framework for this research, and both quantitative and qualitative data were used to answer the research questions. The research findings revealed that the majority of pre-service teachers have overall positive attitudes, interests, and views about the use of school gardens in EfS. The study found that according to Parajuli's Partnership Model of Sustainability, the majority of pre-service teachers do not have a proper understanding of the holistic viewpoint of the concept of EfS, and their understanding of the use of school gardens in education for sustainability is limited to the ecological and economical aspects of sustainability. Furthermore, pre-service teachers emphasized specific learning outcomes of school gardens that address students' knowledge, skills, and attitudes toward sustainability, and these learning outcomes of school gardens addressed all four main aspects of sustainability. In addition, the study revealed pre-service teachers' future tendencies to use school gardens in education as well. These findings contribute to the limited body of knowledge about pre-service teachers' perceptions of the use of school gardens in EfS

and add to the existing literature on teachers' current knowledge and understanding of the concept of "education for sustainability." The study recommends incorporating sustainability education into pre-service teacher education as a mandatory component to enhance teachers' knowledge and understanding of the concept of EfS.

Acknowledgments

Foremost, I would like to express my deep and sincere gratitude to my dear professor, Dr. Isha DeCoito, for her encouraging supervision and supportive guidance for my Master's program. Her inspiration and immense knowledge supported me during the conduct of research and the writing of the thesis.

I express my heartfelt gratitude to Ms. Erin Peterson, program coordinator of teacher education at Western University, for her help in recruiting potential participants for the study. Further, I would like to express my sincere gratitude for all the science and STEM course instructors in the B.Ed. program at Western University for their support in the data collection process.

I would also like to thank my thesis advisory committee for their insightful comments and feedback.

Further, I would like to offer my heartfelt thanks to my friends and colleagues for their support and encouragement. Finally, I would like to give my special thanks to my husband, Buddhika Liyanage, for his love, understanding, and continuous support.

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Abbreviations

EfS	Education for Sustainability
ESD	Education for Sustainable Development
GBL	Garden-Based Learning
NMREB	Non-Medical Research Ethics Board
PACT	Participation, Acknowledgment, Commitment and Transformation

Chapter 1: Introduction

With increases in human populations, several environmental, economic, and social challenges have developed globally, posing a threat to the sustainability of the planet. Furthermore, with scientists confirming the presence of a global environmental crisis, the preservation of the planet for future generations has become a primary concern in the world (Lewis & Maslin, 2015). To address these global challenges, education for sustainability (EfS) is crucial for developing individuals who are more environmentally conscious and aware of global issues (Novo, 2017). Education for sustainable development (ESD) emphasizes changes in knowledge, skills, values, and attitudes of citizens in order to create a more sustainable present and future, taking economic, environmental, and social factors into account (UNESCO, 2018). To achieve the sustainable development goals, it is necessary to improve outdoor education or naturalize school surroundings, which may be accomplished by adding gardens to schools at all levels (Perez-Lopez et al., 2021). Garden-based learning (GBL) is an instructional strategy that uses gardens as a teaching resource and tool to implement many educational activities (Desmond et al., 2002, p. 9). School gardens provide children with a variety of educational benefits and act as a platform for them to learn about environmental education and sustainability in both theoretical and practical ways (Papadopoulou et al., 2020).

Although school gardens offer many positive impacts on improving education for sustainability, there are significant challenges to effective school garden programs. According to the literature, a lack of teachers' interest, knowledge, experience, and training in relation to school gardens and garden-based learning are significant barriers to

adopting garden-based learning in schools (Graham et al., 2005; Graham & Zidenberg-Cherr, 2005). Also, as Cramer and Tichenor (2021) asserted, school gardens continue to meet opposition from school administrators and teachers. Teachers may play an important role in building students' sustainability awareness by teaching students about sustainability education (Evans et al., 2012; Uitto & Saloranta, 2017). However, many studies have found that in-service and pre-service teachers have limited knowledge and awareness about EfS (Borg et al., 2012; Borg et al., 2014; Burmeister et al., 2013; Evans et al., 2012; Pepper & Wildy, 2008; Spiropoulou et al., 2007; Uitto & Saloranta, 2017).

Research studies on teachers' perceptions, attitudes, beliefs, and interests about school gardens are much less in the literature than in studies on the impacts of school gardens on children. However, several studies were found in the literature that investigated in-service teachers' perceptions, attitudes, and likelihood to use school gardens and garden-based learning (Cramer & Tichenor, 2021; Fisher-Maltese & Zimmerman, 2015; Graham et al., 2005; Graham & Zidenberg-Cherr, 2005; Kincy et al., 2016; Murakami et al., 2016; Skelly & Bradley, 2000). Even though there is limited knowledge available regarding in-service teachers' perceptions of school gardens and both pre-service and in-service teachers' perceptions of EfS, there is a dearth of research that specifically examine pre-service teachers' perceptions of the use of school gardens in education for sustainability. As Murakami et al. (2016) stated, since there is "limited published research available, it is important to investigate educators' thoughts and perceptions about gardening programs" (p. 2). Also, as Kincy et al. (2016) suggested, there is a need for more qualitative research to determine the specific reasons why teachers use school gardens and why gardens are so important to their teaching.

According to Hart (2003), teachers' thoughts, beliefs, and feelings are reflected within their daily teaching practice, and teachers' perceptions and attitudes matter when implementing education for sustainability. Furthermore, as Beilock et al. (2010) affirmed, both in-service and pre-service teachers' attitudes about what they teach are important, because negative attitudes among teachers can hinder students' learning. When pre-service teachers become in-service teachers in the future, they play a key role in teaching sustainability education and fostering pro-environmental attitudes and behaviors to future generations. Therefore, it is important to examine pre-service teachers' attitudes, interests, and what they know, think, and believe about school gardens and their role in education for sustainability.

1.1 Scope, Context, and Purpose

After a careful review of the literature, I noticed that there is very limited research focusing on pre-service teachers' perceptions about the use of school gardens in education for sustainability, particularly in the Canadian context. Thus, research on this topic is warranted. Also, there is a knowledge gap in the literature about school gardens and their role in promoting pro-environmental behavioral changes in students. In order to address these concerns, I conducted an in-depth study to examine pre-service teachers' perceptions about the use of school gardens in EfS using a mixed-method research approach.

The context for this research is based on my view that in order to achieve sustainable development goals, school students should be educated on sustainability, and teachers can use school gardens as an excellent learning environment to teach sustainability education. In this sense, teachers play a key role in promoting school

gardens as a context to teach sustainability. As well, pre-service teachers play a significant role in enhancing environmental and sustainability education in the school system by conveying what they learned throughout their pre-service education (Elliott & Rodenburg, 2019). Furthermore, teachers' thoughts, beliefs, and feelings matter when implementing their daily teaching in the school (Hart, 2003). Since pre-service teachers become in-service teachers in the future, it is important to examine their views about school gardens for sustainability education.

Hence, the primary goal of this research study is to examine pre-service teachers' perceptions about the use of school gardens in EfS. To achieve the main purpose, I examine pre-service teachers' attitudes, interests, and views about the use of school gardens in EfS; their range of understanding about the use of school gardens in EfS; and how they think school gardens impact students' cognitive, affective, and psychomotor learning for sustainability.

1.2 Statement of Problem

This study explores pre-service teachers' attitudes, interests, and views about the use of school gardens for sustainability education as it may reflect the pre-service teachers' future tendencies toward the use of school gardens for sustainability. In addition, this study identifies pre-service teachers' range of understanding about the use of school gardens in EfS and their perceptions of how school gardens impact students' cognitive, affective, and psychomotor learning in EfS. Research findings will capture pre-service teachers' intention to utilize school gardens in the future to teach sustainability education as well as add to the literature on gaps in environmental and sustainability

education curricula in initial teacher education programs. Hence, this study is dedicated to exploring pre-service teachers' perceptions about the use of school gardens in EfS.

1.3 Researcher's Positionality

Through my undergraduate studies in the field of biological sciences and my long-term work experiences in the field of education as a teacher in biology, general science, and environmental science, I am interested in working with students in natural and outdoor settings, such as school gardens. I believe school gardens can be used as a great resource to teach students about sustainability. However, I noticed that the majority of teachers are hesitant to use school gardens, and if they do, it's only for the purposes of environmental education. Also, I observed that most teachers do not think that they can use school gardens to educate students on every aspect of sustainability. But I believe the integration of garden-based learning and sustainability education into the initial teacher education programs may awaken the pre-service teachers' knowledge and interest in the use of school gardens in EfS. Since pre-service teachers will become in-service teachers in the future, they play a key role in promoting school gardens as a context to teach sustainability. As a teacher, I also believe that teachers' perspectives are important when bringing their daily teaching into practice in the classroom. Therefore, as a researcher, I was curious to explore pre-service teachers' perceptions about the use of school gardens in EfS.

1.4 Research Questions

The following research questions provided the direction for my study:

1. What are pre-service teachers' attitudes, interests, and views about the use of school gardens in EfS?

2. What are pre-service teachers' range of understanding about the use of school gardens in EfS?
3. What are pre-service teachers' perceptions of how school gardens impact students' cognitive, affective, and psychomotor learning in EfS?

1.5 Significance of the Study

In accordance with the exploration of pre-service teachers' attitudes, interests, and views on the use of school gardens in education for sustainability, as well as their range of understanding about the use of school gardens in education for sustainability and how they think school gardens impact students' knowledge, skills, and attitudes for sustainability, my research study has the potential to improve education for sustainability in pre-service and in-service teacher education programs. This study is based on the assumption that what pre-service teachers know, think, and believe reflects their future teaching practices as well as their acquired knowledge and pedagogies of EfS during the teacher education program. Therefore, the findings will be helpful in determining their EfS curricular content and pedagogies in initial teacher education programs, as well as how they could be modified to better prepare pre-service teachers to use school gardens for sustainability education. Similarly, the research findings will help predict pre-service teachers' future tendencies to use school gardens for sustainability education. Also, the findings of this research may contribute to the knowledge gap in the literature on how school gardens are involved in promoting pro-environmental behavioral changes in students (Chaeng et al., 2017; Eugenio- Gozalbo et al., 2020; Laycock Pedersen & Robinson, 2018). Finally, this study will add to the limited body of knowledge about pre-service teachers' perceptions of school gardens in EfS.

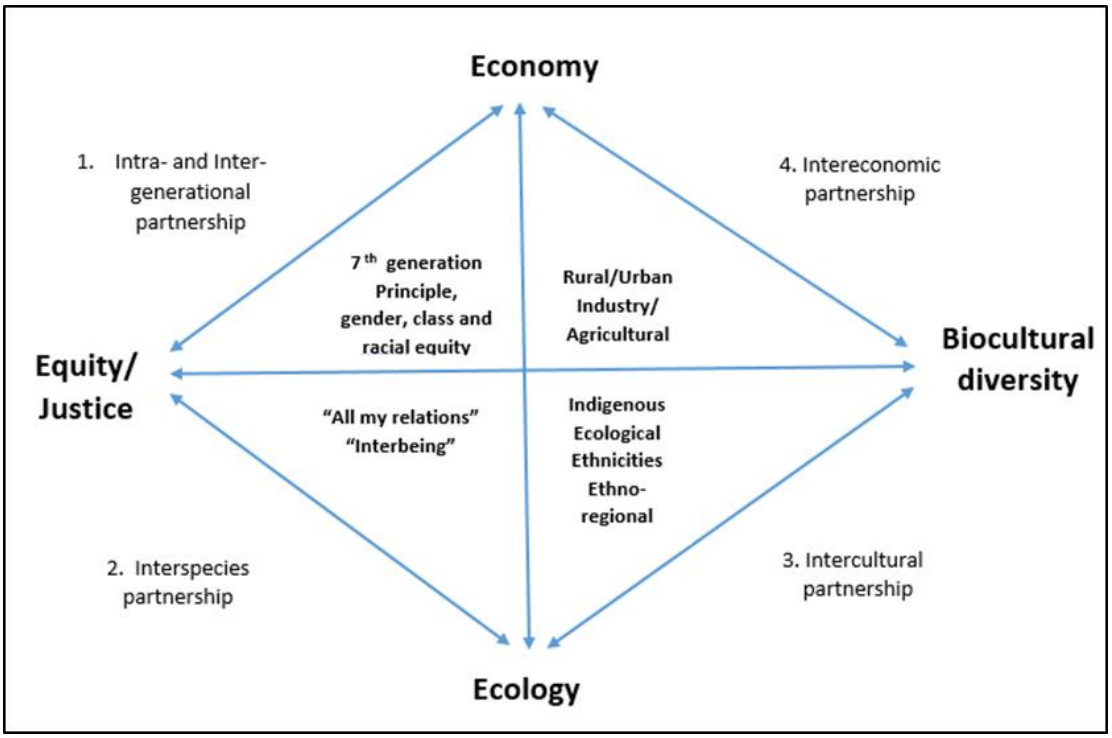
1.6 Conceptual Framework

My research study utilizes Parajuli's "Partnership Model of Sustainability" and experiential learning theory for sustainability education. As illustrated in Figure 1, Parajuli's Partnership Model of Sustainability emphasizes that sustainability education includes: Intra and inter-generational partnership; Interspecies partnership; Intercultural partnership and Inter-economic partnership guided by four main concepts: economy, ecology, equity/social justice, and bio-cultural diversity (Williams & Brown, 2012). This model addresses concerns related to the economy and ecology as well as those related to equity/social justice and bio-cultural diversity (Williams & Brown, 2012).

- Intra and inter-generational partnership examines "social class, gender, caste, race, ethnicity, and other human-created constructs, institutions, and practices of social inequities".
- Interspecies partnership addresses "ecological, philosophical, and ethical aspects of human relationships with the more-than-human world".
- Intercultural partnership explores "the field of biological, cultural, and linguistic diversity, diversity of knowledge systems and ways of knowing, teaching, and learning".
- Inter-economic partnership includes "social and economic institutions, arrangement of exchange and surplus, fair trade and free trade between global North and global South, rural and urban relationships, agriculture and industry, producers and consumers" (Williams & Brown, 2012, p. 20).

Figure 1

Parajuli`s Partnership Model of Sustainability



Note. Four main concepts of Parajuli's Partnership Model of Sustainability: economy, ecology, equity/social justice, and bio-cultural diversity. From *Learning Gardens and Sustainability Education* (p. 20), by D. R. Williams & J. D. Brown, 2012, Routledge. Copyright 2012 by Taylor and Francis.

Other than the aforementioned sustainability model, experiential learning theory is also utilized in my research study. As proposed by philosopher John Dewey, experiential learning is commonly defined as "learning by doing" (Dewey, 1938, as cited in Gaffney & O'Neil, 2019). "Learning by doing involves engaging the learner in hands-on activities that take the learner out of the traditional classroom and into environments that allow them to engage in learning through hands-on experiences" (Gaffney & O'Neil,

2019, p. 1). Dewey emphasized "experience" as an important component of learning that encourages interaction with people and the environment (Dewey, 1938, as cited in Gaffney & O'Neil, 2019). Dewey's philosophy of experiential learning encourages students to participate in a learner-centered active learning process, contrary to traditional classroom approaches, which rely on a teacher-directed education system (Williams, 2017).

Later, David A. Kolb expanded Dewey's work, which led to the development of modern experiential learning theory (Manafu, 2021). This experiential learning theory describes learning as "the process whereby knowledge is created through the transformation of experience" (Kolb, 2015, p. 49). According to Kolb's experiential learning cycle, concrete experiences lead to reflective observations, which lead to the production of abstract concepts, and these concepts apply in new situations through active experimentation (Manafu, 2021). Kolb's experiential learning cycle is the foundation for action-oriented learning, which emphasizes that learners take actions and consider their experiences during the learning process (UNESCO, 2018, p. 49).

As Dewey and Kolb mentioned, experiential learning theory emphasizes the importance of "experiences" in the learning process. Sipos et al. (2008) stated that the emotions felt during experiences aid in achieving the basic functions of education and have the ability to transform society by changing learners' knowledge, skills, and attitudes. Similarly, the major goal of education for sustainability is to transform society by changing learners' knowledge, skills, values, and attitudes by employing learner-centered, action-oriented, and transformative learning as key pedagogical approaches (UNESCO, 2018). Transformative learning encourages learners to examine carefully and

change their worldviews, and educators serve as facilitators in this process (Mezirow, 2000; UNESCO, 2018). As Gaffney and O'Neil (2019) stated, "experiential learning closely relates to transformative learning as sustainability because they are both situated as 'learning process as change'" (p. 3). Since experiential learning relates to learner-centered, action-oriented, and transformative learning, educators can use it to achieve the goals of education for sustainability. Desmond et al. (2002) argued that many aspects of garden-based learning are supported by experiential learning theory, and school gardens act as places to practice experiential-based educational approaches for sustainable development.

As Sipos et al. (2008) stated, "head, hands, and heart are emerging as an obvious planning principle for sustainability education" (p. 73). According to Bloom's taxonomy, students' intended learning outcomes in education are in the form of behavior change, and learning behavior can be categorized into cognitive, psychomotor, and affective domains, which commonly utilize head, hand, and heart respectively (Bloom et al., 1956, as cited in Ali, 2017). The cognitive domain is concerned with the growth of intellectual and knowledge capacities, whereas the psychomotor domain is focused on the capacity to coordinate physical movements and use motor skills (Ali, 2017). According to Ali (2017), "the affective domain includes things related to emotions such as feelings, values, appreciation, enthusiasm, motivation, and attitude" (p.151).

I believe that both Parajuli's Partnership Model of Sustainability and experiential learning theory are suitable frameworks for my research study. As Parajuli's model explains, learning gardens serve as an ecological model where sustainability education is centered, facilitating and encouraging diverse partnerships among human and non-human

entities (Williams & Brown, 2012). Parajuli's Partnership Model of Sustainability helps to determine whether i) pre-service teachers' understanding of the use of school gardens in education for sustainability falls within the four main concepts of sustainability: economy, ecology, equity/social justice, and bio-cultural diversity, and ii) pre-service teachers' perceptions about the use of school gardens for sustainability education align with the main aspects of these sustainability concepts. Experiential learning theory is used to assess whether pre-service teachers have capacity to use experiential learning approaches to develop students' knowledge, skills, and attitudes for sustainability when using school gardens.

Chapter 2: Theoretical Overview and Related Literature

The literature review addresses three main areas related to the proposed study. First, it begins with a brief exploration of the term "education for sustainability" and its development in the past. Second, it highlights the background of school gardens and their role in education for sustainability. Finally, it examines current literature on teachers' perceptions of school gardens and education for sustainability.

2.1 Education for Sustainability (EfS)

Sustainability is crucial for people's well-being, environmental protection, and the preservation of natural resources for future generations. Hence, the United Nations has established sustainability and sustainable development as global education goals (UNESCO, 2010). The history of sustainability education started with the concept of environmental education and the inaugural Intergovernmental Conference on Environmental Education, held in Tbilisi in 1977, emphasized the importance of environmental education (UNESCO, 1978). It underlined the main goals of environmental education and clearly stated the significance of environmental education in cultivating "concerns about economic, social, political, and ecological interdependence in urban and rural areas, as well as providing people with opportunities to acquire the knowledge, values, attitudes, commitments, and skills needed to protect and improve the environment" (UNESCO, 1977, p.11, as cited in Gaylie, 2009, p. 22). But after the proposal of the UNESCO International Conference in 1997, the phrase "Environmental Education" was replaced by the terms "Education for Sustainability" or "Education for Sustainable Development" (Spiropoulou et al., 2007). Today, the sustainability focus has

shifted from environmental education to education for sustainability (EfS) or education for sustainable development (ESD), and it incorporates the interrelationships between the social and economic dimensions in addition to environmental aspects (Martins et al., 2006). Although education for sustainability was initially conceived in response to the world's growing environmental issues, it now aims to empower and educate people to meet their needs through a holistic approach to the economic, social, and environmental aspects of sustainable development (UNESCO, 2018). The current approach to sustainable development is based on the belief that it can only be accomplished by obtaining a comprehensive understanding of these three aspects (Martins et al., 2006).

According to UNESCO (2018), to achieve sustainable development goals, education must evolve to offer learners the necessary knowledge, skills, values, and attitudes. Hence, education for sustainable development aims to equip all learners with the knowledge, skills, values, and attitudes that they need to build a sustainable future by incorporating many key themes into education, such as "climate change, biodiversity, sustainable production and consumption, global justice, disaster risk reduction, and poverty reduction" (UNESCO, 2018, p. 63). The primary goal of EfS or ESD is to incorporate all important sustainability concerns into education, and these were recognized by the United Nations Decade of Education for Sustainable Development (DESD 2005-2014) as a collective movement to realign education to confront the sustainability challenges (UNESCO, 2018; Uitto & Saloranta, 2017). Today, ESD is a fundamental component of the 2030 Agenda for Sustainable Development and its goals, and it creates a suitable platform for ESD implementation (UNESCO, 2018).

2.2 School Gardens and their Role in Education for Sustainability

During the late 1800s and early 1900s, school gardens grew in popularity across Europe, Australia, Canada, and the United States (Haase, 2020). In the United States, the emergence of people's concerns about the environment led to the concept of the school garden as a progressive and dynamic approach to education that would help students better comprehend the environment (Desmond et al., 2004). In the early 1990s, changes in the educational tendency toward more experiential and environmental education promoted the distribution and expansion of school gardens across the globe (Desmond et al., 2004). As Williams and Brown (2012) mentioned, in the twentieth century, various rationales, aims, and outcomes have been offered to support school gardens, and many researchers have examined a range of school garden effects, including academic learning in various disciplines, changes in food habits, social growth, environmental attitudes, and school bonding. School gardening has resurfaced in recent years, with gardens being a popular part of many elementary and secondary schoolyards (Hirschi, 2015, as cited in Cramer & Tichenor, 2021). According to Doyle (2014), today there are a large number of school gardening initiatives across Canada supported by various governmental and non-governmental organizations.

The garden may be considered an urban imitation of nature, and many educators who recognize the value of nature in education strongly promote garden-based learning (GBL) (Papadopoulou et al., 2020). As Desmond et al. (2002) stated, GBL is an experiential learning-based instructional strategy that uses gardens as a resource and tool to implement programs, activities, and projects from an interdisciplinary perspective. Similarly, Gaylie (2009) asserted that school gardens encourage students to view learning

as a continuous process in which theory and practice are constantly swapped. As many studies outline in the literature, school gardens play an important role in educating students about sustainability through hands-on approaches.

School gardens can be used as a great resource to teach sustainability education to students at all levels. Williams and Brown's (2012) study, "Learning Gardens and Sustainability Education" strongly supports the idea that school gardens may function as a rich sustainability learning site and emphasizes how school gardens link to sustainability education in elementary and secondary schools across the world. For instance, Williams and Brown (2012) mentioned how learning gardens in Portland public schools in the United States involve improving students' awareness of sustainability.

> The learning gardens nurture students' love for nature, increase their understanding of the production and uses of edible plants, educate about nutrition and the benefits of healthy eating habits, explore the cultural significance of foods including those from their native cultures, demonstrate the healing properties of nature and gardening, and elucidate the environmental benefits of local fresh foods and resources cycling. (p. 30)

Furthermore, "in rain gardens and native gardens, students learn other sustainable practices such as rainwater harvesting, landscaping with native plants, and incorporating wildlife into gardens" (Williams & Brown, 2012, p. 30). According to Williams and Brown (2012), a school garden is a whole-system solution for addressing public concerns relating to economic, social, and environmental sustainability, and students, teachers, and communities can use it as a gateway to sustainability education. Similarly, Gaylie (2009) claimed that learning in school gardens is strongly related to the concepts of social and

ecological justice, and gardens aid in the creation of social, ecological, and cultural circumstances conducive to long-term sustainability.

As many studies have outlined, school gardens significantly contribute to sustainability education by providing environmental knowledge, environmentally friendly skills, and positive environmental attitudes. For instance, several studies revealed that participating in school garden programs develops primary and secondary school students' attitudes toward the environment more positively (Aguilar et al., 2008; DeCoito, 2021; Dricks & Orvis, 2005; Fisher- Maltese & Zimmerman, 2015; Skelly & Bradley, 2007; Skelly & Zajicek, 1998; Upitis et al., 2013; Waliczek & Zajicek, 1999).

Upitis et al. (2013) described students' active participation in the gardens, such as building the gardens, planting, caretaking, maintenance, and harvesting and the fact that these tasks broaden students' sense of connection to nature and improve environmental stewardship. DeCoito's (2021) study explored students' attitudes, interests, and knowledge about school gardens, and findings revealed that students believe school garden programs increase their awareness of the environment and increase their interest in learning about the environment. Similarly, LaCharite's (2021) study highlighted students' improvement in pro-environmental behaviors and behavioral intentions associated with working on agricultural initiatives.

According to Skelly and Bradley (2007), involving students in garden-based activities such as "planting seeds, watering plants, and taking care of the garden" can increase their responsibility and positive attitudes towards the environment (p.103). As Waliczek and Zajicek (1999) revealed in their study, outdoor activities in school garden programs help to build more positive environmental attitudes in relating to topics such as

wildlife conservation, water pollution, pesticide usage, deforestation, and recycling. Dricks and Orvis's (2005) study disclosed that primary-grade students' attitudes toward horticulture and the environment dramatically improved due to the Junior Master Gardener program in school. According to Bowker and Tearle (2007), students' knowledge and awareness of agriculture, farming, soil profile, and ecology develop with gardening. Other studies found that school garden programs improve students' environmental knowledge and awareness (Miller, 2007; Morgon et al., 2009). Through their study, Ruiz- Gallardo et al. (2013) discovered that school gardens help students acquire and improve practical skills such as watering plants in the greenhouse or garden, weeding, and cleaning that are beneficial to the environment. Furthermore, as Malberg and Wistoft (2018) indicated, students' interactions with nature, such as engaging in school gardens, have an impact on their social well-being as well as help them build empathy for animals, insects, and plants.

Similarly, Papadopoulou et al. (2020) emphasized in their review that active participation in gardens appears to have a significant impact on students' environmental awareness, attitudes, and behaviors toward nature. According to Papadopoulou et al. (2020), through school gardens and garden activities, students can be exposed to the notion of sustainable development and learn about its educational goals. Perez-Lopez et al.'s (2021) study also argued that learning gardens contribute to environmental conservation and global environmental issues through increasing concern for nature and promoting values and knowledge that help preserve the environment. Their study establishes the belief that garden-based learning programs can be applied from early childhood education to higher education to achieve long-term sustainability goals (Perez-

Lopez et al., 2021). Even though several studies revealed the improvement of pro-environmental behavior with garden-based learning, no reported studies have shown the effectiveness of garden-based learning in developing pro-environmental behavioral changes in the school context, signaling a knowledge gap in the literature (Chaeng et al., 2017; Eugenio- Gozalbo et al., 2020).

School gardens can act as a learning site to provide the necessary knowledge, skills, and attitudes to achieve the social and economic dimensions of sustainability. Food production in gardens is becoming an important part of garden-based educational programs, which teach students how to produce their own food in an ecologically responsible manner and are seen as an important step toward sustainability (Desmond et al., 2004). Teachers can use school gardens to teach students about a healthy lifestyle by sharing knowledge about the health benefits of eating nutritious food. Many studies in the literature reveal that school gardens and garden-based activities significantly improve students' attitudes toward healthy fruit and vegetable consumption (Beckman & Smith, 2007; Gibbs et al., 2013; Heim et al., 2011; Parmer et al., 2009) as well as their nutritional knowledge (Beckman & Smith, 2008; Kotch et al., 2006; Parmer et al., 2009).

School gardens help teach and learn social justice education in schools and help students understand their role in the community locally and globally (DeCoito, 2021). As DeCoito (2021) reported, some schools have developed school gardens with the goal of assisting underprivileged individuals. For instance, the PACT school gardens program in Ontario, Canada, grows fruits and vegetables across several schools in low-income neighborhoods and donates large amounts of perishables to local food banks (DeCoito, 2021). According to studies, school garden initiatives teach students about food

production and help them improve their diet while addressing the issues of hunger and poverty both inside and outside of the school and in the broader community (DeCoito, 2021; Fisher et al. 2019).

As Williams and Brown (2012) explained in their study, locally established school gardens help to improve the health and well-being of both children and adults in the community, promote wellness by increasing vegetable and fruit intake, and foster social bonds among school communities. Similarly, Ratcliffe et al. (2011) revealed that garden-based activities influence positively on students' knowledge, attitudes, and behaviors related to vegetable intake and boost low-income students' consumption of various vegetables.

Studies indicate that school gardens help culturally diverse immigrant students to share their cultural values and encourage students to investigate the food and culinary traditions of various families and cultures (Blanchet-Cohen & Reliiy, 2017; Williams & Brown, 2012). According to Lever (2020), Indigenous gardens provide space to incorporate Indigenous knowledge and offer decolonizing learning opportunities to Indigenous students. As Mundel and Chapman (2010) reported, gardens can be used for many purposes, such as honoring traditional culinary rituals and promoting health in a more culturally appropriate way by employing Indigenous healing approaches. As well, Peach et al.'s (2020) study revealed that gardens offer Indigenous populations a crucially important place to exchange and deepen their Indigenous knowledge.

In addition, Williams and Brown (2012) noted that school gardens offer extra educational pathways supporting a variety of learning methods, interests, and cultural understandings. For example, multicultural family gardens have been established in the

learning grade laboratory of a Portland public school in the United States to honor immigrant and refugee families and to allow parents to participate in food-based educational activities that support the exploration of multiculturalism (Williams & Brown, 2012). Similarly, Kelly et al. (2021) mentioned in their study that gardens provide culturally responsive, place-based education to culturally diverse students who are coming from different backgrounds. According to Williams and Brown (2012), learning garden pedagogy improves the holistic learning of students through cultivating a sense of place and valuing biocultural diversity.

Furthermore, school gardens have been involved in improving students' educational performance and skill development. As several studies have shown, school gardens dramatically improve students' science learning outcomes (Dircks & Orvis, 2005; Klemmer et al., 2005; Skinner et al., 2021; Smith & Mostenbocker, 2005). According to the Skinner et al. (2021), students who have been highly engaged in gardens exhibit improvements in their science learning and achievements, while students who have been less engaged exhibit no changes or declines in learning and achievements. Also, some studies have revealed that school gardens are used as a tool to teach other subjects such as environmental sciences, agriculture, math, nutrition, and languages (Berson & DeCoito, 2021; DeCoito, 2021; Graham et al., 2004; Willams & Brown, 2012). Robinson and Zajicek's (2005) study findings indicate that the general life skills of students, such as teamwork abilities and self-awareness, have developed with gardening programs.

According to Gaylie (2009), when students participate in learning gardens, they become more aware of how their food and energy choices are linked, as well as how their

collective decisions have a significant influence on both local and global economies. As Wolsey and Lapp (2014) explained in their study, when students sell their school garden agricultural products, they contribute to sustainable economic growth. Furthermore, as Desmond et al. (2004) discovered from a landscape designer who worked at a school, gardening activities such as "soil preparation, digging, watering, and harvesting" lead to major improvements in the knowledge, abilities, and behavior of students, which prepare them for developing economies (p. 58).

2.3 Teachers' Perceptions about School Gardens and Education for Sustainability

Teachers can assist students in developing the necessary knowledge, skills, and attitudes for sustainability by educating them about environmental and sustainability education, and the school garden is an ideal learning context. But to "implement the school garden programs, educators' attitudes, knowledge, and motivation are important" (Murakami et al., 2016, p.1). The literature revealed that several studies have investigated in-service teachers' attitudes, beliefs, interests, and knowledge about school gardens. Some studies reported that many teachers realize the usefulness of school gardens for environmental education, experiential learning, and fulfilling students' nutritional requirements (DeCoito, 2021; Murakami et al., 2016; Skelly & Bradley, 2000).

DeCoito's (2021) study investigated teachers' perspectives, interests, and knowledge about school gardens, and found that teachers believe school garden programs benefit students in a variety of ways, including learning about the environment and practicing environmental stewardship, engaging in hands-on learning, understanding global issues like poverty and hunger, and leading healthy lives and consuming

wholesome food (p. 110). In addition, the study revealed that teachers believe school gardens have an impact on students' affective domain (DeCoito, 2021, p.110).

Murakami et al.'s (2016) study examined educators' perceptions associated with the school garden programs in the Clark County School District in Nevada, USA, and the teachers' responses to this study indicate that they use school gardens for various instructional purposes and commonly to teach subjects such as math, science, English language arts, health, and nutrition. As the findings revealed, the majority of educators accept that school gardens enhance students' environmental awareness, positive attitude, and nutritional knowledge (Murakami et al., 2016, p. 4). As reported in this study, teachers note that students acquire important knowledge and skills through school gardens that are beneficial for sustainability, such as environmental consciousness, practical gardening skills, and an understanding of various agricultural aspects relating to soil, composting, insects, and irrigation systems (Murakami et al., 2016, p. 5). Additionally, teachers agree that school gardens are great learning tools that are enjoyable for both students and teachers. Furthermore, the study explored teachers' perceptions of the most important resources for using school gardens, and many believe that teacher training, funding, and access to a curriculum centered on gardens are critical resources (Murakami et al., 2016).

Graham and Zidenberg-Cherr's (2005) study explored how teachers use school gardens in their teaching as well as how they feel about the incorporation of school gardens in the curriculum. Findings of their study revealed that the majority of teachers believe school gardens can improve, moderately to very effectively, students' social skills, academic achievements, healthy eating habits, and subject learning. Study findings

further indicate that teachers commonly use school gardens for academic instruction, and that the most frequent subjects they teach are science, nutrition, mathematics, agriculture, environmental studies, and language arts (Graham & Zidenberg-Cherr, 2005, p.1798). Despite the fact that many teachers believe school gardens are very effective for improving students' healthy eating habits and nutritional knowledge, most of them claim they are less effective for improving the school meal program (Graham & Zidenberg-Cherr, 2005). Teachers in the study are also adamant that tools like teacher training in gardening and curriculum materials related to gardening would help teachers use school gardening in their instruction (Graham & Zidenberg-Cherr, 2005).

According to the study by DeMacro et al. (1999), teachers believe school gardens are extremely or moderately effective for many subject areas and the academic and social development of elementary students. As teachers revealed in this study, gardens facilitate students' engagement with nature at an individual level, which encourages positive behavioral changes (DeMacro et al., 1999). Rosenthal's (2018) study investigated pre-service teachers' perceptions of primary school students' understanding of garden-based concepts when they worked with students in the garden. Teacher reflections revealed that they see the benefits of the garden for student learning of plant growth and development, sustainable food production, and healthy behavior (Rosenthal, 2018).

Kincy et al. (2016) examined teachers' likelihood to use school gardens as a supplement for their curriculum and reported that teachers who use their personal time for gardening have a more positive attitude regarding the gardens and are more likely to use them. According to Kincy et al. (2016), expertise, time, enough space, financial resources, and guidance are all essential factors that determine a teacher's capacity to

integrate school gardens into the curriculum. Also, as several studies reported, teachers see a lack of time as well as a lack of their personal interest, experience, training, and knowledge in gardening as prominent barriers to implementing effective school garden programs (Graham & Zidenberg-Cherr, 2005; Graham et al., 2005; Murakami et al., 2016).

Furthermore, Cheang et al.'s (2015) study examined university educators' and different stakeholders' perceptions of the role of eco-gardens in education for sustainability and findings revealed that university educators expect that the student's knowledge, skills, and attitudes toward sustainability would be enhanced by garden-based learning initiatives.

There are several studies in the literature that focus solely on pre-service and in-service teachers' attitudes, beliefs, conceptions, and knowledge of education for sustainability (EfS). As these studies revealed, in-service and pre-service teachers have limited knowledge and awareness about EfS. For instance, many studies claimed that teachers do not have proper awareness of the holistic viewpoint of EfS and they mostly focus only on one dimension of it (Borg et al., 2014; Burmeister et al., 2013; Evans et al., 2012; Pepper & Wildy, 2008; Spiropoulou et al., 2007).

Borg et al. (2014) in their study revealed that teachers do not have a proper understanding of the overall aspects of EfS, and their understanding varies based on their teaching subjects. They noted that science teachers emphasize more about the environmental aspects of EfS, and social studies teachers emphasize more about the social aspects of EfS, while most of them have uncertainty about the economic aspects of EfS (Borg et al., 2014).In addition, findings revealed that newly qualified teachers have a

poor understanding of EfS when compared to experienced teachers, and most of them need additional training in EfS.

Evans et al. (2012) investigated both primary and secondary pre-service teachers' understanding of the concept of EfS, and found that the majority of pre-service teachers have limited knowledge about EfS, and many of them simply highlight one aspect of EfS, which is focused on environmental sustainability. As well, they noted that first year students had less understanding of EfS when compared to final year students. Similarly, the study by Spiropoulou et al. (2007) examined primary teachers' perceptions of EfS, and found that teachers do not have a proper understanding of the "sustainability" concept.

Moreover, Burmeister et al. (2013) examined chemistry teachers' understanding of EfS, and noted that even though teachers have more favorable attitudes toward incorporating concerns related to EfS into their teaching, most of them do not have a clear understanding of the theoretical principles underlying EfS. The study by Pepper and Wildy (2008) explored how EfS is conceptualized and integrated into secondary school settings, and the results show that the majority of teacher participants do not distinguish between environmental education and EfS, and they primarily concentrate on the environmental aspects of EfS rather than a more general focus on all aspects of sustainability.

After reviewing the literature, it is evident that limited knowledge is available regarding pre-service teachers' perceptions of the role of school gardens in education for sustainability, especially in the Canadian context. Thus, investigating pre-service teachers' attitudes, interests, and what they know, think, and believe about school gardens

and their role in education for sustainability is critical. Hence, this study explores pre-service teachers' perceptions of the role of school gardens in education for sustainability.

Chapter 3: Methodology

The main purpose of the research is to examine pre-service teachers' perceptions about the use of school gardens in education for sustainability, and a mixed-method research approach was employed to achieve the objectives of the study. Below in this section, I provide arguments for employing a mixed-methods research design along with detailed information on research participants and settings, data sources utilized, and a description of research methods and the procedure of data analysis.

3.1 Research Design

In this study, a mixed-methods research approach was used to address the main research questions. According to Creswell and Creswell (2018), the mixed-method research approach is widely applicable in the fields of evaluation, education, management, sociology, and health sciences where researchers collect, analyze, and interpret both quantitative and qualitative data simultaneously in order to respond to research questions or hypothesis. I also think that mixed-methods research design is the ideal research methodology for my study. I used both quantitative and qualitative data for my research, and data sources included a Likert scale survey questionnaire to gather quantitative data and open-ended survey questions to gather qualitative data. The Likert scale survey questionnaire examined pre-service teachers' attitudes, interests, and views about the use of school gardens in sustainability education, and open-ended survey questions were used to further analyze the participants' perceptions and knowledge about school gardens, their range of understanding of the use of school gardens in education for

sustainability, and how they think school gardens help improve students' cognitive, affective, and psychomotor learning in education for sustainability.

As Creswell and Creswell (2018) stated, the mixed-method research approach is ideal for much research because it provides a more complete understanding of the research problem by drawing on both quantitative and qualitative data and increases the strength of the research by minimizing the limitations of both quantitative and qualitative approaches. According to Ahmed et al. (2019), the quantitative research approach use statistics to get a big picture of the research study and aid in determining the causal relationship between the two variables using statistical techniques. In contrast, the qualitative research approach is an exploratory research technique that examines extremely complicated phenomena that cannot be understood by quantitative research. Furthermore, as Ahmed et al. (2019) stated, "qualitative research is used to gain an in-depth understanding of human behavior, experience, attitudes, intentions, and motivations, on the basis of observation and interpretation, to find out the way people think and feel" (p. 2829). Hence, I believe that the mixed-method research approach, which utilizes both quantitative and qualitative data, is ideal for this study to explore pre-service teachers' perceptions about the use of school gardens in education for sustainability.

3.2 Participants and Settings

Pre-service teachers who are in their first or second year of the Bachelor of Education (B.Ed) program at Western University, Ontario, and are pursuing curricular courses related to or addressing environmental and sustainability education were

recruited for the study. Curricular courses (teaching subjects) related to or addressing environmental and sustainability education in this study included:

1. Sciences (Biology/ Physics/ Chemistry/ General Science/ Environmental Science/ Elementary Science & Technology)
2. Science, technology, engineering and mathematics (STEM)
3. Social Studies (General Social Studies /Elementary Social Studies)
4. Canadian & World Studies (Geography)

The participants were recruited online through the assistance of the Teacher Education Office at Western University.

3.3 Procedure

Since there are human participants in this research study, obtaining ethical approval before data collection was necessary to meet the study's objectives. The gain of ethical approval prior to the data collection was initiated by submitting the research ethics application to the Non-Medical Research Ethics Board (NMREB) at Western University. The objective of the research study, main research questions, study activities, participants' experience in the study, and researcher's procedures for conducting the study were defined and explained, with supporting documentation. Consent to proceed with the research was requested from Western University's NMREB according to the requirements of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2).

Following ethical approval, participants were recruited via the Teacher Education Office at Western University. An introduction to the research study, the significance of the study, and its potential contribution were explained to the participants through a

recruitment email (Appendix B). The online survey link, which proceeds to the Qualitrics survey platform, was included in the same recruitment email. Participants were provided the opportunity to continue the survey after reading the letter of information on the Qualtrics platform, and by responding and submitting the online survey, they agreed to give implicit consent to participate in the study. All study-related information was forwarded by the Teacher Education Office, and participants were asked to contact the researchers with regard to any inquiries about the study.

Pre-service teachers were requested to participate in the online survey from November 2022 to January 2023 (Appendix A). A reminder email was sent to the participants two weeks after the first recruitment email invitation (Appendix D). It was mentioned that the online survey can take about 20 minutes to complete via the Qualitrics survey platform, and all the survey responses were collected anonymously to ensure the privacy and confidentiality of participants. After collecting the data, it was analyzed using relevant tools.

3.4 Data Sources

The following techniques were used to collect the data online.

1. Technique I: Demographic Questionnaire (Appendix A, Part A) - This questionnaire was developed by the researcher to collect the demographic data of participants, such as their age, sex, year of study in the Bachelor of Education program, and their teachable subjects.
2. Technique II: Closed-Ended Questionnaire (Appendix A, Part B) -This five-point Likert scale survey, which consisted of 24 statements, was established by the researcher and was divided into three sections. Section A) examined pre-service

teachers' attitudes, section B) examined pre-service teachers' interests, and section C) examined pre-service teachers' views about the use of school gardens in education for sustainability.

The five-point Likert Scale contained five responses ranging from 1 to 5. (1=Strongly Disagree; 2=Disagree; 3= Neutral; 4=Agree; 5= Strongly Agree)

3. Technique III: Open-Ended Questions (Appendix A, Part C) – Seven questions were formulated by the researcher to further explore pre-service teachers' perceptions and knowledge about school gardens, their range of understanding about the use of school gardens in education for sustainability, and their perceptions of how school gardens help improve students' cognitive, affective, and psychomotor learning in education for sustainability.

3.5 Data Analysis

Data analysis is essential in a research study to address research questions or hypotheses (Cross & Plunkett, 2014). According to Creswell and Creswell (2018), "a survey design provides a quantitative description of trends, attitudes, and opinions of a population, or tests for associations among variables of a population, by studying a sample of that population" (p. 207). The data obtained through the Likert Scale survey was utilized as quantitative data to examine pre-service teachers' attitudes, interests, and views about the use of school gardens in education for sustainability. Qualitative data obtained through the open-ended questions were used to explore pre-service teachers' range of understanding of the use of school gardens in education for sustainability and

their perceptions of how school gardens impact students' cognitive, affective, and psychomotor learning in education for sustainability.

According to Ali (2021), quantitative data analysis uses descriptive statistics to categorize and summarize collected data and inferential statistics to allow researchers to make predictions and determine whether data is generalizable to the larger population. As Rahman and Muktadir (2021) asserted, a computer software package such as SPSS is a powerful statistical tool for quantitative data analysis. Hence, SPSS statistical software was used to analyze the collected data using descriptive and inferential statistics.

The quantitative data retrieved from Likert scale survey responses were transferred into Microsoft Excel and analyzed using descriptive and inferential statistics in the SPSS statistical software program. Descriptive statistics such as frequency distribution and percentage, mean, and standard deviation of variables, as well as inferential statistical tests such as the T-test, were used to analyze the collected data. Frequencies and percentages of pre-service teachers' demographic data such as their age range, sex, year of study, and teachable subjects were calculated first. The closed- ended survey questionnaire that measure pre-service teachers' attitudes, interest and views compromised with 24 statements and participants' response frequencies and percentages for each statement were also calculated.

Pre-service teachers' overall attitudes, interests, and views were calculated by finding the participants' overall mean score for each dimension and interpreting that score by comparing it to a standard Likert scale interval. The overall mean scores were interpreted according to the standard Likert scale interval as follows: Strongly disagree (Likert scale 1) in the point range of 1.00 - 1.79, Disagree (Likert scale 2) in the point

range of 1.80 - 2.59, Neutral (Likert scale 3) in the point range of 2.60 - 3.39, Agree (Likert scale 4) in the point range of 3.40 - 4.19, and Strongly agree (Likert scale 5) in the point range of 4.20 – 5.00 (Pimentel, 2010). When interpreting overall attitudes, interests, and views, both "strongly agree" and "agree" Likert scales were considered positive, and both "strongly disagree" and "disagree" were considered negative.

The independent T-tests were carried out to determine if there is a statistically significant mean difference in the overall attitudes, interests, and views between male and female pre-service teachers, as well as between year 1 and year 2 teachers. Since very limited pre-service teachers were available in the age group of 41-50 years and social studies teaching groups, those data were omitted during the mean comparison. Therefore, another independent T-test was performed to determine if there is a statistically significant mean difference in the overall attitudes, interests, and views between preservice teachers of the 21-30 year and 31- 40 year age groups, as well as between science and STEM teaching subject groups. The 5% significance level ($p = 0.05$) was considered in the study to determine if there is statistical significance in the analysis of the results.

According to Welsh (2002), NVivo coding software is a simple, transparent, and accurate tool for qualitative data coding. The qualitative data derived from open-ended questions was incorporated into Microsoft Excel and then imported into NVivo 12 Pro coding software to develop themes to address the proposed research questions. As Linneberg and Korsgaard (2019) claimed, "coding is an important tool in the process of turning raw qualitative data into a communicative and trustworthy 'story'" (p. 3). The primary process of coding involved examining a cohesive part of raw qualitative data and

labeling it with a word or short sentence that summarizes its information to build up thematic codes. Then, derived codes were examined and grouped with shared relationships to build up themes to address each research question. Word frequency queries were created using NVivo software to determine the most frequently occurring words in the transcript and to identify possible themes using them. Themes that developed from word clouds indicated the generated codes, and their font size represents their frequency.

Research findings derived from quantitative and qualitative data are presented in the following chapter.

Chapter 4: Research Findings

The objective of this research study was to examine pre-service teachers' attitudes, interests, and views about the use of school gardens in education for sustainability as well as pre-service teachers' range of understanding about the use of school gardens in education for sustainability and how they think school gardens impact students' cognitive, affective, and psychomotor learning for sustainability. Study findings are discussed in this chapter in relation to the following research questions:

1. What are pre-service teachers' attitudes, interests, and views about the use of school gardens in EfS?
2. What are pre-service teachers' range of understanding about the use of school gardens in EfS?
3. What are pre-service teachers' perceptions of how school gardens impact students' cognitive, affective, and psychomotor learning in EfS?

The findings derived from the data are reported in the following sections. To address the research questions in the study, research findings from the quantitative data (i.e., Likert scale survey responses) are presented, followed by those obtained from the qualitative data (i.e., open-ended questions).

4.1 Quantitative Research Findings

Pre-service Teachers' Demographics

This questionnaire was established by the researcher to collect the demographic data of pre-service teachers such as their age, sex, year of study in the Bachelor of Education program, and their teachable subjects.

In total, 75 pre-service teachers who are enrolled in the Bachelor of Education program at Western University completed the survey. Table 1 represents the demographic data of participants in terms of their age, sex, year of study in the B.Ed. program, and their teachable subjects. Participants in the study ranged in age from 21 to 50 years, with more than 90% falling between the ages of 21 and 30. Few participants ranged in age from 31 to 40 years and from 41 to 50 years. Female pre-service teachers represented 60% of participants, and the remaining 40% were male pre-service teachers. The majority of participants (69.3%) were in their first year of the B. Ed. program, while 30.7% were in their second year of study. In terms of teachable subjects, the majority of participants (76.0%) were enrolled in science subjects, while 21.3% were enrolled in the STEM Specialty Focus, and the remaining participants (2.7%) in social studies.

Table 1

Demographic Frequencies and Percentages of Research Group

Variables	Study Group	
	n	*%*
Age:		
21- 30	70	93.3
31- 40	4	5.3
41- 50	1	1.3
Sex:		
Male	30	40.0
Female	45	60.0
Year of Study in B.Ed.:		
First Year	52	69.3
Second Year	23	30.7

Teachable subjects:		
Sciences (Biology/Physics/ Chemistry/General Science/ Environmental Science/ Elementary Science & Technology)	57	76.0
Science, technology, engineering and mathematics (STEM)	16	21.3
Social Studies (General Social Studies/ Elementary Social Studies)	2	2.7

Pre-Service Teachers' Attitudes, Interests, and Views - Survey Data

This Likert scale survey consisted of 24 statements that were used to measure the pre-service teachers' attitudes, interests, and views about the use of school gardens in EfS. The first eight statements examined pre-service teachers' attitudes; followed by eight statements which explored their interests; and the final eight statements examined their views. The participants responded to each statement by selecting their choice ranging from strongly agree to strongly disagree. Table 2 illustrates participants' response frequencies and percentages for each statement. Findings indicate that the majority of participants (> 60%) agree to strongly agree for all statements, and a smaller percentage (≤10%) disagree to strongly disagree for most of the statements.

In terms of attitudes, more than 90% of pre-service teachers agreed or strongly agreed that they can use school gardens to teach students about the environment, natural resources, biodiversity, and the importance of the environment. Also, more than 80% of pre-service teachers believed that they could use school gardens to improve students' pro-environmental attitudes and behaviors, while only 12% showed neutral attitudes. While more than 60% of participants agreed or strongly agreed that the school gardens can be

used to teach students about sustainable energy resources, approximately 23% had neutral attitudes and 13% had negative ones. When more than 80% agreed or strongly agreed that the school garden can be used to promote healthy food consumption and sustainable farming among students and teach them about living a healthy lifestyle, 9–12% showed neutral attitudes. While more than 60% of participants agreed that the school gardens can be used to improve students' educational performances, a significant percentage (29.3%) had neutral attitudes and 8% had negative ones.

In relation to interests, more than 80% of pre-service teachers agreed or strongly agreed that they would like to use school gardens for teaching purposes and spend more time in school gardens with students. Over 90% of participants agreed that they would like to use school gardens to teach eco-friendly concepts. More than 70% showed interests in implementing many educational activities, agricultural/garden activities in the school gardens for students, and developing existing school garden programs, whereas 16–18% had neutral interest regarding that and approximately 10% had no interest. Around 60% of participants showed a likelihood to initiate new school garden programs for students, while a considerable percentage (30.7%) had neutral interest. Among pre-service teachers, approximately 55% showed interest in implementing garden-based competitions for students and a significant percentage showed neutral (32%) and no interest (≈ 13%).

In terms of pre-service teachers' views, more than 90% agreed that school gardens can be used to improve students' positive environmental attitudes and behaviors. Over 80% of participants agreed that school gardens can be used to improve students' knowledge of good health and well-being, academic achievement, and links with local

communities, but just 10-19% held neutral or negative views. While more than 80% of respondents held positive views that school gardens promote local sustainable practices that have an impact on the world's economy and contribute to the teaching of knowledge, attitudes, values, and skills for sustainable development, 12-16% had neutral views. When 60% of respondents agreed that school gardens might be used to alleviate hunger and poverty, a significant portion (26.7%) had a neutral view, and 14.3% expressed a negative view. The majority of participants—approximately 70%—agreed that gardens support diverse cultural understanding and allow students to share their cultural heritage; 20% had neutral opinions; and only about 10% disagreed. Around 69% of respondents agreed that garden-based learning should be included in the curriculum at all grade levels in order to teach sustainability principles, whereas 21% neither agreed nor disagreed. Finally, 88% agreed that it is beneficial to have any type of garden in every school, while 85% had neutral views and 4% disagreed.

Table 2

Participants' Response Frequencies and Percentages for Statements

Statement	Response Frequencies (*n*) and Percentages *(%)*					*M*	*SD*
	SA	A	N	D	SD		
Attitudes							
1. I can use school gardens to teach students about the importance of the environment.	33 44.0	36 48.0	3 4.0	1 1.3	2 2.7	4.29	0.84
2. I can use school gardens to teach students about the environment, natural resources, and biodiversity.	40 53.3	29 38.7	4 5.3	0 0.0	2 2.7	4.40	0.82
3. I can use school gardens to improve students' pro-environmental attitudes and behaviors.	34 45.3	28 37.3	9 12.0	2 2.7	2 2.7	4.20	0.94
4. I can use school gardens to teach students about sustainable energy resources.	23 30.7	25 33.3	17 22.7	8 10.7	2 2.7	3.79	1.08
5. I can use school gardens to promote healthy food consumption among student.	27 36.0	36 48.0	8 10.7	2 2.7	2 2.7	4.12	0.90
6. I can use school gardens to promote sustainable farming among students.	32 42.7	33 44.0	7 9.3	1 1.3	2 2.7	4.23	0.88
7. I can use school gardens to teach students about living a healthy lifestyle.	20 26.7	43 57.3	9 12.0	1 1.3	2 2.7	4.04	0.83
8. I can use school gardens to improve students' educational performances.	17 22.7	30 40.0	22 29.3	4 5.3	2 2.7	3.75	0.96

Interests							
9. I would like to use school gardens for teaching purposes.	28 37.3	38 50.7	6 8.0	1 1.3	2 2.7	4.19	0.85
10. I would like to spend more time in school gardens with students.	25 33.3	38 50.7	7 9.3	2 2.7	3 4.0	4.07	0.95
11. I would like to implement many educational activities in the school gardens for students.	22 29.3	34 45.3	12 16.0	3 4.0	4 5.3	3.89	1.05
12. I would like to initiate new school garden programs for students.	18 24.0	27 36.0	23 30.7	4 5.3	3 4.0	3.92	0.94
13. I would like to develop existing school garden programs.	19 25.3	39 52.3	12 16.0	2 2.7	3 4.0	3.92	0.94
14. I would like to engage in many agricultural/ garden activities in the school gardens with students.	17 22.7	36 48.0	14 18.7	4 5.3	4 5.3	3.77	1.03
15. I would like to use school gardens to teach eco-friendly concepts.	29 38.7	39 52.0	4 5.3	1 1.3	2 2.7	4.23	0.83
16. I would like to implement garden-based competitions for students.	12 16.0	29 38.7	24 32.0	8 10.7	2 2.7	3.55	0.98
Views							
17. School gardens can be used to improve students' positive environmental attitudes and behaviors.	25 33.3	46 61.3	2 2.7	0 0.0	2 2.7	4.23	0.75
18. School gardens can be used to improve students' knowledge of good health and well-being, academic performance, and links with local communities.	20 26.7	42 56.0	8 10.7	4 5.3	1 2.7	4.01	0.85

19. School gardens can be used to improve sustainable local practices that impact global economies.	22 29.3	38 50.7	9 12.0	4 5.3	2 2.7	3.99	0.94
20. School gardens can be used to alleviate hunger and poverty.	9 12.0	36 48.0	20 26.7	7 9.3	3 4.0	3.55	0.96
21. School gardens significantly contribute to teaching knowledge, attitudes, values and skills for sustainable development.	15 20.0	47 62.7	12 16.0	0 0.0	1 1.3	4.00	0.70
22. School gardens support diverse cultural understanding and allow students to share their cultural heritage.	13 17.3	42 56.0	15 20.0	3 4.0	2 2.7	3.81	0.87
23. To teach sustainability principles, garden based learning should be integrated into the school curriculum at all levels	13 17.3	39 52.0	16 21.3	6 8.0	1 1.3	3.76	0.88
24. It is beneficial to have any type of garden in every school.	25 33.3	41 54.7	6 8.0	1 1.3	2 2.7	4.15	0.83

Table 3 illustrates the findings of overall attitudes, interests, and views which indicate that 90.6% of pre-service teachers held positive attitudes, 6.7% held neutral attitudes, and 2.7% held negative attitudes. In terms of interest, 86.6% had positive interest, 6.7% had neutral interest, and 6.7% were not interested. Related to pre-service teachers' views, 86.7% held positive views, 12.0% held neutral views, and 1.3% held negative views. The findings indicate that a large majority had overall positive attitudes, interests, and views, whereas only a small percentage reported negatively.

Table 3

The Frequencies and Percentages of Overall Attitudes, Interests, and Views

Variables	Study Group		*M*	*SD*
	n	*%*		
Pre-service teachers' attitudes				
Positive	68	90.6	4.32	0.83
Neutral	5	6.7		
Negative	2	2.7		
Pre-service teachers' interests				
Positive	65	86.6	4.12	0.94
Neutral	5	6.7		
Negative	5	6.7		
Pre-service teachers' views				
Positive	65	86.7	4.13	0.72
Neutral	9	12.0		
Negative	1	1.3		

Table 4 illustrates the results of the independent T- test that indicates there was no statistically significant difference in the overall attitudes between male pre-service teachers (M = 4.27, SD= 0.91) and female pre-service teachers (M = 4.36, SD= 0.77); t (73) = 0.45, p= 0.65. As well, there was no statistically significant difference in the overall interests between male pre-service teachers (M = 3.93, SD= 1.14) and female pre-service teachers (M = 4.24, SD= 0.77); t (73) = 1.41, p= 0.16 and there was no statistically significant difference in the overall views between male pre-service teachers (M = 4.17, SD= 0.70) and female pre-service teachers (M = 4.11, SD= 0.74); t (73) = 0.32, p= 0.75.

Table 4

Comparison of Means Related to Male and Female Pre- Service Teachers' Overall Attitudes, Interests, and Views

Variables	Male		Female		*t* (73)	*p*
	M	*SD*	*M*	*SD*		
Attitude	4.27	0.91	4.36	0.77	0.45	0.65
Interests	3.93	1.14	4.24	0.77	1.41	0.16
Views	4.17	0.70	4.11	0.74	0.32	0.75

Table 5 indicates results of the independent T- test that show there was no statistically significant difference in overall attitudes between 1st year pre- service teachers (*M* = 4.31, *SD*= 0.78) and 2nd year pre-service teachers (*M* = 4.35, *SD*= 0.93); *t* (73) = 0.19, *p*= 0.85. Also, it was noticed that there was no statistically significant difference in the overall interests between 1st year pre-service teachers (*M* = 4.12, *SD*= 0.94) and 2nd year pre-service teachers (*M* = 4.13, *SD*= 0.97); *t* (73) = 0.06, *p*= 0.95 and there was no statistically significant difference in the overall views between 1st year pre-service teachers (*M* = 4.19, *SD*= 0.66) and 2nd year pre-service teachers (*M* = 4.00, *SD*= 0.85); *t* (73) = 1.06, *p*= 0.75.

Table 5

Comparison of Means Related to 1st Year and 2nd Year Pre- Service Teachers' Overall Attitudes, Interests, and Views

Variables	Year 1		Year 2		*t* (73)	*p*
	M	*SD*	*M*	*SD*		
Attitude	4.31	0.78	4.35	0.93	0.19	0.85
Interests	4.12	0.94	4.13	0.97	0.06	0.95
Views	4.19	0.66	4.00	0.85	1.06	0.75

Another independent T- test was conducted to determine if there is a mean difference in the overall attitudes, interests, and views of preservice teachers in the age groups of 21–30 years and 31–40 years. Since only one pre-service teacher was available in the age range of 41-50 years, that data was omitted during this comparison of means. Table 6 shows that there was no statistically significant difference in the overall attitude between the 21–30 year group of pre- service teachers (M = 4.33, SD = 0.85) and the 31-40 year group of pre- service teachers (M = 4.00, SD = 0.00); t (72) = 0.77, p = 0.44. Also, there was no statistically significant difference in the overall interests between the 21–30 year group of pre-service teachers (M = 4.10, SD = 0.96) and the 31-40 year group of pre-service teachers (M = 4.25, SD = 0.50); t (72) = 0.31, p = 0.76 and there was no statistically significant difference in the overall views between the 21–30 year group of pre-service teachers (M = 4.13, SD= 0.74) and the 31-40 year group of pre-service teachers (M = 4.00, SD = 0.00); t (72) = 0.35, p = 0.73.

Table 6

Comparison of Means Related to 21-30 Years and 31-40 Years Age Groups of Pre-Service Teachers' Overall Attitudes, Interests, and Views

Variables	21- 30 years		31-40 years		*t* (72)	*p*
	M	*SD*	*M*	*SD*		
Attitude	4.33	0.85	4.00	0.00	0.77	0.44
Interests	4.10	0.96	4.25	0.50	0.31	0.76
Views	4.13	0.74	4.00	0.00	0.35	0.73

Similarly, another independent T- test was performed to examine if there is a mean difference in the overall attitudes, interests, and views of preservice teachers who are in the sciences and STEM teaching groups. Since a very limited number of social studies pre-service teachers were available, their data were omitted during this comparison of means. Table 7 shows that there was no statistically significant difference in the overall attitude between science (M = 4.30, SD = 0.86) and STEM pre- service teachers (M = 4.31, SD = 0.70); t (71) = 0.60, p = 0.95. Also, there was no statistically significant difference in the overall interests between science (M = 4.16, SD = 0.96) and STEM pre-service teachers (M = 3.88, SD = 0.88); t (71) = 1.06, p = 0.29 and there was no statistically significant difference in the overall views between science (M = 4.14, SD= 0.77) and STEM pre-service teachers (M = 4.00, SD = 0.52); t (71) = 0.69, p = 0.49.

Table 7

Comparison of Means Related to Sciences and STEM Pre- service Teachers' Overall Attitudes, Interests, and Views

Variables	Sciences		STEM		*t* (71)	*p*
	M	*SD*	*M*	*SD*		
Attitude	4.30	0.86	4.31	0.70	0.60	0.95
Interests	4.16	0.96	3.88	0.88	1.06	0.29
Views	4.14	0.77	4.00	0.52	0.69	0.49

To sum up, after analyzing the closed-ended survey, it can be said that more than 80% of pre-service teachers had overall positive attitudes, interests, and views about the use of school gardens in education for sustainability. In addition, it should be noted that less than 15% of participants had overall neutral attitudes, interests, and views, and less than 10% had negative attitudes, interests, and views. Statistical analysis revealed no statistically significant difference in the overall attitudes, interests, and views between male and female pre-service teachers. There was no statistically significant difference in the overall attitudes, interests, and views between first y and second-year pre-service teachers. In addition, there was no statistically significant difference in the overall attitude, interests, and views between pre-service teachers in different age groups, and there was no statistically significant difference in the overall attitude, interests, and views between the science and STEM teaching groups.

4.2 Qualitative Research Findings

Analysis of Open-Ended Questions

In this study, participants responded to seven open-ended questions which further explored their perceptions and knowledge about school gardens, as well as their range of understanding about the use of school gardens in education for sustainability and their perceptions of how school gardens impact students' cognitive, affective, and psychomotor learning in education for sustainability.

Pre-service teachers' perceptions and knowledge about school gardens

Participants' responses to question one: *Have you ever participated in school garden programs? If so, what do you know about school gardens*? were analyzed using NVivo12 software to develop appropriate themes, and a word cloud was generated to find out the most often used words or concepts. Figure 2 illustrates the most commonly used words by pre-service teachers and their frequency based on font size. Most frequently used words in terms of pre-service teachers' participation and knowledge about school gardens include "like," "learn," "never," "agriculture," "plants," "sustainable," "lessons," "hands," "grow," and "yes."

Figure 2

Word Cloud Examining Participants' Responses to Their Participation and Knowledge in School Garden Programs

To the first half of the question, which examined whether pre-service teachers have participated in school gardens programs before, the majority of participants (86%) gave responses such as "no," "I have not," and "I have never," while a smaller percentage (14%) said "yes". Participants commented that:

> I have not participated in any school garden programs. (First year, female, science pre-service teacher)
>
> We had a green house in my high school. I was never involved in the program.(First year, female, science pre-service teacher)

> I didn't participate, however, my high school had gardens available for certain courses. (Second year, female, science pre-service teacher)
>
> I have not participated in anything like this before... (First year, female, science pre- service teacher)
>
> No, I have seen them in pop culture and television, plus this survey. (Second year, male, science pre- service teacher)
>
> No and I don't really know anything about them. (First year, male, science pre-service teacher)
>
> Yes when I was in grade 1 so I barely remember. (First year, male, science pre-service teacher)
>
> I participated in creating a school garden during a practicum placement.... (Second year, female, science pre- service teacher)
>
> I participated in an ECO schools club which involved taking care of the school garden….. (First year, female, science pre-service teacher)

Upon further analyzing participants' responses related to their current understanding and knowledge about school gardens, the following themes were identified: provide learning opportunities and interesting. The most significant theme identified was that school gardens provide learning opportunities (67%). This was followed by the theme that school gardens are interesting (33%). The majority of pre-service teachers commented that school gardens provide many learning opportunities and lessons through a hands- on approach:

> I work at a school located on a farm, so most of our lessons are taught using hands-on approaches outside, surrounded by food production…. (First year,

> female, science pre-service teacher)
>
> I've worked at a garden center and understand the learning opportunities such a program would provide students. (First year, male, science pre-service teacher)
>
> My high school had a school garden at the back of the school. We had a gardening club who was in charge of maintaining it, and biology teachers sometimes used the garden for lesson… (First year, male, science pre-service teacher)

Some pre-service teachers mentioned that school gardens provide learning opportunities related to planting, environment, agriculture, food production, healthy food consumption, and sustainable development. Participants commented that:

> I participated in creating a school garden during a practicum placement. Students were actively involved in choosing what went in the garden and actively planted things themselves. The plan for this garden was to be used in the years to come by different classes to learn about agriculture and sustainable development. It was also going to be a place where classes could gather outside for outdoor learning. (Second year, female, science pre-service teacher)
>
> Fruits and vegetables can be grown by students and fed to students. Students can learn about healthy eating practices and how plants grow… (First year, female, science pre-service teacher)
>
> I do see the positive social, environmental, and educational stances associated with it. (Second year, male, science pre-service teacher)

> I've read significant research about the impacts of school garden projects on community, sustainability and education and support their inclusion in more schools. (First year, male, STEM pre-service teacher)
>
> My old elementary/high school did have a school garden and many elementary students participated in a variety of ways (planting, maintenance, harvesting)…. (First year, female, science pre-service teacher)
>
> Fruits and vegetables can be grown by students and fed to students. Students can learn about healthy eating practices and how plants grow…. (First year, female, science pre-service teacher)

Regarding the second theme, a group of participants commented that they think, believe, and have heard that school gardens are very interesting to engage in, and those who have not participated would like to participate in the future:

> This is something I would have been interested in as a student so I fully support creating or improving school garden programs. (First year, female, science pre-service teacher)
>
> I have not participated, but I would like to in the future….. (Second year, male, STEM pre-service teacher)
>
> I know they were an enjoyable and exciting thing to engage with….. (First year, male, science pre-service teacher)
>
> My middle school had a school garden, but we only used it a couple times for class. We had scavenger hunts and other activities for the most part. (First year, male, science pre-service teacher)
>
> We had a green house in my high school. I was never involved in the program.

> Many students used to go there to have a break from class. It was warm and calming and I know many students loved to visit for a moment of quietness. (First year, female, science pre-service teacher)
>
> We never had one at any of the schools I have been at but have heard from other students that they are wonderful... (First year, female, science pre-service teacher)
>
> I have not participated, sounds like a great idea though. (Second year, male, STEM pre-service teacher)

Participants' responses to the second question: *Do you believe it is beneficial to have gardens at school? If so, explain why* were analyzed using NVivo 12 software to develop appropriate themes based on participants' comments. A word frequency query was created to find the most frequently used words or concepts. Figure 3 illustrates the most often mentioned words by participants and their frequency based on font size. The most frequently mentioned words include "hands," "environment," "food," "learning," "sustainability," "agriculture," "nature," and "experiences."

Figure 3

Word Cloud Examining Participants' Comments on Why They Believe Having Gardens at Schools is Beneficial

To the first half of the question, almost all participants (100%) responded that it is beneficial to have gardens at school. Upon analyzing the participants' responses further to determine why they believe school gardens are beneficial, the following four themes were identified: provide learning opportunities; provide hands-on experiences; build connection to the environment; and provide a better physical environment for learning. The most significant theme identified was that school gardens are beneficial in terms of providing learning opportunities (51%), followed by hands-on experiences (24%). These were followed by the themes that school gardens are beneficial in terms of building students' connection to the environment (15%) and providing a better physical environment for learning (10%).

A majority of pre-service teachers mentioned that school gardens provide learning opportunities for students to become more knowledgeable about plants, biodiversity, the environment, agriculture, nutrition, food, and sustainability. Participants commented:

> Opportunities for students to connect and learn about the environment, sustainability, and nutrition… (Second year, female, STEM pre-service teacher)
>
> I think that it would be useful to have when teaching students about plant biology, nutrition, and sustainability... (Second year, female, science pre-service teacher)
>
> I think it would be beneficial because learning about where food comes from and what native plants grow in the area that the school is in is good knowledge… (First year, female, science pre-service teacher)
>
> This would provide opportunity for the students to learn about the environment, where their food comes from, biodiversity, and ecofriendly thinking. (First year, female, science pre-service teacher)
>
> Not all students have gardens at home and having them around school would be a great way to teach students about the environment and where food comes from. (First year, female, science pre-service teacher)
>
> I do think there's a lot of potential for having gardens at school. It could be an opportunity to learn about the environment, sustainability, and agriculture. (Second year, female, STEM pre-service teacher)

Participants commented on the second theme that school gardens are beneficial to get hands-on experiences in planting, agriculture, food production, sustainability, and the application of science concepts:

> I feel like it would be beneficial since it can provide hands on learning

> experiences with many concepts such as agriculture and sustainability. (First year, female, science pre-service teacher)
>
> Gardens are a great way for students to get practical hands-on experience working with plants and allows them to see first-hand results from their hard work. (Second year, male, science pre-service teacher)
>
> Indeed, for hands-on education experiences that will stick with students better..... (First year, female, science pre-service teacher)
>
> Gardens are a great way for students to get practical hands-on experience working with plants and allows them to see first-hand results from their hard work… (Second year, male, science pre-service teacher)
>
> I do believe that gardens at schools are beneficial because they provide useful opportunities for application and use of science concepts… (First year, female, science pre-service teacher)
>
> Students can get hands on experience with a valuable life skill (gardening).. (First year, female, science pre-service teacher)
>
> Yes, I believe it is beneficial because it would allow for a hands-on teaching approach. (First year, female, science pre-service teacher)

Regarding the third theme, participants commented that school gardens are beneficial because they foster students' sense of connection to the environment and natural world:

> Help to teach students more eco-friendly concepts and students become closer to the nature. (First year, male, science pre-service teacher)
>
> It is a great way for students to build relationships with each other and the environment. (Second year, female, science pre-service teacher).

> I do believe it is beneficial to have gardens as they provide a way for students to connect with nature … (Second year, male, science pre-service teacher)
>
> It helps students build a connection to nature teaching them to care for the planet … (Second year, male, science pre-service teacher)
>
> It teaches so much and helps students become grounded in our nature and environment … (First year, male, science pre-service teacher)
>
> I think it connects students with the natural world, and can be used to foster change in the overall community outside of school … (First year, male, science pre-service teacher)
>
> They provide positive environmental attitudes for students. (First year, female, science pre-service teacher)

For the final theme, participants commented that school gardens create a better physical environment for learning:

> In addition to the ample learning opportunities, school gardens give students a positive and relaxing environment to spend some time outdoors..... (First year, male, science pre-service teacher)
>
> I believe it is extremely important for students to spend time in nature as it helps with their focus and mental well-being … (Second year, male, science pre-service teacher)
>
> This is a good way for students to be engaged in an outdoors setting and builds teamwork. (First year, female, science pre-service teacher)
>
> It is beneficial to have gardens at school. It can create a safe and comfortable environment for students to get together and discuss in. Also, students can find

peace and build positive mental health by working on something constructive like gardening … (Second year, female, science pre-service teacher)

Pre-service teachers' range of understanding about the use of school gardens in EfS

Participants' responses to the third question: *What is your understanding of education for sustainability (EfS)*? Explain were analyzed using NVivo 12 software to develop appropriate themes based on participants' comments. Then a word frequency query was developed, and Figure 4 interprets the most frequently mentioned words by participants and the frequency of words based on their font size. The most frequently mentioned words include "sustainability," "sustainable," "environment," and "practices."

Figure 4

Word Cloud Examining Participants' Understanding of Education for Sustainability

Upon analyzing participants' responses based on their understanding of EfS, the following four themes were identified: no understanding of EfS; an education about environmental aspects of sustainability; an education about sustainability, and sustainable practices; and an educational approach that aims to provide knowledge, skills, and values to take actions for sustainability. For the most significant theme identified, the majority of participants responded that they do not have a proper understanding of EfS (47%). These were followed by the themes that EfS is an education about environmental aspects of sustainability (26%), and an education about sustainability and sustainable practices (24%). The least reported theme that was identified was EfS, which is an educational approach that provides knowledge, skills, and values to take actions for sustainability (3%).

Many pre-service teachers claimed that they did not have a proper understanding of EfS. Participants commented:

> I do not have an understanding, but I would like to learn more. (First year, female, science pre-service teacher)
>
> I have never heard of this. (First year, female, science pre-service teacher)
>
> I do not know much about this topic. (First year, female, science pre-service teacher)
>
> I have no specific knowledge of this concept. (First year, female, science pre-service teacher)
>
> I am unfamiliar with the concept, this is the first I have heard of it. (First year, male, science pre-service teacher)
>
> I do not have a deep understanding around education for sustainability practices

> currently in place. (First year, female, science pre-service teacher)
>
> I do not know anything about EfS. I was hoping to learn about it in this degree, but it looks like there is nothing in first or second year. (Second year, male, science pre-service teacher)
>
> I do not have a strong understanding of education for sustainability. (Second year, male, science pre-service teacher)

As for the second theme, EfS is education that addresses the environmental aspect of sustainability, participants commented that:

> Education for sustainability is focused on guiding students and the community to value the environment. There is a focus on teaching and sharing ways in which we can better take care of our Earth … (First year, female, science pre-service teacher)
>
> I believe it to be related to using education to promote a sustainable future and environmental consciousness in our students. (First year, female, science pre-service teacher)
>
> Allow students to understand their impact on the environment. (First year, male, science pre-service teacher)
>
> Education for sustainability is the way to teach students about different ways we can be sustainable in our lives. This can be teaching about water consumption, reducing, reusing and recycling, or about the environment. (First year, female, science pre-service teacher)
>
> I am not sure about the term. But it means around environmental sustainability. (First year, male, science pre-service teacher)

> EfS involves renewable energy sources, and other topics that focus on students creating a positive environment. (First year, male, science pre-service teacher)
>
> Education that can help students live without needing heavily refined products that use unsustainable energy, material sources. (First year, male, social studies pre-service teacher)
>
> It is about testing students' sustainable practices and methods of producing food that does not have a detrimental impact on the environment. (First year, female, science pre-service teacher)

Regarding the third theme, participants commented that EfS is an education about sustainability and sustainable practices:

> Education for sustainability is a way to promote students to take sustainable action in their communities. (Second year, female, STEM pre-service teacher)
>
> I could guess that it is referring to an incorporating sustainability and sustainable practices into the curriculum. (First year, female, science pre-service teacher)
>
> I believe that it is teaching students about sustainable practices. This will help foster and encourage students to be more sustainable in the future…. (Second year, male, STEM pre-service teacher)
>
> My best guess would be that EfS is education that teaches students the importance and practice of sustainability. (Second year, male, science pre-service teacher)
>
> I believe that it means educating children about the importance of sustainability. (First year, female, science pre-service teacher).
>
> Education for sustainability is teaching in a way that informs students about sustainability… (First year, male, science pre-service teacher)

> Education that aims to teach students the importance of sustainable practices and some strategies that they can implement in their day-to-day lives. (First year, male, science pre-service teacher)
>
> Educating students about sustainability so they can use it for themselves in the future. (Second year, female, STEM pre-service teacher)

For the final theme, very few participants commented that EfS is an educational approach that aims to provide knowledge, skills, and values to take actions for sustainability:

> Education for sustainability aims to gear students with the knowledge and skillset to change our currently unsustainable practices in the future. (First year, female, science pre-service teacher)
>
> This term of education for sustainability is an approach to which students are driven to values and motivations so that they can be sustainable throughout their life and their environment. (First year, female, science pre-service teacher)

Participants' responses to the fourth question, *Do you think school gardens contribute to education for sustainability?* were analyzed, and a large majority (91%) responded that they believe school gardens contribute to education for sustainability. A very small percentage (9%) of participants responded that they do not have a proper understanding of it. Participants commented:

> Yes I believe contributing to a garden and having students learn hands on teaches sustainability... (Second year, female, science pre-service teacher)
>
> I think that they could, depending on how the teacher incorporates the gardens into lessons. (Second year, female, science pre-service teacher).
>
> Yes, may not have a huge impact overall but the ripple effect is helpful for

students to learn concepts. (Second year, female, science pre-service teacher).

I think that they could, but it will depend a lot on the teachers at the school. (Second year, female, science pre-service teacher).

Not sure… (Second year, female, science pre-service teacher)

As I am unfamiliar with the concept, I can't answer this question meaningfully. (Second year, female, science pre-service teacher)

Participants' responses to the fifth question, *How do you think school gardens can be used to teach students about sustainability? Explain in detail* were analyzed using NVivo 12 software to develop relevant themes based on participants' comments. A word frequency query was developed, and Figure 5 illustrates the most often mentioned words by participants as well as their frequency based on font size. The most frequently mentioned words include "food," "growing," "sustainable," "farming," "soil," "water," "plants," "environment," and "biodiversity."

Figure 5

Word Cloud Examining Participants' Responses on How They Think School Gardens Can Be Used to Teach Students about Sustainability

Upon analyzing participants' responses on how they think school gardens can be used to teach students about sustainability, the following three major themes were identified: use to teach students how to grow their own food; use to teach environmental aspects of sustainability; and use to teach sustainable agricultural and farming practices.

The most prominent theme identified was that school gardens could be used to teach students how to grow their own food in a more sustainable manner (42%). Participants commented that:

> The gardens can show students how to grow their own food by using the garden and growing/cultivating the right kinds of vegetables & fruits. (First year, male, science pre-service teacher)

> Can teach about growing own products instead of buying mass produced ones … (First year, female, science pre-service teacher)
>
> Students can learn techniques to grow their own food at home, using what they learn in school. (First year, female, science pre-service teacher)
>
> They can be used in many ways, it can show students that you can grow your own fruits and vegetables in a garden (more sustainable) instead of going to the store and buying them. (First year, female, science pre-service teacher)
>
> We can teach them how to use the earth to grow their own food. (First year, female, science pre-service teacher)
>
> They teach that food production can happen locally, with a small carbon footprint. (First year, male, science pre-service teacher)
>
> Gardens can teach us how to grow our own food and how to grow a working & effective ecosystem right in our own backyard. (Second year, female, science pre-service teacher)

The second most prevalent theme was that school gardens could be used to teach environmental aspects of sustainability (35%). Participants noted that:

> If it is filled with native plants, the conversation with the students might be more based on biodiversity and supporting the local wildlife. (First year, female, science pre-service teacher)
>
> We could teach students about land use, energy transfers, pollution, sustainable fertilizers, water contamination concerns, human impacts on the environment, artificial environments and the danger of modifying an environment too much. (First year, male, science pre-service teacher)

> Teach them about scientific principles and how we can use our natural resources sustainably… (First year, female, science pre-service teacher)
>
> I think that school gardens could provide students with the opportunity to understand how we interact with our environment and the importance of the natural world in our success as a species ... (First year, female, science pre-service teacher)
>
> In addition can help educate about renewable energy sources… (First year, female, science pre-service teacher)
>
> It allows for them to have more of a connection and appreciation for nature and in turn the subject of sustainability (First year, female, science pre-service teacher)
>
> Provide Environmental knowledge. Provide more knowledge about biodiversity. (First year, male, science pre-service teacher)
>
> We can use school gardens to teach students about the earth and micro ecosystems that exists around us. (Second year, female, science pre-service teacher)

The third theme reported was that school gardens could be used to teach sustainable agricultural and farming practices (23%), echoed by several participants:

> It can teach them about sustainable farming practices, how to grow their own food, how to use wastes (compost) and promote students to discover innovative ways for sustainability. (First year, female, science pre-service teacher)
>
> I think that gardens can be used to explain sustainable practices and sustainable farming. (Second year, female, science pre-service teacher)
>
> Students can use sustainable practices regarding water, fertilizer, and soil, which

> will also affect the types of crop they choose to grow ... (First year, female, science pre-service teacher)
>
> Students could learn about when the best time to water plants is so the soil absorbs as much as it can. (Second year, male, science pre-service teacher)
>
> Gardening can also encourage conversations of water usage and over-usage which you can discuss more sustainable practices to combat these problems… (First year, female, science pre-service teacher)
>
> Teach them about the use of soil, how to maintain soil, the power of the sun, rainfall… (First year, male, social studies pre-service teacher)
>
> This should give students some insight into why sustainable farming is necessary to support the entire human population. (First year, male, STEM pre-service teacher)
>
> Gardens can be used to discuss concepts such as soil composition, crop rotation, and carbon, water, nitrogen cycles. (Second year, female, STEM pre-service teacher)
>
> You can easily teach about crop and soil diversity, nutrient uptake, compare and contrast with modern mass farming methods… (First year, male, science pre-service teacher)

Pre-service teachers' perceptions of how school gardens impact students' cognitive, affective, and psychomotor learning in EfS

Participants' responses to the sixth question, *What educational purposes would be accomplished with the help of school gardens?* were analyzed using NVivo 12 software to identify certain educational purposes of school gardens for sustainability as suggested

by pre-service teachers. Many participants asserted that school gardens can be used to provide knowledge and understanding about the environment, ecology, plant biology, biodiversity, climate change, agriculture, sustainable food production, nutrition and sustainability. Participants commented that:

> This could cover a range of topics like ecology and biology. (Second year, female, STEM pre-service teacher).
>
> Sustainability, growing your own food, the importance of plants, plant systems in general, the role that plants & pollinators have in the ecosystem. (First year, female, science pre-service teacher)
>
> Teaching students about ecosystems. More specifically, taking students to the school garden and teaching lessons about the different organisms that contribute to a healthy garden ecosystem. (First year, female, science pre-service teacher).
>
> The biology strand of the grade 9 science curriculum is focused on ecosystems and climate change and a garden could help that unit out. (First year, female, science pre-service teacher)
>
> Teaching about plant biology and the environment and sustainability… (Second year, male, science pre-service teacher)
>
> I believe school gardens could be used as a tool to help enhance a student's learning about sustainability and agriculture… (First year, male, STEM pre-service teacher)

Many pre-service teachers responded that school gardens can be utilized to foster students' positive attitudes, values, emotions, and feelings towards sustainability. One participant mentioned that school gardens can be used for cultural pedagogy as well.

Participants commented that:

> Teach students about environmental friendly attitudes. (First year, male, science pre-service teacher)
>
> Love for Environment. (First year, female, science pre-service teacher)
>
> Give them the opportunity to share (if the garden grows food) with disadvantaged students in their school/community. (First year, female, science pre-service teacher)
>
> Allowing students to create a bond with nature and learn its relation to the health of our planet and the health of us. Help feed the school community so no one is hungry. Teach students how to care for the environment. (First year, male, science pre-service teacher)
>
> I think this would be especially beneficial for younger students to start them thinking about sustainable practices. (First year, female, science pre-service teacher)
>
> Provide Fun and joy. (Second year, male, science pre-service teacher)
>
> Additionally, students can learn and appreciate how much time it takes for food to growth. (First year, female, science pre-service teacher)
>
> Stewardship, involvement, cultural pedagogy. (First year, male, science pre-service teacher)

Several pre-service teachers claimed that school gardens can be used to provide hands-on experience for planting, farming, managing gardens, creating scientific projects, making scientific observations, and conducting scientific investigations, as shared by participants:

> Discovering biodiversity in gardens (plants, insects, and animals), discovering the microbiology of soil (with a telescope and soil samples). (First year, female, science pre-service teacher)
>
> Hands on lab work, connecting concepts to real life… (First year, male, science pre-service teacher)
>
> Students can have a hands on understanding of gardens/farming and sustainable practices. (Second year, female, science pre-service teacher)
>
> Students would be able to practice using dichotomous keys using a variety of plants and can understand identification and diversification through practice... (First year, female, science pre-service teacher)
>
> Direct experience with farming/agriculture, practical knowledge dealing with growing plants (First year, female, science pre-service teacher).
>
> School gardens could be used to create a project related to biology when teaching about ecosystems, physics when coming up with watering systems in the garden, and chemistry when thinking about the chemical process of photosynthesis. (First year, male, science pre-service teacher)

Upon analyzing further, those identified educational purposes were classified into the following three main domains, which are considered the students' intended learning outcomes in education: cognitive domain of learning (knowledge); psychomotor domain of learning (skills); and affective domain of learning (attitudes, values, feelings, enthusiasm, appreciations, motivations) (Ali, 2017). As proposed by pre-service teachers, Table 8 illustrates the major learning outcomes of school gardens for sustainability. The majority of educational purposes of the school gardens suggested by pre-service teachers

belonged to the cognitive domain of learning (43%). This was followed by the purposes belonging to the affective (28.5%) and psychomotor (28.5%) domains of learning.

Table 8

Major Learning Outcomes of School Gardens for Sustainability as Proposed by Pre-Service Teachers

Domain of learning	Major learning outcomes
Cognitive (knowledge)	The understanding of what sustainability means
	The understanding the value of sustainability
	The understanding of biodiversity
	The understanding of where food comes from
	The understanding of climate change
	The understanding of the environment
	The understanding of human impacts on the environment
	The understanding of the ecology and biology
	The understanding of the plant and plant biology
	The understanding of the importance of plants and plant systems
	The understanding of agriculture and farming
	The understanding of nutrition
Affective (appreciations attitudes, values, feelings enthusiasm, motivations)	Start to think about sustainable practices
	Develop pro-environmental attitudes and behaviors
	Appreciation for the work put into making food
	Appreciation of the environment and nature
	Enjoy learning in the garden
	Love for the environment
	Motivate students to share food with disadvantaged students in the school or community
	Value cultural diversity

Psychomotor (skills)	Ability to observe the biodiversity
	Ability to plant trees
	Ability to manage gardens
	Ability to practice sustainable farming
	Ability to practice scientific concepts
	Ability to cook healthy foods
	Ability to conduct scientific investigations
	Ability to create scientific projects

Pre-service teachers' future tendencies to use school gardens in EfS.

Participants' responses to the seventh question, *If you used school gardens in the future, for what purposes would you like to use them?* were analyzed using NVivo 12 software to determine pre-service teachers' main purposes for using a school garden in future. Appropriate themes were developed based on participants' responses, and a word frequency query was developed to determine the most often used words. The most often mentioned words by participants include "biology," "science," "plant," "project," "agriculture," "hands," and "club." (Figure 6)

Figure 6

Word cloud Examining Participants' Purposes of the Use of School Gardens in the Future

Through analyzing participants' responses to perceived purposes for using school gardens in the future, the following themes were identified: link to the curriculum for teaching purposes; provide students with hands-on experience; extracurricular activities; students' well-being; improve students' pro-environmental behavior; and provide community outreach. The most significant purpose mentioned by pre-service teachers was that school gardens could be linked to the curriculum for teaching purposes (62%). They mainly emphasized biology, science, and environmental science as major curricular areas to incorporate school gardens. Most of them commented that they will use school gardens to teach lessons, concepts, and activities in biology and the sciences. As well,

some participants commented that they would use school gardens for the long-term STEM learning projects associated with the curriculum. Participants noted:

> Definitely for the lessons in biology that revolve around plants (primarily the photosynthesis unit) because it will allow the students to see the plants and see the impact that they have first-hand. Additionally, they can see how sun and water impact the plants. (Second year, female, science pre-service teacher)
>
> I would like to use them to teach a variety of biology topics. Specifically, photosynthesis, the carbon cycle, sustainability, ecosystems, nutrients, the conditions needed for plant growth, etc. (First year, female, science pre-service teacher)
>
> I would probably use them for a grade 9 science course in the biology strand focusing on ecosystems or in a grade 10 course for the earth and space science strand focusing on climate change. (First year, female, science pre-service teacher)
>
> I would like to use them in all grade levels to incorporate into the curriculum and maybe use as a STEM learning project. (Second year, female, STEM pre-service teacher)
>
> I am looking to teach grade 9 and 10 science which would be great opportunities to use a garden in these units. (First year, female, science pre-service teacher).
>
> I will use school gardens for biology and environmental sciences lessons mainly focusing about bio diversity, gardening, and agriculture… (Second year, female, science pre-service teacher)
>
> For biology and science classes to teach about plants, resources and sustainability

> Various STEM projects could be implemented with the presence of school gardens. (Second year, female, science pre-service teacher)
>
> I would use then for semester long projects about plant life and the development of agricultural and agricultural practice. (First year, female, science pre-service teacher)

The second-most significant purpose suggested by pre-service teachers was that they would use school gardens to provide students with hands-on experiences in terms of planting trees, farming and agriculture, and scientific investigations (14%). Participants noted that:

> I would like to use these gardens to provide a more hands-on lens on agriculture. This is in terms of food production, water usage, and the use of pesticides and GMO… (First year, female, science pre-service teacher)
>
> I am a proponent of hands-on learning, and I think school gardens provide many opportunities for this... (Second year, female, science pre-service teacher)
>
> I would like students to be able to plant something and watch it grow into a product that they can consume. (Second year, male, science pre-service teacher).
>
> I would like to use them to conduct science experiments with my students and to have a place to grow vegetables for and with my students. (Second year, female, science pre-service teacher)

The third most popular purpose among pre-service teachers was that school gardens can be used for many extra-curricular activities, such as garden clubs, class competitions, and volunteer work (10%). This was followed by the use of school gardens for the purpose of students' physical and mental well-being (9%). Participants stated that:

> For recreational purposes (hanging out in a peaceful environment)… (Second year, female, science pre-service teacher)
>
> I would have my Health & Physical Education class visit once a week to do their part and learn about lifelong physical activity participation…. (First year, female, science pre-service teacher)
>
> A way to get students to find positive mental health at school… (Second year, male, science pre-service teacher)

A few participants mentioned that they intend to use school gardens to improve pro-environmental behavior among students (3%) and provide community outreach (2%).

To summarize, findings from qualitative data analysis (see Table 9) indicate that, while the majority of pre-service teachers did not participate in school garden programs, they believed school gardens were interesting platforms with many learning opportunities for students. Almost all pre-service teachers claimed that it is beneficial to have gardens at school because they provide many learning opportunities, hands-on experiences, connections to the environment, and a better place to learn. The majority of pre-service teachers reported that they do not have a proper understanding of EfS and others mainly emphasized that EfS is an education about environmental sustainability or an education about sustainability and sustainability practices. The majority of participants felt that school gardens can be used to teach students about sustainability by providing opportunities to learn about producing their own food, environmental aspects of sustainability, and sustainable agricultural and farming practices. The pre-service teachers identified specific educational purposes of school gardens in education for sustainability, which belong to the cognitive, psychomotor, and affective learning

domains. Finally, a large majority of pre-service teachers stated that they will use school gardens for the purpose of teaching biology and science curricula in the future.

Table 9

Summarization of Qualitative Data Analysis

Open-ended questions	Significant themes identified and their percentages (%)
1) Have you ever participated in school garden programs?	No (86%) Yes (14%)
If so, what do you know about school gardens?	Provide learning opportunities (67%) Interesting (33%)
2) Do you believe it is beneficial to have gardens at school?	Beneficial (100%)
If so, explain why.	Provide learning opportunities (51%) Provide hands-on experiences (24%) Build students' connection to the environment (15%) Provide a better physical environment for learning (10%)
3) What is your understanding of education for sustainability (EfS)? Explain.	No understanding of EfS (47%) An education about environmental aspect of sustainability (26%) An education about sustainability and sustainability practices (24%) An educational approach that provides knowledge, skills, and value to take actions for sustainability (3%)

4) Do you think school gardens contribute to EfS?	Yes (91%) No understanding (9%)
5) How do you think school gardens can be used to teach students about sustainability? Explain in detail.	Teach students how to grow their own food (42%) Teach environmental aspects of sustainability (35%) Teach sustainable agricultural and farming practices (23%)
6) As you believe, what educational purposes would be accomplished with the help of school gardens? Explain in detail.	(See Table 8) Cognitive domain of learning (43%) Affective domain of learning (28.5%) Psychomotor domain of learning (28.5%)
7) If you used school gardens in the future, for what purposes would you like to use them?	Link to the curriculum for teaching purposes (62%) Provide students with hands-on experience (14%) Extracurricular activities (10%) Address students' well-being (9%) Improve students' pro-environmental behavior (3%) Provide community outreach (2%)

Chapter 5: Discussion

The findings of this study provide insights into pre-service teachers' perceptions of the use of school gardens in education for sustainability. In this chapter, I discuss key research findings based on research questions and relate them to the existing literature. Finally, I discuss the significance and implications of this study.

Pre-service Teachers' Attitudes, Interests, and Views about the Use of School Gardens in EfS

The first research question mainly explored pre-service teachers' attitudes, interests, and views about the use of school in EfS. Based on the findings of the quantitative data analysis, outlined in Tables 2 and 3, the majority of pre-service teachers held overall positive attitudes, interests, and views about the use of school gardens in education, while a smaller percentage had neutral or negative attitudes, interests, and views. There was no statistically significant difference in the overall attitude, interests, and views between different demographic data of pre-service teachers such as their age, sex, year of study and teachable subjects.

The results of my study are somewhat consistent with the previously mentioned literature regarding teachers' perceptions about the use of school gardens in education. For instance, DeCoito's (2021) study found that teachers had more positive attitudes and views towards the school gardens in terms of providing students opportunities to learn about the environment and responsible and protective action against it, hands-on experience, worldwide challenges like poverty, and the promotion of good eating habits and lifestyles. Similarly, Murakami et al. (2016) revealed that most of the teachers had

positive views of school gardens in terms of improving students' environmental awareness and nutritional knowledge. According to Graham and Zidenberg-Cherr (2005), teachers had more positive attitudes and views regarding the incorporation of school gardens into the curriculum. Rosenthal (2018) also showed that pre-service teachers had positive attitudes and views regarding school gardens in terms of providing learning opportunities to primary school students. In addition, Kincy et al. (2016) found that teachers who were using their personal time for gardening had more positive attitudes towards school gardens and were more likely to use the gardens as a supplement to the curriculum.

As per Table 2, my study findings showed some exceptions, such as the fact that a significant proportion of pre-service teachers held neutral and negative attitudes toward using school gardens to teach students about sustainable energy resources and to improve students' educational performances. These somewhat contradict the existing literature on teachers' perceptions of school gardens in education. According to Gaylie (2009) and Williams and Brown (2012), teachers hold more positive attitudes about school gardens in terms of providing students with knowledge related to environmental sustainability. As well, DeMacro et al. (1999) and Graham and Zidenberg-Cherr's (2005) studies claimed that teachers hold more positive attitudes about school gardens in terms of improving students' academic performances.

The quantitative results related to pre-service teachers' attitudes, interests, and views are more consistent with the qualitative research findings because pre-service teachers' responses to the open-ended questions showed that the majority of them held positive attitudes, interests, and views towards the use of school gardens in education.

According to my study findings, a large majority of pre-service teachers claimed that school gardens are beneficial because they provide students many learning opportunities through hands-on approaches and provide learning opportunities related to environment, planting, agriculture and farming, food production, nutrition, healthy food consumption, and sustainable development. These findings are comparable to those of numerous other studies that exist in the literature. For instance, Desmond et al. (2002) and Gaylie (2009) stated that school gardens offer many opportunities for experiential learning. Williams and Brown (2012) asserted that school gardens provide students with many learning opportunities for sustainable development. Bowker and Tearle (2007) claimed that school gardens provide learning opportunities for environment, agriculture, and farming. Ruiz-Gallardo et al. (2013) revealed that school gardens provide opportunities for planting and agriculture, while Miller (2007) and Morgon et al. (2009) found that school gardens offer opportunities to learn more about the environment. Furthermore, Beckman and Smith (2007), Gibbs et al. (2011), Heim et al. (2011), and Parmer et al. (2009) revealed that school garden activities provide opportunities to learn about nutrition and healthy food consumption.

Similarly, my study found many pre-service teachers claiming that school gardens are beneficial in terms of building students' connections to the environment. This aligns with Upitis et al. (2013) and Williams and Brown (2102) who found that garden-based activities improve students' connection to the environment.

Pre-service Teachers' Range of Understanding about the Use of School Gardens in EfS

The second research question mainly explored pre-service teachers' range of understanding about the use of school gardens in EfS. The conceptual framework for my research study was Parajuli's Partnership Model of Sustainability, which emphasizes four main dimensions of sustainability: ecology, economy, equity/social justice, and bio-cultural diversity (Williams & Brown, 2012). Hence, I used this framework to determine pre-service teachers' understanding of the concept of EfS and their range of understanding about the use of school gardens in EfS. Findings based on open-ended questions provided insights into pre-service teachers' understanding of the concept of EfS, with 47% of pre-service teachers asserting that they do not know anything about the concept of "education for sustainability." Another 50% of pre-service teachers did not demonstrate proper understanding of the concept of EfS. The majority of them emphasized only the environmental (ecological) aspects of sustainability without considering the overall aspects of EfS. The remaining participants asserted that EfS is education or teaching about sustainability or sustainability practices. A few participants stated that EfS is an educational approach that aims to provide knowledge, skills, and values to take actions for sustainability, which demonstrated the most comprehensive understanding of EfS.

My study findings highlight pre-service teachers' perceptions of how school gardens could be used to teach students about sustainability. All pre-service teachers' views are situated under three main areas: to teach sustainable food production, to teach environmental sustainability, and to teach sustainable agriculture and farming practices.

According to Parajuli's Partnership Model of Sustainability, these three areas mainly covered the environmental (ecological) and economic aspects of sustainability but not the aspects of equity/social justice, and bio-cultural diversity. In response to the question, *how do you think school gardens can be used to teach students about sustainability?* I found that none of the pre-service teachers included in their responses information addressing the equity/social justice and bio-cultural diversity aspects of sustainability. These findings based on open-ended questions are somewhat comparable to findings obtained from the survey responses. As per Table 2, a significant proportion of pre-service teachers hold neutral to negative opinions related to the viewpoint that school gardens can be used to alleviate hunger and poverty, support diverse cultural understanding, and allow students to share their cultural heritage. Hence, it is obvious from the results that pre-service teachers did not have a proper understanding of the holistic viewpoint of EfS according to Parajuli's Partnership Model of Sustainability, and their range of understanding about the use of school gardens in EfS was within the limits of environmental (ecological) and economical aspects of sustainability.

The aforementioned findings align with several other studies in the literature, which revealed that many teachers do not have a proper understanding of the holistic viewpoint of EfS. Borg et al. (2014) found that teachers do not have a proper understanding of the overall aspects of EfS, and their understanding varies based on their teaching subjects. Evans et al. (2012) and Pepper and Wildy (2008) revealed that many teachers do not have a proper understanding of EfS and that it is only limited to the environmental education or environmental aspect of sustainability. Similarly, Burmeister

et al. (2013) and Spiropoulou et al. (2007) found that teachers do not have a clear understanding of the concept of EfS.

Pre-service Teachers' Perceptions of How School Gardens Improve Students' Cognitive, Affective, and Psychomotor Learning in EfS

The third research question mainly explored pre-service teachers' perceptions of how school gardens impact students' cognitive, affective, and psychomotor learning in EfS. As per Table 8, based on pre-service teachers' responses, a total of 28 particular educational outcomes that could be accomplished with school gardens were identified. According to Ali (2017), the improvement of intellectual and knowledge capacities is a focus of the cognitive domain of learning. Hence, all educational purposes specified by pre-service teachers that primarily addressed improving students' knowledge and understanding were credited to the cognitive domain of learning. A vast majority of pre-service teachers claimed that school gardens can be utilized to provide knowledge and understanding about the environment, ecology, plants and plant biology, biodiversity, climate change, agriculture and farming, sustainable food production, nutrition, and sustainability. These learning outcomes mainly addressed the environmental and economic aspects of sustainability.

The aforementioned educational purposes suggested by pre-service teachers align with many studies in the literature that reveal the importance of school gardens in education. The study by Williams and Brown (2012) revealed how school gardens improve students' awareness of sustainability, and DeCoito (2021) found that students believe school garden programs make them more aware of the environment. Similarly,

Miller (2007) and Morgon et al. (2009) found that school garden programs improve environmental knowledge and awareness. Bowker and Tearle (2007) disclosed that students' knowledge of agriculture, farming, and ecology develops through gardening. Papadopoulou et al. (2020) stressed that active participation in gardens significantly impacts students' environmental awareness and improves their knowledge about sustainable development. Desmond et al. (2004) revealed that school gardens teach students to produce their own food in an ecologically responsible manner. The studies of Beckman & Smith (2008), Kotch et al. (2006), and Parmer et al. (2009) disclosed the impact of school gardens on improving students' nutritional knowledge.

According to Ali (2017), emotions such as feelings, values, appreciation, enthusiasm, motivation, and attitudes belong to the psychomotor domain of learning (p. 151). Hence, all learning outcomes specified by pre-service teachers that addressed promoting students' positive attitudes, values, emotions, and feelings towards sustainability were attributed to the psychomotor domain of learning. The main educational outcome suggested by pre-service teachers here was that school gardens help develop students' pro-environmental attitudes and behaviors. Many of them commented that school gardens: "Teach students how to care for the environment"; "Teach students about environmentally friendly attitudes"; "Teach students about environmental stewardship". This learning outcome is consistent with most research in the literature. Upitis et al. (2013) revealed garden-based activities broaden students' sense of connection to nature and improve environmental stewardship. The study of Skelly and Bradley (2007) revealed that student involvement in garden-based activities increases their responsibility and positive attitudes towards the environment. Similarly, the studies

of Dricks and Orvis (2005) and Waliczek and Zajicek (1999) revealed that school garden programs help build more positive environmental attitudes in students. Furthermore, Papadopoulou et al. (2020) and Perez-Lopez et al. (2021) argued that school gardens significantly impact students' attitudes and behaviors towards nature and promote the value of preserving the environment. Although several studies indicated improvement in students' pro-environmental behavior as a result of garden-based learning, there was a knowledge gap in the literature that noted the lack of evidence in the development of pro-environmental behavioral changes associated with garden-based learning (Chaeng et al., 2017; Eugenio-Gozalbo et al., 2020). Also, I found in my study that pre-service teachers did not emphasize the development of pro-environmental behavioral changes associated with garden-based learning, such as reducing purchasing behavior or reducing recycling.

Another learning outcome suggested by pre-service teachers was that school gardens motivate students to share food with disadvantaged students in the school or community. This learning outcome is also aligned with the studies of DeCoito (2021) and Fisher et al. (2019), which revealed that school garden initiatives improve students' diets while addressing the issue of hunger and poverty both inside and outside of the school and in the broader community. One participant commented that school gardens can be used to implement cultural pedagogy as well. According to the Ontario Ministry of Education (2013, as cited in Maniyaran, 2017), cultural pedagogy incorporates students' cultural knowledge into the teaching and learning process in the classroom. Hence, if teachers use school gardens to practice cultural pedagogy in the school, this may provide students an opportunity to value and share their culture with others. This educational outcome suggested by pre-service teachers is found in the studies of Blanchet-Cohen and

Reliiy (2017) and Williams and Brown (2012), which disclosed that school gardens help culturally diverse immigrant students share their cultural values. Similarly, Kelly et al. (2021) indicated in their study that gardens offer culturally responsive, place-based education to culturally diverse pupils who come from various backgrounds. The aforementioned learning outcomes suggested by pre-service teachers mainly addressed the equity/social justice and bio-cultural diversity aspects of sustainability in Parajuli's Partnership Model of Sustainability.

According to Ali (2017), the psychomotor domain is focused on the capacity to coordinate physical movements and use motor skills (p. 151). Hence, all learning outcomes specified by pre-service teachers that addressed improving students' skills were incorporated into the psychomotor domain of learning. In my study, many pre-service teachers claimed that school gardens can be used to provide students hands-on skills for planting, farming, managing gardens, creating scientific projects, making scientific observations, and conducting scientific investigations. These learning outcomes suggested by pre-service teachers are more consistent with the study of Ruiz-Gallardo et al. (2013), which revealed that school gardens help students acquire and improve practical skills such as watering plants in the greenhouse or garden, weeding, and cleaning that are beneficial to the environment. Similarly, Desmond et al. (2004) reported that school gardens help students learn agriculture-related skills such as preparing soil, irrigating, and harvesting.

Furthermore, in my study, I also examined how and for what purposes pre-service teachers would use school gardens in their future practice. The most significant purpose mentioned by pre-service teachers was that they would link school gardens to the

curriculum for teaching. They focused on integrating school gardens into the primary curricular areas of science, biology, and environmental science to teach lessons, concepts, and activities in those areas. This result aligns with many studies in the literature that disclose that school gardens have been used as a tool to teach science and improve students' science learning outcomes (Dircks & Orvis, 2005; Klemmer et al., 2005; Skinner et al., 2021; Smith & Mostenbocker, 2005). Similarly, the studies of Berson and DeCoito (2021), Graham et al. (2004), and Williams and Brown (2012) revealed that school gardens are used as a tool to teach other subjects such as environmental sciences and agriculture. Pre-service teachers also reported that they would use school gardens for several other purposes, such as to provide students with hands-on skills, for extracurricular activities such as garden clubs, class competitions, and volunteer work, and for students' physical and mental well-being. Few participants mentioned that they would use school gardens to improve students' pro-environmental behavior and provide community outreach.

To sum up, I addressed the research questions focusing on pre-service teachers' perceptions about the use of school gardens in education for sustainability based on research findings and the related literature. My research findings revealed that the majority of pre-service teachers hold positive attitudes, interests, and views about the use of school gardens in education for sustainability. In relation to pre-service teachers' range of understanding about the use of school gardens in EfS, the majority of them did not have a proper understanding of the holistic viewpoint of the concept of EfS according to Parajuli's Partnership Model of Sustainability, and they mainly focused on using school gardens to achieve the environmental and economic aspects of sustainability. Moreover,

pre-service teachers suggested specific learning outcomes of school gardens, which belong to the cognitive, psychomotor, and affective learning domains, and these learning outcomes of school gardens addressed all four main aspects of sustainability mentioned in Parajuli's Partnership Model of Sustainability: ecology, economy, equity/social justice, and bio-cultural diversity.

My research findings contribute to the limited body of knowledge about pre-service teachers' perceptions about the use of school gardens in EfS and provide insights into pre-service teachers' attitudes, interests, and views about the use of school gardens in education for sustainability. Also, this study adds to the existing literature on teachers' current knowledge and understanding about the concept of "education for sustainability" and their range of understanding about the use of school gardens in education for sustainability. Furthermore, this study sheds light on pre-service teachers' future tendencies to use school gardens in education.

Chapter 6: Conclusion

This research study aimed to examine pre-service teachers' perceptions about the use of school gardens in EfS. I explored three main research questions, focusing on pre-service teachers' attitudes, interests, and views about the use of school gardens in education for sustainability, as well as pre-service teachers' range of understanding about the use of school gardens in education for sustainability and how they think school gardens impact students' cognitive, affective, and psychomotor learning for sustainability. With the aim of achieving the main objective of the research study, I used a mixed-methods research approach that used both quantitative and qualitative data to answer my research questions. The mixed-methods approach was chosen in order to increase the strength of the study by minimizing the limitations of both quantitative and qualitative approaches and to obtain a deep understanding of the research questions.

The literature indicates that there is very limited knowledge about pre-service teachers' perceptions about the use of school gardens in EfS and that the majority of teachers do not have a proper understanding of the concept of EfS. This research study revealed that the majority of pre-service teachers have positive attitudes, interests, and views about the use of school gardens in education for sustainability. Also, the study findings indicated that, according to Parajuli's Partnership Model of Sustainability, the majority of pre-service teachers do not have a proper understanding of the holistic viewpoint of the concept of EfS, and their understanding of the use of school gardens in education for sustainability is mainly aligned with the environmental and economic aspects of sustainability. In addition, pre-service teachers emphasized specific learning outcomes of school gardens that address students' knowledge, skills, and attitudes toward

sustainability. From the research findings, it is evident that they answered the research questions as well as provided insight into pre-service teachers' future tendencies to use school gardens in education. Nevertheless, the study did not address the literature gap related to students' pro-environmental behavior changes associated with garden-based learning.

6.1 Implications and Recommendations

According to study findings, there are some implications and recommendations that can be incorporated into pre-service teacher education. It is recommended to incorporate sustainability education into pre-service teacher education as a mandatory component to enhance teachers' knowledge and understanding of the concept of EfS. Also, it is recommended to incorporate garden-based learning into pre-service teacher education as a supplement for sustainability education with both a theoretical and practical component. In addition, it is recommended to incorporate garden-based learning into the school curriculum across certain subjects, such as science, biology, and environmental science.

6.2 Limitations

The research study was carried out with a small sample size (n = 75) in a small geographical location in Canada. Since this sample size is relatively low and does not represent all pre-service teachers in Canada, the study results cannot be generalized to all pre-service teachers in Canada. As well, some pre-service teachers avoided the open-ended questions in the online survey, demonstrating nonresponse bias that reduces the sample's external validity by making it less representative of the population as a whole.

Additionally, participants may not have answered the online survey truthfully, which would result in response bias and may lessen the validity of the research findings.

6.3 Areas of Further Research

This study explored pre-service teachers' perceptions about the use of school gardens in education for sustainability. Since the study sample size does not represent all pre-service teachers in Canada, further research needs to aim to incorporate a significant sample size that represents pre-service teachers from different geographical locations in Canada. Also, future studies should focus on obtaining an in-depth understanding of pre-service teachers' knowledge and understanding of the concept of EfS by expanding the sample size and including pre-service teachers from different backgrounds and different geographical locations in Canada.

6.4 Concluding Thoughts

To conclude, this research study was able to demonstrate pre-service teachers' perceptions about the use of school gardens in EfS. In this study, the majority of pre-service teachers showed poor understanding of the concept of EfS. But the majority of teachers had positive attitudes, interests, and views about the use of school gardens in education for sustainability. Hence, it is essential to incorporate sustainability education and garden-based learning into pre-service teacher education to better utilize the school gardens to achieve sustainable development goals.

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Appendices

Appendix A: Online Survey

Part A: Demographic Questionnaire

1. What is your sex?
    - Male
    - Female
    - Other
2. What is your age?
    - Less than 21
    - Between 21- 30
    - Between 31- 40
    - Between 41- 50
    - Between 51- 60
    - Between 61- 70
3. What is your year of study in the Bachelor of Education program?
    - First year
    - Second year
4. Please select your teachable subjects.
    - Sciences (Biology/Physics/ Chemistry/General Science/ Environmental Science/ Elementary Science & Technology)
    - Science, technology, engineering and mathematics (STEM)
    - Social Studies (General Social Studies/ Elementary Social Studies)
    - Canadian and World Studies (Geography)

Part B: Likert Scale Survey

Close ended survey questionnaire has 3 main sections - A) Pre-service teachers' attitudes B) interests and C) views. Please select your response to each statement.

(SD=Strongly Disagree; D=Disagree; N= Neutral; A=Agree; SA= Strongly Agree)

Statement	SD 1	D 2	N 3	A 4	SA 5
A) Pre-service teachers' attitudes					
1. I can use school gardens to teach students about the importance of the environment.					
2. I can use school gardens to teach students about the environment, natural resources, and biodiversity.					
3. I can use school gardens to improve students' pro-environmental attitudes and behaviors.					
4. I can use school gardens to teach students about sustainable energy resources.					
5. I can use school gardens to promote healthy food consumption among student.					
6. I can use school gardens to promote sustainable farming among students.					
7. I can use school gardens to teach students about living a healthy lifestyle.					
8. I can use school gardens to improve students' educational performances.					
B) Pre service teachers' interests					
9. I would like to use school gardens for teaching purposes.					

10. I would like to spend more time in school gardens with students.					
11. I would like to implement many educational activities in the school gardens for students.					
12. I would like to initiate new school garden programs for students.					
13. I would like to develop existing school garden programs.					
14. I would like to engage in many agricultural / garden activities in the school gardens with students.					
15. I would like to use school gardens to teach eco-friendly concepts.					
16. I would like to implement garden-based competitions for students.					
C) Pre service teachers' views					
17. School gardens can be used to improve students' positive environmental attitudes and behaviors.					
18. School gardens can be used to improve students' knowledge of good health and well-being, academic performance, and links with local communities.					
19. School gardens can be used to improve sustainable local practices that impact global economies.					
20. School gardens can be used to alleviate hunger and poverty.					
21. School gardens significantly contribute to teaching knowledge, attitudes, values, and skills for sustainable development.					

22. School gardens support diverse cultural understandings and allow students to share their cultural heritage. 23. To teach sustainability principles, garden-based learning should be integrated into the school curriculum at all levels. 24. It is beneficial to have any type of garden in every school.					

Part C: Open-Ended Questions

1. Have you ever participated in school garden programs? If so, what do you know about school gardens?

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2. Do you believe it is beneficial to have gardens at school? If so, explain why?

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3. What is your understanding of education for sustainability (EfS)? Explain

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4. Do you think school gardens contribute to education for sustainability?

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5. How do you think school gardens can be used to teach students about sustainability? Explain in detail.

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6. As you believe, what educational purposes would be accomplished with the help of school gardens? Explain in details.

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7. If you used school gardens in the future, for what purposes would you like to use them? Explain

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Appendix B: E-mail for the Teacher Education Office, Western University Administrators

Dear Sir/Madam,

My name is Dona Ishara Yahampath, and I am an MA student, under the supervision of Dr. Isha DeCoito, in Curriculum Studies at the Faculty of Education, Western University. My research study is titled: Exploring Pre-service Teachers' Perceptions about the Use of School Gardens in Education for Sustainability. The study aims to explore pre service teachers' knowledge, attitudes, interests, and views about the use of school gardens in education for sustainability. I'm writing to you to let you know about my study and to ask for your assistance in recruiting potential participants for it.

Benefits of the Study

Participants may not directly benefit from participating in this study, but information gathered may be beneficial in determining the strength of curricular content and pedagogies of environmental and sustainability education in initial teacher education programs, as well as how they could be modified to better prepare pre-service teachers to use school gardens for sustainability education. Similarly, gathered information will help to predict pre-service teachers' future tendencies to use school gardens to teach sustainability.

I am writing you to ask for your help in contacting potential participants for my study. Participants will be invited to complete an online survey about their knowledge, attitudes, interests, and views about the use of school gardens in education for sustainability. To be eligible to participate in this study, participants need to be enrolled in the first or second year of the Bachelor of Education (BEd) program at Western University, Ontario, Canada and are pursuing or have pursued the following teaching subject course/ courses (at least one subject).

1. Sciences (Biology/ Physics/ Chemistry/ General Science/ Environmental Science/ Elementary Science & Technology)
2. Science, technology, engineering and mathematics (STEM)
3. Social Studies (General Social Studies /Elementary Social Studies)
4. Canadian & World Studies (Geography)

The survey will be administered online and it will take approximately 20 minutes to complete. Kindly forward the below mentioned recruitment email to the potential participants for this study. Please note that the reminder email will be sent two weeks after the first recruitment email.

If you would like more information about this study, please contact the researcher at the contact information given below.

Your cooperation is much appreciated.

Thank you

Dr. Isha DeCoito
The Faculty of Education
Western University

Or

Dona Ishara Yahampath
The Faculty of Education
Western University

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Email Script for Recruitment

Invitation to participate in research study

Hello Teacher Candidates,

You are being invited to participate in a study that Dr. Isha Decoito and Dona Ishara Yahampath are conducting. The study aims to explore pre-service teachers' perceptions about the use of school gardens in education for sustainability.

As a participant in the study, you will be invited to complete an online survey about your knowledge, attitudes, interests, and views about the use of school gardens in education for sustainability. The survey will be administered online and it will take approximately 20 minutes to complete. If you would like to participate in this study, please click on the link below to access the letter of information and the online survey

https://uwo.eu.qualtrics.com/jfe/form/SV_3P2tLZxMfNdE6Zo

Please note that a reminder email will be sent two weeks from now.

If you would like more information about this study, please contact the researcher at the contact information given below.

Your cooperation is much appreciated.

Thank you

Dr. Isha DeCoito
The Faculty of Education
Western University

Or

Dona Ishara Yahampath
The Faculty of Education
Western University

Appendix C: Letter of Information and Implied Consent

Study Title

Exploring pre-service teachers` perceptions about the use of school gardens in education for sustainability.

Document Title

Letter of Information and Consent.

Principal Investigator

Dr. Isha DeCoito, Faculty of Education, Western University.

Additional Research Staff + Contact

Dona Ishara Yahampath, Faculty of Education, Western University.

Invitation to participate

You are being invited to participate in this research study focusing on assessing pre service teachers' perceptions about the use of school gardens in education for sustainability because you are a teacher candidate pursuing the Bachelor of Education (BEd) program at Western University. The main purpose of this letter is to provide you with the information you need to decide for yourself whether or not to take part in this research study. Please read the information given below and clarify anything you do not understand before considering whether or not to participate.

Background/ Purpose

The purpose of this study is to explore pre-service teachers' perceptions about the use of school gardens in education for sustainability. The study aims to examine pre-service

teachers' knowledge, attitudes, interests, and views about the use of school gardens in education for sustainability.

Procedures

Participation in this research study is voluntary. If you decide to participate in this study, you will be invited to complete an online survey. It is expected that the online survey will take approximately 20 minutes to complete, and you can complete it at your convenience. By responding and submitting the survey, you will indicate your implicit consent to participate in the study. But even if you start the survey, you have the right to not answer individual questions or to withdraw from the study at any time. If you decide to withdraw from the study before submitting your data, you may do so at any time by exiting the survey window. But once your survey responses have been submitted, the researchers will be unable to withdraw your data due to the anonymous nature of your data.

Inclusion criteria

To be eligible to participate in this study, participants need to be enrolled in the first or second year of the Bachelor of Education (BEd) program at Western University, Ontario, Canada and are pursuing or have pursued the following teaching subject course/ courses (at least one subject).

1. Sciences (Biology/ Physics/ Chemistry/ General Science/ Environmental Science/ Elementary Science & Technology)
2. Science, technology, engineering and mathematics (STEM)
3. Social Studies (General Social Studies /Elementary Social Studies)
4. Canadian & World Studies (Geography)

Risks

There are no known or anticipated risks or discomforts associated with participating in this study.

Benefits

You may not directly benefit from participating in this study, but information gathered may be beneficial in determining the strength of environmental and sustainability

education curricular content and pedagogies in initial teacher education programs, as well as how they could be modified to better prepare pre-service teachers to use school gardens for sustainability education. Similarly, gathered information will help to predict pre-service teachers' future tendencies to use school gardens to teach sustainability.

Data Security and Confidentiality

The data collected will be used only for research purposes and will be stored and archived securely. Representatives of Western University's Non-Medical Research Ethics Board may require access to study-related records to monitor the conduct of the research. Your survey responses will be collected anonymously through a secure online survey platform called Qualtrics. Qualtrics uses encryption technology and restricted access authorizations to protect all data collected. In addition, Western's Qualtrics server is in Ireland, where privacy standards are maintained under the European Union safe harbor framework. The data will then be exported from Qualtrics and securely stored on Western University's server. The study data will be retained by the researcher for a minimum of 7 years as per the research data retention policy in Western University's Faculty Collective Agreement, and all collected data will be destroyed thereafter.

Compensation

You will not be compensated for your participation in this research.

Rights as a participant

Your participation in this study is voluntary. You may decide not to be in this study. Even if you consent to participate, you have the right to not answer individual questions or to withdraw from the study at any time. If you choose not to participate or to leave the study at any time, it will have no effect on your academic standing. You do not waive any legal rights by consenting to this study.

Questions about the Study

If you have any questions about the study, please contact the principal investigator, Dr. Isha Decoito or the co-investigator Dona Ishara Yahampath.

If you have any questions about your rights as a research participant or the conduct of this study, you may contact the Office of Human Research Ethics at Western University. This office oversees the ethical conduct of research studies and is not part of the study team. Everything that you discuss will be kept confidential.

Publication

The results of the study will be made public via peer reviewed publications or presentations.

Consent

Submitting the online survey is an indication of your consent to participate. This consent will be confirmed by checking a consent box before starting the survey questionnaire.

This letter is yours to keep for future reference.

Appendix D: Reminder E-mail for the Teacher Education Office, Western University Administrators

Dear Sir/Madam,

My name is Dona Ishara Yahampath, and I am an MA student, under the supervision of Dr. Isha DeCoito, in Curriculum Studies at the Faculty of Education, Western University. My research study is titled: Exploring Pre-service Teachers' Perceptions about the Use of School Gardens in Education for Sustainability. The study aims to explore pre service teachers' knowledge, attitudes, interests, and views about the use of school gardens in education for sustainability. I'm writing to you to let you know about my study and to ask for your assistance in recruiting potential participants for it.

Benefits of the Study

Participants may not directly benefit from participating in this study, but information gathered may be beneficial in determining the strength of curricular content and pedagogies of environmental and sustainability education in initial teacher education programs, as well as how they could be modified to better prepare pre-service teachers to use school gardens for sustainability education. Similarly, gathered information will help to predict pre-service teachers' future tendencies to use school gardens to teach sustainability.

I am writing you to ask for your help in contacting potential participants for my study. Participants will be invited to complete an online survey about their knowledge, attitudes, interests, and views about the use of school gardens in education for sustainability. To be eligible to participate in this study, participants need to be enrolled in the first or second year of the Bachelor of Education (BEd) program at Western University, Ontario, Canada and are pursuing or have pursued the following teaching subject course/ courses (at least one subject).

1. Sciences (Biology/ Physics/ Chemistry/ General Science/ Environmental Science/ Elementary Science & Technology)
2. Science, technology, engineering and mathematics (STEM)
3. Social Studies (General Social Studies /Elementary Social Studies)
4. Canadian & World Studies (Geography)

The survey will be administered online, and it will take approximately 20 minutes to complete. Two weeks ago, the first recruitment email was sent to the potential participants through your assistance. Kindly forward the below mentioned reminder email to the potential participants for this study.

If you would like more information about this study, please contact the researcher at the contact information given below.

Your cooperation is much appreciated.

Thank you

Dr. Isha DeCoito
The Faculty of Education
Western University

Or

Dona Ishara Yahampath
The Faculty of Education
Western University

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Reminder Email: Invitation to participate in research study

Hello Teacher Candidates,

As you may recall, you received an email two weeks ago inviting you to participate in a research study that Dr. Isha Decoito and Dona Ishara Yahampath are conducting. This is a gentle reminder to complete the survey, if you would like to be a participant. The study aims to explore pre-service teachers' perceptions about the use of school gardens in education for sustainability.

As a participant in the study, you will be invited to complete an online survey about your knowledge, attitudes, interests, and views about the use of school gardens in education for sustainability. The survey will be administered online and it will take approximately 20 minutes to complete. If you would like to participate in this study, please click on the link below to access the letter of information and the online survey (https://uwo.eu.qualtrics.com/jfe/form/SV_3P2tLZxMfNdE6Zo).

If you would like more information about this study, please contact the researcher at the contact information given below.

Your cooperation is much appreciated. If you have already completed the survey thank you very much for your participation.

Thank you

Dr. Isha DeCoito
The Faculty of Education
Western University

Or

Dona Ishara Yahampath
The Faculty of Education
Western University

Ethics Approval

Western Research

Date: 7 November 2022

To: Dr. Isha DeCoito

Project ID: 121474

Study Title: Exploring Pre-service Teachers' Perceptions about the Use of School Gardens in Education for Sustainability.

Short Title: Pre-service Teachers' Perceptions of School Gardens in Education for Sustainability

Application Type: NMREB Initial Application

Review Type: Delegated

Full Board Reporting Date: 02/Dec/2022

Date Approval Issued: 07/Nov/2022 12:14

REB Approval Expiry Date: 07/Nov/2023

Dear Dr. Isha DeCoito

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the above mentioned study, as of the date noted above. NMREB approval for this study remains valid until the expiry date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

This research study is to be conducted by the investigator noted above. **All other required institutional approvals and mandated training must also be obtained prior to the conduct of the study.**

Documents Approved:

Document Name	Document Type	Document Date	Document Version
Letter of Information and Implied Consent	Written Consent/Assent	04/Sep/2022	1
Email-Recruitment of participants for reaserch	Recruitment Materials	01/Nov/2022	02
Reminder email- Recruitment of participants for reaserch	Recruitment Materials	01/Nov/2022	02
Online SurveyID	Online Survey	01/Nov/2022	02

No deviations from, or changes to the protocol should be initiated without prior written approval from the NMREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Ms. Zoë Levi, Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Curriculum Vitae

Name:	Dona Ishara Yahampath
Post-secondary Education and Degrees:	University of Colombo Colombo, Sri Lanka 2011- 2015 B.Sc (Plant Biotechnology)
Related Work Experience:	Secondary School Teacher St Nicholas International School, Negombo, Sri Lanka Feb 2021- Aug 2021 Secondary School Teacher Royal Institute International School, Colombo, Sri Lanka Aug 2017- Dec 2019 Secondary School Teacher Gateway International School, Hulumale, Maldives Jan 2017- July 2017 Teaching Assistant Faculty of Science, University of Colombo, Sri Lanka Feb 2016 – Jan 2017