Teaching Sustainability In Technology Education: A Comparison Of Perception And Practice

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Abstract

The purpose of this project is to promote a sustainable future for the entire globe by using technology education (TE) at the second level in India. In this study, teaching for sustainability in TE is examined from the perspectives of current and aspiring instructors. These subjects, which cover things like product design, material consumption, and product lifespan assessments, to name a few, are excellent candidates to encourage social change that moves us closer to a sustainable future. To examine the sustainability teaching in Second Level TE, it is critical to consider instructors' theoretical concepts of sustainability (perception) and also their preparation of students for it (practice). To do this, instructors and student instructors with prior teaching experience in Irish Second Level TE were given access to an online survey. The survey's goal was to find out more about the perceptions of sustainability among teachers and how they are integrating it into their curricula. The 140 respondents' responses to the poll indicate that the professional as a whole consistently comprehends the concept of sustainability. The data indicate that 83.4 percent of teachers in TE courses are including sustainability in their lessons. However, the prevalence varies significantly among the educators who were questioned. The findings indicate that 95.34 percent of the participants comprehend the value and benefits of incorporating sustainability into their instruction. Although most participants acknowledged these benefits, they also spoke of the various limitations and challenges that preclude the practical learning of sustainability. Our findings point to the need for further sustainability incorporation into TE given the subjects' potential to impact social shift in direction of an inclusive sustainable future.

Key Words: Sustainable development, sustainability education, Technology education, perception, evaluations

1. Introduction

Governments and institutions have put in place many efforts to encourage more environmentally conscious habits since the 2015 Sustainable Development Summit. The meeting's conclusion saw the creation of 17 Sustainable Development Goals (SDGs) that must be accomplished by the year 2030. These objectives are the outcome of an

unparalleled global accord. These overarching and universal objectives aim to, among other things, eradicate poverty,[1] safeguard the environment, and ensure everyone's prosperous growth. SDG 4, which asserts the crucial role of education in creating a just, accessible, and high-quality society, is one of the goals established. It is broken into seven partial aims, and target 4.7 outlines the significance of advancing scientific and applied knowledge to assist sustainable environmental growth in education.

[2] The integration of sustainable development (SD) into curricula at higher education institutions has made significant strides. This has included research on pedagogical approaches and competencies for SD; however, there has been little investigation into the relationship between the use of pedagogical approaches and the potential development of sustainability competences.

[3] Sustainability has undergone a significant transition in recent years as a crucial educational subject. Therefore, there is a rising argument over what it means. It has experienced a significant fusion of meanings from other domains, including ecology and environmental consciousness as well as politics, ethics, and even spiritual perspectives. The development of this subject concept required participation from all of these fields.

While SDG 4 particularly mentions education,[4] it is clear how this relates to the other goals when you consider that each goal cannot be achieved without adequate education. For instance, SDG 12 emphasizes the significance of responsibly exploiting technical resources. [5]The urgent necessity to utilize technology resources efficiently while developing clean and ecologically friendly technologies is one of the specific aims of SDG 9. To avert the worsening of climate change, SDG 13 asks for education to increase knowledge and give society more authority.

The SDGs' all-encompassing breadth necessitates a commitment from each member of the social fabric.[6] In this regard, principals and teachers, who work in the field of learning, play a crucial role due to their willingness and training. They improve students' knowledge of sustainability and, by extension, that of future citizens, [7]which has a clear effect on society. In reality, many international organizations have maintained their crucial role by highlighting the importance of educating people about situations and events that have an effect the sustainability.[8] Examples include the different programs run by academic institutions to encourage the growth of research, cross-disciplinary learning opportunities, and the dissemination of knowledge focused on sustainability.

These institutions have a high level of social accountability since they are crucial in attaining the goals of sustainable development.[9] These projects, which all center on advancing sustainability, include place-based learning as a methodological strategy to apply ESD principles, scales to evaluate the impact of educational digital materials on sustainable behavior, and recommendations to integrate the SDG into curricula.[10] According to the study, other educational levels have also been the subject of research, with particular attention paid to plans for reusing technical equipment in educational

settings or the integration of the SDGs into the curricula for primary and secondary education.[11] All of these pieces demonstrate the transdisciplinary advantages of ESD and the influence of teacher preparation on future generations' sustainable usage of technology.

[12]The goal of HESD is to support students in developing sustainability skills, knowledge, and attitudes that guide decision-making for their benefit and the benefit of others, now and then tomorrow, and (ii) acting on these decisions. Global frameworks like the United Nations' Decade of Education for Sustainable Development [13] and the Global Action Program on Education for Sustainable Development, both of which are coordinated by the United Nations Educational, have encouraged and supported education for sustainable development over the past few decades.

As they assume numerous tasks and duties, institutions of higher education can significantly contribute to the promotion of sustainable development. [14]Some of these include fostering the development of future workers as change agents, promoting the creation of venues where ideas can be openly expressed, paradigms can be challenged, creativity can be encouraged, and new information can be obtained.

To answer UNESCO's task, many learning and teaching strategies are needed because sustainable development was multidisciplinary on many dimensions and much more difficult than it may first appear. Higher education should help students become more capable of identifying and comprehending the intricacy of sustainability concerns, as well as of thinking critically about presumptions, beliefs, attitudes, and biases while actively contributing to solutions. The contentious, multidimensional, and multifaceted nature of sustainability itself offers a wealth of chances for rational reflection and transfer of skills.

The nature of the pedagogy that disregards to tend to students' prior knowledge and lectures from "a right position" is untenable, making it unsustainable in students' lives. This is true even though young people must acquire crucial understanding and knowledge of sustainability matters—and don the position of pro-sustainability citizens in action and thought.[15] There is a contradiction between the text of sustainability in higher education, which calls for theory and practice through conceptual change, and the sustainable development currently used in higher education, which frequently stymies such behavior and thinking by being transmissive and lecture-driven. There are a few things to think about, including whether there is a gap between the transformative component in sustainability continuous learning and reality; (ii) what there is to know about teaching approaches that could make a distinction; and (iii) whether or not sustainability courses, as they are conceptualized and implemented right now, encourage learning that aligns with initial goals.

2. Education for sustainability in technology

2.1. The Value of Eco-Responsibility in the Context of Technological Advancement and Its Equivalents

The broad use of digital technology in today's knowledge and information society affects all areas, including the work, economic, and cultural spheres. The end effect is excessive trash generation, which is leading to pollution issues. For instance, updating is frequently difficult and useless due to programmed obsolescence, which affects the majority of devices. Another occurrence is perceived obsolescence, in which some users discard their products soon after using them because they believe they are outmoded. The cost of technical products has come down, and large-scale marketing and advertising operations have shown to be effective. A typical usage period of two years for mobile devices reflects this early discarding of digital technology. Therefore, disposing of equipment rather than using them excessively is the fundamental issue.

The SDGs are founded on the idea that resources should be used to meet present requirements without being depleted. This entails either explicitly opting to employ environmentally friendly technologies or using innovations in an eco-responsible way. The latter are products that can be reused, that require less energy and fewer finite resources in their production, sale, and consumption activities, and that do not harm explicitly or implicitly.

ICT use that is eco-responsible includes not only the environmental aspect of sustainability but also its other components, namely the social and economic aspects. Lack of accountability in this area may negatively affect the SDG's attainment, which could have very bad effects on the world's population. Thus, the notion of approaching sustainability holistically to raise students' knowledge. As mentioned, such a strategy has favorable benefits on students' sustainability consciousness.

2.2. Sustainable Development Education

The 1983 World Conference on Environment and Development (WCED) led to the issuance of the "Brundtland report," which defined sustainable progress (SD) as "development that fulfills the requirements of the current with out compromising the capability of future civilizations to satisfy their own needs." This definition acknowledges the value of the environment and also the necessity of societal development. As a result, the Brundtland report emphasized the three essential elements of sustainable development: environmental conservation, support for growth in the economy, and social equity and justice.

Because SD is a complicated idea that is still developing, descriptions of ESD are still hazy, and the explanation of EDS from "Our Common Future" depends on the reader because the concept can be interpreted in a variety of ways, SD is challenging to describe. While some academics hold the opinion that there is no one "proper" conception of SD, this

diversity of viewpoints results in various notions and pedagogies of ESD. UNESCO, which played a key role in advancing ESD, is one organization that has acknowledged the significance of ESD. Intending to ensure that everyone had access to education and the values, habits, and lifestyles required for a sustainable future and beneficial interpersonal reforms, UNESCO designated the years 2005 to 2014 as the Decade of ESD.

The Strategy for ESD (UNECE, 2005) prioritized education because it can advance and reinforce knowledge, skills, and values while enabling people of all ages to take action for a sustainable future. This highlights the challenge for ESD in figuring out the kind of education that inspires students to become engaged citizens in a complicated and uncertain world, encouraging democratic citizenship, juggling competing interests, and encouraging critical thinking, argumentation, and alternative courses of action. For many educators, the subject's complexity, breadth, and multidisciplinary nature present a real difficulty. In addition, as stated

"Reorienting education to address sustainability is a deep method that demands changes to policies, procedures, and programs as well as increased awareness, acceptance of the sustainability paradigm, and knowledge, skills, and values. Reorienting is a thoughtful process that requires effort, time, and intentionality to complete. To make significant and long-lasting changes, reorienting teacher education often requires years of work in teacher education institutes. Education professionals must be knowledgeable about the topics that establish ESD and have a favorable attitude toward it. They must also be aware of the best teaching strategies to use when tackling ESD concerns in the classroom.

2.3.   Understanding of issues related to sustainable development

Lack of environmental information is a key barrier to teaching kids about SD, so teachers must be competent in this area. Due to the interdependence of the economy, environment, and society, economic or social decisions might have harmed the environment. Therefore, development is necessary to encourage environmental protection to meet economic and social needs. This study discovered that in-service educators have a solid general development in three elements of ESD but the absence of comprehension of how they relate to one another. It also discovered that while teachers are generally knowledgeable of the significance of the 3 components of ESD to varying degrees, they typically lack a comprehensive understanding. Similar findings were found in other research, demonstrating that the ecological approach was the most widely acknowledged and that the majority of teachers will not have a comprehensive comprehension of the SD ideas.

Many studies still highlight the lack of proper learning during their research, which outcomes in a poor understanding of sustainability problems and significantly hinders the execution of ESD in the classroom, even though some studies claim that teachers' theory differs greatly and that those who have had a good understanding frequently fail to realize the interconnectedness of the SD elements. This study discovered that taking an ESD course during teacher development boosted pre-service teachers' environmental

knowledge and gave them more confidence to educate about sustainability-related topics. While many researchers contend that teachers' knowledge and comprehension of sustainability problems may not always motivate them to take action or instruct about ESD problems in an effective way, it has been proposed that teachers' confidence and willingness to enforce ESD in the classroom could very well be boosted by their knowledge of sustainability problems in conjunction with the required pedagogical knowledge, attitudes, and values.

2.4. Perceptions of education for sustainability

People function by creating personal frameworks that allow them to engage with and understand the environment around them. These personal conceptions are influenced by social, cognitive, and individual aspects and are constantly being updated as a result of fresh experiences. Education professionals frequently mix the terms "beliefs," values," and   "constructs," while   many   academics   allude   to   them   as "perceptions" or"views"   As aspect relates, beliefs are frequently regarded as such, and as such, the word belief is employed as a social construct.

The knowledge and views of teachers regarding subject material and pedagogy have a bearing on their ability and capability to approach sustainability at schools. This states that effectiveness as a system of belief is not a universal characteristic but rather a diverse set of self-beliefs connected to many domains of functioning. Self-efficacy is focused on people's beliefs in their capacities to create certain accomplishments. Therefore, self-efficacy could be utilized to forecast behavior. It is crucial to consider how teachers assess their knowledge of ESD topics and their capacity to instruct these topics.
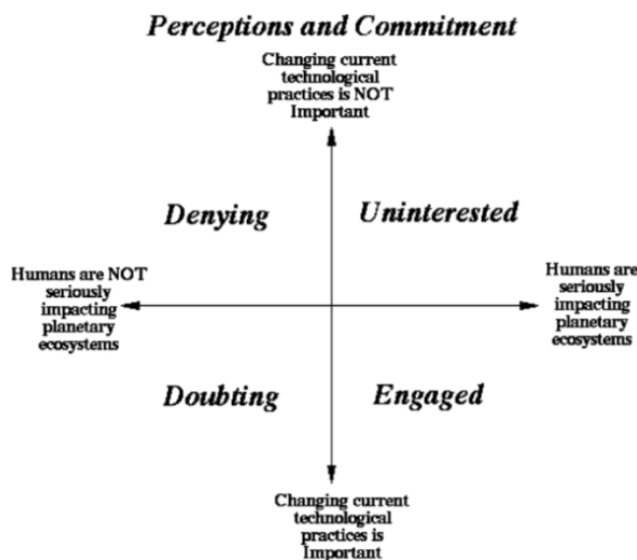

Perceptions and Commitment

Changing current technological practices is NOT Important

Denying   Uninterested

Humans are NOT seriously impacting planetary ecosystems

Humans are seriously impacting planetary ecosystems

Doubting   Engaged

Changing current technological practices is Important

Fig. 1. - Teacher Commitment and Perceptions Regarding Sustainable Development

2.5. Teacher Attitudes Toward Sustainable Development Education

Many academics contend that having knowledge and comprehension of sustainability can not always result in moral behavior or the successful instruction of ESD in the classroom. However, it has been argued that teachers' confidence and preparedness to teach ESD in schools may be improved by having a broad understanding of sustainability problems in addition to the essential teaching knowledge, beliefs, and attitudes. This suggests that helping future educators alter their attitudes may have a stronger impact on attitude transformation once they are impacting students in the classroom. The significance of attitudes for learning about ESD is stressed by many studies. Pre-service teachers' positive attitudes towards sustainability could be fostered by teaching them about ESD. Additionally, research on ESD demonstrates that classroom instruction covers both fact-based knowledge and ethical and value-based problems, as also reasoning, lifestyle, and attitudes difficulties. When Chunteng (2004) examined the teaching abilities of EE in elementary and high school teachers, he also found a good opinion toward ESD concepts. Despite this, experts suggested that the participants' ignorance and lack of understanding harmed these attitudes.

2.6. Suitable Teaching Methods for ESD

Participants in the 2030 Incheon Declaration declared that they recognized the critical role that education plays in driving development and attaining the other suggested SDGs, and that their ambition is to improve lives through education. In addition, they made the following pledge: "We reaffirm that learning is a public benefit, a basic human right, and a foundation for ensuring the fulfillment of other rights." For harmony, acceptance, personal fulfillment, and sustained development, it is necessary.

Additionally, teachers' opinions on the significance of ESD for their instruction have a big impact on how they feel about the topic and how eager they are to learn more. Participatory methods can be viewed as resources for acquiring and exchanging information, abilities, and experiences that enhance cognition, consistency and integrity, and community development. Additionally, by involving teachers and students in the development of their educational process, participatory techniques can be utilized to jointly determine educational performance and effectiveness. Participatory methods give participants several chances to develop their democratic rights to take part in civil society, in decisions that advance equality, justice, and the well-being of all, and in other activities.

3. METHODOLOGY

3.1. Research Design

This study intends to examine how sustainability is taught in TE Ireland, both theoretically and practically. This paper is a component of a broader investigation that used the Action Research methods. This was used to close the knowledge gap between theory and application. The use of an online survey helped to accomplish the research

goal outlined in this work. Since the purpose of this study was to learn more about perception and practice, the research study was the main methodology employed.

3.2.   Respondents

Participants in the survey were seasoned TE educators. The sample level estimations for the population investigated are shown in Tables 1 and 2. These sample numbers have a 90% confidence level for the responses of the survey participants. Based on the DES, the size of the sample was chosen. The number of beginning teachers who have finished teaching practice determines the size of the population of TE educators.

Table 1. - Indians Leaving Certificate Level Sample Size

Subject:	Number (count)	
	Pupils	*Teachers**
Construction Studies	18,516	772
Technology	3,096	129
Engineering	12,002	500
Design Communication and Graphics	12,218	509
Total population:	**45,832**	**1,910**
Sample size involved in this study:	**240 for 90% Confidence interval**	

The information would be most appropriate if it took into account the fact that teachers can instruct at both Junior and Leaving Certificate Levels. For this reason, the teaching population will be made up of Leaving Certificate Level instructors. This prevents teachers from being twice counted.

Table 2. - For LM094 and LM095, the sample size.

Course:	Students (count)
Bachelor of Technology (Education) in Materials and Architectural Technology LM094	60 per year
Bachelor of Technology (Education) in Materials and Engineering Technology LM095	40 per year
Total number over 3rd/4th years:	**200**
Sample size:	**115 for 90% Confidence Interval**

There should be about 115 beginning teachers and 240 practicing teachers in the sample for this study. To address the research objectives by utilizing both multiple regression analysis and correlation analysis, the total sample could be expanded to N = 177 trainee instructors and N = 247 teachers, according to the G*Power software tool. The table below displays the total number of teachers and student teachers whose information was used in this research. The number of teachers and student teachers needed to verify a 90% sampling error in the data was not reached. Instead of reaching broader conclusions, this study aims to merely acquire an understanding of the beliefs and methods used by TE teachers in Ireland. In total, 145 people answered the questionnaire. 55 student teachers, 5 teachers working abroad, and 85 instructors working domestically made up this group. Since the goal of the study is to examine contemporary practices within Irish

TE at Second Level, the five professors who teach abroad were not considered for it. Thus, 140 people in all were used to collect this data.

Table 3. - Population data was preserved for the study.

Cohort Experience Teaching	No. of Cohort
Trainee Teachers	55
Less than 1 year	7
Between 1 - 3 years	18
Between 3 - 7 years	17
Between 7 - 15 years	21
Between 15 - 20 years	8
More than 20 years	14

3.3. Survey Methodology

A platform for conducting online surveys was used. After receiving ethical approval, surveys were created, tested, and improved. Following the revision, the survey was made available to those with TE teaching experience, as shown in Table 3. Both quantitative and qualitative components were included in the questions. A 5-point Likert scale was used in the design of the quantitative questions. By doing so, participants can declare how much they disagree or agree with a given statement or issue. Additionally, it gives researchers the option to mix quality, opinion, and quantity with measurement. To provide participants the chance to express their opinions, values, and attitudes in their responses, qualitative style questions were also employed. Then, to facilitate thematic evaluation, this qualitative information was coded.

4. RESULTS

How much do you believe the following statement to be true or false: "Global warming and climate change are a hoax"?

Results - Q1.

6%
26%
68%

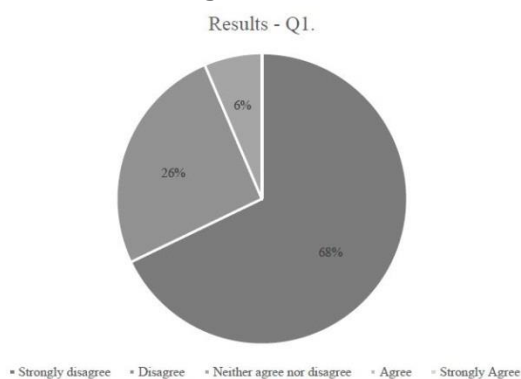▪ Strongly disagree ▪ Disagree ▪ Neither agree nor disagree ▪ Agree ▪ Strongly Agree

Fig. 2. - Level of agreement among participants with the sentence "global warming and Climate change is a scam."

This remark received no "agree" or "strongly agree" votes from participants. Participants "strongly disagreed" in 67.9 percent of cases, "disagreed" in 25.7 percent of cases, and "neither disagreed nor agreed" in 6.4 percent of cases.

Q2. Perception - Could you kindly briefly explain, in your own words, what the term "sustainable" means to you?

The responses of the participants were categorized into the categories shown in Table 4. Both of these can be classified broadly as being based on material or societal security. A response like "using resources that are not hazardous to the environment to produce" is an example of a material-based answer. While societal protection refers to actions like "limiting the level of environmental damage now to protect it for coming generations."

Table 4. - Results of themes that participants' conceptions of sustainability were coded for.

Theme	% Theme identified
Environment	29.83
Resource	24.53
Material	18.32
World and planet	11.35
Future generations	11.09
Maintain and sustain	10.98
Design	9.63
Product	9.26
Economical	3.99
Future	3.37
Responsible	1.46
Economy	1.31
Society	0.87
Total referenced (excluding theme overlap)	77.27

When it comes to the following statement, "It is necessary to teach subsequent generations about ecological sustainability and production habits," how much do you disagree or agree with it?
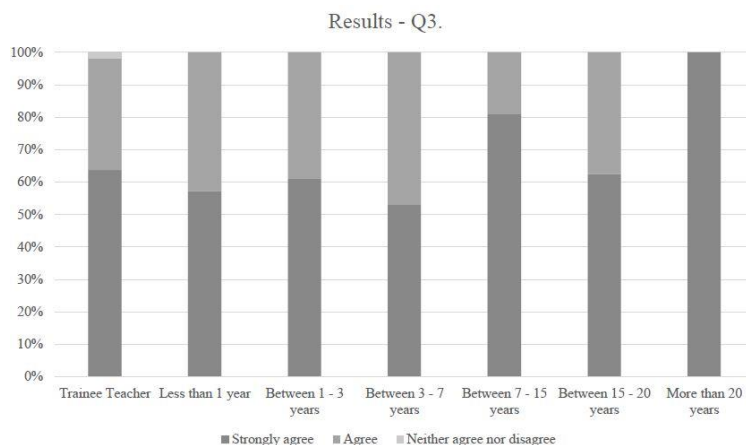

Fig. 3. - demonstrates teachers' agreement with the statement, "It is critical to teach the next generation about ethical patterns of producers and consumers."

The majority of the 140 participants, or 95.67%, agreed with the aforementioned statement. Of those, 32.3% agreed, 69.45% strongly agreed, and 0.8% neither disagreed nor agreed.

Q4(a). Do you instruct your students about sustainable practices? As an illustration, consider the following concepts: upcycling, life cycle analyses, cradle-to-cradle, ECO design, environmental design, green design, regenerative design, etc.

Only replies from individuals who are currently educated in schools were utilized in this data set for validity purposes. This is because school placements for beginning teachers only last a minimum of six weeks and a max of 10 weeks.
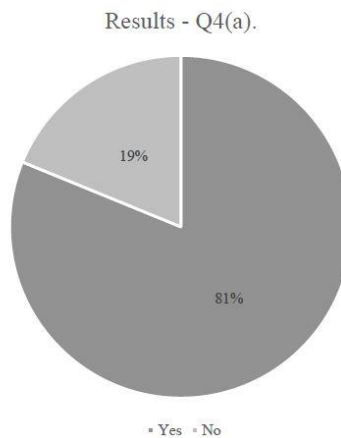

Fig. 4. - The proportion of educators who educate students about sustainable practices.

Yes, according to 83.23 percent of instructors, they do educate about sustainability. When asked if they educate for sustainability, 20,3% of teachers responded "no." The next question questioned those who had responded "yes" and how frequently they educate for sustainability.

Q4(b). How often do you instruct your students about sustainable practices?
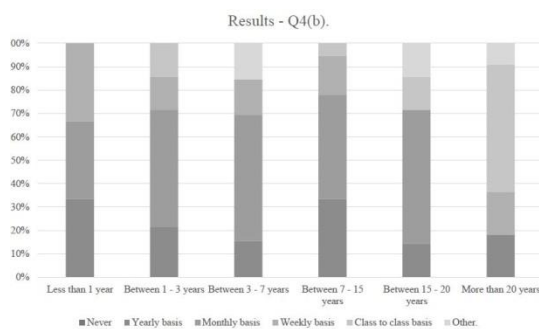

Figure 5. -. The regularity of teachers instructing in sustainability (69 teachers Participants)

Table 5. -. The table lists those who indicated they were educating for sustainability and how often they do so. (69 teachers Participants)

	Never	Yearly basis	Monthly basis	Weekly basis	Class to class basis	Other
Less than 1 year	0	2	2	2	0	0
Between 1 - 3 years	0	3	7	2	2	0
Between 3 - 7 years	0	2	7	2	0	2
Between 7 - 15 years	0	6	8	3	1	0
Between 15 - 20 years	0	1	4	0	1	1
More than 20 years	0	2	0	2	6	1
TOTAL	0	16	28	11	10	4

Of the 83.4 percent who indicated they did, 15.34 percent of teachers said they did teach about sustainable practices on a class-by-class basis, 16.34 percent said they did it weekly, 39.32 percent said they did it monthly, 25.34 percent said they did it annually, and 6.3 percent said they did it in some other way.

Question 5: In your opinion, are there any obstacles, difficulties, or constraints to incorporating sustainability into technology-related subjects?
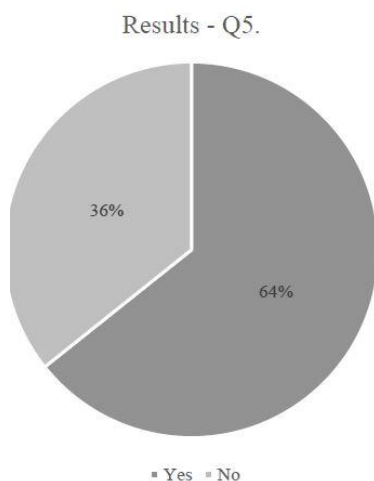

Results - Q5.

36%

64%

▪ Yes ▪ No

Fig. 6. Percent of participants who believe that incorporating sustainability into TE subjects is restricted, difficult, or limited.

When asked if they saw any restrictions, hurdles, or limits to incorporating sustainability within TE courses, 65.2% of participants said "yes" and 36.21% said "no."

Question 6: In your opinion, are there any advantages or opportunities to incorporating sustainability into technology-related subjects?
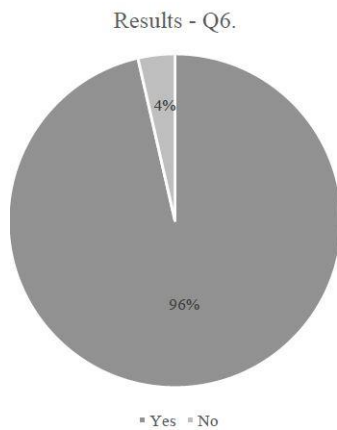
Fig. 7. - Participants think that incorporating sustainability within TE subjects has potential or advantages.

95.76% of respondents said they saw advantages or chances for incorporating sustainability into TE courses. But only 4.1 percent of respondents said they do not perceive any.

5. Conclusion

The study's findings show that 93.6% of participants acknowledge the reality of global warming and climate change, offering a window into their beliefs and perspectives on the subject. Furthermore, 78.21% of participant responses demonstrated a consistent and comprehensive comprehension of the idea of sustainability. This remains a not insignificant proportion of individuals, whose responses indicated a cursory knowledge of sustainability. Furthermore, 96.12% of the teachers and student instructors who responded to the poll acknowledged the significance of teaching future generations about ethical consumption and production practices. The results also show that most teachers are aware of the advantages of including sustainability in their lessons. Despite this, 70.12% of respondents acknowledged that it is difficult to incorporate sustainability into TE courses.

Time constraints, financial constraints, a lack of certainty in TE curricula, and CPD accreditation were the main limitations noted. While 83.2 percent of participants claimed to teach about sustainability, the results show that in reality, teachers only include sustainability into their lessons sometimes, with just 45.32 percent saying they do so regularly. Similar findings show that few respondents integrate sustainability into several facets of their teaching when questioned where they educate for sustainability. Given the subject's potential to influence social change in the direction of a sustainable global future, our findings underscore the necessity for additional incorporation of sustainability throughout TE.

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