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Measuring Sustainability Literacy: Scale Development and Validation

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Measuring Sustainability Literacy: Scale Development and Validation

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Abstract

Concerns have been raised after recent reports from the United Nations and Higher Education Sustainability Initiative showed a lower score in sustainability literacy of people. Among other things, these reports show that educational practices are not effective enough to inform and educate people about sustainability. Thus, an effective assessment of the sustainability literacy of a society can be a turning point and will tremendously help in improving sustainability literacy. In recent years, different researchers tried to develop tools to measure sustainability literacy, however, most of the research focused on specific or limited dimensions of sustainability literacy such as environment or society, and lacked inclusivity. Thus, in this study, we aimed to develop a tool that can measure sustainability literacy holistically. We developed the scale under the UNESCO framework of Sustainable Development and used the existing literature and focus group recommendations to generate items for the scale. The methodology used in the paper involved Exploratory Factor Analysis (EFA) followed by the reliability analysis of the developed scale. The sample size of the data was 172 individuals. The EFA and reliability results indicate that the developed scale is strongly valid and highly reliable and can be used to measure sustainability literacy holistically.

Table of Content

List of Abbreviations

SD	Sustainable Development
UN	United Nations
SDGs	Sustainable Development Goals
MDGs	Millennium Development Goals
ESD	Education for Sustainable Development
DESD	Decade of Education for Sustainable Development
GAP	Global Action Program
HESI	Higher Education Sustainability Initiative
HEIs	Higher Education Institutions
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNSD	United Nations Statistics Division
WCED	World Commission on Environment and Development
NGOs	Non-government Organizations
TASK	The Assessment of Sustainability Knowledge
REB	Responsible Environmental Behavior
ASK	Assessment of Sustainability Knowledge
SAS	Sustainability Attitudes Scale
SLT	Sustainability Literacy Test
SK	Sustainability Knowledge
SB	Sustainability Behaviour
SA	Sustainability Attitude
EFA	Exploratory Factor Analysis
CL	Climate Literacy

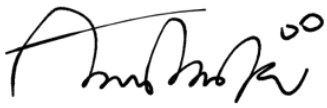
List of Figures

List of Tables

Statutory Declaration

I hereby declare that I have developed and written the enclosed thesis completely by myself and have not used sources or means without declaration in the text. Any thoughts from others or literal quotations are clearly marked. The thesis was not used in the same or in a similar version to achieve an academic grading or is being published elsewhere.

Hamburg, 25.05.2024



1. Introduction

1.1 Motivation and Problem Statement:

"*Unless we act now, the 2030 Agenda will become an epitaph for a world that might have been.*" this is what António Guterres the Secretary-General of the United Nations (UN) said as he was briefing the Member States in New York on April 23, 2023, about a report that was showing the progress toward Sustainable Development Goals (SDGs) (United Nations, 2023a). His above statement is an alarming fact for the whole world as the latest reports about SDGs explicitly mention that a preliminary assessment of 140 SDGs targets shows that only 12 percent are on track, more than 50 percent are showing some progress or are either out of track or the rest 30 percent shows no movement or even move backward (United Nations, 2023b). We do hear such news and alarming facts about the environment, poverty, and sustainability almost every day and it's not new. The history of such topics goes back to 1972 when the first Earth Summit was conducted in Stockholm which afterward led to the United Nations Conference on Sustainable Development (UNCSD) in 2012 and the creation of Sustainable Development Goals (SDGs) and Agenda 2030. All these initiatives were created to solve problems such as climate change and environmental degradation (Calder & Cligston, 2005).

Among all these initiatives the United Nations Decade of Education for Sustainable Development (DESD) established in 2005 and the Higher Education Sustainability Initiative (HESI) established at the 2012 UNESCO conference insisted on consideration of sustainable development issues in Higher Education Institutions (HEIs) and asked the institutions to go beyond their current efforts and include sustainability topics and education across all their disciplines (UNESCO, 2017). Unfortunately, after more than a decade since the establishment of DESD and HESI whose main purpose is education for sustainable

development, do fall behind. A recent test conducted by Sulitest (2023) which co-chairs the HESI shows that from a total of 4346 individuals, only 11.1% demonstrated high sustainability knowledge remaining respondents scored below 50.95 out of 100 scores. This is why the United Nations (2023b) once again calls on all educational institutions to contribute to spreading sustainability knowledge through different means. Looking into the above statement by the UN a need arises for assessment tools that could measure sustainability literacy and point to the areas where actions need to be taken. Therefore, this research will aim to develop a tool for measuring sustainability literacy.

In recent years different tools have been developed by researchers to measure and do the assessment of sustainability knowledge within HEIs (Michalos et al., 2010; Zwickle et al., 2014; Atabek-Yiğit et al., 2014; Olsson et al., 2015; Kapitulčinová et al., 2018; Ozdemir, 2021; Husamah Husamah et al., 2022;). Most of these tools focus on a specific or limited dimension of sustainability literacy such as environment and society or a specific group within an institution such as students (Hernández-Diaz et al., 2021; Ozdemir, 2021; Lozano, 2018; Trapeznikov, 2017) and lacks an inclusive focus. Therefore, this research paper aims to fill the gap by developing a holistic scale that will cover all dimensions of sustainability.

1.2 Research Questions:

Throughout this research I will provide answers to the following:

1. How can sustainability literacy be measured holistically?
2. Which specific dimensions are represented by the sustainability literacy scale?

1.3 Organization of the Study:

This study is organized into five parts: The first part is an introduction to the research, where the author will explain the motivation behind conducting this research and touch upon the research problem and questions. The second part is a literature review where

we dive deep into the history and definition of sustainability, its dimensions and framework, the integration of sustainability into the educational system, and the meaning of sustainability literacy. It ends with an extensive review of the existing scales developed to measure sustainability literacy and the common approaches used. The third part is the methodology where we explain how the instrument (scale) is developed for this study, what is the sample and data collection methods and how the data is analyzed. The fourth part will be about the results of the data we analyzed and its meaning. The fifth part will be a discussion where we will touch upon the real-world implementation and implication of the scale developed to measure sustainability literacy. Finally, in the sixth part, we will touch upon the limitations of the study and the future research possibilities.

2. Literature Review

2.1 Sustainability

To develop the tool for measuring sustainability literacy, one must clearly understand each component, its history, and how it can be developed and validated. That is why this review seeks to shed light on those components. It will start by defining sustainability and its history, the dimensions of sustainability, sustainable education, and its connection or integration into the educational context. Additionally, the concept of sustainability literacy will be discussed. Finally, this review concludes with a summary of existing tools for measuring sustainability literacy and their findings.

2.1.1 History and Definition of Sustainability

The concept of sustainability is no longer new and is currently used in many contexts in politics, finance, economy (Raj & Musgrave, 2014). But to understand it better and not mix it up one needs to go deeper and understand its meaning, origin, and basics.

A place to start with is the etymology ("the study of the origin of words and the way in which their meanings have changed throughout history"). According to Caradonna (2014) the words "sustainable" and "sustainability" are both derived from the Latin *sustinere* which is a combination of two words *sub* (up from below) and *tenere* (to hold), and means to "endure", "maintain", "sustain", or "to restrain". Afterward from Latin, the word passed to old French as *sostenir* and then to the new French as *soutenir*. During the modern period, it was transferred to English as the verb "to sustain" which was used vastly. According to the Oxford English Dictionary the adjective "sustainable" entered common usage in 1965 and the verb "sustainability" in the early 1970s. Thus, these dates indicate the verb "to sustain" had developed in the last part of the twentieth century into a clearer concept (To restrain human society in the long term).

Now that we have laid down the origin and meaning of the words “sustainable” and “sustainability” we need to go a step further and talk about when were those two worlds used in the global context, when they became important and what is its definition. There are different opinions about the origin of the concept of sustainability that we currently know. Some say it goes back to 1713 when a forestry named Hans Carl von Carlowitz stated his concerns about deforestation and proposed to remove as much wood as we could regenerate again (Mauch, 2014). Another argument is from the environmental movement of the 70s and 80s which led to the report such as “The Limits to Growth” by the Club of Rome in 1972 where they pointed out concerning issues such as the finiteness of resources, population growth, harmful consequences of increasing industrialization, and a way for more sustainable and conscious living for the public (Meadows et al., 2017). Such arguments and concerns remained the same for a few years until the very current and mostly accepted definition of the concept of sustainability was stated in the Brundtland report in 1987 which was issued by the World Commission on Environment and Development (WCED). This report describes the main principles for what is known today as Sustainable Development (SD) and provides a guideline on what SD is. This definition is very famous and mostly used as the Brundtland definition and they explain SD as “*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*” (Brundtland, G.H., 1987). This definition clearly explains that human and their needs are the center of the focus for SD and urges all humans to keep the balance of their needs within their generation and the needs of future generations. This definition also shows that sustainability is not static but rather an ongoing process (Glotzbach & Baumgartner, 2012).

The Brundtland report provided some guidance on where the world and our actions need to be directed. Thus this led to the Earth Summit in 1992 in Rio de Janeiro, Brazel. In the Earth Summit more than 178 countries' political leaders, diplomats, scientists,

representatives of the media, and non-governmental organizations (NGOs) came together and adopted Agenda 21. This conference highlighted how different environmental, social, and economic factors are interconnected to each other and how improvement in one section requires actions in another section. Thus, this conference came up with a new agenda for the international community on how to build a global partnership on SD to improve human lives and protect the environment (United Nations, 2023a).

Eight years later in September 2000 the above member countries came together at UN headquarters in New York and adopted the Millennium Declaration which included 8 Millennium Development Goals (MDGs) to reduce poverty by 2015 (Mensah, 2019). These goals were later replaced by 17 Sustainable Development Goals (SDGs) in 2015 and a new 2030 agenda was introduced recently which is the most relevant guideline for action at a global level (United Nations, 2023a). According to UNESCO (2017, p. 6), "*the aim of the 17 SDGs is to secure a sustainable, peaceful, prosperous, and equitable life on the earth for everyone now and in the future.*" These goals also address many global challenges that are important for the survival of humanity and nature. Several thresholds are set in place for the use of natural resources and a range of social needs such as education, health, poverty, inequality, and many other factors are addressed as well.

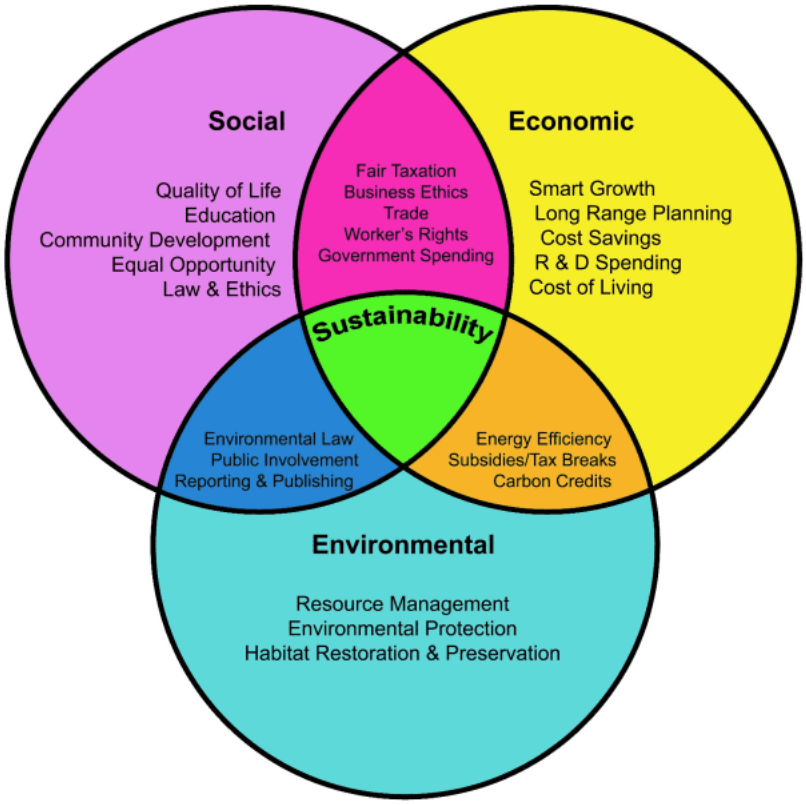
2.1.2 Dimensions of Sustainability

Although the term SD has been widely used in society during recent years, it is often criticized due to its broad definition (Bonnett 1999; Giddings et al., 2002; Jabareen 2008) it includes almost everyone and concerns everyone thus making it easy for anyone to adapt the concept according to their own agenda. Furthermore, there is the risk that the meaning of SD is too broad, so individuals feel that they are not responsible for everything (Sandell et al. 2005).

Therefore, an integrated concept of SD has been emphasized one example is the report of the Rio Conference in 1992 where they expressed the compatibility of economics, ecology, and social issues into SD. These three dimensions of SD are further described in the framework of the United Nations Decade of Education for Sustainable Development (UN-DESD) implementation scheme. Thus while addressing sustainability an emphasis has been put on maintaining the connection between the different dimensions of SD to have a holistic and complete view of sustainability (UNESCO, 2006). This eventually leads us to three dimensions of sustainability that describe the relationship among the environmental, social, and economic aspects of SD as captured in Figure 1 (Wanamaker, 2022).

Figure 1

Relationships Among Social, Environmental, and Economic Dimensions.



Source: Wanamaker (2022)

This figure clearly shows that all three dimensions are interconnected and that each dimension complements each other and stands on an equal footing (Mensah, 2019). Kahn (1995) and Basiago (1999) provide examples to illustrate the relationship between economic, social, and environmental sustainability and argue that sustainability requires the integration of the three areas. According to Khan (1995) as cited in Bassiago (1999, p. 150):

> "*If a man in a given geographical area lacks a job (economic), he is likely to be poor and disenfranchised (social); if he is poor and disenfranchised, he has an incentive to engage in practices that harm ecology, for example, by cutting down trees for firewood to cook his meals and warm his home (environmental). As his actions are aggregated with those of others in his region cutting down trees, deforestation will cause vital minerals to be lost from the soil (environmental). If vital minerals are lost from the soil, the inhabitants will be deprived of the dietary nutrients required to sustain the intellectual performance needed to learn new technologies, for example, how to operate a computer, and this will cause productivity to reduce or stagnate (economic). If productivity stagnates (economic), poor people will remain poor or poorer (social), and the cycle continues.*"

The hypothetical case above illustrates the link between the three interrelated dimensions of sustainability and the need to integrate them for SD (Basiago, 1999). Although this example may be an oversimplification, it provides context for how the three dimensions of sustainability are interrelated and can promote SD. (Basiago, 1999; Khan, 1995). Below are the three dimensions, each briefly described.

The economic dimension refers to production systems that meet current consumption levels without compromising future needs (Lobo et al., 2015). Traditionally, economists assumed that the supply of natural resources was infinite and placed too much emphasis on the ability of markets to allocate resources efficiently (Du & Kang, 2016). They also believed

that economic growth is accompanied by technological advances that replenish natural resources destroyed in the production process (Cooper & Vargas, 2004). However, it was recognized that natural resources are not infinite, moreover, not all of them can be replenished or renewed. The expansion of the scale of the economic system has led to the overuse of natural resources, which has led to a reconsideration of traditional economic assumptions (Basiago, 1996, 1999; Du & Kang, 2016). For this reason, many scholars question the feasibility of uncontrolled growth and consumption. Allen and Clouth (2012) assert that human life on Earth is supported and sustained using the Earth's limited natural resources. Dernbach (2003) previously argued that population growth is increasing human needs such as food, clothing, and shelter, but that the means and resources available worldwide cannot be increased to permanently meet them. Additionally, Retchless and Brewer (2016) note that as the main concern appears to be economic growth, key cost factors such as the effects of wastage and pollution are ignored. Also, the increasing demand for goods and services continues to grow and drive the market while the harm to the environment is ignored (UNSD, 2018c). Therefore, economic sustainability requires that decisions are made in the fairest and financially sound way possible while considering other aspects of sustainability (Zhai & Chang, 2019).

The social dimension includes social issues such as equity, accessibility, empowerment, cultural identity, and institutional stability. The objective is to make sure that everyone can live up to their rights and can make social decisions freely without any force or interference (Daly, 1992). According to Kolk (2016), social sustainability is not about ensuring that everyone’s needs are met. Rather, it aims at providing enabling conditions for everyone to have the capacity to realize their needs if they so desire. Anything that goes against this is considered unsustainable and must be resolved to make progress toward SD. Therefore, understanding the nature of social dynamics and how these structures emerge from

a systems perspective is of great importance to social sustainability (Lv, 2018). Above all, in Gray's (2010) and Guo's (2017) views, social sustainability also encompasses many issues such as human rights, gender equity and equality, public participation, and the rule of law all of which promote peace and social stability for SD.

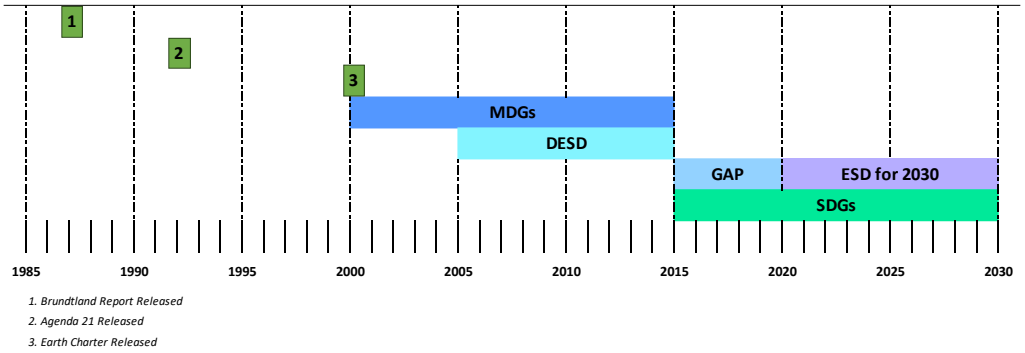
The environmental dimension is about the natural environment and how to keep it stable and resilient to support human lives. It includes issues such as the preservation of biodiversity, climate protection, access to drinking water, and the careful usage of natural resources (Mensah, 2019). The main purpose is to use as many natural resources as it can be regenerated again, and the waste should be produced as much as the environment can handle (Diesendorf, 2000; Evers, 2018).

By explaining the above SD dimensions and sub-dimensions we therefore use the UNESCO framework as the theoretical foundation for developing the scale that will be able to measure sustainability holistically (UNESCO, 2006).

2.2 Sustainability & Education and Sustainability Literacy

As discussed above, after the release of the Brundtland Report in 1987 by WCED it showcased three issues. First, the Brundtland Report defined sustainability. Second, the Brundtland Report stated that sustainability is more than just an environmental perspective, it includes and addresses interconnectedness between environmental, economic, and social perspectives. Lastly, it addressed education and a way to help accomplish sustainability initiatives (Nolet, 2015). From this point onward, there have been different global initiatives happening at various times that tried to address the issue of sustainability and education (Figure 2).

Figure 2
Timeline of Sustainability and Education Initiatives



Source: Own illustration

The release of the Brundtland Report led to a conference held under the name of Earth Summit in Rio de Janeiro in 1992 which resulted in Agenda 21 which produced a blueprint for SD that encompassed environmental, social, and economic impacts. Afterward based on the points raised in Agenda 21, the MSGs were developed where both sustainability and education represented a part of goals number 2 and 7 respectively (United Nations, 2015). After the completion of MDGs in 2015 there was still a need for further steps to achieve the goals thus it led to the very current initiative called SGDs which includes a total of 17 goals (United Nations, 2023a).

It was during the MDGs that led to the creation of the United Nations Decade of Education for Sustainable Development (DESD), which started in 2005 and ended in 2014. According to UNESCO (2017, p. 7), DESD is defined as "*integrating the principles and practices of sustainable development into all aspects of education and learning. It also aimed to encourage changes in knowledge, values, and attitudes with the vision of enabling a more sustainable and just society for all"*. Initially, DESD was focused on bringing awareness of SD into education, however, after some time it shifted from only awareness to integration of

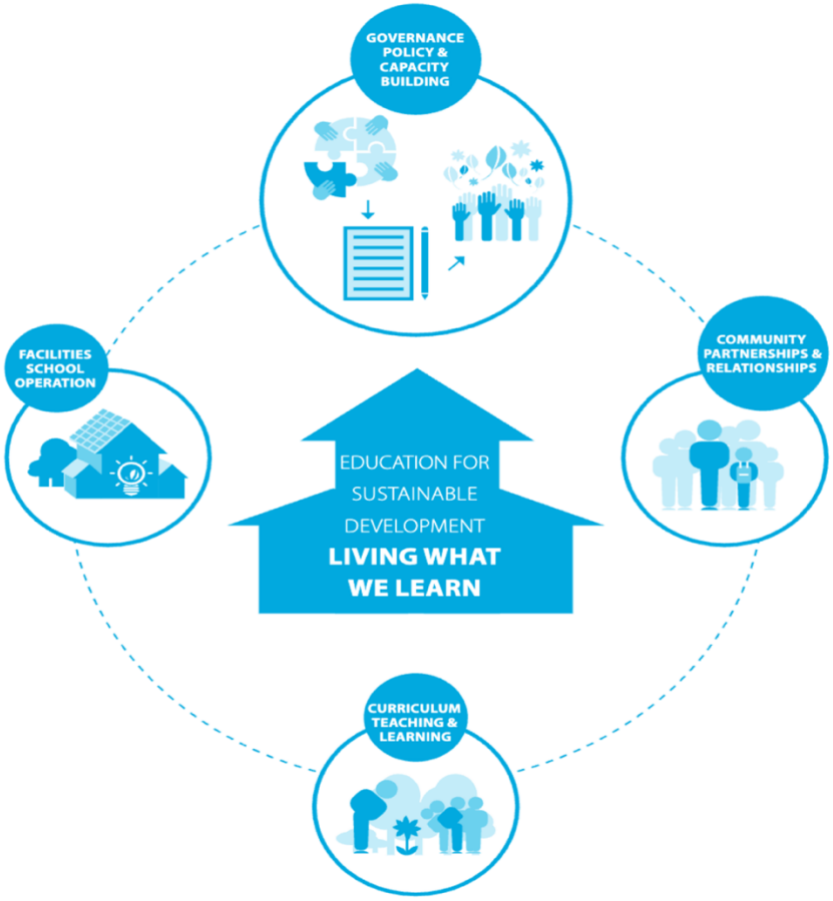
SD into the educational system and focused on even broader topics such as climate change, biodiversity, and disaster risk reduction (UNESCO, 2014; Potter-Nelson, 2020).

The completion of the DESD led to increasing the awareness and integration of sustainability into the education system but there was still a need for further development and improvement which ultimately led to a new program titled Global Action Program on Education for Sustainable Development (GAP on ESD) (UNESCO, 2014; UNESCO, 2017). The GAP on ESD continued the tasks of DESD and according to UNESCO (2016, p. 3) "*It focuses on generating and scaling up ESD action at all levels and in all areas of education, and in all sustainable development sectors"*. To enable a better stakeholder commitment and strategic focus the GAP has also identified five priority areas:

> "*1) Advancing policy; 2) Transforming learning and training environments; 3) Building capacities of educators and trainers; 4) Empowering and mobilizing youth, and 5) Accelerating sustainable solutions at the local level*" (UNESCO, 2016, p. 3).

After the end of the GAP program in 2019, *ESD for 2030* is built upon the lessons learned from the GAP on ESD. ESD for 2030 currently helps to develop competencies that can empower individuals to consider their current and future social, environmental, economic, and cultural impacts from both a local and global perspective (UNESCO, 2020). Although ESD is recognized in SDGs as part of Target 4.7, its contribution encompasses all SDGs in the sense that ESD enables individual-specific cognitive, socio-emotional, and behavioral learning outcomes which ultimately enables individuals to deal with almost all other SDGs. In short, ESD helps individuals to increase their knowledge concerning SDGs but also shows them how they can contribute and be change makers (UNESCO, 2014). ESD has a very broad perspective and is working on integrating the education for SD into policies, strategies, programs, curricula, textbooks, teacher education, and other learning settings which is illustrated in (Figure 3) (UNESCO, 2014).

Figure 3
The whole Institution Approach



Source: (UNESCO, 2014, p. 89)

While most of the above-mentioned initiatives might have a finite timeline, they do echo each other and transfer a message that every individual matters and that everyone should be sustainability literate and motivated to take part in shaping a better life for themselves and future generations.

The term literacy initially meant the ability to read and write but it has evolved considerably and now literacy encompasses the ability of someone in different and broad areas such as technology, science, communication, computer, and environmental science (Stables & Bishop, 2001). The framework for the term environmental literacy was first stated by Roth (1992, p. 17), the author defined environmental literacy as:

> *"Environmental literacy is the capacity to perceive and interpret relative health of environmental systems and to take appropriate action to maintain, restore and improve the health of systems."*

According to Roth environmentally literate citizens can identify and evaluate environmental problems and afterward take action to solve those problems considering the needs of future generations as well. Accordingly, Orr (1992, p. 92) describes environmental literacy as:

> *"… a broad understanding of how people and societies relate to each other and to natural systems, and how they might do so sustainability."*

Furthermore, with the recent shift from environmental education to sustainability education, the term environmental literacy has expanded to sustainability literacy (Sterling, 2020). This means that sustainability literacy has become a major outcome of sustainability education and that sustainability literacy encompasses a broader perspective for a sustainable future rather than environmental literacy which only focuses on the environmental aspect (Sandri, 2014). Thus, sustainability literacy is defined by Sulitest (2023) as the knowledge, skills, and mindsets that compel an individual to become committed to building a sustainable future and allow him to make effective decisions. Stibbe and Luna (2009) describe sustainability literacy as a collection of skills, attitudes, competencies, and values that could help an individual to thrive and survive in the current declining condition of the world. Accordingly, Parkin et al. (2004) argue that sustainability literacy means having knowledge, skills, and understanding of the relationship among environmental, social, and economic dimensions of SD. From the above definitions, we can argue that sustainability literacy includes and addresses multiple competencies such as knowledge, attitude, skills, and behavior and explains the relationship between humans and nature.

2.3 Existing Sustainability Measurement Tools

Different scales have been used to measure sustainability literacy (Table 1). The scales mainly focus on environmental, social, and economic domains and are measured using different dimensions such as knowledge, skills, sensibility, attitude, and behavior. The scales are targeted at different groups of participants such as secondary school teachers in Taiwan (Hsu & Roth, 1998), 3rd-grade students in Korea using domains such as knowledge, attitude, behavior, and skills (Chu et al., 2007), university students in Turkey (Teksoz et al., 2011), students in USA (Szczytko et al., 2018), University students in Iran (Veisi et al., 2018), USA population (Coyle, 2005), and university students in UK (Ozdemir, 2023).

One of the measurement tools developed is Sulitest (sustainability literacy test). Sulitest was developed by 300 experts in the field of SD who came from private organizations, NGOs, and universities (Sulitest, 2023) under the umbrella of HESI. As Sulitest (2023, p. 8) states the reason behind building this test is:

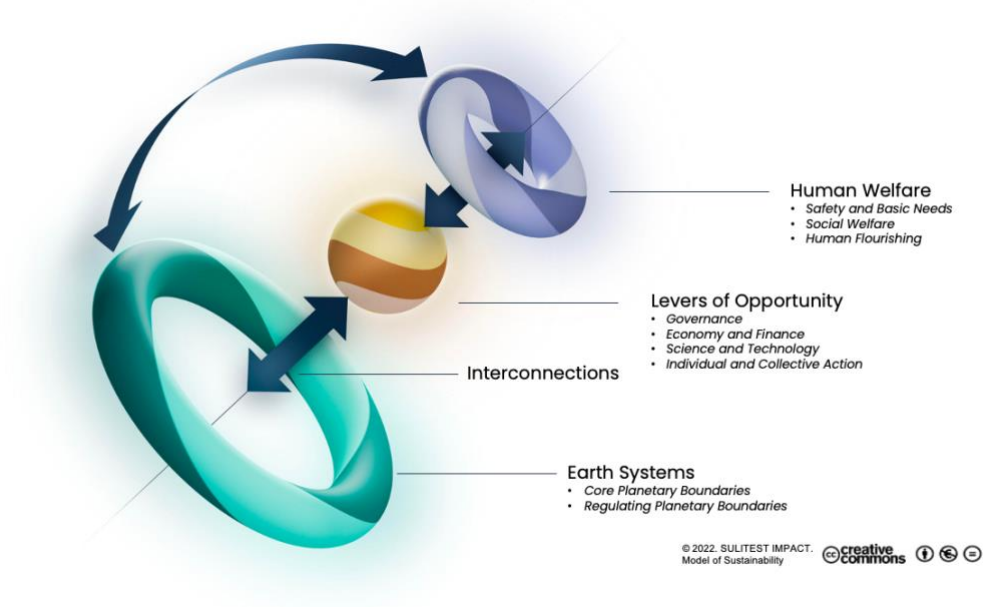
> "*To build a sustainable world, it is imperative to improve the knowledge, skills and mindset on sustainable development, referred to as sustainability literacy. While society needs experts who can solve specific problems in their field, we need to mainstream sustainability knowledge, so that everyone has a sufficient understanding of it, and can use it in their personal and professional lives. This is the "raison d'être" of the Sulitest movement.*"

Over 160,000 individuals across 63 countries have taken the Sulitest so far making it one of the most implemented and leading measurement tools for sustainability (Kuehl et al., 2021). The test includes different question categories, and the questions are divided into two parts, a series of international questions and a series of questions developed according to the specific testing location. According to Leiva-Brondo et al. (2022, p. 4), The questions for the older version of Sulitest were developed under four themes:

"(1) sustainable humanity and ecosystems on planet Earth; (2) global and local human-constructed systems to cover people's needs; (3) transition toward sustainability; (4) we each have roles to play to create and maintain individual and systemic changes."

Despite the substantial use of the Sulitest, it is challenged by some scholars such as Kuehl et al. (2021) who question the incoherence of the test and ask for caution when using this test. Sulitest (2023) is also regularly working on developing its measurement tools and recently 2023 released a new measurement tool called TASK (The Assessment of Sustainability Knowledge) which in comparison to the old test is developed using UN SDGs 2023, the Planetary Boundaries Framework, and the Kate Raworth Model of Doughnut Economics under the model named "model of sustainability knowledge" (Figure 4).

Figure 4
Model of Sustainability Knowledge



Source: (Sulitest, 2023b)

On the other hand, some tools are developed to study a limited or reduced dimension or domain of sustainability such as Assessment of Sustainability Knowledge (ASK) where they developed and tested 16 multiple choice questions to measure sustainability knowledge considering three domains: environmental, social, and economic (Zwickle et al., 2014; Michel & Zwickle, 2021). Furthermore, the Sustainability Attitude Scale (SAS) (Zwickle & Jones, 2017) and the New Environmental Paradigm (NEP) (Dunlap et al., 2000) were developed to test the attitude dimension of sustainability. Moreover, a ten-year survey conducted by the Roper organization and the National Environmental Education and Training Foundation used a batter of 12 multiple-choice questions, while the Yale Project on Climate Change used 81 tur-false questions to measure the environmental domain of sustainability in the American population (Coyle, 2005; Leiserowitz et al., 2010).

Hsu and Roth (1998) used a nine-page instrument to assess the environmental literacy of teachers and to analyze the predictors of teachers' responsible environmental behavior (REB) in Taiwan. The question was sent to 300 secondary school teachers and the results indicated that the most appealing predictors for REB were: perceived knowledge of environmental action strategies, intention to act, area of residence, and perceived skills in using environmental action strategies. Erdogan and Ok (2011) developed the Elementary School Environmental Literacy Instrument (ESELI) to assess the young Turkish pupils' environmental literacy which was made of five parts and a total of 75 items. ESELI was developed using the Environmental Literacy framework which the authors derived from scholars like Simmons (1995) and Wilke (1995) and the results revealed that 61% of the students had a moderate level of environmental literacy. Szczytko et al. (2018) developed the Environmental Literacy Instrument for Adolescents (ELI-A) for measuring the environmental literacy of adolescents using four domains of environmental literacy (ecological knowledge, hope, cognitive skills, and behavior) which was based on the Tbilisi Declaration (UNESCO-

UNEP, 1977). The author developed a tool that was short enough for use in the field (i.e. 5 to 15 min) and in the meantime inclusive and used factor analysis, item response theory, and validity test for the validation of the ELI-A. As part of the EDINSOST project which included fifty-five researchers from Spanish universities an 18-item questionnaire was developed in 2015 using four sustainability competencies defined by the Conference of Rectors of Spanish Universities (CRUE) "*(1) critical contextualization of knowledge; (2) sustainable use of resources; (3) participation in community processes; (4) the application of ethical principles*" (Sánchez-Carracedo et al., 2018, p. 5). Muñoz-Rodríguez et al. (2020) used the questions developed in the EDINSOST project and implemented on university students to measure their progress before and after a study course concerning sustainability competencies. Sekhar and Raina (2021) assessed the sustainability literacy of students from Management Education Institutions (MEIs) across India under social, environmental, and economic domains. The questions to measure sustainability literacy were developed under the Sulitest and the UNDESD framework. Akeel et al. (2019) developed a Sustainability Literacy Test (SLT) to measure the sustainability knowledge of the engineering community of Nigeria, including engineering students. The 15-item test was developed using the literature review and it covered environmental, social, economic, and crosscutting domains of sustainability. As noted by Akeel et al. (2019), the domains in the SLT lack clear demarcation, as questions are intentionally blended to prevent a modular test structure. Yamane and Kaneko (2021a; 2021b) conducted two online surveys in Japan, the main target of the survey was the adult population which helped the author analyze and compare the sustainability lifestyle preferences between different generations. To measure the preferred sustainable lifestyle the author asked about what the expected efforts of society are to contribute to the SDGs, and what the pro-environmental, pro-globalization, and pro-sustainable consumption behaviors are. The second survey by Yamane and Kaneko (2021b)

was developed for university students to inspect their preferences for companies based on the SDGs contribution from those companies and their offered salaries, and how the students' choices were affected by information about SDGs. In the same way, Aginako and Guraya (2021) and Aginako et al. (2021) also developed two scales, one to measure the students' perception regarding SD insertion into their academic programs and the second to measure the importance engineering students give in their training process to the three dimensions of sustainability (environmental, social, and economic). The scale developed went through three validation stages: experts' advice and student feedback were acquired regarding the scale; a pilot test was conducted regarding the internal validity of the scale; and Cronbach alpha was used to test the internal consistency of the scale. Aleixo et al. (2021) used previous studies to develop their set of questionnaires for public higher education institute students in Portugal. Through this questionnaire, they wanted to measure students' habits, experiences, and behaviors toward SD and SDGs and how this would influence their decisions as future professionals.

Table 1

Scales for Measuring Sustainability Literacy

No	Name	Type of Scale	Reference
1	Sulitest	Multiple Choice	(Sulitest, 2023)
2	Assessing Sustainability Knowledge (ASK)	Multiple Choice	(Zwickle et al., 2014; Michel & Zwickle, 2021).
3	Sustainability Attitude Scale (SAS)	Multiple Choice	(Zwickle & Jones, 2017)
4	Assessment of environmental literacy	Likert Scale	(Hsu & Roth, 1998)
5	Korean children's environmental literacy	Multiple Choice/Likert	(Chu et al., 2007)

		Scale/Open Ended	
6	Turkish university student environmental literacy	Multiple Choice/Likert Scale	(Teksoz et al., 2011)
7	USA adolescents environmental literacy	Multiple Choice/Likert Scale	Szczytko et al., 2018
8	University Student in Iran	Likert Scale	(Veisi et al., 2018)
9	US-Population environmental literacy	Multiple Choice	(Coyle, 2005)
10	UK university student sustainability literacy	Likert Scale	(Ozdemir, 2023)
11	Yale project on climate change	True/False	(Leiserowitz et al., 2010)
12	Elementary School Environmental Literacy Instrument (ESELI)	Multiple Choice/Likert Scale/True & false	(Erdogan & Ok, 2011)
13	Environmental literacy instrument for adolescents	Multiple Choice/Likert Scale	(Szczytko et al., 2018)
14	EDINSOST	Multiple Choice	(Sánchez-Carracedo et al., 2018; Muñoz-Rodríguez et al., 2020)
15	Sustainability literacy questionnaire	Likert Scale	(Sekhar & Raina, 2021)
16	Sustainability literacy test	True/False	(Akeel et al., 2019)
17	Sustainable lifestyles survey in Japan	Likert Scale	(Yamane & Kaneko, 2021a; 2021b)
18	Spanish students' perception of SD & SGDs	Multiple Choice	Aginako & Guraya, 2021; Aginako et al., 2021)
19	Portugal student perceptions of SDGs	Likert Scale	(Aleixo et al., 2021)

Source: Own illustration

Looking into the above assessment tools, we can argue that they are developed to collect information regarding self-knowledge about the environment, sustainability, SD or SDGs, and the learning level of the targeted group. From the above assessment tools, we can also observe that most of them mainly focused on aspects such as knowledge, attitudes, and behaviors (Chu et al., 2007; Ozdemir, 2023; Harmon, 2017; Olsson et al., 2015). Some tools measured only one aspect such as knowledge in the ASK model (Zwickle et al., 2014; Michel & Zwickle, 2021) or attitude in the SAC model (Zwickle & Jones, 2017). Such individualistic approaches are criticized by numerous researchers such as Courtenay-Hall and Rogers (2002) who recommend a broader approach and that knowledge, attitude, and behavior constitute a complex system that interrelates and thus they should be studied together. For example, in socio-scientific issues (SSI) when Christenson et al. (2011) and Eriksson and Rundgren (2012) investigated the secondary students 'written argumentation regarding their knowledge, personal experience, and value in relation to different SSI that were related to SD. They found that alongside other aspects, the value aspect was used the most by students in their SSI arguments. Therefore, considering only one component cannot fulfill the goals of ESD and integrating aspects other than knowledge is an important factor in developing a scale for measuring sustainability literacy (Olsson et al, 2015). We agree with this and therefore suggest that knowledge, behavior, and attitude components must be included when trying to measure sustainability literacy.

To better define and conceptualize our research, we propose to have a definition for the above three aspects. According to The American Heritage Dictionary of the English Language (2022), knowledge is defined as "*Familiarity, awareness, or understanding gained through experience or study*". Thus, in the context of sustainability knowledge means understanding or having an awareness about SD issues. Attitude is defined as "*the enduring positive or negative feeling about some person, object, or issue*" (Kollmuss & Agyeman,

2002, p. 525). Here we mean the positive or negative feelings toward SD issues. Lastly, Eagly and Chaiken (1993, p. 12) define behavior as "*intentions to act.*" which in the context of sustainability means the self-reported intentions to act associated with SD issues.

3. Methods

To answer the research questions, a quantitative research design is implemented. In this section, I will explain the question development process for our scale, the participants of the study, and the data collection and analysis process.

3.1 Research Design and Materials

A mixture of deductive and inductive methods is recommended as best practice to develop the questions for the scale (Hinkin, 1998; Boateng et al., 2018). Therefore, the sustainability literacy scale for this study was developed in the light of the literature review as well as the feedback from the focus group in the below stages:

Firstly, various instruments explained in the literature review were evaluated with the aim of our research to not only find validated instruments but also make sure the instruments fall under the dimensions of SD according to the UNESCO framework (UNESCO, 2006). A draft version of 137 questions respectively 40 for Sustainability Knowledge (SK), 43 for Sustainability Attitude (SA), and 54 for Sustainability Behavior (SB) were extracted in the light of relevant literature (Olsson et al, 2015; Husamah Husamah et al., 2022; Koçoğlu et al., 2023; Michalos et al., 2011; Zwickle & Jones, 2017;). The questions were modified according to our research, and duplicates or questions that illustrated the same meaning were removed. As a result, 84 questions were retained for the second stage (Focus Group).

In the second step, we conducted content validity by providing the drafted questions to the focus group consisting of 4 master's students who were studying sustainability and some even working in the field (Hinkin, 1998; Kyriazos & Stalikas, 2018; Boateng et al., 2018). The focus group worked on eliminating, correcting, and adjusting the questions. Questions that were too easy, too difficult, or irrelevant to the concept of sustainability were eliminated. Questions that belonged to other aspects were also adjusted accordingly and

lastly, comprehensibility and grammar were checked. As a result, 56 questions were removed, and 28 questions were retained for this study as seen in Table 2. Out of 28 questions, 11 belonged to SK and involved statements such as "*Improving access to long and healthy lives greatly contributes to sustainable development.*", 8 to SB which involved statements such as "*I recycle as much as I can.*", and finally 9 to SA which included statements like "*I am committed to ensuring future generations enjoy a similar quality of life as our own.*" which are adapted from Michalos et al. (2011) and Olsson et al. (2015). A five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree) was used for the measurement of all 28 questions.

Table 2

Questionnaire list

No	Code	Questions
1	SK1*	Ensuring the protection of the environment is vital for achieving sustainable development.
2	SK2	Taking steps to reduce water usage is essential for promoting sustainable development.
3	SK3	Shifting towards the use of renewable natural resources is a key requirement for attaining sustainable development.
4	SK4	Human activities are significantly contributing to changes in our atmosphere and climate systems.
5	SK5	Respecting human rights is crucial for fostering sustainable development.
6	SK6	Improving access to long and healthy lives greatly contributes to sustainable development.
7	SK7	Preserving biodiversity is essential for advancing sustainable development.

8	SK8	Equitable distribution of resources is crucial for sustainable development.
9	SK9	Eradicating global poverty is essential for sustainable development.
10	SK10	If someone asks, I would be able to explain what sustainability means in my own words
11	SK11	Raising awareness about UN SDGs positively impacts global sustainable development efforts.
12	SB1*	I treat individuals of all genders and ages equally and with respect.
13	SB2	I recycle as much as I can.
14	SB3	I prioritize walking or cycling instead of using motor vehicles when feasible.
15	SB4	I consistently exhibit respectful behavior in online interactions (chatting, emailing, gaming,...).
16	SB5	I pick up rubbish in natural areas and public spaces when encountered.
17	SB6	I do things which help poor people.
18	SB7	I prioritize purchasing goods from companies with ethical labor and environmental practices.
19	SB8	I have adjusted my lifestyle to minimize waste, like reducing food waste and conserving materials.
20	SA1*	I strongly advocate for equal opportunities for education and employment for all genders globally.
21	SA2	I believe in equipping individuals with the knowledge and skills necessary for sustainable living.
22	SA3	I am committed to ensuring future generations enjoy a similar quality of life as our own.
23	SA4	The use of environmentally friendly vehicles should be encouraged by governments.
24	SA5	Sustainable development will not be possible until wealthier nations stop exploiting workers in poorer nations.

25	SA6	I recognize the importance of active civic engagement in addressing societal issues.
26	SA7	Companies should prioritize reducing packaging and disposable items.
27	SA8	There is a need for more stringent environmental laws and regulations.
28	SA9	Government decisions should be guided by principles of sustainable development.

*SK: Sustainability Knowledge. *SB: Sustainability Behavour. *SA: Sustainability Attitude

I also included income level and political attitude as confounding variables. With this, we will be able to control the influence of these variables on the degree of sustainability literacy of an individual. In addition to 31 questions, I also included 6 questions from the GREEN scale and 6 questions from the Climate Literacy scale as seen in Appendix B, and adjusted them to a 5-point Likert scale accordingly. The intention is not only to compare our measures with the existing ones but also to use them as a benchmark to develop a concise scale that will measure sustainability literacy, this is why we included questions from Haws et al (2014) which is highly valid and reliable at ($\alpha = 0.89$). We also want to check how much more our scale will be able to explain sustainability literacy compared to the scales that focus only on one dimension of sustainability such as the Pan et al (2023) Climate Literacy (CL) scale.

Apart from these, demographic questions were also included questions such as age, gender, occupation, and education to have a general overview of the respondents. The full version of the survey sent to participants is available in Appendix C.

3.2 Sample and Data Collection Procedure

The final version of the questionnaire composed of 47 questions was drafted in Unipark an online survey platform and was published through Prolific an online platform for reliable and swift data collection. Since the survey was in English and to ensure that it would

not cause any problem with data collection the survey was limited only to participants with proficient skills of English. Further data were collected through social media and other web-based means. Following a span of six days, supplemented by three reminders, the amount of data accumulated to 130 which was not sufficient. Therefore, the data went through another round of distribution through Prolific, and after 1 day the data collection process was concluded. The final dataset encompassed a total of 258 responses out of which 172 were complete and were kept for the data analysis of the study. According to Hinkin, (1998) a sample of 150 observations is considered sufficient to obtain accurate solutions in exploratory factor analysis for scale development studies, thus the sample size for our questionnaire was sufficient according to this criterion.

A comprehensive summary of the study participants' demographic attributes, including gender, age, education, occupation, location, income, and political attitude, is given in Table 3. The gender distribution of the sample indicates a relatively balanced representation, with 50.6% of the sample being male and 48.3% being female. Just 1.2% of respondents said they were "Other," and none of them decided to hide their gender identity. The sample's age distribution shows a wide range, with a mean age of 34 years and a noteworthy range of 53 years, suggesting a wide range of age groups. The most common degree type (43.6%) was a bachelor's degree, followed by a master's degree (21.5%) and completion of high school or a GED (15.1%). The levels of education varied greatly. Regarding occupation, 66.3% of respondents said they were either self-employed or employed while students represented 22.7% of the sample, with retirees and other categories comprising smaller proportions.

The geographical location of the participants illustrates almost a worldwide pool of participants from almost 27 countries but mostly from Western countries with the UK being the top at 25%, Canada and Germany at 15.1% and 14% respectively the next ones. The

participants' income level indicates a variety of economic landscapes. 40.7% of the participants had more than €3500 monthly income which is in line with 66.3% of the participants being employed as we discussed above. While there were some in the middle as well with 12.8% which indicated €1001 – €1500 monthly income there were also 8.1% having a monthly income < €500. The political opinions of the participants demonstrate different viewpoints; the most common political attitude of respondents was somewhat liberal (32%), followed by moderate attitudes and very liberal toward politics (26.7% and 20.3%), with a smaller portion being very conservative (5.2%).

This extensive breakdown of demographic factors provides vital insights into the study's diverse participant population, allowing for a more in-depth knowledge of potential implications on research outcomes as well as more nuanced analyses and interpretations of the study findings.

Table 3

Demographic Profile of Respondents

	Demographics	**Count**	**N %**	**M**	**Range**	**SD**
Gender	Male	87	50.6			
	Female	83	48.3			
	Other	2	1.2			
	Prefer not to say	0	0.0			
Age				34	53	11
Education	Did not complete high school	1	0.6			
	High school/GED	26	15.1			
	Some college	30	17.4			

	Bachelor's degree	75	43.6
	Master's degree	37	21.5
	Advanced graduate work or PhD	3	1.7
Occupation	Student	39	22.7
	Employee/self-employee	114	66.3
	Retired	4	2.3
	Other (unemployed/disabled)	15	8.7
Location	Afghanistan	3	1.7
	Australia	1	0.6
	Austria	1	0.6
	Azerbaijan	2	1.2
	Belgium	1	0.6
	Canada	26	15.1
	Czech Republic	2	1.2
	France	4	2.3
	Germany	24	14.0
	Greece	2	1.2
	Hungary	1	0.6
	Ireland	5	2.9
	Israel	1	0.6
	Italy	3	1.7
	Latvia	1	0.6
	Mexico	3	1.7
	Nederland	1	0.6
	Poland	4	2.3

	Portugal	4	2.3
	Russia	1	0.6
	Slovakia	1	0.6
	South Africa	21	12.2
	Spain	2	1.2
	Sweden	1	0.6
	Switzerland	1	0.6
	UK	43	25.0
	USA	13	7.6
Income	< €500	14	8.1
	€501 - €1000	15	8.7
	€1001 - €1500	22	12.8
	€1501 - €2000	13	7.6
	€2001 - €2500	16	9.3
	€2501 - €3000	13	7.6
	€3001 - €3500	9	5.2
	> €3500	70	40.7
Political	Very liberal	35	20.3
attitude	Somewhat liberal	55	32.0
	Moderate	46	26.7
	Somewhat conservative	27	15.7
	Very conservative	9	5.2
	Other (please specify)	0	0.0

3.3 Data Analysis

The Statistical Package for the Social Sciences (SPSS, version 29.0.2.0) was used to analyze the data. First of all, I conducted linear regression to control for confounding variables (income and political attitude) the results indicate that both income and political attitude affect some of the items but are rather very small and not concerning (Rothman et al., 2008; Jager et al., 2008). Construct validation was performed for the scale using Explanatory Factor Analysis (EFA). During conducting EFA the Kaiser-Meyer-Olkin test (KMO) and Barlett Sphericity test were used to check for sample adequacy and the significance of the data (Taherdoost et al., 2014). The results show that the sample size is both appropriate and significant for this study. The extraction method used was principal component analysis. Items with a variation of less than 0.50 were deleted (Hinkin, 1998). Items that could fall under several factors were also investigated. The Varimax factor rotation approach was chosen. For reliability analysis, Cronbach's Alpha was used to check for internal consistency of the scale (Hinkin, 1998).

We also used Google Sheets, Google Docs, and Excel for the operationalization of the questionnaire and SPSS tables.

4. Results

To ensure the validity and accuracy of the results, confounding variables should be controlled for (Jager et al., 2008; VanderWeele, 2019). Thus we included income level and political attitude as confounding variables. These two factors could significantly impact individuals' points of view in regard to sustainability literacy and if not controlled for could potentially distort the results of the analysis. To address the issue I used linear regression analysis, and incorporated income level and political attitude as control variables. This will allow for a more precise assessment of sustainability literacy, and minimize the risk of biased outcomes, and provide a clear understanding of the genuine factors affecting sustainability literacy. According to Thomas (2020, p.1), "*It's important to consider potential confounding variables and account for them in your research design to ensure your results are valid. Left unchecked, confounding variables can introduce many research biases to your work, causing you to misinterpret your results.*". Appendix C at the end of the paper contains detailed tables from the linear regression analysis, which illustrate the coefficients and significance levels for income level and political attitude. This method emphasizes the dedication to performing extensive and rigorous research, guaranteeing that the generated scale appropriately evaluates sustainability literacy while not being overly impacted by external influences (Mansournia et al., 2017).

4.1 Construct Validity

Construct validity involves ensuring that the instrument measures the theoretical construct it intends to measure and Explanatory Factor Analysis is one of the most common and widely used methods in the evaluation and validation of measurement instruments (Watkins, 2018). Thus many researchers (Michalos et al., 2011; Olsson et al., 2015; Chu et al., 2007; Haws et al., 2014) used EFA to check for the construct validity of their scale. It is

worth mentioning one conducting EFA must use several thoughtful and evidence-based approaches and decisions to make sure that the analysis is performed properly (Fabrigar et al., 1999; Watkins, 2018).

As explained in the data analysis section, prior to conducting EFA, Kaiser-Meyer-Olkin (KMO) and Bartlett's test of Sphericity was performed to check for both adequacy and suitability of the data for EFA as seen in Table 4. The KMO test was performed and a coefficient of 0.87 was found. This value is above 0.70 so the sample size is considered adequate for conducting EFA. Bartlett's test of Sphericity is also statistically significant at [χ^2 (378)=2028.92, p=<0.00], thus the criteria for conducting EFA are met (Taherdoost et al., 2014).

Table 4

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.876
Bartlett's Test of Sphericity	Approx. Chi-Square	2028.925
	df	378
	Sig.	<.001

SPSS Version 29.0.2.0

After addressing KMO and Bartlett's test of Sphericity, EFA was conducted in two stages: factor extraction and factor rotation. Factor extraction was performed by selecting the most common method, the principle component analysis for all 28 items with Kaiser eigenvalue over 1 (Taherdoost et al., 2014). The Kaiser eigenvalue extraction method showed that there were six factors in the scale and the total variance explained by those factors was 58.96% which is an acceptable value according to Taherdoost et al. (2014). Although there is

no widely preferred technique for factor rotation, varimax is considered as the most common form of rotational method. 0.50 was selected as the lower cut-point of the factor loading, this means items with factor loading lower than 0.50 were not included (Watkins, 2018; Taherdoost et al., 2014). The rotated factor matrix in Table 4 shows that there is a six-factor scale and that some items fall under other factors or into two factors at the same time. To solve this issue and reach our desired model where relevant items fall under their relevant factor the items that are wrongly located must be deleted and both factor extraction and factor rotation must be reimplemented. This method is performed and recommended by many authors such as (Atabek-Yiğit et al., 2014; Webb et al., 2008; Haws et al., 2014; Kaiser et al., 2007).

Table 5

Rotated Factor Matrix

	Factor					
Items	**1**	**2**	**3**	**4**	**5**	**6**
SK1	.727					
SK2	.605					
SK3	.671					
SK4	.692					
SK5		.651				
SK6		.636				
SK7						
SK8		.671				
SK9		.750				
SK10					.698	
SK11					.664	
SB1						
SB2	.500					
SB3						.762

SB4	.601					
SB5				.611		
SB6				.776		
SB7						
SB8						.628
SA1						
SA2			.608			
SA3			.670			
SA4						
SA5		.683				
SA6						
SA7	.687					
SA8	.508					
SA9					.596	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

During the item removal and adjustment process, 7 items from Sustainability Knowledge (SK1, SK2, SK3, SK4, SK7, SK10, SK11), 5 items from Sustainability Attitude (SA2, SA3, SA5, SA6, SA9), and 3 items from Sustainability Behavior (SB1, SB2, SB4) were removed. Both KMO and Bartlett's Test of Sphericity were performed again after item removal. The KMO is coefficient at 0.81 which is well above the minimum standard and Bartlett's Test of Sphericity is also statistically significant at [χ^2 (78)=596.38, p=<0.00] as seen in Table 6. This means that data are both adequate and suitable for reconducting factor extraction and rotation (Taherdoost et al., 2014).

Factor extraction was performed on the revised items and this time Scree test eigenvalue was used which is said to be more accurate compared to the Kaiser eigenvalue used previously. Generally, eigenvalues are helpful tools in deciding how many factors should be in the analysis and one of the effective methods is the Scree test. Thus factors with eigenvalues in the sharp descent part of the plot should be included before the eigenvalues

start to level off (Green & Salkind, 2014; Watkins, 2018). Figure 5 illustrates the Scree test which shows our model has 3 factors before the eigenvalue starts to level off which confirms our research design of having three dimensions namely sustainability knowledge, sustainability attitude, and sustainability behavior.

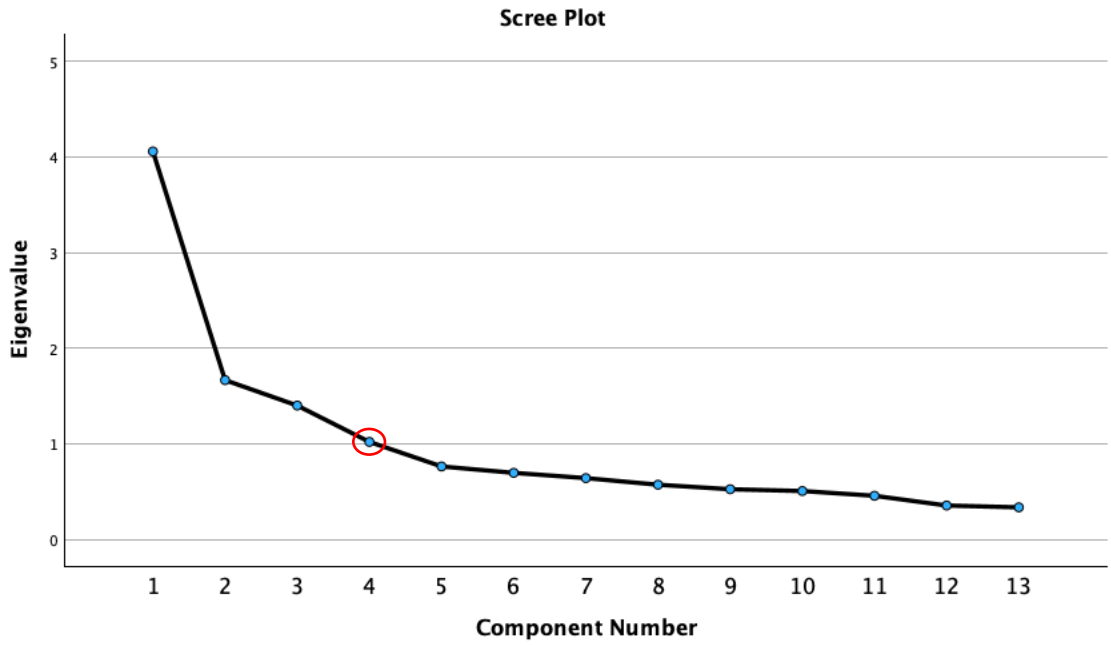
Table 6

Revised KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.810
Bartlett's Test of Sphericity	Approx. Chi-Square	596.382
	df	78
	Sig.	<.001

Figure 5

Plot of Eigenvalues (Scree Plot)



Factor rotation with the varimax method also supports the factor extraction and shows that there are three-factor loading for this scale which ranges between 0.538 and 0.814 which is considered a strong loading and reflects a substantial relationship between the items and the factor (UCLA, 2021). Both revised factor rotation and revised total variance can be seen in Table 7 and Table 8.

Table 7

Revised Rotated Factor Matrix

Code	Items	Factor		
		1	2	3
SA1	I strongly advocate for equal opportunities for education and employment for all genders globally.	.593		
SA4	The use of environmentally friendly vehicles should be encouraged by governments.	.670		
SA7	Companies should prioritize reducing packaging and disposable items.	.733		
SA8	There is a need for more stringent environmental laws and regulations.	.773		
SK5	Respecting human rights is crucial for fostering sustainable development.		.673	
SK6	Improving access to long and healthy lives greatly contributes to sustainable development.		.657	
SK8	Equitable distribution of resources is crucial for sustainable development.		.745	
SK9	Eradicating global poverty is essential for sustainable development.		.814	
SB3	I prioritize walking or cycling instead of using motor vehicles when feasible.			.540
SB5	I pick up rubbish in natural areas and public spaces when encountered.			.694
SB6	I do things which help poor people.			.687

SB7	I prioritize purchasing goods from companies with ethical labor and environmental practices.	.538
SB8	I have adjusted my lifestyle to minimize waste, like reducing food waste and conserving materials.	.618

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Table 8

Total variance explained.

Factors	Eigenvalue	% of Variance Explained
F1	4.05	31.21
F2	1.66	12.81
F3	1.40	10.77
Total		54.80

As a result of EFA and according to Table 7, our first factor of the scale sustainability attitude includes 4 items (SA1, SA4, SA7, SA8), the second factor sustainability knowledge includes 4 items (SK5, SK6, SK8, SK9), and the third factor sustainability behavior includes 5 items (SB3, SB5, SB6, SB7, SB8). The first, second, and third factors accounted for 31.21%, 12.81%, and 10.77% of the total variance explained respectively, which makes a total of 54.80% of the variable explained based on these three factors which are in accordance with the acceptance rate (Taherdoost et al., 2014).

4.2 Reliability Analysis

Reliability analysis is used to evaluate the stability of measurement instrument. It makes sure that the instrument provide reliable and consistent results over repeated

application under similar conditions(Boateng et al., 2018). According to Peterson (1994) and Morgado et al. (2017) Cronbach's alpha is the most common and approved method used to measure the reliability of a scale. Cronbach's alpha evaluates internal consistency by measuring the average correlation between items in a test. An alpha value above 0.70 is generally considered acceptable meaning that the items measure a common underlying construct and a value of 0.8 or above indicates a very good measurement of the construct (Hinkin, 1998). Our analysis of Cronbach's alpha as seen in Table 9 is well above the acceptable rate and the coefficient level was found to be 0.80 for our scale.

Table 9

Cronbach's Alpha

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.804	.809	13

Table 10 explains the correlation between each item and the overall score on the scale. An item-total correlation value above 0.30 is generally considered acceptable which means that the item correlates well with the total scale and contributes to the favor of scale's internal consistency. Item total correlations for our scale are well above 0.3 with one exception of item SB3. Cortina, (1993) and Devellis (2017) state that items falling below 0.30 are not contributing to the internal consistency of the scale and if removing them increases the Cronbach alpha it should be considered. In our case removing item SB3 will only increase Cronbach's alpha value by 0.005 which is not that significant thus we intend to keep it since removing items could sometimes have an advers effect on Cronbach's alpha value (Cortina, 1993).

Table 10

Item-Total correlations and Cronbach's Alpha if item deleted.

Item	Item-Total Correlation	Cronbach's Alpha if Item Deleted
1. I strongly advocate for equal opportunities for education and employment for all genders globally.	.444	.791
2. The use of environmentally friendly vehicles should be encouraged by governments.	.494	.787
3. Companies should prioritize reducing packaging and disposable items.	.409	.794
4. There is a need for more stringent environmental laws and regulations.	.500	.786
5. Respecting human rights is crucial for fostering sustainable development.	.406	.794
6. Improving access to long and healthy lives greatly contributes to sustainable development.	.478	.787
7. Equitable distribution of resources is crucial for sustainable development.	.536	.783
8. Eradicating global poverty is essential for sustainable development.	.392	.795
9. I prioritize walking or cycling instead of using motor vehicles when feasible.	.267	.809
10. I pick up rubbish in natural areas and public spaces when encountered.	.367	.798
11. I do things which help poor people.	.364	.797

12. I prioritize purchasing goods from companies with ethical labor and environmental practices.	.644	.770
13. I have adjusted my lifestyle to minimize waste, like reducing food waste and conserving materials.	.448	.790

4.3 Comparison with Other Scales

With the thirteen-item scale, we proceeded to analyze the relationship between the GREEN scale from Haws et al. (2014) and the Climate Literacy scale from Pan et al. (2023). Reliability and validity analysis were performed to assess the relationship among three scales and a summary is shown in Table 11. The reliability analysis indicates a similarity between our scale and the GREEN scale, with each having a Cronbach's Alpha of 0.80 and 0.91, respectively. This is contrary to the CL scale as it has just above the acceptable Cronbach Alpha value of 0.72 (Peterson, 1994). To establish convergent validity, we examined the Person correlation coefficients between our scale and the two other scales. Campbell and Fiske (1959) recommend that a correlation greater than 0.30 indicates good convergent validity. As anticipated, the sustainability literacy scale is highly correlated to the GREEN scale ($r = 0.76$, $p < 0.01$). On the other hand, the moderate correlation of 0.47 between our scale and the CL scale states that while they are related, they are not measuring the same construct.

The high correlation of our scale with the GREEN scale provides evidence for the validity of our measurement tool, and what we wanted to achieve by comparing our scale with existing other scales. The lower correlation with the CL scale which focuses only on the climate aspect of sustainability reveals that our scale offers a broader assessment of sustainability literacy. As such we conclude that our scale provides good reliability and

validity compared to existing scales, thus, it offers a holistic measurement of sustainability literacy.

Table 11

Summary of Correlations among Sustainability Literacy Scale and Other Scales

		Alpha	**Mean**	**SD**	**1**	**2**
1	Sustainability Literacy Scale	0,80	39,07	0,52		
2	GREEN	0,91	37,67	0,79	0,76**	
3	CL	0,72	43,66	0,49	0,47**	0,40**

Note: **All correlation of .30 or greater are significatn at the 0.01 level. GREEN Scale is from Haws et al. (2014); CL is Climate Literacy from Pan et al. (2023).

5. Discussion

To make life on Earth sustainable the international communities and the UN came up with different initiatives to support a move toward sustainable life. One of the initiatives is the HESI which is working toward spreading sustainability knowledge through different means such as integrating sustainability into the Higher Education System. A recent report by HESI indicates that from a total of 4346 individuals, only 11.1% demonstrated high sustainability knowledge, and the remaining scored below the minimum (United Nations, 2023b; Sulitest, 2023). These reports indicate education practices are not effective enough to achieve sustainability literacy (Saylan et al., 2011). Therefore, assessing the sustainability literacy of a society can be a turning point and will tremendously help in increasing sustainability awareness and literacy. In this paper, I have developed a scale that could measure sustainability literacy holistically. The scale was developed considering the UNESCO framework for SD and included three dimensions namely sustainability knowledge, sustainability attitude, and sustainability behavior. The data was obtained using an online survey using a 5-point Likert scale. I have analyzed the collected data using EFA and reliability analysis, after some adjustment and controlling the results provide a strong and high validity and reliability 13-item scale.

In order to operationalize the scale, there are two widely used scoring methods for the scale: The first method is administering the developed sustainability literacy scale as a structured survey or questionnaire. Participants answer the questions using a 5-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree. Participants' responses are scored numerically, and with the use of statistical tools the scores from individual items are aggregated to provide an overall measure of sustainability literacy, as well as sub-scores for the knowledge, attitudes, and behaviors dimensions. Thus the lowest score on this scale will be 13 and the highest 65.

The second method is pre- and post-intervention assessment, which in an almost efficient way would measure the effectiveness of the education program in sustainability literacy. In this case, the method is going to measure the level of sustainability literacy that the participants have before and after going through an educational form of intervention. The pre-test will provide knowledge of the starting point of participants before going through the educational intervention. The educational intervention could encompass lectures, workshops, project-based learning, and other learning approaches tailored to bring enhancement in sustainability literacy. A post-test can thereafter be administered using the same sustainability literacy scale after an educational intervention. A comparison of the scores before and after the test run will show a change in the knowledge, attitude, and behavior of the participants. The lowest possible score remains 13 and the highest is 65. This method collects direct evidence on the effectiveness of educational interventions for the improvement of sustainability literacy and gives a way for measuring the actual change in time. However, this will require a good plan for the administration of pre-and post-tests under almost similar conditions to ensure that results are not swayed by other causes that are not foreseen. This type of measurement can also be resource-intensive and may suffer from issues such as participant dropout. Nonetheless, previous research on pre- and post-intervention assessment to measure change in sustainability literacy and the effectiveness of educational intervention has shown that the method is quite appropriate for this kind of study (Olsson et al., 2015; Haws et al., 2014).

These measurement mechanisms could be used in applying the scale of sustainability literacy for reliable and valid assessments to further the frontiers of sustainability education and research.

5.1 Theoretical Implications

The process of developing and validating the scale we presented in this paper significantly contributed to theoretical contributions in the field of sustainability education and its measurement. Most importantly, in this paper, it was also told that a theoretical framework has to be selected and implemented to address SD and sustainable education. How to extract the items for a scale, what kind of content validity tools to use to make sure that the extracted items are valid content-wise. How to develop and conduct a survey and which tools to use while measuring the validity and reliability to make sure that exactly what we want is measured with the scale and that it will be accurate under different circumstances.

In addition, this study validates the theoretical idea that sustainability literacy consists of more than one dimension: knowledge, attitudes, and behaviors. This three-dimensional structure is consistent with the works of such scholars as (Michalos et al., 2011; Haws et al., 2014; Olsson et al., 2015; Zwickle et al., 2014), which agreed on a comprehensive approach to measuring sustainability literacy. Having validated this structure, the study has offered empirical support for the integrated model to contribute to a more nuanced understanding of how different aspects of sustainability literacy interact and influence each other. This integration of knowledge, attitudes, and behaviors into a single scale is in line with the Social Cognitive Theory developed by Bandura in 1986, meaning that human behavior is influenced by the interaction of personal factors, behaviors, and the environment. In general, this theoretical framework provides the possibility to emphasize that the number of dimensions can be assessed and, as a result, a comprehensive approach to the evaluation of sustainability literacy can be observed.

In addition, the strength and applicability of the scale are ascertained through stringent validation in this study by conducting EFA and reliability analysis. The high internal consistency (Cronbach's Alpha = 0.80) and the sound construct validity converge

upon the theoretical expectations and earlier research findings (Boateng et al., 2018; Hinkin, 1998). This validation ensures that the scale successfully captures the chosen dimension of the theoretical construct of sustainability literacy and remains a reliable instrument for future use. The integration of knowledge, attitudes, and behaviors into a single scale aligns with Bandura's (1986) Social Cognitive Theory, which posits that human behavior is influenced by the interaction of personal factors, behaviors, and the environment. This theoretical framework underscores the importance of assessing multiple dimensions to understand sustainability literacy comprehensively.

Finally, comparing the new scale with those scales, which have become quite popular, such as the GREEN scale and the Climate Literacy (CL) scale, also highlighted its comprehensibility. The scale's strong correlation with the GREEN scale ($r = 0.76$, $p < 0.01$) states that the new scale succeeds in capturing the wider dimension of the sustainability-related competencies and remains a valid and reliable instrument for measuring sustainability literacy, as suggested by Haws et al. (2014). Its moderate correlation with the CL scale justifies the wider dimension of its construct representation by covering a scope of dimensions beyond climate literacy, as suggested by Pan et al. (2023). Thus, the comparison does make a worthy theoretical debate about the dimensionality and the scope of sustainability literacy. The scale also satisfies the conceptual frameworks suggested by UNESCO (2006), and the United Nations Decade of Education for Sustainable Development (DESD), where the integration of all the dimensions of sustainability education, including the environmental, social, and economic dimensions, is emphasized. Such validated scales support those frameworks to create a single tool that can measure the comprehensive nature of sustainability.

5.2 Practical Contribution

The validated scale has several practical implementations that can notably impact education and policy-making. These contributions are pivotal for advancing sustainability education and promoting sustainable behaviors in various contexts.

This scale can be integrated into the design and evaluation of educational programs aimed at improving students' sustainability literacy. By identifying specific strengths and weaknesses in students' knowledge, attitudes, and behaviors, instructors can tailor interventions to effectively close gaps. This is in line with the objectives of the UNESCO-sponsored Education for Sustainable Development initiative (2014, 2017), which emphasizes the embedding of sustainability into education at all levels. Using the scale can improve curriculum development by ensuring that sustainability education addresses all relevant aspects. For example, active learning approaches such as project-based learning, case studies, and community engagement projects can be designed to improve not only student knowledge but also student attitudes and behaviors related to sustainability (Sterling, 2010). Higher education institutions (HEIs) can use this scale to embed sustainability skills into their curriculum across disciplines. The comprehensive nature of this scale allows the concept of sustainability to be incorporated into a variety of subjects, facilitating interdisciplinary learning. This approach is consistent with the recommendations of Cortese (2003) and Sterling (2010), who advocated integrating sustainability principles into higher education curricula. Educators can use this scale to evaluate the effectiveness of their teaching methods and make data-driven improvements. This will eventually provide a more systematic and consistent approach to sustainability education and ensure that students develop a comprehensive understanding of sustainability issues.

Furthermore, the scale can be used to develop training programs that can provide teachers with the knowledge and skills they need to teach sustainability principles effectively.

Workshops, seminars, and collaborative projects with sustainability experts can improve teachers' capacities and ultimately the quality of sustainability education (UNESCO, 2017). These training programs can use the scale to assess teachers' core sustainability competencies and based on the results provide training sessions to address identified gaps. This will result in more effective teaching methodologies and improved student outcomes. As discussed this could be a resource-intense process but it will definitely yield very positive results.

Moreover, policymakers can use the scale to understand current levels of sustainability literacy and identify areas in need of targeted interventions. By providing a standardized assessment tool, this scale facilitates the development of policies and programs that promote sustainability education and awareness (Zwickle et al., 2014). This scale can also support the implementation of Sustainable Development Goals (SDGs). The scale provides a reliable measure of sustainability literacy to help policymakers track progress and make informed decisions toward achieving these goals. This scale can also be used in public awareness campaigns to highlight the importance of sustainability literacy in achieving the Sustainable Development Goals (SDGs). These campaigns can target a wide variety of people, ensuring a broad understanding and engagement with sustainability issues. By measuring the impact of these campaigns, this measure can help refine strategies to increase public awareness and participation (United Nations, 2023). Public awareness campaigns can use this scale to evaluate their effectiveness and tailor their messages to better appeal to different audiences. This enables more effective campaigns that drive meaningful behavior change. Finally, this measure can also be used to examine the relationship between sustainability capabilities and other variables such as academic performance, career choice, and civic engagement. This provides valuable insight into the broader implications of sustainability education.

6. Limitations and future research

Although the current sample of 172 respondents was adequate to conduct EFA, a larger sample with more diversity will further validate the scale more strongly (Rothman et al., 2008; Jager et al., 2008). The current sample for the study was geographically diverse; however, it was mostly of Western origin; this again brings a question to the generalizability of the study to other cultural contexts (Hinkin, 1998). Future studies should aim to include more samples and more diversity to ensure the generalizability of the findings across different cultural and educational contexts.

The study relied on self-reported data, which can be subject to biases such as social desirability bias. Participants might have responded in ways they believed were expected rather than reflecting their true knowledge, attitudes, or behaviors toward sustainability (Podsakoff et al., 2003). Even though we controlled for confounding variables such as income level and political attitude, the incorporation of objective measures, such as performance-based tasks or third-party assessments, can complement self-reported data and provide a more accurate picture of an individual's sustainability literacy.

Future studies should increase the behavioral component of the scale to include more actions and behaviors. The scale might be developed into other sub-scales of the behavioral component to include attributes such as consumer choice, advocacy, and community involvement areas (Haws et al., 2014). Expanding the behavioral component of the scale may increase the overall measure of sustainability literacy as well as pinpoint those areas that may need improvement.

With the increasing importance of digital tools in education, future studies could explore the role of digital literacy in sustainability education. Understanding how digital competencies interact with sustainability literacy could provide insights into designing effective online educational resources (Nolet, 2015). Exploring the role of digital literacy in

sustainability education can provide valuable insights into designing effective online educational resources and enhancing sustainability literacy in the digital age.

By addressing these limitations and exploring these future research possibilities, the field can advance towards more effective strategies for promoting sustainability literacy, ultimately contributing to the achievement of sustainable development goals globally.

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8. Appendices

8.1 Appendix A: Initial Questions Extracted from Literature

No	Component	Question
1	Sustainability behavior	When I leave the house, I turn off the lights.
2	Sustainability behavior	When not in use, I turn off the water.
3	Sustainability behavior	I close the fridge door after removing items or if I have not decided what to remove for a while.
4	Sustainability behavior	At home, I recycle.
5	Sustainability behavior	On campus and/or in the community, I am involved in natural resource conservation activities.
6	Sustainability behavior	I learned skills that can help a lot of people and prefer eco-friendly skills.
7	Sustainability behavior	I take care to acquire the necessary skills for ecological acquisitions.
8	Sustainability behavior	I take a distant approach to products that harm the environment.
9	Sustainability behavior	I make an effort to follow ecological activities in education systems in the world.
10	Sustainability behavior	I strive to promote environmentally friendly daily life practices.
11	Sustainability behavior	I participate in ecologically based organizations around the world.
12	Sustainability behavior	I share information about developments that increase ecological awareness with my environment.
13	Sustainability behavior	I strive to preserve the ecosystem.
14	Sustainability behavior	I participate in the environmental action strategies in the world in the virtual environment.
15	Sustainability behavior	I produce solutions to prevent artificialization of ecological environments.
16	Sustainability behavior	I research the effects of unconscious use of natural resources on living life.
17	Sustainability behavior	I analyze economic activities, their effects on the ecological environment.

18	Sustainability behavior	I demonstrate how the local government's decisions on the ecological environment affect the ecology.
19	Sustainability behavior	I search for ways to live in harmony with ecology.
20	Sustainability behavior	I take an active role in solving ecological problems for a livable world.
21	Sustainability knowledge	Protecting the environment is necessary for SD.
22	Sustainability knowledge	Conservation of fresh water is necessary for SD.
23	Sustainability knowledge	Human actions are contributing to changes in our atmosphere and climate systems.
24	Sustainability knowledge	SD requires shifting to the use of renewable resources as much as possible.
25	Sustainability knowledge	‘Maintaining biodiversity’ means maintaining the number and variety of living organisms. This is necessary for SD.
26	Sustainability knowledge	SD requires respect for human rights.
27	Sustainability knowledge	Improving people’s opportunities for long and healthy lives contributes to SD.
28	Sustainability knowledge	SD requires individuals to reduce all kinds of waste.
29	Sustainability knowledge	SD requires access to good quality education for everyone.
30	Sustainability knowledge	Economic development is necessary for sustainable development (SD).
31	Sustainability knowledge	SD requires businesses to behave responsibly to their employees, customers and suppliers.
32	Sustainability knowledge	SD requires people to reflect on what it means to improve the quality of life.
33	Sustainability knowledge	Respect for cultural diversity is necessary for SD.
34	Sustainability knowledge	SD requires people to learn new things throughout their lives.
35	Sustainability knowledge	Good citizenship is necessary for SD.
36	Sustainability knowledge	A culture of peace where people settle conflicts by discussion is necessary for SD.
37	Sustainability knowledge	SD results in fair distribution of goods and services to all people around the world.
38	Sustainability knowledge	The elimination of poverty is necessary for SD.
39	Sustainability knowledge	SD requires that people understand how the economy works.

40	Sustainability knowledge	SD requires achieving the United Nations' Millennium Development Goals.
41	Sustainability knowledge	I have taken a course in which sustainable development was discussed.
42	Sustainability attitude	Males and females should have equal access to all kinds of education and employment.
43	Sustainability attitude	Every person should receive education that teaches the knowledge, values and skills necessary for sustainable living in a community.
44	Sustainability attitude	The present generation should make sure that the next generation can live in communities that are at least as healthy as those that exist today.
45	Sustainability attitude	It is important to find ways to reduce poverty.
46	Sustainability attitude	Use of fuel-efficient vehicles should be encouraged by governments.
47	Sustainability attitude	Household tasks should be equally shared among members of the household regardless of gender.
48	Sustainability attitude	I believe that the household tasks in my home should be equally shared among family members regardless of gender.
49	Sustainability attitude	Citizens should be well-informed and actively participate in democratic processes like voting.
50	Sustainability attitude	Governments should adopt SD as a national priority.
51	Sustainability attitude	Manufacturers should discourage the use of disposables.
52	Sustainability attitude	Understanding and addressing the problems of climate change is not important.
53	Sustainability attitude	It is possible to protect the environment and create jobs even when the economy is doing poorly.
54	Sustainability attitude	As long as resources are available, using more than we need now does not threaten the health and welfare of future generations.
55	Sustainability attitude	SD will not be possible until wealthier nations stop exploiting workers in poorer nations.
56	Sustainability attitude	People who pollute our land, air or water should pay for damage done to communities and the environment.

57	Sustainability attitude	It is alright to use as much water as we want, as long as it is available.
58	Sustainability attitude	It is useful to estimate the dollar value of the services that the ecosystem provides to us.
59	Sustainability attitude	We don't need stricter laws and regulations to protect the environment.
60	Sustainability behavior	I give men and women, boys and girls the same level of respect.
61	Sustainability behavior	I treat people respectfully, except those who have racial backgrounds different from my own.
62	Sustainability behavior	I usually examine problems from many points of view.
63	Sustainability behavior	At home I recycle as much as I can.
64	Sustainability behavior	I choose to walk or bike to places instead of using a motor vehicle.
65	Sustainability behavior	When I use the computer or phone for social networking or gaming I always treat everyone as respectfully as I would in person.
66	Sustainability behavior	I have thought quite a bit about how to live sustainably.
67	Sustainability behavior	I do not think about how I might be damaging the natural environment.
68	Sustainability behavior	I try to do things that will help people living in poverty.
69	Sustainability behavior	I have changed my personal lifestyle to reduce waste.
70	Sustainability behavior	I try to avoid buying goods from companies with poor track records on caring for their workers or the environment.
71	Sustainability behavior	I pick up litter when I see it in a park or a natural area.
72	Sustainability behavior	I participate in democratic activities related to student life at my school.
73	Sustainability behavior	I volunteer to work with local charities or environmental groups.
74	Sustainability behavior	I make lifestyle choices that are not good for my health.
75	Sustainability behavior	I never waste water.
76	Sustainability behavior	Even when I have the option, I do not always compost.
77	Sustainability attitude	Equal rights for all people strengthens a community.
78	Sustainability attitude	Community cooperation is necessary to solve social problems.

79	Sustainability attitude	Generally speaking consumerism is not sustainable.
80	Sustainability attitude	Access to clean water is a universal human right.
81	Sustainability attitude	I am willing to put forth a little more effort in my daily life to reduce my environmental impact.
82	Sustainability attitude	An unsustainable economy values personal wealth at the costs of others.
83	Sustainability attitude	I believe that many people can work together to solve global problems.
84	Sustainability attitude	Clean air is part of a good life.
85	Sustainability attitude	Our present consumption of natural resources will result in serious environmental challenges for future generations.
86	Sustainability attitude	The well-being of others affects me.
87	Sustainability attitude	Biological diversity in itself is good.
88	Sustainability knowledge	Economic development is necessary for sustainable development.
89	Sustainability knowledge	Improving people's chances for a long and healthy life contributes to sustainable development.
90	Sustainability knowledge	Reducing water consumption is necessary for sustainable development.
91	Sustainability knowledge	Preserving nature is not necessary for sustainable development.
92	Sustainability knowledge	A culture where conflicts are resolved peacefully through discussion is necessary for sustainable development.
93	Sustainability knowledge	Sustainable development demands that we humans reduce all sorts of waste.
94	Sustainability knowledge	People who exercise their democratic rights are necessary for sustainable development (for example, they vote in elections, involve themselves in social issues, express their opinions).
95	Sustainability knowledge	Reinforcing girls' and women's rights and increasing equality around the world is necessary for sustainable development.
96	Sustainability knowledge	Respecting human rights is necessary for sustainable development.

97	Sustainability knowledge	To achieve sustainable development, all the people in the world must have access to good education.
98	Sustainability knowledge	Sustainable development requires that companies act responsibly towards their employees, customers and suppliers.
99	Sustainability knowledge	Preserving the variety of living creatures is necessary for sustainable development (preserving biological diversity).
100	Sustainability knowledge	Having respect for other cultures is necessary for sustainable development.
101	Sustainability knowledge	Sustainable development requires fair distribution of goods and services among people in the world.
102	Sustainability knowledge	Wiping out poverty in the world is necessary for sustainable development.
103	Sustainability knowledge	Sustainable development requires a shift to renewable natural resources.
104	Sustainability knowledge	Sustainable development demands that people understand how the economy functions.
105	Sustainability knowledge	For sustainable development, big infectious diseases such as HIV/AIDS and malaria must be stopped.
106	Sustainability knowledge	For sustainable development, people need to be educated in how to protect themselves against natural disasters.
107	Sustainability attitude	I think that everyone ought to be given the opportunity to acquire the knowledge, values and skills that are necessary to live sustainably.
108	Sustainability attitude	I think that we who are living now should make sure that people in the future enjoy the same quality of life as we do today.
109	Sustainability attitude	I think that companies have a responsibility to reduce the use of packaging and disposable articles.
110	Sustainability attitude	Using more natural resources than we need does not threaten the health and well-being of people in the future.
111	Sustainability attitude	I think that we need stricter laws and regulations to protect the environment.
112	Sustainability attitude	I think it is important to reduce poverty.

113	Sustainability attitude	I think that companies in rich countries should give employees in poor nations the same conditions as in rich countries.
114	Sustainability attitude	I think that it is important to take measures against problems which have to do with climate change.
115	Sustainability attitude	I think that the government should provide financial aid to encourage more people to make the shift to green cars.
116	Sustainability attitude	I think that the government should make all its decisions on the basis of sustainable development.
117	Sustainability attitude	I think that it is important that people in society exercise their democratic rights and become involved in important issues.
118	Sustainability attitude	I think that people who pollute land, air or water should pay for the damage they cause to the environment.
119	Sustainability attitude	I think that women and men throughout the world must be given the same opportunities for education and employment.
120	Sustainability attitude	I think it is okay that each one of us uses as much water as we want.
121	Sustainability behavior	Where possible, I choose to cycle or walk when I'm going somewhere, instead of travelling by motor vehicle.
122	Sustainability behavior	I never waste water.
123	Sustainability behavior	I recycle as much as I can.
124	Sustainability behavior	When I use a computer or mobile to chat, to text, to play games and so on, I always treat others as respectfully as I would in real life.
125	Sustainability behavior	I often make lifestyle choices which are not good for my health.
126	Sustainability behavior	I do things which help poor people.
127	Sustainability behavior	I pick up rubbish when I see it out in the countryside or in public places.
128	Sustainability behavior	I don't think about how my actions may damage the natural environment.
129	Sustainability behavior	I often purchase second-hand goods over the internet or in a shop.

130	Sustainability behavior	I always separate food waste before putting out the rubbish when I have the chance.
131	Sustainability behavior	I avoid buying goods from companies with a bad reputation for looking after their employees and the environment.
132	Sustainability behavior	I have changed my personal lifestyle in order to reduce waste (e.g., throwing away less food or not wasting materials).
133	Sustainability behavior	I work on committees (e.g. the student council, my class committee, the cafeteria committee) at my school.
134	Sustainability behavior	I treat everyone with the same respect, even if they have another cultural background than mine.
135	Sustainability behavior	I support an aid organisation or environmental group.
136	Sustainability behavior	I watch news programs or read newspaper articles to do with the economy.
137	Sustainability behavior	I show the same respect to men and women, boys and girls.

Note: Source of questions 1-6 (Husamah Husamah et al., 2022), 7-20 (Koçoğlu et al., 2023), 21-76 (Michalos et al., 2011), 77-87 ((Zwickle & Jones, 2017), 88-137 (Olsson et al, 2015).

8.2 Appendix B: GREEN Scale and Climate Literacy Scale

No	Code	Component	Question
1	GS	Green Scale	It is important to me that the products I use do not harm the environment.
2	GS	Green Scale	I consider the potential environmental impact of my actions when making many of my decisions.
3	GS	Green Scale	My purchase habits are affected by my concern for our environment.
4	GS	Green Scale	I am concerned about wasting the resources of our planet.
5	GS	Green Scale	I would describe myself as environmentally responsible.
6	GS	Green Scale	I am willing to be inconvenienced in order to take actions that are more environmentally friendly.
7	CL	Climate Literacy	The Sun is the primary source of energy for Earth ’s climate system.
8	CL	Climate Literacy	In addition to CO2, water vapor, methane are also greenhouse gases.
9	CL	Climate Literacy	Climate change leads to an overall rise in the sea level due to the melting of polar ice.
10	CL	Climate Literacy	Climate change causes an increase in extreme events, such as droughts, floods, and storms.
11	CL	Climate Literacy	Climate change has consequences for nature and human lives.
12	CL	Climate Literacy	Climate change is mainly caused by human activity.

Note: Source of questions 1-6 (Haws et al., 2014), 7-12 (Pan et al., 2023).

8.3 Appendix C: Survey Questionnaire

Welcome Note:

Dear participants, I am Abdul Hakim Karimi, a student enrolled in the Master of International Business and Sustainability program at Hamburg University. I am currently conducting research for my thesis, investigating individual preferences and knowledge related to sustainability. All responses provided will remain confidential and anonymous. The survey is expected to take 7 to 10 minutes, and your participation is entirely voluntary and there are no right or wrong answers. Your unique perspective is invaluable to this study and contributes to broader research on individual preferences and knowledge concerning sustainability.

Thank you for dedicating your time and contributing to this research.

Please indicate: To what extent do you agree with the following statements?

1 Strongly disagree

2 Disagree

3 Neither agree nor disagree

4 Agree

5 Strongly agree

No	Questions
1	Ensuring the protection of the environment is vital for achieving sustainable development.

2 Taking steps to reduce water usage is essential for promoting sustainable development.

3 Shifting towards the use of renewable natural resources is a key requirement for attaining sustainable development.

4 Human activities are significantly contributing to changes in our atmosphere and climate systems.

5 Respecting human rights is crucial for fostering sustainable development.

6 Improving access to long and healthy lives greatly contributes to sustainable development.

7 Preserving biodiversity is essential for advancing sustainable development.

8 Equitable distribution of resources is crucial for sustainable development.

9 Eradicating global poverty is essential for sustainable development.

10 If someone asks, I would be able to explain what sustainability means in my own words

11 Raising awareness about UN SDGs positively impacts global sustainable development efforts.

12 I treat individuals of all genders and ages equally and with respect.

13 I recycle as much as I can.

14 I prioritize walking or cycling instead of using motor vehicles when feasible.

15 I consistently exhibit respectful behavior in online interactions (chatting, emailing, gaming,...).

16 I pick up rubbish in natural areas and public spaces when encountered.

17 I do things which help poor people.

18 I prioritize purchasing goods from companies with ethical labor and environmental practices.

19 I have adjusted my lifestyle to minimize waste, like reducing food waste and conserving materials.

20 I strongly advocate for equal opportunities for education and employment for all genders globally.

21 I believe in equipping individuals with the knowledge and skills necessary for sustainable living.

22 I am committed to ensuring future generations enjoy a similar quality of life as our own.

23 The use of environmentally friendly vehicles should be encouraged by governments.

24 Sustainable development will not be possible until wealthier nations stop exploiting workers in poorer nations.

25 I recognize the importance of active civic engagement in addressing societal issues.

26 Companies should prioritize reducing packaging and disposable items.

27 There is a need for more stringent environmental laws and regulations.

28 Government decisions should be guided by principles of sustainable development.

29 It is important to me that the products I use do not harm the environment.

30 I consider the potential environmental impact of my actions when making many of my decisions.

31 My purchase habits are affected by my concern for our environment.

32 I am concerned about wasting the resources of our planet.

33 I would describe myself as environmentally responsible.

34 I am willing to be inconvenienced in order to take actions that are more environmentally friendly.

35 The Sun is the primary source of energy for Earth ’s climate system.

36 In addition to CO2, water vapor, methane are also greenhouse gases.

37 Climate change leads to an overall rise in the sea level due to the melting of polar ice.

38 Climate change causes an increase in extreme events, such as droughts, floods, and storms.

39 Climate change has consequences for nature and human lives.

40 Climate change is mainly caused by human activity.

41 What is your approximate monthly household income before taxes?

1. < €500
2. €501 - €1000
3. €1001 - €1500
4. €1501 - €2000
5. €2001 - €2500
6. €2501 - €3000
7. €3001 - €3500
8. > €3500

42 Which of the following statements best describes your political attitude or ideology?

1. Very liberal
2. Somewhat liberal
3. Moderate
4. Somewhat conservative
5. Very conservative
6. Other (please specify)

43 What is your country of residence?

44 What is your gender?

1. Male
2. Female
3. Other
4. Prefer not to say

45 What is your age group?

46 What is your education level?

1. Did not complete high school
2. High school/GED
3. Some college
4. Bachelor’s degree
5. Master’s degree
6. Advanced graduate work or PhD

47 What is your occupation?

1. Student
2. Employee/self-employee
3. Retired

4. Other (unemployed/disabled)

48 This is the end of the survey. Thank you very much for participating!

8.4 Appendix D: Controlling for Confounding Variables

		Unstandardized Coefficients		Standardized Coefficients		
DV[1]	Title	B	Std. Error	Beta	t	Sig.
SK1	(Constant)	4.870	.170		28.611	<.001
	Income	-.003	.020	-.013	-.174	.862
	Political attitude	-.113	.044	-.193	-2.546	.712
SK2	(Constant)	4.698	.216		21.764	<.001
	Income	-.005	.025	-.015	-.203	.840
	Political attitude	-.143	.056	-.192	-2.531	.092
SK3	(Constant)	4.686	.158		29.605	<.001
	Income	.033	.019	.134	1.802	.073
	Political attitude	-.125	.041	-.225	-3.025	.083
SK4	(Constant)	5.106	.158		32.264	<.001
	Income	.001	.019	.004	.057	.955
	Political attitude	-.225	.041	-.387	-5.443	.881
SK5	(Constant)	5.046	.211		23.861	<.001
	Income	-.042	.025	-.124	-1.698	.091
	Political attitude	-.237	.055	-.312	-4.284	.991
SK6	(Constant)	4.131	.243		16.973	<.001
	Income	-.040	.029	-.108	-1.408	.161
	Political attitude	-.031	.064	-.038	-.492	.623
SK7	(Constant)	4.628	.168		27.531	<.001
	Income	.027	.020	.105	1.387	.167
	Political attitude	-.100	.044	-.172	-2.286	.094

SK8	(Constant)	4.462	.240		18.558	<.001
	Income	-.015	.028	-.040	-.528	.598
	Political attitude	-.116	.063	-.141	-1.841	.067
SK9	(Constant)	4.689	.248		18.919	<.001
	Income	-.055	.029	-.142	-1.899	.089
	Political attitude	-.169	.065	-.195	-2.602	.120
SK10	(Constant)	3.934	.223		17.611	<.001
	Income	-7,14E-02	.026	.000	-.003	.998
	Political attitude	.038	.058	.050	.646	.519
SK11	(Constant)	3.913	.206		19.041	<.001
	Income	-.058	.024	-.184	-2.426	.036
	Political attitude	-.034	.054	-.049	-.641	.522
SB1	(Constant)	4.681	.186		25.232	<.001
	Income	.016	.022	.054	.720	.473
	Political attitude	-.119	.048	-.185	-2.451	.045
SB2	(Constant)	4.267	.230		18.573	<.001
	Income	.056	.027	.153	2.088	.038
	Political attitude	-.220	.060	-.268	-3.666	.031
SB3	(Constant)	3.780	.300		12.588	<.001
	Income	-.017	.035	-.038	-.490	.625
	Political attitude	.012	.078	.012	.150	.881
SB4	(Constant)	4.815	.172		28.015	<.001
	Income	.013	.020	.046	.621	.535
	Political attitude	-.160	.045	-.265	-3.571	.081
SB5	(Constant)	3.115	.278		11.211	<.001

	Income	.016	.033	.038	.490	.625
	Political attitude	-.013	.073	-.014	-.184	.854
SB6	(Constant)	3.108	.257		12.111	<.001
	Income	.031	.030	.080	1.036	.302
	Political attitude	.021	.067	.024	.312	.756
SB7	(Constant)	3.767	.283		13.316	<.001
	Income	-.010	.033	-.024	-.313	.755
	Political attitude	-.140	.074	-.145	-1.898	.079
SB8	(Constant)	3.194	.229		13.930	<.001
	Income	.084	.027	.236	3.145	.672
	Political attitude	.032	.060	.040	.534	.594
SA1	(Constant)	4.556	.211		21.553	<.001
	Income	.019	.025	.058	.769	.443
	Political attitude	-.141	.055	-.193	-2.553	.972
SA2	(Constant)	4.761	.176		27.122	<.001
	Income	.002	.021	.008	.110	.913
	Political attitude	-.113	.046	-.186	-2.453	.055
SA3	(Constant)	4.065	.243		16.730	<.001
	Income	.022	.028	.059	.767	.444
	Political attitude	-.025	.064	-.030	-.389	.698
SA4	(Constant)	4.634	.201		23.026	<.001
	Income	.037	.024	.117	1.590	.114
	Political attitude	-.194	.053	-.271	-3.682	.345
SA5	(Constant)	4.894	.229		21.335	<.001
	Income	-.001	.027	-.004	-.055	.956

	Political attitude	-.285	.060	-.345	-4.761	.991
SA6	(Constant)	4.376	.189		23.202	<.001
	Income	-.002	.022	-.005	-.071	.943
	Political attitude	-.147	.049	-.225	-2.988	.093
SA7	(Constant)	4.719	.202		23.368	<.001
	Income	.003	.024	.009	.124	.901
	Political attitude	-.116	.053	-.167	-2.192	.030
SA8	(Constant)	4.692	.220		21.309	<.001
	Income	.011	.026	.033	.444	.658
	Political attitude	-.178	.058	-.232	-3.101	.042

DV[1] Dependent Variable