Awareness of Sustainability and Green STEM Practices among STEM Teachers and Learners

THIRUVASUVI B S

24PED013

A THEIS SUBMITTED TO

AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN

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In Partial Fulfilment to the Requirements for the Degree of

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UNDER THE GUIDANCE OF

DR. R VAIJANTHI

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CERTIFIED AS BONAFIDE RESEARCH WORK

Signature of the Guide   Signature of the Head of the Department   Signature of the Dean

DECLARATION

DECLARATION

I, **THIRUVASUVI B S**, hereby declare that the thesis entitled "**Awareness of sustainability and Green STEM practices among STEM Teachers and Learners"** submitted to Avinashilingam Institute for Home Science and a Higher Education for Women, Coimbatore, in partial fulfilment of the requirements for the award of the **Degree of Master of Education**, is a record of original and independent research work done by me during the period under the supervision and guidance of **Dr.R.VAIJAYANTHI, Assistant Professor (SG),Department of Education,** Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, and it has not formed the basis for the award of any Degree/ Diploma/ Associateship/ Fellowship or other similar title to any candidate of this or any other University.

Signature of the Student

Signature of the Guide

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The investigator wishes to convey heartfelt thanks to the **LORD ALMIGHTY** for the blessings received throughout this journey

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INTRODUCTION

CHAPTER I

INTRODUCTION

INTRODUCTION

The twenty-first century has been marked by rapid advancements in science, technology, industrialization, and globalization. These developments have significantly contributed to improving human life by enhancing healthcare systems, communication technologies, transportation, and economic growth. However, these advancements have also resulted in serious environmental consequences, including climate change, global warming, air and water pollution, deforestation, biodiversity loss, and depletion of natural resources. These environmental challenges have raised critical concerns about the sustainability of human development and the long-term survival of ecosystems **(United Nations, 2015).**

The increasing environmental crises have highlighted the urgent need for sustainable development. The concept of sustainability gained global recognition through the report of the **World Commission on Environment and Development (1987),** which defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This definition emphasizes the importance of balancing present and future requirements while ensuring responsible use of natural resources. Sustainability encompasses three major dimensions: environmental protection, economic growth, and social well-being. Environmental sustainability focuses on preserving natural resources and ecosystems. Economic sustainability ensures growth without environmental degradation, while social sustainability emphasizes equality, justice, and quality of life. These three dimensions are interconnected and must be addressed simultaneously to achieve long-term sustainability.

In the current environmental context, it is essential that STEM education integrates sustainability principles. This integration ensures that technological advancements contribute positively to the environment rather than causing harm. As a result, the concept of Green STEM practices has emerged, which focuses on incorporating environmentally responsible approaches into STEM education. These practices include energy conservation, renewable energy, waste management, resource conservation, and eco-friendly innovations **(UNESCO, 2019).**

Teachers and students are key stakeholders in implementing sustainability in education. Teachers act as facilitators who guide students in understanding and applying sustainability concepts, while students actively engage in learning and practicing sustainable behaviours. Therefore, assessing the awareness levels of both teachers and learners is essential for effective implementation of sustainability education.

The present study aims to examine the awareness of sustainability and Green STEM practices among STEM teachers and learners. The findings of this study are expected to contribute to improving sustainability education and promoting environmentally responsible practices.

1.1 Objectives of the Study

- ❖ To assess the level of awareness of sustainability concepts among STEM Teachers and Learners
- ❖ To identify the types of green practices adopted by students in academic and daily activities.
- ❖ To analyse the role of STEM education in promoting environmentally responsible behaviour among students and learners.
- ❖ To examine barriers faced by students in adopting green and sustainable practices.
- ❖ To explore the relationship between students' knowledge of sustainability and their actual practices.

1.2 Hypotheses of the Study

- ❖ There is no significant difference in Green STEM practices between male and female teachers.
- ❖ There is no significant difference in Green STEM practices among teachers with different designations.
- ❖ There is no significant difference in Green STEM practices among teachers with varying years of experience.
- ❖ There is no significant difference in Green STEM practices among teachers from different types of institutions.
- ❖ There is no significant relationship between sustainability awareness and Green STEM practices among teachers.

Learners

- ❖ There is no significant difference in Green STEM practices between male and female learners.
- ❖ There is no significant difference in Green STEM practices between undergraduate and postgraduate learners.
- ❖ There is no significant difference in Green STEM practices among learners from different types of institutions.
- ❖ There is no significant difference based on learners' exposure to STEM activities.
- ❖ There is no significant difference based on learners' career interest in STEM.
- ❖ There is no significant relationship between sustainability awareness and Green STEM practices among learners.

1.3 Definition of Key Terms

1.3.1 Sustainability Awareness

Sustainability awareness refers to the level of knowledge and understanding regarding environmental protection, responsible resource use, and ecological balance **(UNESCO, 2017).**

1.3.2 Green STEM Practices

Green STEM practices refer to the integration of environmentally sustainable principles into STEM education, including eco-friendly technologies and conservation strategies **(UNESCO, 2019).**

1.3.3 STEM Teachers

STEM teachers are educators who teach science, technology, engineering, and mathematics at various educational levels.

1.3.4 Learners

Learners refer to students studying STEM-related subjects in educational institutions.

1.3.5 Sustainability

Sustainability refers to responsible resource management to meet present needs without affecting future generations **(World Commission on Environment and Development, 1987).**

1.4 Scope of the Study

- The study focuses on assessing awareness of sustainability and Green STEM practices among teachers and learners.
- It is limited to selected educational institutions.
- Variables include gender, type of institution, and role (teacher/learner).
- Data is collected using a structured questionnaire.
- The study is limited to awareness assessment and does not involve intervention.

1.5 Concept of Sustainability

Sustainability is a comprehensive and multidimensional concept that has gained global importance due to increasing environmental challenges and resource scarcity. It refers to the responsible utilization and management of natural resources in a manner that ensures the wellbeing of both present and future generations. The widely accepted definition of sustainable development was given by the **World Commission on Environment and Development (1987),** which states that development should meet present needs without compromising the ability of future generations to meet their own needs.

1.6 Sustainable Development in Education

Education for sustainable development (ESD) is a transformative approach that integrates sustainability principles into all aspects of teaching and learning. It aims to develop learners' knowledge, skills, attitudes, and values necessary to create a sustainable future. According to **UNESCO (2017),** ESD promotes critical thinking, problem-solving, and decision-making skills that enable individuals to address environmental, social, and economic challenges.

Educational institutions play a significant role in promoting sustainability by incorporating it into curricula, teaching methods, and institutional practices. Schools and colleges can implement sustainability through activities such as energy conservation programs, waste management initiatives, green campus projects, and environmental awareness campaigns. Teachers act as facilitators who guide students in understanding sustainability concepts and applying them in real-life situations. Thus, education serves as a powerful tool for achieving sustainable development goals.

1.7 Importance of STEM Education

STEM education is highly important in the twenty-first century due to rapid technological advancements and global challenges. It equips students with essential skills such as critical thinking, creativity, communication, and collaboration. According to the **National Research Council (2012),** STEM education enhances scientific literacy and prepares learners to solve complex real-world problems. One of the key advantages of STEM education is its focus on innovation and problem-solving. Students learn to analyse situations, design solutions, and evaluate outcomes. This approach is particularly important in addressing global issues such as climate change, energy crises, and environmental degradation.

Furthermore, STEM education contributes to economic development by preparing a skilled workforce capable of driving technological advancements. It also encourages entrepreneurship and supports the development of sustainable solutions. Therefore, integrating sustainability into STEM education becomes essential to ensure that innovation is environmentally responsible.

1.9 Integration of Sustainability in STEM

The integration of sustainability into STEM education involves incorporating environmental awareness, conservation principles, and sustainable problem-solving into teaching and learning processes. This approach enables students to apply their scientific and technological knowledge to address environmental challenges such as climate change, renewable energy, and resource management **(UNESCO, 2017).**

Through this integration, students can engage in activities such as designing solar-powered devices, developing waste management systems, analyzing environmental data, and creating ecofriendly solutions. These activities help learners understand the relationship between science, technology, and the environment. Integrating sustainability into STEM education also promotes interdisciplinary learning. It encourages students to think critically about the impact of human activities on the environment and to develop innovative solutions that are sustainable and ethical.

This approach prepares students to become responsible citizens who contribute to sustainable development.

1.10 Green STEM Practices

Green STEM practices refer to the integration of environmentally sustainable principles and practices into STEM education to promote ecological awareness and responsible innovation. These practices aim to reduce the negative impact of human activities on the environment while simultaneously encouraging students to develop solutions that are sustainable and future oriented. According to **UNESCO (2019),** Green STEM practices include energy conservation, waste reduction, recycling, the use of eco-friendly materials, and the adoption of sustainable laboratory procedures. In educational institutions, Green STEM practices can be implemented in various ways. For instance, schools and colleges can promote the use of renewable energy sources such as solar panels and energy-efficient systems. Paper usage can be minimized by encouraging digital learning methods, and recycling programs can be introduced to manage waste effectively. Laboratories can adopt environmentally friendly practices by reducing the use of harmful chemicals and promoting safe disposal methods.

1.11 Role of Teachers in Sustainability

Teachers play a crucial role in promoting sustainability within the education system. They act as facilitators, mentors, and role models who influence students' knowledge, attitudes, and behaviours. Their awareness, understanding, and commitment to sustainability significantly determine how effectively these concepts are integrated into the teaching-learning process. According to **UNESCO (2017),** teachers are considered key agents of change in advancing sustainability education.

Teachers can integrate sustainability into their teaching by incorporating environmental topics into lesson plans and linking them with real-life situations. They can encourage classroom discussions on environmental issues such as climate change, pollution, and resource conservation. By using innovative teaching strategies such as experiential learning, inquiry-based learning, and collaborative learning, teachers can make sustainability education more engaging and effective.

1.12 Role of Students in Green STEM Practices

Students play a significant role in achieving sustainable development as they are the future citizens, innovators, and decision-makers of society. Their level of awareness and understanding of sustainability directly influences their behaviour and actions. Green STEM education encourages students to actively participate in sustainable practices and take responsibility for environmental protection. Through STEM-based learning, students are exposed to real-world environmental challenges and are encouraged to develop innovative solutions. Activities such as conserving energy, reducing waste, recycling materials, and participating in environmental campaigns help students develop environmentally responsible habits. These practices not only improve their awareness but also motivate them to act.

1.13 Research Gap

Although sustainability and STEM education have been widely studied, most research has focused on these areas separately. There is limited research that examines the integration of sustainability into STEM education, particularly in the context of Green STEM practices. Additionally, many studies focus either on teachers or students, but very few studies consider both groups simultaneously. In the Indian context, research on sustainability awareness and Green STEM practices is still limited. There is a lack of empirical studies that assess awareness levels using structured tools. Furthermore, the practical implementation of sustainability in STEM education, such as eco-friendly teaching methods and student participation in environmental projects, has not been extensively explored **(UNESCO, 2019).**

Therefore, the present study aims to address these gaps by examining the awareness of sustainability and Green STEM practices among both teachers and learners.

1.14 Overview of the Study

The present study focuses on examining the awareness of sustainability and Green STEM practices among STEM teachers and learners. It aims to analyze their level of knowledge, attitudes, and practices related to sustainability. The study also explores the influence of variables such as gender, type of institution, and career interest on sustainability awareness.

By analysing the data collected, the study seeks to provide insights into the status of sustainability awareness in educational institutions. The findings are expected to help educators and policymakers develop effective strategies for integrating sustainability into STEM education.

1.15 Conclusion

Sustainability has become a critical necessity in addressing the environmental challenges faced by the world today. Education plays a vital role in promoting sustainability by creating awareness and encouraging responsible behavior among individuals. In this context, STEM education provides a strong platform for integrating sustainability concepts and promoting innovative solutions. Green STEM practices help students connect theoretical knowledge with real-world environmental issues and develop practical skills. Teachers and students both play an important role in implementing sustainability in education. While teachers act as facilitators and role models, students actively participate in learning and practicing sustainable behaviours.

Therefore, enhancing awareness of sustainability and Green STEM practices among teachers and learners is essential for achieving sustainable development. Educational institutions must take active steps to integrate sustainability into STEM education and promote environmentally responsible practices for a better future.

1.16 Research Reporting

A research report is a well-crafted document that outlines systematic investigation processes, data, and findings.

The research study is reported in five chapters as per the details below.

Chapter I – consists of the problem, purpose, hypotheses or research questions, definitions, theoretical framework, and significance of the study.

Chapter II – consists of a review of the literature.

Chapter III – consists of the methodology: sample, setting, design, data analysis methods, and ethical concerns.

Chapter IV – consists of the results of the data analysis.

Chapter V – consists of a discussion of results, conclusions, implications, and recommended future studies.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Introduction

A Literature review is a thorough examination and analysis of published works pertaining to a specific research question or topic. Journal articles, books, articles from magazines and blogs, published abstracts, conference proceedings, and dissertations are among the many types of literature that are reviewed. One of the pillars supporting your research idea is the literature review, which gives the research problem you are investigating context, relevance, and background. Here some of the literature review based on the research topic,

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INTERNATIONAL STUDIES

Tarlochan et al. (2025) conducted a large-scale scientometric and narrative review to examine the integration of sustainability in STEM education, analysing a sample of 2,721 publications, of which 113 studies were reviewed in depth. The study employed a mixed-method review methodology, combining bibliometric analysis with qualitative synthesis, and focused on key variables such as sustainability integration, student agency, and significant increase in sustainability-related STEM research after 2010, while also identifying major gaps, particularly the lack of studies in non-western and localized educational contexts. This study is highly relevant to the present research as it underscores the need for context-specific investigations into sustainability awareness among STEM teachers and learners, thereby justifying the focus of the current study in addressing these identified research gaps.

Sintiya and Ahsani (2024) used a descriptive qualitative methodology to investigate sustainability awareness through STEM-based Education for sustainable Development (ESD) among primary school students (sample size:30 Grade 4 students), with variables including behavioural, emotional, and attitudinal awareness. Observations, questionnaires, and documentation analysis were sued to gather data. The results showed that when exposed to STEM based activities, students showed high behavioural awareness, moderate emotional engagement, and favourable attitudes toward sustainability. This study supports the need to gauge awareness levels among teachers and students in the current study by demonstrating how STEM- based learning raises learners' awareness of sustainability.

Torre et al. (2017) used a quantitative methodology to conduct a survey study among 33 academics in software engineering education, concentrating on factors like teaching practices, curriculum integration, and sustainability awareness. The results showed that there was little structured integration of sustainability concepts into integration and the educators had little knowledge of them. This study supports the inclusion of teachers as a key group in the inclusion of teachers as a key group in the current study by highlighting the significance of teacher awareness in implementing sustainability practices.

Ahmed (2023) used a quantitative research design to survey 150 schoolteachers about their awareness of sustainability, concentrating on factors like professional training, teaching methods, and awareness. Correlation analysis and descriptive statistics were used to examine the data. The results showed that while teachers were aware of the fundamentals, they lacked the professional training necessary to successfully apply sustainability concepts. This study supports the necessity of evaluating teacher awareness and preparedness in sustainability education, which is pertinent to the current study's goals.

Chen (2022) used surveys and interviews to conduct a mixed method study on STEM based sustainability education among 120 students, concentrating on factors like STEM engagement, critical thinking, and environmental awareness. The results showed that student's awareness and capacity to apply sustainability concepts in practical settings were greatly enhanced by STEM-based learning. This study supports the inclusion of students in the current study by demonstrating how STEM education can raise awareness of sustainability.

Using a descriptive research design, **Ali (2021)** carried out a survey study on sustainability awareness among college students (sample size:100), concentrating on factors like curriculum exposure, awareness levels, and sustainability practices. The results showed that students who were exposed to curriculum related to sustainability had higher awareness levels that other students. This study is pertinent to the current research because it supports the examination of awareness among STEM learners by highlighting the role of curriculum in forming awareness.

Using a control group design, **Wong (2023)** carried out an experimental study on Green Stem education with 80 students, concentrating on factors like academic performance, engagement, sustainability awareness. ANOVA was used to analyse the data. When compared to demonstrated that Green STEM instruction increased student engagement and enhanced sustainability awareness. The idea of Green STEM practices, which is essential to the study, making it pertinent to the current investigation.

Khan (2022) used a quantitative approach to survey 140 schoolchildren, about their awareness of sustainability, concentrating on variables like awareness levels, socioeconomic factors, and locality. The results showed that students in urban areas were more aware that those in rural areas. This study supports the investigation of demographic variations in awareness, which can be taken into consideration in the current investigation.

Using questionnaires and interviews, **Dasgupta (2022)** carried out a mixed-method study with 95 teachers and students, concentrating on factors like instructional practices, student awareness, and teacher attitudes. The results showed that student awareness levels are highly influenced by teacher attitudes. This study is pertinent to the current research because it encourages teachers and students to be included in the assessment of sustainability awareness.

Mishra (2023) used a quantitative approach to survey 125 students about sustainability awareness, sustainability knowledge, and educational exposure. The results showed that student's knowledge of sustainability policies was low, underscoring the necessity of curriculum changes. This study is pertinent to the current investigation because it supports the goal of the current study by highlighting the role that policy and curriculum support play in raising awareness.

Garcia (2022) used a descriptive survey approach to study university student's awareness of sustainability (sample size:130), concentrating on factors like awareness, attitudes, and sustainable practices. The results showed that although students lacked consistent sustainable practices, they had a moderate level of awareness. This study is pertinent to the current research because it highlights the awareness-practice gap, which is a crucial aspect of examining teacher's and student's Green STEM practices.

Lopez and Kim (2022) employed a mixed-method approach, focusing on curriculum integration and instructional strategies, to examine sustainability awareness among 95 teachers and students. The findings demonstrated that while interdisciplinary STEM approaches significantly raised awareness, their use was infrequent due to a lack of training. This study is relevant because it emphasizes how important it is to assess teacher's familiarity with and preparedness for Green STEM practices.

Nguyen et al. (2023) conducted an experimental study with 85 students using STEM-based project learning. Among the factors were cooperation, critical thinking, and sustainability awareness. These results demonstrated a notable improvement in awareness and problem-solving skills. This study promotes the use of innovative STEM methods to increase sustainability awareness.

Singh and Kaur (2021) used a survey approach to look at 100 teacher candidates' awareness of sustainability. The results showed a moderate level of awareness but inadequate preparation for teaching. This study is pertinent because it emphasizes how crucial teacher preparation is to sustainability education.

Martinez (2022) measured institutional support and sustainability awareness among 140 university students. The findings indicated that while awareness was positively impacted by institutional initiatives, practice was not. Examining institutional factors in the current research is supported by this study.

Khan and Ali (2023) examined sustainability awareness and classroom practices among 110 educators using a survey design. The results showed that sustainability concepts were not incorporated into instruction. This is pertinent because it emphasizes how important it is to assess teachers' awareness in STEM settings.

Johnson (2021) used inquiry-based STEM learning in an experimental study involving 75 students. The findings indicated a rise in environmental engagement and awareness. The efficacy of STEM pedagogy in raising awareness is supported by this study.

INDIAN STUDIES

Using a quantitative survey methodology, **Sharma and Gupta (2022)** investigated sustainability awareness among secondary school teachers in India (sample size: 120 teachers), concentrating on factors like environmental awareness, sustainability knowledge, and teaching practices. T-tests and descriptive statistics were used to analyse the data. The results showed that although teachers had a moderate understanding of sustainability concepts, they lacked the necessary training and practical application of green practices in the classroom. This study is pertinent to the current research because it emphasizes the necessity of evaluating and raising teachers' awareness of sustainability, which directly relates to the current study's focus on STEM educators and students.

Using a survey approach, **Reddy (2021)** examined environmental awareness among higher secondary students (sample size:150), concentrating on focus like environmental knowledge, attitude, and awareness levels. The mean, standard deviation, and t-tests were used to analyse the data. The results showed that students' awareness ranged from moderate to high, with notable variations according to locality and gender. This study supports the significance of looking at demographic variations in awareness, which can be applied to STEM learners in the current study, making it pertinent to the current investigation.

Using a descriptive survey methodology, **Kumar and Singh (2023)** investigated the integration of STE M practices in Indian classrooms among 100 teachers, concentrating on factors like teaching effectiveness, sustainability practices, and STEM integration. The results demonstrated that interdisciplinary teaching was minimal and that most teachers had little exposure to green STEM practices. This study is pertinent to the current investigation because it directly supports the necessity of evaluating teachers' awareness of Green STEM practices, which is a key element of the current study.

Using a quantitative survey approach, **Patel (2020)** investigated sustainability awareness among B.Ed. trainees (sample size:80), concentrating on factors like sustainability knowledge, attitude and practice. The results showed that although trainees had a high level of theoretical understanding, they applied sustainability concepts in a limited way. This study is pertinent to the current research because it emphasizes the gap between awareness and practice, which is a crucial aspect of researching STEM educators and students.

Iyer (2022) used a survey approach to investigate environmental literacy among urban school students (sample size:200), concentrating on factors like awareness, attitude, and environmental behaviour. The results indicated that although students showed positive attitudes and good awareness, their actual environmental practices were insufficient. This study supports the need to measure awareness thoroughly in STEM contexts by highlighting the distinction between awareness and behavioural outcomes, which makes it pertinent to current research.

Using a descriptive research design, **Kaur and Mehta (2021)** examined STEM teaching practices among ninety schoolteachers, concentrating on factors like instructional strategies, interdisciplinary teaching, and STEM awareness. The results showed that teachers rarely incorporated sustainability concepts into their lessons and had little knowledge of interdisciplinary STEM approaches. This study supports the necessity of examining teacher awareness of Green STEM practices, which is a key focus of the current study, making it pertinent to the current investigation.

Using a mixed-method approach, **Das (2023)** examined sustainability education in higher education institutions among 110 students, concentrating on factors like curriculum integration, awareness, and sustainability competencies. The results showed that students' awareness of sustainability issues was only moderate due to inadequate curriculum integration. This study supports the necessity of assessing awareness in STEM education by highlighting curriculum gabs that affect awareness, making it pertinent to the current research

Nair (2021) used an experimental approach to examine the impact of environmental education on 130 school children, concentrating on factors like learning outcomes and environmental awareness. When compared to conventional teaching techniques, that results demonstrated that experiential and activity-based learning considerably raised awareness levels. This study is pertinent to the current research because it supports the emphasis on Green STEM practices by highlighting the efficacy of STEM- based and experiential learning approaches.

Joshi (2023) used a survey approach to investigate green practices in schools among sixty teachers, concentrating on factors like institutional support, implementation, and awareness. The results showed that despite teachers' basic awareness, their adoption of green practices was low because they lacked resources and support. The gap between awareness and practice, a crucial component of the current study, is reinforced by this study, making it pertinent to the current investigation.

Using descriptive statistics, **Chandra (2022)** investigated 130 secondary students' awareness of sustainability. The results showed that awareness levels varied by gender. This study is in Favor of incorporating demographic factors into the current investigation.

Conclusion

The review of literature reveals that sustainability awareness and Green STEM practices have gained increasing attention in recent years across both international and Indian contexts. Most of the studies indicate that STEM-based approaches, including project-based learning, inquiry based learning, and interdisciplinary teaching, significantly enhance students' and teachers' awareness of sustainability. However, despite the growing emphasis on sustainability education, several gaps persist.

Many studies highlight that although students and teachers possess moderate levels of awareness, there exists a noticeable gap between awareness and actual practice. Learners often demonstrate theoretical understanding but lack practical application of sustainable behaviours. Similarly, teachers show limited preparedness due to insufficient professional training and lack of structured curriculum integration.

CHAPTER III

METHODOLOGY

CHAPTER III
METHODOLOGY

Introduction

The methodology used for the current study, **"Awareness of Sustainability and Green STEM Practices among STEM Teachers and Learners"**, is thoroughly described in this chapter. The foundation of any scientific inquiry is research methodology, which offers a methodical and rational framework for gathering, evaluating, and interpreting data. The accuracy, validity, and reliability of the results are guaranteed by a clearly defined methodology, which raises the study's overall credibility.

This chapter's main goal is to describe the methods and approaches used to find out how much STEM teachers and students know about sustainability and green STEM practices. It contains a thorough description of the research design, study variables, population, sample, and sampling technique; data collection tools; instrument validity and reliability; data collection process; and statistical analysis techniques.

The study uses a suitable design that reflects real-life conditions by examining the current level of awareness without changing any variable. The sample has been carefully chosen to guarantee that both teachers and students are fairly represented. The research tool has been methodically created and verified to access the pertinent aspects of Green Stem practices and sustainability awareness. Additionally, this chapter explains how the right statistical tools were used to analyse the data objectively and highlights the ethical considerations that were followed during data collection. As a result, this chapter offers a precise and well-organized basis for the analysis and interpretation that follow.

3.1 Design of Research

The study uses the Descriptive Survey Method. This method is suitable because it helps in studying the present situation as it exists, without making any changes to it. Through this method, the researcher can collect information from many participants and understand their awareness, opinions, and attitudes. It is especially useful in educational research where the aim is to describe current conditions rather than to test cause-and-effect relationship.

In the study, the descriptive method helps in identifying how much teachers and students know about sustainability and green STEM practices. It also allows comparison between different groups based on their background.

3.2 Variables of the Study

Variables are important elements in research as they help in measuring and analysing different aspects of the study. The present study includes the following variables:
The study includes the following variables,

3.2.1 Primary Variables

- Sustainability Awareness Score
- Green STEM Practices Score

These variables directly measure the level of awareness among participants.

3.2.2 Demographic Variables

- Gender **(Male/Female**)
- Type of Institution **(Government/Private)**
- Teaching Experience **(For teachers)**
- Academic Stream **(For learners)**

These variables help in comparing how awareness differs among different categories of participants. They also provide deeper insights into the factors influencing awareness levels.

3.3 Population of the Study

The current study's population consists of:

- STEM educators employed by educational institutions.
- Learners who are pursuing STEM- related courses.

The population was selected from accessible institutions to make the data collection process easier and practical. Since the study focuses on STEM education, only those who are directly involved in STEM teaching and learning were considered. The selected population represents individuals who are likely to have some level of exposure to sustainability concepts, making the study more relevant.

3.4 Study Sample

A total of 300 participants were chosen for the current study.

This includes:

- 250 Students
- 50 Teachers

The sample size was chosen to ensure that enough data is collected for meaningful analysis. Having both teachers and students in the sample helps in making comparisons between the two groups.

This distribution also ensure that student responses are well represented while still including teacher perspectives.

3.4.1 Distribution of Selected Sample

CATEGORY	NUMBER OF PARTICIPANTS
Students	250
Teachers	50
Total	**300**

3.5 Method of Sampling

The study mainly used Simple Random Sampling, which gives every individual an equal chance of being selected. This helps in reducing bias and improves the fairness of the sample. However, in some cases, Convenience Sampling was also used due to time and accessibility limitations. This means participants who were easily available were included in the study. Using both methods helped the researcher collect data efficiently while still maintaining a reasonable level of accuracy.

3.6 Data Gathering Instrument

3.6.1 Tool Description

A structured questionnaire created by the researcher was used to gather data for the current study. Questionnaires are commonly used in survey studies because they are easy to distribute and help collect responses from many participants.

The questionnaire consists of two sections:

- **Section A:** Respondent’s demographic information.
- **Section B:** Sustainability and green STEM practices awareness items.

A five-point Likert scale was used to frame the items:

- Strongly Disagree
- Disagree
- Undecided
- Agree
- Strongly Agree

This scale helps in measuring the level of agreement and make it easier to analyse responses.

3.6.2 Dimensions of the Tool

The questionnaire covers the following dimensions:

- Conceptual understanding of Sustainability
- Awareness of Environmental issues
- Knowledge of renewable energy
- Integration of sustainability in STEM education

- Green practices in teaching and learning

These dimensions ensure that different aspects of awareness are properly measured. Together, they give a complete picture of how much participants know and practice sustainability concepts.

3.6.3 The Tool's Validity

The questionnaire was reviewed by experts in education and environmental studies. Their feedback was used to improve the quality of the questions.

Changes were made to ensure that the questions are clear, relevant, and easy to understand. This process helped in improving the accuracy of the tool and ensured that it measures what it is supposed to measure.

3.6.4 Reliability of the Tool

The reliability of the tool was tested using the Cronbach's Alpha method. This method checks whether the questionnaire gives consistent results.

The result showed that the tool reliable and suitable for the study. This means the responses collected can be trusted for analysis.

3.7 Procedure for Gathering Data

The procedure for gathering data was done in a methodical manner:

- The relevant institutions granted permission
- Participants were informed of the study's purpose
- The Google Forms were used to distribute the survey
- Participate gave their voluntary answers
- The gathered information was arranged for analysis

This systematic process helped in collecting data smoothly and avoiding errors.

3.8 Methods of Statistics Employed

The data was analysed using the following statistical methods:

- Percentages Analysis
- Mean and Standard Deviation
- Independent Sample t-test
- ANOVA (for institution wise comparison)
- Correlation Analysis

These statistical techniques help in understanding patters in the data and comparing different groups. They also make it easier to interpret the result in a clear and meaningful way.

3.9 Ethical Considerations

The researcher followed important ethical guidelines throughout the study:

- Participation was completely voluntary
- Participants' responses were kept confidential
- Data was used only for academic purpose
- No harm or discomfort was caused to participants
- Consent was obtained before collecting data

Following these principles helped in maintaining trust and integrity in the research process.

3.10 Conclusion

The chapter explained the methodology used in the study, including the research design, variables, population, sample, tools, and methods of data analysis. The procedures followed in the study ensure that the results are reliable and meaningful. By using proper methods and careful planning, the researcher was able to collect accurate data.

The next chapter presents the analysis and interpretation of the collected data in detail.

CHAPTER IV

ANALYSIS AND INTERPRETATION

CHAPTER IV

ANALYSIS AND INTERPRETATION

Introduction

The chapter presents the analysis and interpretation of the data collected for the titled **“Awareness of Sustainability and Green STEM Practices among STEM Teachers and Learners”.** The purpose of this chapter is to systematically analyse the collected data to achieve the objectives of the study and to test the formulated hypotheses.

The analysis is carried out using both quantitative and qualitative approaches. The quantitative analysis involves statistical techniques such as percentage analysis, mean, standard deviation t-test, ANOVA and correlation. The qualitative interpretation explains the meaning and implementation of the statistical findings in relation to the research problem.

For clarity and systematic presentation, this chapter is organized into the following sections:

- Personal data analysis of students
- Students Awareness and Practices towards Sustainability
- Hypothesis testing for students
- Personal data analysis for teachers
- Teachers Awareness and Practices towards Sustainability
- Hypothesis testing for teachers

4.1 Quantitative Analysis

Quantitative analysis refers to the numerical and statistical examination of the collected data. In this study, statistical tools such as percentage analysis, descriptive statistics, and inferential statistics were used to analyse awareness and practices related to green STEM education.

4.2 Qualitative Interpretation

Qualitative interpretation involves explaining the statistical results in a meaningful way. It helps in understanding patterns, trends, and relationships in the data and provides educational significance to the findings.

4.3 Personal Data Analysis of Students

The chapter deals with the analysis and interpretation of data collected from 250 students regarding their awareness of sustainability and green STEM practices. The data were analysed using descriptive and inferential statistics.

Before analysing the main variables of the study, it is essential to understand the background characteristics of the student respondents. The personal variables considered include gender, age, level of study, year of study, discipline, type of institution, residence, STEM exposure, STEM participation, and career interest.

4.2 Personal Data Analysis of Students

4.2.1 Distribution of Students Based on Gender

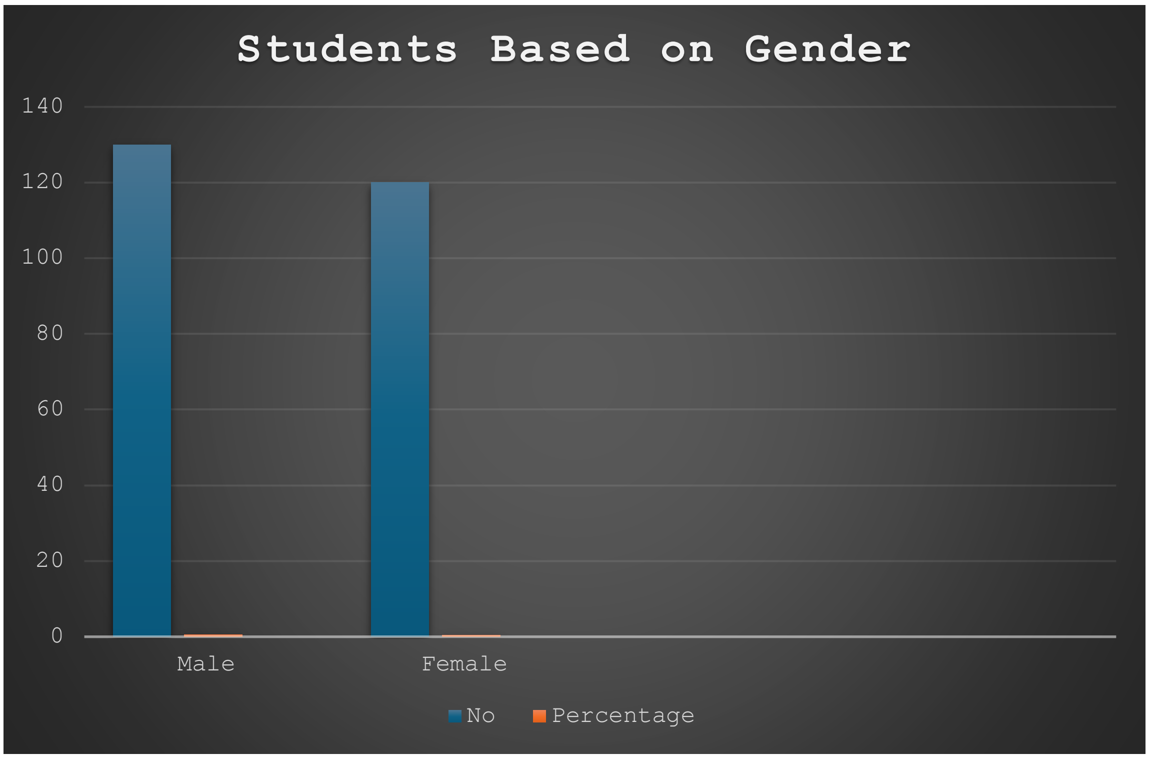
The distribution of students based on gender is presented in Table 4.1. This helps to understanding whether the sample consists of balanced representation from both male and female.

4.1 Table of Distribution of Students based on Gender

Gender	No.	Percentage
Male	130	52 %
Female	120	48 %
Total	**250**	**100 %**

The table shows that 52% of the students are male and 48% are female. This indicates that the sample has an almost equal representation of both genders, ensuring fairness in the responses collected for the study.

Fig 4.1 Students based on Gender



The graphical representation further confirms that there is only a marginal difference between male and female respondents, indicating a balanced distribution.

4.2.2 Distribution of Students based on Age

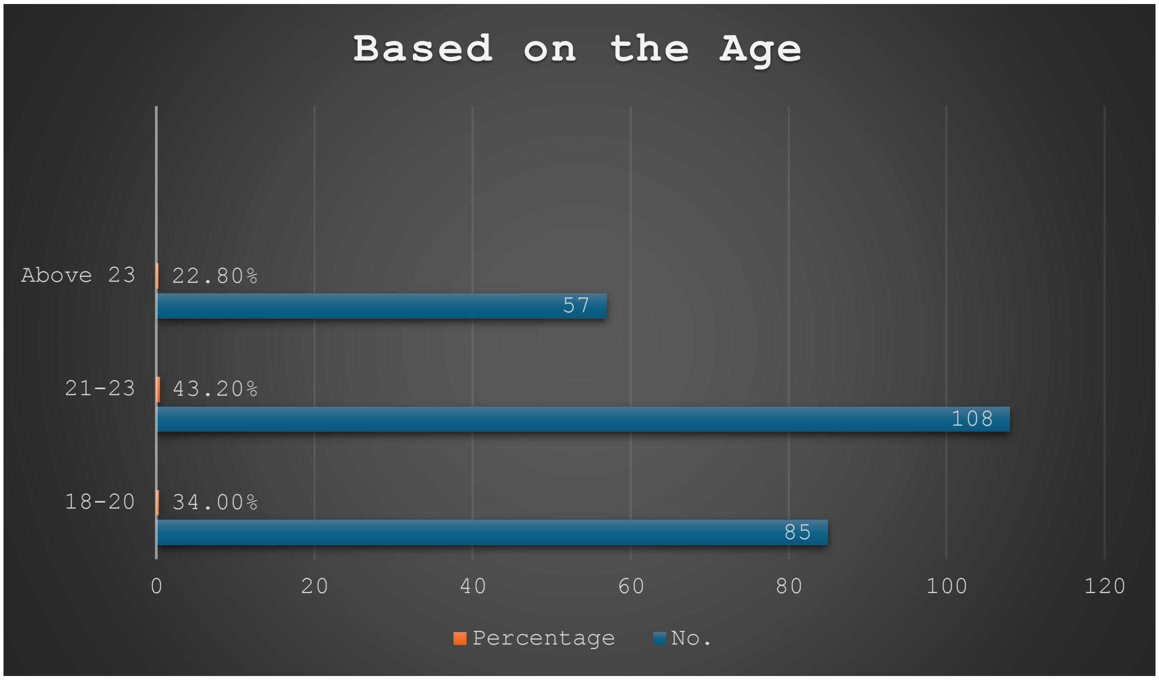
The age-wise distribution of student respondents is presented in Table 4.2 Age is an important variable as I t reflects the maturity and academic stage of the learners.

4.2.2 Table of Distribution of the Students based on Age

Age	No.	Percentage
18-20 years	85	34.0 %
21-23 years	108	43.2 %
Above 23 years	57	22.8 %
Total	**250**	**100.0 %**

The table reveals that 43.2% of the students belong to the 21-23 years age group, followed by 34% in 18-20 years and 22.8% above 23 years. This indicates that most students are in the typical college-going age group.

Fig 4.2 Students based on Age



The above figure clearly shows the age-wise distribution of students. It supports the table data and highlights that most respondents fall withing the 21-23 years category

4.2.3 Distribution of Students based on Level of Study

The classification of students based on their level of study is presented in Table 4.3. This helps in identifying whether undergraduate or postgraduate students dominate the sample.

4.3 Table of Distribution of Students based on Level of Study

Level	No.	Percentage
Undergraduate	183	73.2
Postgraduate	67	26.8
Total	**250**	**100.0**

The above figure illustrates the distribution of students based on their level of study. It supports the table data and highlights the dominance of undergraduate students. The above figure illustrates the distribution of students based on their level of study. It supports the table data and highlights the dominance of undergraduate students.

4.2.4 Distribution of Students Based on Year of Study

The year-wise distribution of student respondents is presented in Table.4.4. This helps in understanding the academic level of the students.

4.2.4 Table Distribution of Students Based on Year of Study

Year	No.	Percentage
I Year	78	31.2
II Year	95	38.0
III Year	77	30.8
Total	**250**	**100.0**

The table reveals that 38% of students are in the second year, followed by 31.2% in the first year and 30.8% in the third year. This indicates a balanced distribution across different years of study.

4.2.5 Distribution of the students based on Subject

The distribution of students based on their discipline is presented in Table.4.5. This helps in understanding the representation of different STEM fields.

4.5 Table of the students based on Subject

Discipline	No.	Percentage
Physics	53	21.2
Chemistry	58	23.2
Mathematics	50	20.0
Computer Science	37	14.8
Engineering	52	20.8
Total	**250**	**100.0**

The table reveals that the highest percentage of students belong to Chemistry (23.2%), followed by Physics (21.2%), Engineering (20.8%), Mathematics (20%), and Computer Science (14.8%). This indicated that students are fairly distributed across various STEM disciplines.

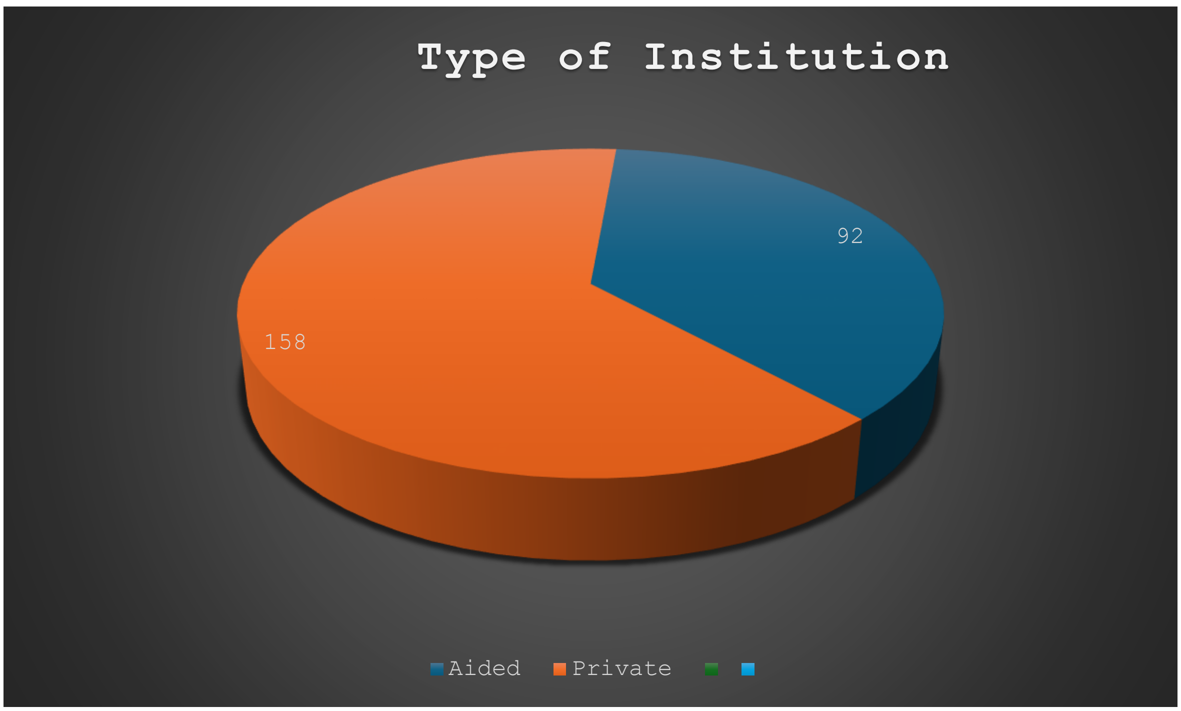
4.2.6 Distribution of students based on Type of Institution

The classification of students based on type of institution is presented in Table 4.6

Institution	No	Percentage
Aided	92	36.8
Self -Financing /Private	158	63.2
Total	**250**	**100.0**

The table shows that 63.2% of students belong to self-financing institutions, while 36.8% are from aided institutions. They indicated that most respondents are from private institutions

Fig 4.6 Type of Institution (Students)



The above figure clearly illustrates the type of institutions of students. It supports the table data.

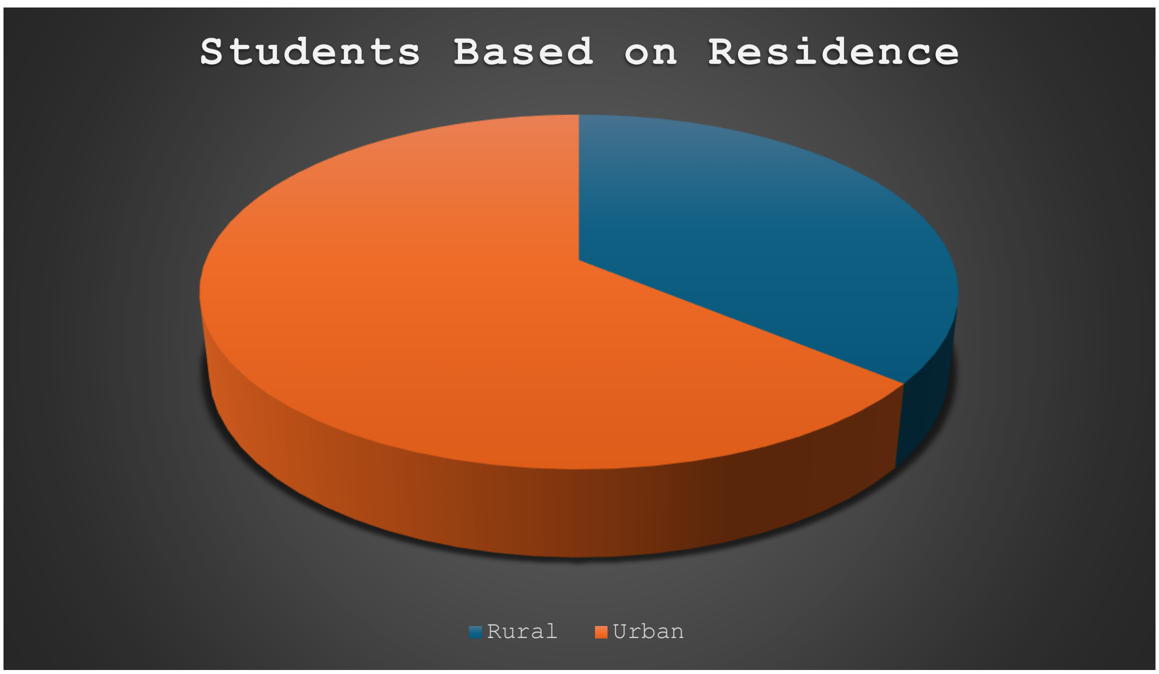
4.2.7 Distribution of Students Based on Residence

The distribution of students based on their place residence is presented in Table.4.7

Residence	No.	Percentage
Rural	90	36.0
Urban	160	64.0
Total	**250**	**100.0**

The table reveals that 64% of students are from urban areas and 36% are from rural areas. This indicates that respondents belong to urban backgrounds.

Fig 4.7 Residence of Students



The above figure shows the residential distribution of students and supports the findings in the table.

4.2.8 Distribution of Students Based on STEM Exposure

The distribution of students based on STEM exposure is presented in Table 4.8

STEM Exposure	No	Percentage
Yes	172	68.8
No	78	31.2
Total	**250**	**100.0**

The table shows that 68.8% of students have STEM exposure, while 31.2% do not. This indicated that most students are exposed to STEM activities.

4.2.9 Distribution of Students Based on STEM Participation

The participation of students in STEM activities is presented in Table 4.9

Participation	No.	Percentage
Yes	153	61.2
No	97	38.8
Total	**250**	**100.0**

The table reveals that 61.2% of students participate in STEM activities, while 38.8% do not. This indicates that more than half of the students are actively involved in STEM.

4.2.10 Distribution of Students Based on Career Interest

The participation of students in STEM activities is presented in Table 4.1

Response	No.	Percentage
Yes	152	60.8
No	60	24.0
Not Sure	38	15.2

Total	250	100.0

The table shows that 60.8% of students are interested in STEM careers, 24% are not interested, 15.2% are not sure. This indicates a positive inclination towards STEM careers among students.

4.11 Students Awareness and Practices towards Sustainability

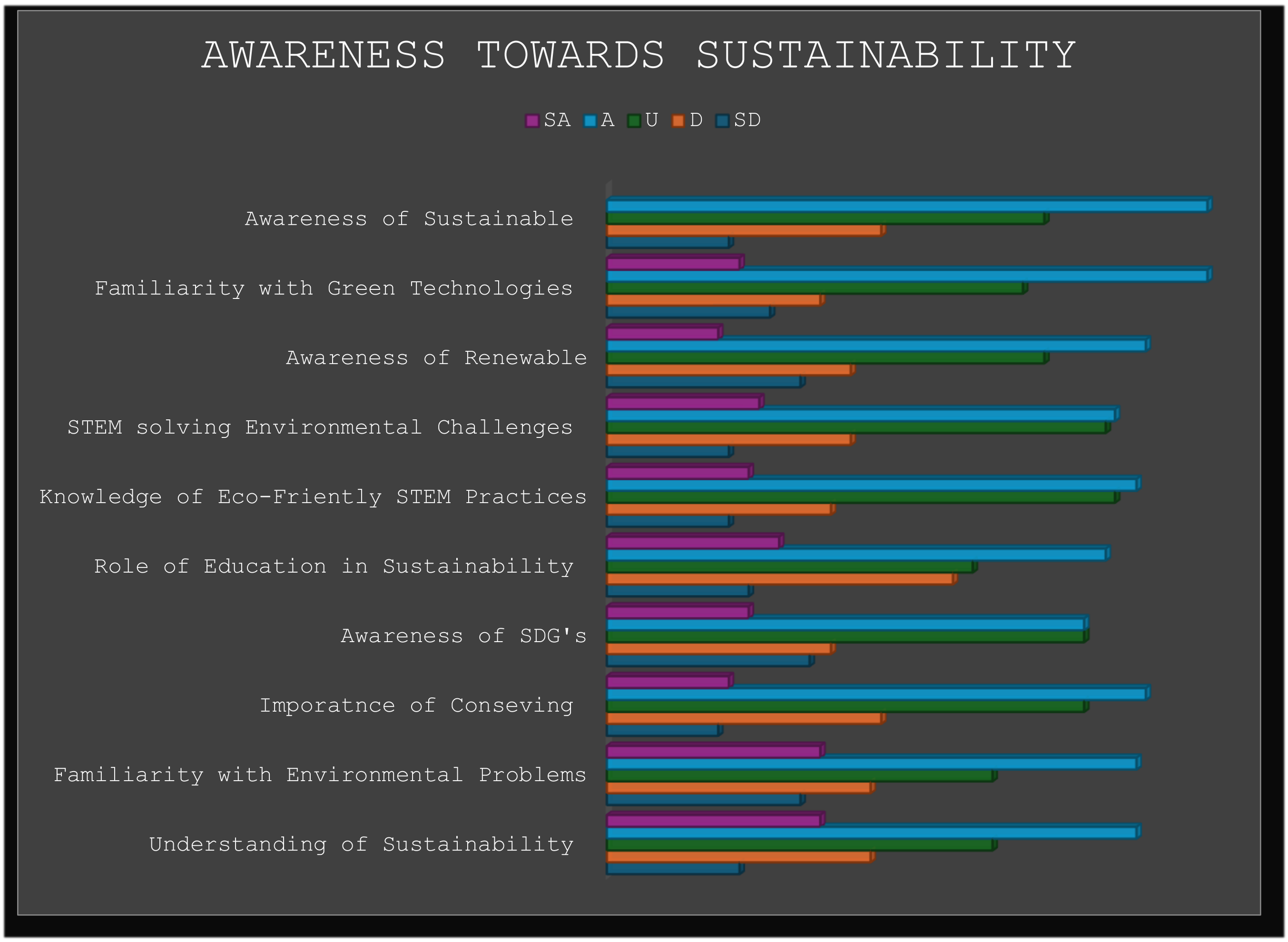
The following table presents a consolidated analysis of students' awareness and practice levels towards sustainability and Green STEM concepts. It includes responses across various dimensions such as understanding of sustainability, environmental responsibility, eco-friendly practices, and participation in sustainable activities. This combined presentation helps in identifying overall trends in students' knowledge and practical engagement. Table: Students Awareness towards Sustainability (N-250)

S. No	Statement	SD (%)	D (%)	N (%)	A (%)	SA (%)
1.	Understanding of Sustainability	8.7	17.3	25.3	34.7	14.0
2.	Familiarity with Environmental Problems	12.7	17.3	25.3	34.7	14.0
3	Importance of Conserving	7.3	18.0	31.3	35.3	8.0
4	Awareness of SDGs	13.3	14.7	31.3	31.3	9.3
5	Role of Education in Sustainability	9.3	22.7	24.0	32.7	11.3
6	Knowledge of Eco-Friendly STEM Practices	8.0	14.7	33.3	34.7	9.3
7	STEM solving Environmental Challenges	8.0	16.0	32.7	33.3	10.0
8	Awareness of Renewable	12.7	16.0	28.7	35.3	7.3
9	Familiarity with Green Technologies	10.7	14.0	27.3	39.3	8.7
10	Awareness of Sustainable	8.0	18.0	28.7	39.3	6.0

The results reveal that students have a moderate level of awareness towards sustainability concepts, with most responses concentrated in the "Agree" category. Areas such as green technologies and sustainable laboratory practices show relatively higher awareness among students.

However, a considerable proportion of neutral responses indicate that students' understanding is not fully developed in all aspects. This suggests the need for enhanced educational efforts to strengthen awareness and deepen students' knowledge of sustainability and Green STEM concepts.

Figure 4.11Awareness towards sustainability



Testing of Hypotheses Gender and STEM Practices H01: STEM Practices does not differ significantly between Male and Female learners

To examine whether gender has any significant influence on STEM practices among students, the following null hypothesis was formulated and tested.

Descriptive Statistics

		Practices Score		
		Mean	**S. D**	**No.**
Gender	**Male**	22.13	2.87	130
	Female	22.86	3.06	120
Total		**22.48**	**2.98**	**250**

The descriptive statistics show the STEM practices scores of students based on gender. Female learners have a slightly higher mean score (M = 22.86, SD = 3.06) compared to male learners (M = 22.13, SD = 2.87). The overall mean score is 22.48 with a standard deviation of 2.98. The difference in mean scores between male and female learners is relatively small, indicating similar levels of STEM practices. The descriptive statistics show that female students have a slightly higher mean score compared to male students. However, the difference between the mean scores is minimal.

To find out whether the difference between the groups is statistically significant, the following hypothesis was framed and tested:

H01: STEM practices do not differ significantly between male and female learners. T-Test for Equality of Means

T	Df	Sig.
1.514	**248**	**Ns**

p> 0.05 (Not significant)

Critical value: 1.976

The t-test results show that the calculated t-value (1.514) is less than the critical value (1.976) at the 0.05 level of significance. Hence, the result is not statistically significant.

Since the result is not significant, the null hypothesis is accepted. This indicates that there is no significant difference in STEM practices scores between male and female learners.

H02: STEM Practices do not differ significantly between UG and PG Students

To determine whether the level of study influences STEM practices among students, the following null hypothesis was formulated.

Descriptive Statistics

		Practices Score		
		Mean	**S. D**	**No.**
Level	**Undergraduate**	22.55	3.17	183
	Postgraduate	22.28	2.40	67
Total		**22.48**	**2.98**	**250**

The descriptive statistics explain the STEM practices scores of students based on their level of study. Undergraduate students have a slightly higher mean score (M = 22.55, SD = 3.17) compared to postgraduate students (M = 22.28, SD = 2.40). The overall mean score is 22.48 with a standard deviation of 2.98. The difference in mean scores between the two groups is minimal, indicating nearly similar levels of STEM practices.

To find out whether the difference between the groups is statistically significant, the following hypothesis was framed and tested:

H02: STEM practices do not differ significantly between undergraduate and postgraduate students.

T-Test for Equality of Means

T	**Df**	**Sig.**
0.508	**248**	**Ns**

$p>0.05$ (Not significant)

Critical value: 1.976

The t-test results show that the calculated t-value (0.508) is less than the critical value (1.976) at the 0.05 level of significance. Hence, the result is not statistically significant. The results show that undergraduate students have a slightly higher mean score compared to postgraduate students. However, the difference is minimal. The calculated t-value is less than the critical value, indicating that the result is not statistically significant.

Since the result is not significant, the null hypothesis is accepted. This indicates that there is no significant difference in STEM practices scores between undergraduate and postgraduate students.

H03: STEM Practices do not differ significantly between types of institutions

To examine whether the type of institution affects STEM practices among students, the following hypothesis was tested.

Descriptive Statistics

		Practices Score		
		Mean	**S. D**	**No.**
Institution	**Aided**	22.04	3.24	92
	Self - Financing /Private	22.74	2.80	158
Total		**22.48**	**2.98**	**250**

The descriptive statistics present the STEM practices scores of students based on the type of institution. Students from self-financing/private institutions have a slightly higher mean score (M = 22.74, SD = 2.80) compared to those from aided institutions (M = 22.04, SD = 3.24). The overall mean score is 22.48 with a standard deviation of 2.98. The difference in mean scores between the two groups is relatively small, indicating similar levels of STEM practices.

The mean score of students from self-financing institutions is slightly higher than those from aided institutions. However, the difference is not considerable. The calculated t-value is less than the critical value, indicating that the result is not significant. To find out whether the difference between the groups is statistically significant, the following hypothesis was framed and tested:

H03: STEM practices do not differ significantly between Aided and Self-financing/private institutions.

T-Test for Equality of Means

T	Df	Sig.
1.394	**248**	**Ns**

$p>0.05$ (Not significant)

Critical value: 1.976

The t-test results show that the calculated t-value (1.394) is less than the critical value (1.976) at the 0.05 level of significance. Hence, the result is not statistically significant.

Since the result is not significant, the null hypothesis is accepted. This indicates that there is no significant difference in STEM practices scores between students from aided and self-financing/private institutions.

H04: STEM Practices do not differ significantly based on STEM exposure

To examine whether STEM exposure influences students' practices, the following hypothesis was formulated.

Descriptive Statistics

		Practices Score		
		Mean	**S. D**	**No.**
STEM Exposure	**Yes**	22.60	2.98	172
	No	22.21	2.98	78
Total		**22.48**	**2.98**	**250**

To find out whether the difference between the groups is statistically significant, the following hypothesis was framed and tested:

The descriptive statistics present the STEM practices scores of students based on STEM exposure. Students who have STEM exposure show a slightly higher mean score (M = 22.60, SD = 2.98) compared to those without STEM exposure (M = 22.21, SD = 2.98). The overall mean score is 22.48 with a standard deviation of 2.98. The difference in mean scores between the two groups is minimal, indicating nearly similar levels of STEM practices.

H04: STEM practices do not differ significantly based on STEM exposure. T-Test for Equality of Means

T	Df	Sig.
0.742	**248**	**Ns**

$p > 0.05$ (Not significant) Critical value: 1.976 Students with STEM exposure show a slightly higher mean score compared to those without exposure. However, the difference is very minimal. The calculated t-value is less than the critical value, indicating no significant difference.

The t-test results show that the calculated t-value (0.742) is less than the critical value (1.976) at the 0.05 level of significance. Hence, the result is not statistically significant.

Since the result is not significant, the null hypothesis is accepted. This indicates that there is no significant difference in STEM practices scores between students with and without STEM exposure.

H05: STEM Practices do not differ significantly based on Career Interest

To determine whether career interest affects STEM practices among students, the following null hypothesis was formulated.

Descriptive Statistics

		Practices Score		
		Mean	**S. D**	**No.**
Career Interest	**Yes**	22.63	2.98	152
	No	22.44	3.18	60
	Not Sure	21.96	2.69	30
Total		**22.48**	**2.98**	**250**

The descriptive statistics present the STEM practices scores of students based on their career interest. Students who responded "Yes" for career interest have the highest mean score (M = 22.63, SD = 2.98), followed by those who responded "No" (M = 22.44, SD = 3.18), and those who are "Not Sure" (M = 21.96, SD = 2.69). The overall mean score is 22.48 with a standard deviation of 2.98. Although there are slight variations in mean scores among the groups, the differences are minimal.

The mean scores show slight variation among students with different levels of career interest. However, the differences are not substantial. The calculated F-value is less than the critical value at the 0.05 level of significance, indicating that the result is not statistically significant.

To find whether the differences between the groups are statistically significant, the following hypothesis was framed and tested:

H05: STEM practices do not differ significantly based on career interest.

ANOVA for Practices Score

Source	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	8.298	2	4.149	0.465	Ns
Within Groups	1311.142	247	5.308		
Total	**1319.440**	**249**			

$p>0.05$ (Not significant)

Critical value: 3.058

The ANOVA results indicate that the calculated F-value (0.465) is less than the critical value (3.058) at the 0.05 level of significance. Hence, the result is not statistically significant. Since the ANOVA result shows no significance, the null hypothesis is accepted. This indicates that there is no significant difference in STEM practices scores among students based on their career interest.

H06: There is no significant relationship between Awareness and Practice

To examine the relationship between awareness and STEM practices among students, the following hypothesis was tested.

Correlations

Variables	Practices Score
Awareness Score	**0.049Ns**

The correlation analysis shows the relationship between awareness and STEM practices among students. The correlation coefficient is r = 0.049, indicating a very weak positive relationship between awareness and practices. This suggests that awareness and practices are almost independent among students.

To find out whether the relationship is statistically significant, the following hypothesis was framed and tested:

H06: There is no significant relationship between awareness and practice among students.

The calculated t-value for the correlation is t = 0.597 (df = 148), which is less than the critical value (1.976) at the 0.05 level of significance. Hence, the result is not statistically significant. Since the result is not significant, the null hypothesis is accepted. This indicates that there is no significant relationship between awareness and STEM practices among students.

H07: STEM Practices do not differ significantly among students based on Subject Table 4.12

The following table presents the mean scores of STEM practices among students based on their courses discipline. The data were analysed using mean, standard deviation, and Analysis of Variance (ANOVA) to determine whether there is any significant difference among different disciplines.

	Practices Score		
Subject	**Mean**	**S. D**	**No**
Physics	22.25	3.22	53
Chemistry	22.94	3.07	58
Mathematics	21.87	2.56	50
Computer Science	22.64	2.87	37
Engineering	22.68	3.12	52
Total	**22.48**	**2.98**	**250**

The above table shows the mean scores of STEM practices among students belonging to different disciplines such as Physics, Chemistry, Mathematics, Computer Science, and Engineering. It observed that Chemistry Students have the higher mean score, while Mathematics students have the lowest mean score. However, the variation among the groups is minimal, indicating that students across different disciplines demonstrate similar levels of STEM practices.

The diagram represents the mean scores of STEM practices among students based on course discipline. It shows only slight variation among different groups, indicating uniformity in

STEM practices among students

ANOVA for Practices Score by Courses Discipline

Sources	**SS**	**Df**	**MS**	**F**	**S**
Between Groups	22.223	4	5.556	0.621	N
Within Groups	1297.217	245	5.295		
Total	**1319.440**	**249**			

NS-Not Significant

Critical Value= 2.578

The above table shows the mean scores of STEM practices among students belonging to different course disciplines such as Physics (22.25), Chemistry (22.94), Mathematics (21.87), Computer Science (22.64), and Engineering (22.68).

The ANOVA results reveal that the calculated F-value is less than the critical value at the 0.05 level of significance. Hence, the result is not statistically significant. Therefore, the null hypothesis is accepted, indicating that there is no significant difference in STEM practices among students based on discipline. It is observed that Chemistry students have the highest mean score, whereas Mathematics students have the lowest mean score. However, the variation among the groups is minimal, indicating that students across different disciplines demonstrate similar levels of STEM practices.

The ANOVA results that the calculated F-value (0.621) is less than critical value (2.578) at 0.05 level of significant.

Part B

DATA ANALYSIS AND INTERPRETATION (TEACHERS)

This section presents the analysis and interpretation of data collected from teachers regarding their awareness of sustainability and Green STEM practices. The data is analysed systematically to understand their level of knowledge and implementation.

4.5 Personal Data of Teachers

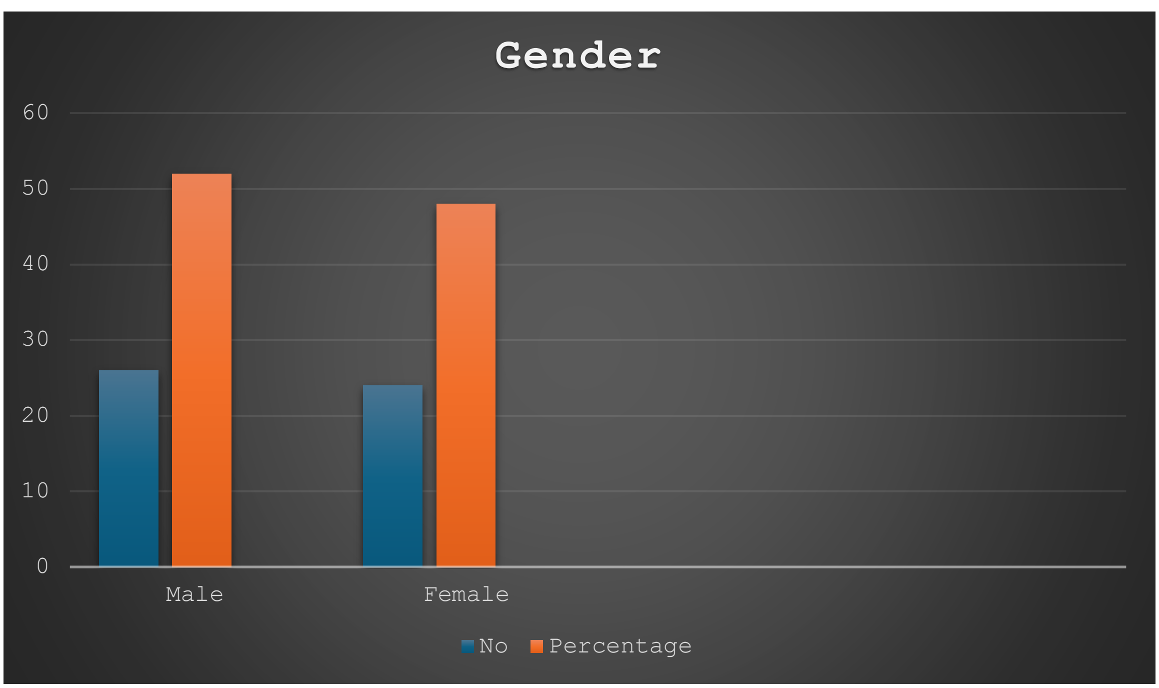
4.5.1Distribution of students based on Teacher

The distribution of teacher respondents based on gender is presented in Table 4.11.

Gender	No.	Percentage
Male	26	52.0
Female	24	48.0
Total	**50**	**100.0**

The table reveals that 52% of teachers are male and 48% are female. This indicates a balanced representation.

Fig 4.5 Gender Distribution of Teachers



The above figure shows a balanced gender distribution, with 52% male and 48% female teacher.

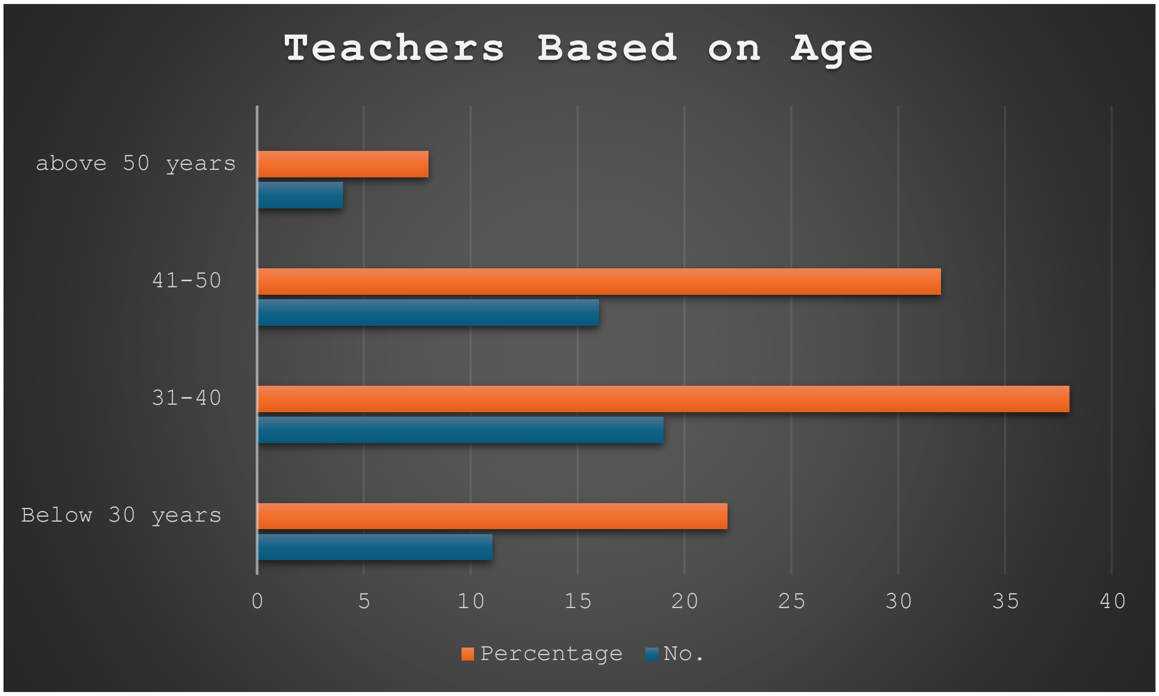
4.5.2 Distribution of Teachers based on Age

The age-wise distribution of teachers is presented in Table 4.13

Age	No.	Percentage
Below 30 Years	11	22.0
31-40 Years	19	38.0
41-50 Years	16	32.0
Above 50 Years	4	8.0
Total	**50**	**100.0**

The table shows that 38% belong to 31–40 years, followed by 32% in 41–50 years. This indicates that most teachers are in the mid-career stage.

Fig 5.2 Distribution of Teachers based on Age



Most teachers (38%) fall into the 31-40-year-old age group, followed by 41-50 years (32%)

4.5.3 Distribution of Teachers based on Qualification

The qualification-wise distribution of teachers is presented in Table 4.5.3

Qualification	**No.**	**Percentage**
M Phil	28	56.0
Ph D	9	18.0
Other	13	26.0
Total	**50**	**100.0**

The table reveals that 56% hold M.Phil., 18% Ph.D., and 26% other qualifications. This indicates that most teachers are well qualified.

4.5.3 Distribution of the teachers based on Designation

The table indicates that 62% are Assistant Professors, followed by 24% Associate Professors and 14% Professors.

This shows that most respondents are in the entry-level academic position.

Designation	No.	Percentage
Assistant Professor	31	62.0
Associate Professor	12	24.0
Professor	7	14.0
Total	**50**	**100.0**

Most respondents (62%) are Assistant Professors, followed by Associate Professors (24%) and Professors (14%).

4.5.4 Distribution of the teachers based on the Subject

The subject-wise distribution of teachers is presented in Table 4.16

Subject	No.	Percentage
Physics	9	18.0
Chemistry	8	16.0
Mathematics	17	34.0
Computer Science	10	20.0
Engineering	6	12.0
Total	**50**	**100.0**

The table shows that Mathematics (34%) has the highest representation. This indicates variation across subjects.

4.5.5 Distribution of teachers based on Experience

The experience-wise distribution of teachers is presented in Table 4.17

Experience	No.	Percentage
Below 5 Years	12	24.0
6-10 Years	14	28.0
11-15 Years	15	30.0
Above 15 Years	9	18.0
Total	**50**	**100.0**

The table shows that 30% have 11–15 years' experience. This indicates moderate experience among teachers.

4.5.6 Distribution of the teachers based on the Institution

The distribution based on institution type is presented in Table 4.18

Institution	No.	Percentage
Aided	31	62.0
Self-Financing /Private	19	38.0
Total	**50**	**100.0**

The table reveals that 62% are from aided institutions. This indicates majority representation.

4.5.7 Distribution of the teachers based on the STEM Training The distribution based on STEM training is presented in Table 4.19

STEM Training	No.	Percentage
Yes	31	62.0
No	19	38.0
Total	**50**	**100.0**

The table shows that 62% have received training. This indicates good exposure.

4.5.8 Distribution of the teachers based on the STEM Facilities

The distribution based on STEM facilities is presented in Table 4.20

STEM Facilities	No.	Percentage
Yes	35	70.0
No	15	30.0
Total	**50**	**100.0**

The table reveals that 70% of people have facilities. This indicates strong infrastructure.

4.5.9 Distribution of teachers based on STEM Tool Usage

The usage of STEM tools is presented in Table 4.5.9

STEM Tool Usage	No.	Percentage
Frequently	5	10.0
Occasionally	32	64.0
Rarely	13	26.0
Total	**50**	**100.0**

The table shows that 64% use tools occasionally. This indicates moderate usage.

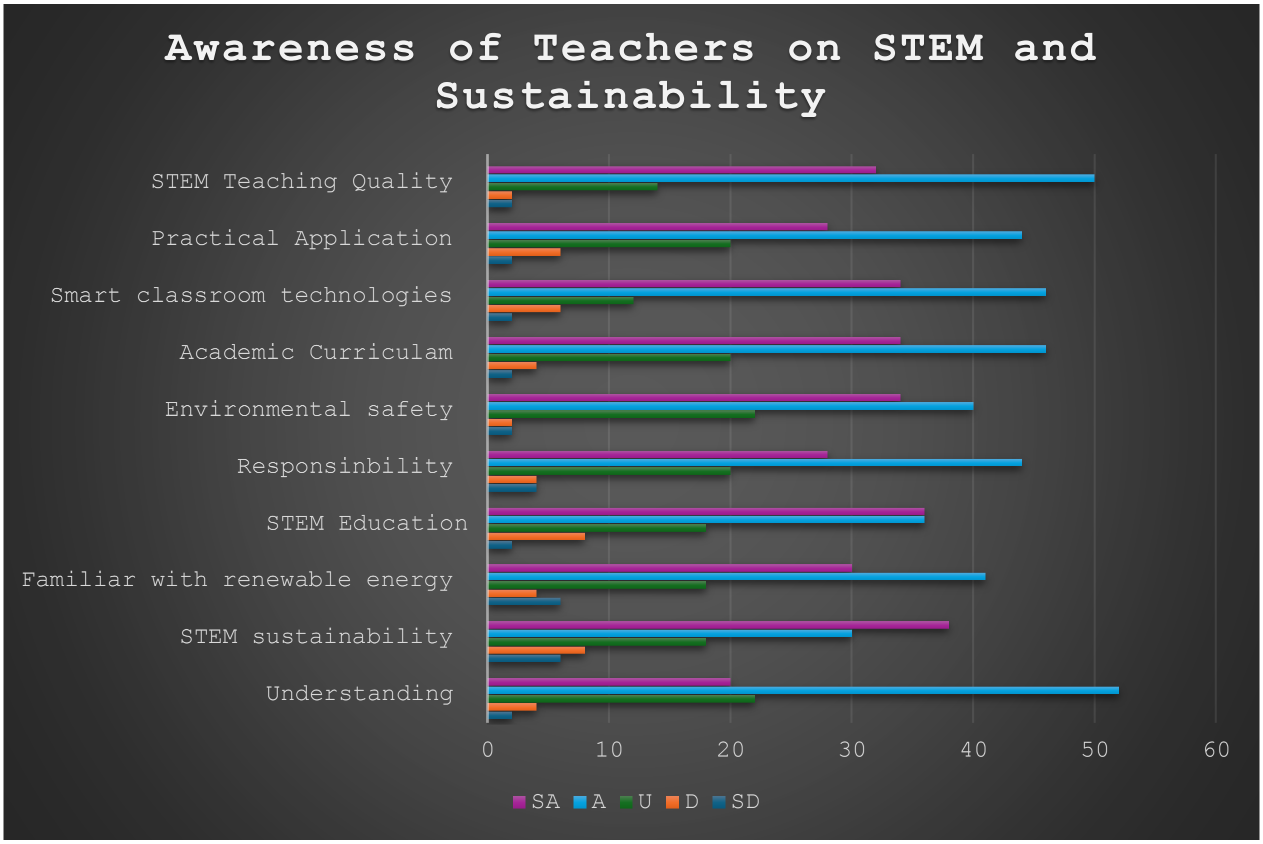
4.6 Awareness of Teachers on STEM and Sustainability

The awareness level of teachers regarding STEM education and sustainability was assessed using a structured questionnaire consisting of twenty-five statements. These statements were designed to evaluate teachers' understanding, perception, and conceptual clarity related to sustainable development, integration of sustainability in STEM, and the role of STEM education in enhancing teaching–learning processes. The responses were collected on a five-point Likert scale ranging from Strongly Disagree to Strongly Agree. The details of teachers' responses are presented in Table 4.6

S. No	Statement	SD	D	N	A	SA
1.	Understand sustainable development	2	4	22	52	20
2.	Explain STEM- Sustainability	6	8	18	30	38
3.	Familiar with renewable energy	6	4	18	41	30
4	Sustainability should be integrated into STEM Education	2	8	18	36	36
5	Environmental protection is everyone's responsibility	4	4	20	44	28
6	STEM innovations hold prioritize environmental safety	2	2	22	40	34
7	STEM should be part of academic curriculum	2	4	20	46	28
8	STEM extends beyond smart classroom technologies	2	6	12	46	34
9	STEM emphasizes practical application	2	6	20	44	28
10	STEM enhance teaching quality	2	2	14	50	32

The results of Table 4.6 show that teachers have a strong awareness of STEM and sustainability concepts. Most respondents fall under the "Agree" and "Strongly Agree" categories for all statements, indicating a positive understanding of sustainable development, environmental responsibility, and the importance of integrating STEM in education. Hence, it can be concluded that the overall awareness level of teachers is high.

Figure 4.6.1



H01: STEM Practices do not differ significantly between Male and Female Teachers

To examine whether gender has any significant influence on STEM practices among teachers, the following null hypothesis was formulated and tested.

		Practices Score		
		Mean	**S. D**	**No.**
Gender	**Male**	70.58	4.07	26
	Female	69.33	3.32	24
Total		**69.98**	**3.74**	**50**

The descriptive statistics show the STEM practices scores of teachers based on gender. The average practices score of teachers (Mean = 70.58, SD = 4.07) is marginally higher compared to female teachers' mean score (Mean = 69.33, SD = 3.32). The overall mean score is 69.98 with a standard deviation of 3.74. The difference in mean scores between male and female teachers is relatively small, indicating similar levels of STEM practices

To find out whether the difference between the groups is statistically significant, the following hypothesis was framed and tested

H01: STEM practices do not differ significantly between male and female teachers. T-Test for Equality of Means

T	**Df**	**Sig.**
1.178	48	Ns

p>0.05 (Not significant)

Critical value: 2.011

The t-test results show that the calculated t-value (1.178) is less than the critical value (2.011) at the 0.05 level of significance. Hence, the result is not statistically significant.

The calculated t-value is less than the critical value at the 0.05 level of significance, indicating that the difference is not statistically significant. Since the result is not significant, the null hypothesis is accepted. This indicates that there is no significant difference in STEM practices scores between male and female teachers.

H02: STEM Practices do not differ significantly among Designations

To determine whether designation influences STEM practices among teachers, the following null hypothesis was formulated.

		Practices Score		
		Mean	S. D	No.
Designation	**Assistant Professor**	69.74	4.01	31
	Associate Professor	70.17	3.59	12
	Professor	70.71	3.09	7
Total		**69.98**	**3.74**	**50**

The descriptive statistics present the STEM practices scores of teachers based on their designation. Professors have the highest mean score (Mean = 70.71, SD = 3.09), followed by Associate Professors (Mean = 70.17, SD = 3.59), and Assistant Professors (Mean = 69.74, SD = 4.01). The overall mean score is 69.98 with a standard deviation of 3.74. Although there are slight differences in mean scores among the groups, the variation appears minimal.

To find whether the differences between the groups are statistically significant, the following hypothesis was framed and tested:

H02: STEM practices do not differ significantly among designations. ANOVA for Practices Score

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5.949	2	2.975	.205	Ns
Within Groups	681.031	47	14.490		
Total	686.980	49			

p>0.05 (Not significant)

Critical value: 3.195

The ANOVA results indicate that the calculated F-value (0.205) is less than the critical value (3.195) at the 0.05 level of significance. Hence, the result is not statistically significant.

Since the ANOVA result shows no significance, the null hypothesis is accepted. This indicates that there is no significant difference in STEM practices scores among teachers based on their designation.

H03: STEM Practices do not differ significantly among Experience

To examine whether teaching experience influences STEM practices among teachers, the following null hypothesis was formulated.

		Practices Score		
		Mean	**S. D**	**No.**
Experience	**Below 5 Years**	68.33	3.75	12
	6-10 Years	70.93	4.29	14
	11-15 Years	71.00	3.44	15
	Above 15 Years	69.00	2.69	9
Total		**69.98**	**3.74**	**50**

The descriptive statistics show the STEM practices scores of teachers based on their years of experience. Teachers with 11–15 years of experience have the highest mean score (Mean = 71.00, SD = 3.44), followed closely by those with 6–10 years (Mean = 70.93, SD = 4.29). Teachers with above 15 years of experience have a mean score of 69.00 (SD = 2.69), while those under 5 years have the lowest mean score (Mean = 68.33, SD = 3.75). The overall mean score is 69.98 with a standard deviation of 3.74. There are some variations in mean scores across experience groups, but the differences are not large enough.

To find whether the differences between the groups are statistically significant, the following hypothesis was framed and tested:

H03: STEM practices do not differ significantly among teachers based on years of experience.

ANOVA for Practices Score

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	69.385	3	23.128	1.723	Ns
Within Groups	617.595	46	13.426		
Total	686.980	49			

$p>0.05$ (Not significant)

Critical value: 2.807

The ANOVA results indicate that the calculated F-value (1.723) is less than the critical value (2.807) at the 0.05 level of significance. Hence, the result is not statistically significant.

Since the ANOVA result shows no significance, the null hypothesis is accepted. This indicates that there is no significant difference in STEM practices scores among teachers based on their years of experience.

H04: STEM Practices do not differ significantly among Type

To determine whether the type of institution influences STEM practices among teachers, the following null hypothesis was formulated.

		Practices Score		
		Mean	**S. D**	**No.**
Institution	**Aided**	69.55	3.81	31
	Self -Financing /Private	70.68	3.62	19
Total		69.98	3.74	50

The descriptive statistics show the STEM practices scores of teachers based on the type of institution. Teachers from self-financing/private institutions have a slightly higher mean score (Mean = 70.68, SD = 3.62) compared to those from aided institutions (Mean = 69.55, SD = 3.81). The overall mean score is 69.98 with a standard deviation of 3.74. The difference in mean scores between the two groups is minimal, indicating similar levels of STEM practices.

To find out whether the difference between the groups is statistically significant, the following hypothesis was framed and tested:

H04: STEM practices do not differ significantly among aided and self-financing/private institutions.

T-Test for Equality of Means

T	Df	Sig.
1.042	**48**	**Ns**

$p>0.05$ (Not significant)

Critical value: 2.011

The t-test results show that the calculated t-value (1.042) is less than the critical value (2.011) at the 0.05 level of significance. Hence, the result is not statistically significant. Since the result is not significant, the null hypothesis is accepted. This indicates that there is no significant difference in STEM practices scores between teachers from aided and self-financing/private institutions.

H05: There is no significant relationship between Awareness and Practice

To examine the relationship between awareness and STEM practices among teachers, the following null hypothesis was formulated and tested.

Correlations between Awareness and Practices-Teachers (n=50)

	Practices Score
Awareness	**-.029Ns**

The correlation analysis shows the relationship between awareness and STEM practices among teachers. The correlation coefficient is r = -0.029, indicating a very weak negative relationship between awareness and practices. This suggests that awareness and practices are almost unrelated among teachers.

To find out whether the relationship is statistically significant, the following hypothesis was framed and tested:

H05: There is no significant relationship between awareness and practice among teachers.

The calculated t-value for the correlation is t = 0.201 (df = 48), which is less than the critical value (2.011) at the 0.05 level of significance. Hence, the result is not statistically significant. Since the result is not significant, the null hypothesis is accepted. This indicates that there is no significant relationship between awareness and STEM practices among teachers.

H06: STEM Practices do not differ significantly among teachers based on Subjects Handled

The following table presents the mean scores of STEM practices among teachers based on the subjects they handle. The data were analysed using mean, standard deviation, and Analysis of Variance (ANOVA) to determine whether there is any significant difference among different subject groups.

Subject	Practices Score		
	Mean	**S. D**	**No of Teachers**
Physics	70.33	5.00	9
Chemistry	71.13	3.44	8
Mathematics	69.88	3.30	17
Computer Science	68.90	3.70	10
Engineering	**70.00**	**4.10**	**6**
Total	**69.98**	**3.74**	**50**

The above table shows the mean scores of STEM practices among teachers handing different subjects such as Physics, Chemistry, Mathematics, Computer Science, and Engineering. It is observed that chemistry teachers have the highest mean score, while computer science teachers have the lowest score. There for the hull hypothesis is accepted, indicating that there is no significant difference in STEM practices among teachers based on subjects handled.

Analysis of Variance (ANOVA for Practices Score Based on Subject Handled

	Sum of Squares	Df	Mean Square	F	Sig
Between Groups	23.440	4	5.860	.397	. Ns
Within Groups	663.540	45	14.745		
Total	686.980	49			

Ns- Not significant

Critical value: 2.434

The above table presents the results of the Analysis of Variance (ANOVA) conducted to determine whether there is a significant difference in the Practices Score among STEM teachers based on the subjects they handle. The obtained F-value (0.397) is lower than the critical value (2.434) at the specified level of significance. Additionally, the significance of value indicates that the result is not statistically significant.

Hence, the null hypothesis stating that there is no significant difference in Practices Score based on subjects handled is accepted.

This implies that the subject handled by the teachers (such as Physics, Chemistry, Mathematics, etc.) does not significantly influence their level of sustainability and green STEM practices.

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V
SUMMARY AND CONCLUSIONS

Introduction

This chapter presents the summary of the study, major findings, conclusions, and suggestions based on the analysis and interpretation of data regarding the awareness of sustainability and green STEM practices among STEM students and teachers. The findings are derived from the statistical analysis carried out in Chapter IV.

5.1 Summary of the Study

The present study was conducted to examine the level of awareness and practices related to sustainability and green STEM education among students and teachers.
The major objectives of the study were:

- ❖ To analyses the level of awareness and STEM practices among students and teachers
- ❖ To study the influence of selected personal variables on STEM practices
- ❖ To examine the relationship between awareness and practice

The study adopted a descriptive survey method. Data was collected from:

- ❖ 250 students
- ❖ 50 teachers

Statistical tools such as percentage analysis, mean, standard deviation, t-test, ANOVA, and correlation were used for analysis.

5.2 Major Findings of the Study

5.2.1 Findings Related to Students

Personal Variables

- ❖ Students were almost equally distributed by gender (52% male, 48% female)
- ❖ Majority of students belonged to the age group 21–23 years (43.2%)

- Most students were undergraduates (73.2%)
- Students were evenly distributed across years of study
- Majority belonged to self-financing institutions (63.2%)
- Most students were from urban areas (64%)
- 68.8% of students had STEM exposure
- 61.2% of students participated in STEM activities
- 60.8% showed interest in STEM careers

Hypothesis Testing

No significant difference in STEM practices based on:

- Gender
- Level of study (UG/PG)
- Type of institution
- STEM exposure
- Career interest
- Discipline (subject)

No significant relationship between awareness and STEM practices (very weak correlation)

5.2.2 Findings Related to Teachers

Personal Variables

- Teachers were evenly distributed by gender (52% male, 48% female)
- Majority were in the 31–40 years age group (38%)
    - Most teachers held M.Phil. qualification (56%)
- Majority were Assistant Professors (62%)
- Most had 11–15 years of experience (30%)

- Majority worked in aided institutions (62%)
- 62% had STEM training
- 70% reported availability of STEM facilities
- Most teachers used STEM tools occasionally (64%)

Hypothesis Testing

No significant difference in STEM practices based on:

- Gender
- Designation
- Teaching experience
- Type of institution
- Subject handled

No significant relationship between awareness and practices

5.3 Educational Implications

- Institutions should focus on practical implementation of sustainability concepts
- More hands-on STEM activities should be introduced
- Teachers should be encouraged to use STEM tools more frequently
- Awareness programs should be linked with real-life applications

5.4 Suggestions

Considering the findings, it is suggested that educational institutions should take steps to enhance the practical implementation of sustainability and green STEM practices. Teachers should be provided with regular training and professional development programs to improve their competency in using STEM tools effectively. Students should be encouraged to actively participate in STEM-based activities, projects, and competitions to develop hands-on experience. Institutions should also focus on improving infrastructure and providing adequate STEM resources. Furthermore, sustainability concepts should be integrated into the curriculum through experiential and project-based learning approaches. Awareness programs such as workshops and seminars should be conducted to bridge the gap between knowledge and practice.

5.5 Summary and Conclusion

The study highlights that although awareness of sustainability and green STEM practices exists among students and teachers, its practical implementation is not strong. There is a need to bridge the gap between knowledge and practice through effective educational strategies and institutional support. Based on the findings of the study, it can be concluded that both students and teachers possess a moderate level of awareness and engagement in sustainability and green STEM practices. The study clearly indicates that personal variables such as gender, qualification, experience, and institutional differences do not significantly influence STEM practices. Moreover, the weak relationship between awareness and practice suggests that having knowledge about sustainability does not necessarily translate into practical implementation. Although students show a positive inclination toward STEM careers and teachers have adequate qualifications and infrastructure, the actual application of green STEM practices remains limited. Therefore, there is a need to strengthen the practical aspects of STEM education and promote effective implementation strategies.

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APPENDICES

Background information of the Teachers

Gender

Age

Highest Educational Qualification

Designation

Subject Taught

Teaching Experience

Types of Institution

Participation in STEM-Related Training /Workshops

Availability of STEM Facilities in the Institution

Frequency of using STEM Tools in Teaching

Likert Scale Response Options

SCALE	RESPONSE
5	Strongly Disagree (SD)
4	Disagree (D)
3	Undecided (U)
2	Agree (A)
1	Strongly Agree (SA)

S. No	STATEMENT	SD	D	U	A	SA
1	I Understand the concept of sustainable development.					
2	I can explain the relationship between STEM and sustainability.					
3	I am familiar with renewable energy technologies such as solar and wind energy.					
4	Sustainability should be integrated into STEM Education					
5	Environmental protection is everyone's responsibility.					
6	STEM innovation should prioritize environmental safety.					
7	I can apply STEM knowledge to develop sustainable solutions.					
8	I can evaluate whether a technology is environmentally sustainable.					
9	I intend to incorporate sustainability into my STEM activities.					

10	I plan to participate in environmental initiatives.					

11	STEM Education should be integrated as a fundamental component of the academic curriculum.					
12	STEM Education extends beyond the mere use of smart classroom technologies.					
13	STEM Education emphasizes the practical application of theoretical knowledge.					
14	The integration of STEM enhances the overall effectiveness and quality of teaching.					
15	STEM Education prepares learners to adapt to emerging technological advancements.					
16	STEM Education has relevance and applicability even within humanities disciplines.					
17	A career in STEM holds significant value and important for me.					
18	STEM Education should be given priority as a viable and promising career pathway.					

19	STEM Education enhances students' concentration and engagement in learning.					
20	STEM learning strengthens student's self-efficacy and belief in their abilities.					
21	STEM Education improves students to logical reasoning and analytical thinking skills.					
22	STEM learning contributes to the development of student's self-confidence.					
23	STEM facilities individualized and learner-centred instructional approaches.					
24	STEM Education promotes positive and effective study habits among students.					
25	STEM Encourages creativity and innovative thinking among learners.					
26	STEM -Based instruction helps reduce classroom anxiety and fear of failure among students.					
27	STEM Education supports interdisciplinary understanding among students.					
28	STEM Learning can be effectively applied in real-life and workplace contexts.					
29	STEM Education develops competencies aligned with industry and societal needs.					

30	STEM Engages students in solving authentic, real-world engineering and scientific problem					
31	STEM Education strengthens the linkage orientation and investigative learning.					
32	STEM Programs encourage research orientation and investigative learning.					
33	STEM Education fosters innovation rather than rote replication of knowledge.					
34	Every higher education institution should establish a well-equipped STEM laboratory.					
35	The presence of STEM laboratories enhances students' motivation to learn.					
36	Institutions should adopt STEM Oriented project-based curricula.					
37	Colleges should actively promote student participation in STEM related competitions and activities.					
38	Institutions should actively promote student participation in STEM -related competitions and activities.					
39	. Teachers should be provided with continuous professional development in STEM Education.					
40	There is an inadequacy of structured STEM training programs for teachers.					

41	A lack of enthusiasm toward STEM education exists among some teachers.					
42	I experience anxiety while integrating STEM tools into my teaching.					
43	Institutional administration does not sufficiently encourage the use of STEM tools in teaching.					
44	There is limited alignment between the prescribed curriculum and STEM activities.					
45	The implementation of STEM education disrupts the regular instructional schedule.					
46	STEM activities are not directly related to my subject specialization.					
47	Financial constraints hinder the effective implementation of STEM education.					
48	Proficiency in STEM enhances employment opportunities.					
49	STEM education enables professionals to define career roles and meet global workforce demands.					
50	STEM education stimulates interest in pursuing careers within STEM fields.					

Background of the Students

Gender

Age

Level of Study

Year of Study

Subject

Type of Institution

Area of Residence

Previous Exposure to STEM Activities

Participation in STEM/Innovation/Research Activities

Career Interest in STEM Field

Likert Scale Response Option

SCALE	RESPONSE
5	Strongly Disagree (SD)
4	Disagree (D)
3	Undecided (U)
2	Agree (A)
1	Strongly Agree (SA)

S. NO	STATEMENT	SD	D	U	A	SA
1.	I have a clear understanding of what sustainability means.					
2.	I am familiar with environmental problems like climate change and pollution.					
3.	I am recognizing the importance of conserving natural resources.					
4.	I am aware of the Sustainable Development Goals (SDGs).					
5.	I understand how education contributes to promoting sustainability					
6.	I Know about the environmentally friendly practices connected to my STEM subjects.					
7.	I understand how the science and technology can address environmental challenges.					
8.	I am aware of renewable energy options such as solar and wind power.					

9.	I am familiar with green technologies used to protect the Environment.					
10.	I am informed about sustainable practices implemented in laboratories or classrooms.					
11.	I believe that sustainability education plays a vital role for students.					
12.	In my opinion, STEM education should encourage environmental responsibility.					
13.	I feel personally accountable for safeguarding the environment.					
14.	I am eager to gain more knowledge about sustainability and green practices.					
15.	I think green STEM initiatives can contribute to a more sustainable.					
16.	I make efforts to minimize waste in my everyday life.					
17.	I try to save electricity and water in my everyday life.					
18.	I choose environmentally friendly or reusable products whenever possible.					
19.	I take part in activities that support environmental conservation.					
20.	I incorporate sustainability principle into my academic projects or assignments.					

Avinashilingam Institute for Home Science and Higher Education for Women
Deemed-to-be-University Estd. u/s 3 of UGC Act 1956, Category A by MHRD (now MoE)
Re-accredited with 'A++' Grade by NAAC CGPA 3.65/4, Category I by UGC
Coimbatore-641 043, Tamil Nadu, India

Institutional Human Ethics Committee (IHEC)

Date 4.3.2026

To
Thiruvasuvi B S
24PED013
Department of Education
Avinashilingam Institute for Home Science and
Higher Education for Women, Coimbatore 641043

Dear Ms Thiruvasuvi B S
Ref: Your application IHEC 2026/EDN9
Awareness of Sustainability and Green STEM practices among STEM Teachers and Learners submitted for approval of IHEC

The Institutional Human Ethics Committee of Avinashilingam Institute for Home Science and Higher Education for Women after careful scrutiny and review of your application, hereby grants approval to your application titled 'Awareness of Sustainability and Green STEM practices among STEM Teachers and Learners'. The approval number for the same is IHEC 2026/EDN9/ XMT
This certificate is issued for the study period specified in your application.

Best Wishes,

4/3/26
Dr. Shubashini K. Sripathi
Member Secretary

Avinashilingam Institute for Home Science and Higher Education for Women Coimbatore — Institutional Human Ethics Committee