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The Role of the "Green Ambassadors" Program in Promoting Hydrogen Energy Education

Abstract: - In the face of escalating global environmental challenges, the need for a swift transition to sustainable energy sources has become more urgent than ever. Among these alternatives, Hydrogen has emerged as a highly promising solution because of its potential to serve as a clean, efficient, and versatile energy carrier. Hydrogen's abundance and ability to produce only water vapor as a byproduct when used as fuel position it as a critical tool in the fight against air pollution and greenhouse gas emissions. This story explores the vital role hydrogen can address environmental concerns and highlights the importance of increasing awareness and understanding of its potential within both academic and community contexts. At the heart of this initiative is the innovative "Green Ambassadors" program, launched at the Holon Institute of Technology (HIT) under the Department of Multidisciplinary Studies and the Dean of Students. This program seeks to foster environmental literacy by providing students with hands-on experiences and in-depth knowledge about ecology, sustainability, and renewable energy sources, particularly hydrogen. Through the program, participants develop educational materials, engage in experiential learning, and lead workshops designed to spread awareness about hydrogen as a sustainable energy source. By actively involving students in both the learning and teaching processes, the program enhances their ecological consciousness and empowers them to become advocates for sustainable practices. In addition to practical educational efforts, the study emphasizes the importance of policy and regulatory frameworks in advancing hydrogen as a key player in the global energy transition. By advocating for national hydrogen strategies, incentivizing initiatives, and updating safety standards, the program underscores the need for a coordinated effort across government, industry, and academia to stimulate the hydrogen market. The research highlights the role of international collaboration in accelerating technological advancements and emphasizes the critical importance of public awareness campaigns, such as the "Green Ambassadors" program, in building societal acceptance of hydrogen technologies.

The results of this initiative have been significant, with both university students and younger pupils reporting improved knowledge of hydrogen and a greater understanding of its role in the transition to renewable energy. The "Green Ambassadors" program not only educated participants on environmental issues but also equipped them with the tools and confidence to lead sustainable practices in their communities. Through this program, HIT students earned the title of "Green Ambassador," a certification that symbolizes their readiness to confront pressing environmental challenges and contribute to a more sustainable future. The research affirms the transformative power of experiential education and recommends the expansion of such programs to other contexts and subjects to promote environmental consciousness and sustainable practices on a larger scale.

Keywords: Engineering education; Sustainable; Hydrogen; Renewable Energy.

I. INTRODUCTION

Environmental challenges such as climate change, pollution, and the depletion of fossil fuels are intensifying the global need for innovative clean energy solutions [1]. Among the emerging alternatives, hydrogen has garnered attention as a clean and efficient energy carrier, offering significant potential to transform industries and reduce our reliance on fossil fuels [2]. This article explores the role of hydrogen in addressing key environmental challenges and highlights how educational programs, such as the 'Green Ambassadors' initiative at the Holon Institute of Technology (HIT), are preparing future leaders to facilitate the energy transition toward sustainability.

Hydrogen is one of the most abundant elements on Earth, possessing high energy content, making it a promising alternative to traditional energy sources. When used as fuel, hydrogen produces only water vapor as a byproduct, drastically reducing air pollution and greenhouse gas emissions. Moreover, hydrogen can be produced using renewable energy sources, such as solar and wind, enhancing its environmental benefits and positioning it as a critical component of a sustainable energy future [3-5].

In this context, hydrogen has the potential to revolutionize transportation, industrial processes, energy storage, and power generation. Its versatility, combined with its capacity for sustainability when sourced from renewable energies, positions hydrogen as a key player in the global effort to combat climate change [6-9].

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Recognizing the pivotal role education plays in advancing such transformative technologies, the 'Green Ambassadors' program at HIT serves as an exemplary initiative. This multidisciplinary program empowers students with the knowledge and practical skills to address pressing environmental challenges through community engagement and sustainability advocacy. Through classroom learning and hands-on projects, program participants create educational materials, lead experiential lessons, and engage with local communities to increase awareness about renewable energy and environmental stewardship [10]. As hydrogen continues to evolve as a clean energy carrier, educational initiatives like the Green Ambassadors program are essential for fostering the next generation of leaders who will drive its adoption and application. By equipping students with the tools and knowledge to advocate for sustainable energy solutions, these programs ensure that future professionals are prepared to tackle the complex environmental challenges of our time [8], [10].

II. HYDROGEN'S POTENTIAL

Submit Hydrogen (H_2), the most abundant element in the universe, is increasingly recognized as a key component in the decarbonization of global energy production and utilization. Its versatility as a clean energy carrier positions hydrogen as a crucial player in efforts to mitigate climate change, reduce greenhouse gas emissions, and create a sustainable energy future. However, the realization of hydrogen's potential hinges on overcoming several challenges related to its production, distribution, and adoption across various sectors [7-9].

The sustainability of hydrogen as an energy source largely depends on its method of production. Green hydrogen, produced through electrolysis powered by renewable energy sources like wind and solar, offers the greatest environmental benefits, emitting no greenhouse gases during production. In contrast, grey hydrogen, which is derived from fossil fuels, contributes significantly to CO_2 emissions. Blue hydrogen provides a transitional solution, utilizing carbon capture technologies to reduce emissions, though it still relies on fossil fuel-based production [5].

The potential of hydrogen has driven substantial global investments and spurred policy initiatives. In July 2021, the European Commission introduced policies targeting a 55% reduction in net greenhouse gas emissions by 2030, with a vision for a climate-neutral Europe by 2050. As part of this effort, the "Hydrogen Valleys" platform was launched to support large-scale hydrogen projects aimed at decarbonizing high-emission sectors. The focus on hydrogen is also expanding globally, with nations like India launching ambitious plans to position themselves as leaders in green hydrogen production. India’s National Green Hydrogen Mission aims to establish a cost-effective hydrogen ecosystem by 2050, with a focus on catalysis and fuel cell technology research and development. Similarly, China has committed to peaking CO_2 emissions by 2030 and achieving carbon neutrality by 2060, incorporating hydrogen into its long-term energy strategy [9].

These global efforts mark the beginning of a new energy revolution, with hydrogen at the forefront. However, the path to fully unlocking hydrogen's potential is not without obstacles. Regulatory barriers, infrastructure limitations, and financial constraints continue to hinder the widespread adoption of hydrogen technologies. In regions like Israel, public engagement and trust in the energy decision-making process remain low, exacerbated by a lack of accurate knowledge about renewable energy solutions and climate policies. Overcoming these challenges requires coordinated action between industry, academia, and policymakers to drive research, innovation, and infrastructure development [6], [8], [10].

Despite these challenges, the opportunities presented by hydrogen are vast. Its applications extend across various industries, including transportation, heating, and power generation, offering the promise of cleaner and more resilient energy systems. As countries continue to invest in hydrogen technologies and integrate them into their energy portfolios, hydrogen is poised to play a pivotal role in shaping the future of clean energy [5-6].

In 2015, Israel, along with other signatories of the United Nations Framework Convention on Climate Change (UNFCCC), committed to reducing electricity consumption and increasing the share of renewable energy production by 2030. The agreement marked a critical turning point for Israel's energy sector, setting ambitious targets aimed at curbing emissions and fostering a cleaner, more sustainable energy landscape. As the global community prepares for the next major climate conference, Israel is expected to reaffirm its commitments and present further measures to limit greenhouse gas emissions, with the goal of halving emissions by 2030 and achieving carbon neutrality by 2050. This commitment aligns with the global effort to limit temperature rise to 1.5 degrees Celsius, thereby preventing the most severe consequences of climate change [8].

In the context of global energy demands, the International Energy Agency (IEA) projects that energy consumption will continue to rise by 1% annually until 2040. Although low-carbon technologies such as solar photovoltaics (PV) are expected to account for a significant portion of this growth, and the demand for coal and oil

is projected to level off, the overall progress in clean energy adoption remains insufficient to meet climate goals. This underscores the critical need for more aggressive measures, particularly in the integration of renewable energy sources and the reduction of emissions across key sectors of the economy. The energy sector is rapidly transitioning, with electrification becoming increasingly prominent, yet the momentum behind clean energy solutions, while substantial, is not yet enough to fully offset the impacts of global economic and population growth [5], [8].

Technological advancements are playing an essential role in transforming energy systems worldwide, and Israel is no exception. As a nation with large reserves of natural gas, significant potential for solar energy, and the challenges of being an energy island with limited renewable energy resources, Israel faces unique circumstances. The nation's long-term energy policy must account for these factors while simultaneously preparing for the transition to a low-emission economy [10]. The introduction of hydrogen as a major component of Israel's energy strategy presents a promising avenue for achieving this transition. Hydrogen, particularly green hydrogen produced from renewable sources, can be utilized to store excess solar energy through electrolysis, offering a clean and efficient energy carrier that can power a wide range of applications, from electricity generation to industrial processes [3].

The role of hydrogen in Israel's energy future cannot be overstated. The process of electrolysis, which produces hydrogen without emissions, offers a sustainable solution for storing renewable energy and addressing the intermittency of solar power. Additionally, blue hydrogen, produced from natural gas with carbon capture and storage, provides another opportunity for Israel to leverage its natural gas reserves while transitioning toward cleaner energy solutions. Hydrogen's versatility as an energy source for transportation, industry, and power generation makes it a critical component of Israel's strategy to meet its climate goals and reduce its carbon footprint [6].

Despite the potential for hydrogen integration, challenges remain, including the need for substantial investments in infrastructure, such as production facilities, storage systems, and distribution networks. The development of a national hydrogen strategy, coupled with regulatory support and international collaboration, will be key to ensuring the successful adoption of hydrogen technologies. Countries like Japan, the UK, Germany, and the Netherlands have already made significant strides in developing hydrogen strategies, investing in research, development, and infrastructure to support this transition. As Israel moves forward with its own hydrogen initiatives, these international efforts serve as valuable models for shaping its approach [5], [8].

III. METHODOLOGY

This study explores the impact of the "Green Ambassadors" educational program at Holon Institute of Technology (HIT) on the knowledge and attitudes of engineering students and school pupils toward renewable energies, with a specific focus on hydrogen. The research was conducted between December 2023, at the start of the program, and March 2024, culminating with a post-intervention evaluation. The aim was to assess the effectiveness of the program in fostering a positive attitude toward hydrogen as an alternative energy source and improving understanding of renewable energies [11].

A. Study Design

The study utilized a mixed-methods approach, combining quantitative surveys and qualitative assessments to evaluate both knowledge acquisition and attitudinal changes in participants. The participants included:

- HIT Engineering Students: Students from all faculties participated, reflecting a cross-disciplinary approach. The diverse cohort included participants from engineering, computer science, and management, with strategic group assignments based on gender, academic year, and faculty.

- Elementary School Pupils: Pupils from various sectors of the Israeli community participated in interactive lessons led by HIT students. These pupils, from grades 3 and 4, including gifted classes, were exposed to sustainability topics and hydrogen technology.

B. Teaching Aids and Demonstrations

The mobile laboratory included various tools and devices that aided in illustrating key concepts:

- Hydrogen-Powered Vehicle: One of the key teaching aids was a small hydrogen-powered vehicle (see figure 1), which visually and interactively demonstrated hydrogen's potential as a clean energy source. The hands-on experiment allowed pupils to see the practical applications of hydrogen fuel technology.

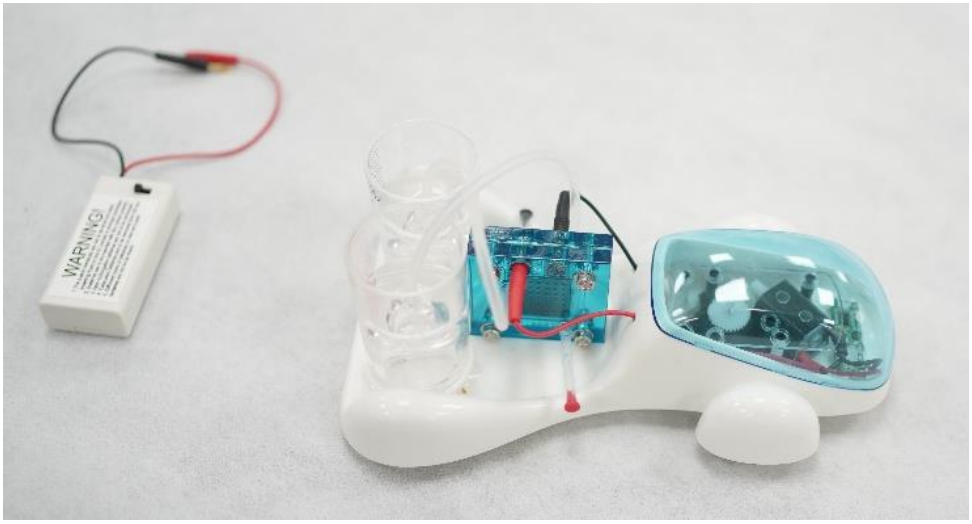

Figure 1 Example of vehicle powered by hydrogen operated by water hydrolysis used during demonstration (Horizon Fuel Cell, FCJJ-20: Hydrocar)

- Energy Consumption Demonstrations: Incandescent and LED bulbs were used to demonstrate differences in energy consumption versus light supply, providing a tangible comparison between traditional and energy-efficient technologies.
- Environmental Impact Demonstrations: To illustrate environmental pollution and its effects, demonstrations included comparisons of contaminated versus clean soil, where seedlings were planted to show the negative impacts of pollution on plant growth.

C. Data Collection and Instruments

Pre- and post-intervention surveys were administered to engineering students and school pupils to evaluate the program's impact. The surveys measured:

- Knowledge Acquisition: Understanding of renewable energy sources, particularly hydrogen.
- Attitudinal Changes: Perceptions of renewable energy technologies and willingness to adopt hydrogen-based solutions in the future.

For the engineering students, the surveys also assessed their experience in delivering the lessons and their perception of hydrogen's role in the energy transition.

The post-intervention evaluation, conducted in March 2024, aimed to capture the immediate impact of the program on participants' knowledge and attitudes.

IV. RESULTS

A. HIT Students Survey

The analysis reveals a positive shift in students' perception of sustainable daily habits.

Understanding of Sustainability: Before the program, students saw sustainability as resource preservation. After the program, their understanding expanded to include environmentally friendly lifestyles critical for a sustainable future.

Knowledge of Renewable Energy Sources: Pre-program, students mainly recognized solar energy. Post-program, they demonstrated a broader awareness, identifying hydrogen and geothermal as alternative energy sources.

Contributions of Renewable Energy to the Environment: Students transitioned from recognizing renewable energy's potential to reduce pollution, to emphasizing its role in reducing carbon emissions and replacing fossil fuels, showing a deepened comprehension of its environmental impact.

Figure 2 depicts the pre- and post-program awareness of renewable energy sources among HIT students. The x-axis represents different energy sources (solar, wind, hydrogen, etc.), while the y-axis shows the percentage of students aware of each source. The post-program awareness, especially for hydrogen and geothermal energy, demonstrates significant improvement.

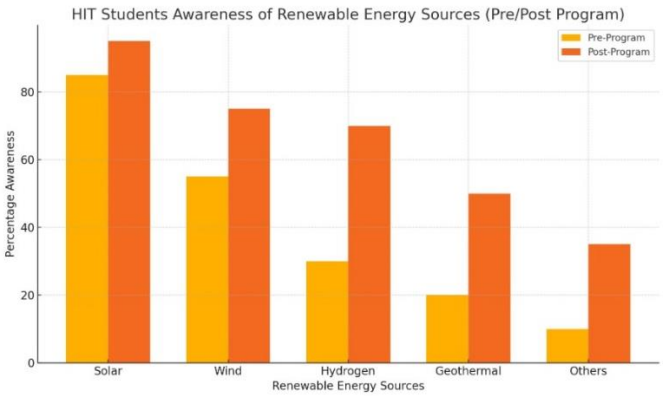

Figure 2 HIT Students' Awareness of Renewable Energy Sources

B. School Pupils Survey

Of the pupils involved in the program, 81.5% enjoyed their participation, and 63.8% felt they learned substantial new information about sustainability.

Understanding of Sustainability: Pre-program, pupils had vague or misunderstood definitions of sustainability. Post-program, there was an improvement, with some pupils correctly linking sustainability to ecological balance and human responsibility, though full comprehension remained elusive for many.

Awareness of Energy Sources: Before the program, pupils identified an average of 3.28 energy sources. After the program, this number rose to 4.05 ($p < 0.001$), with pupils in the hydrogen workshop showing a significant increase in awareness (17.6% to 70.6%). Figure 3 shows the changes in awareness of energy sources among school pupils before and after the program. The post-program data indicates a significant increase in awareness of hydrogen and waste as energy sources.

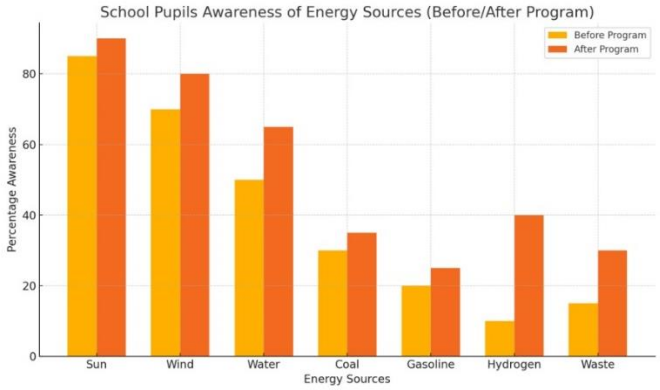

Figure 3 School Pupils' Energy Sources Awareness

Understanding of the Hydrogen Pre-program, the majority of pupils (64%) had no knowledge of hydrogen. Post-program, knowledge improved significantly in the hydrogen workshop group, with more detailed and accurate responses, though misconceptions persisted.

Figure 4 shows the effect of the hydrogen workshop on participants' awareness. There is a substantial increase in awareness among those who attended the workshop, while the control group remains unchanged.

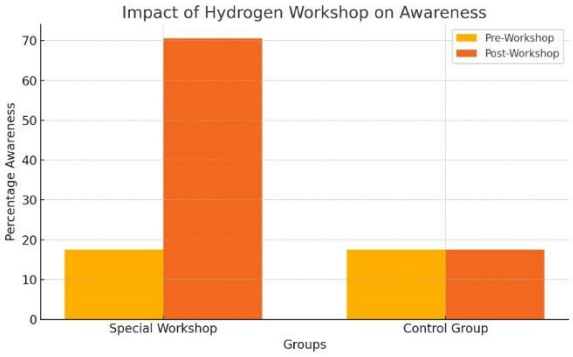

Figure 4 Impact of the Hydrogen Workshop

V. CONCLUSION

The "Green Ambassadors" program demonstrated a profound impact on both university students and younger pupils, highlighting the power of experiential learning through doing. Throughout the program, university students, acting as educators, not only imparted knowledge about sustainability and renewable energy sources but also enhanced their own understanding of these critical topics. Engaging in teaching fostered deeper ecological awareness and honed their pedagogical skills, reinforcing the idea that teaching is a bidirectional process where both educators and learners grow together. The mutual exchange of knowledge between students at different stages of their educational journey created a unique, transformative learning environment [12-14].

Among the younger participants, a significant improvement in their awareness of renewable energy and sustainability was observed. The hands-on workshops, particularly those focused on hydrogen as an alternative energy source, played a pivotal role in broadening their understanding. Concepts that were once abstract or unfamiliar became tangible, offering these young learners a deeper comprehension of the renewable energy landscape [15]. The impact was evident in the increase in correct responses about hydrogen energy in post-program evaluations, in stark contrast to a control group, underscoring the effectiveness of targeted, experiential learning activities. Moreover, the program reinforced already existing sustainable behaviors, such as the consistent use of reusable bottles, while expanding the pupils' knowledge base on broader environmental issues [11], [14-15].

The success of the "Green Ambassadors" program illustrates the transformative potential of experiential education. Learning through doing, especially when it involves peer teaching and hands-on activities, proved to be an effective method for instilling lasting ecological values and environmental literacy. This program could serve as a model for other educational settings, not just in the realm of sustainability but across various subjects. Implementing similar programs that encourage active participation and practical experience could significantly enhance learning outcomes in different fields and across age groups. By empowering students to take an active role in the learning process, educators can foster a deeper, more enduring understanding of complex subjects, helping to cultivate informed, responsible citizens capable of addressing the challenges of the future.

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