"I am a Girl, I am an Engineer": Promoting Engineering Pathways For Underprivileged Secondary School Girls Through Educational Intervention

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ABSTRACT

The underrepresentation of women in engineering disciplines remains a global challenge despite many ongoing initiatives. There has been many reports and studies conducted on the topic of women in STEM that indicated women continue to be significantly underrepresented in energy-related professions, highlighting the need for targeted educational interventions. As an effort to inculcate the interest of women in the field, a project entitled "I am a Girl, I am an Engineer" was conducted at a Malaysian national school in Ipoh, Perak, Malaysia. This report focused on the second implementation of the project continuing from the first pilot study in 2025.

The project was implemented using a training module named REITMO developed in a pilot study conducted previously. Pre-test and post-test research design was employed to evaluate the effectiveness of the intervention. The instructional sessions were delivered by experienced practising female engineers from higher education institutions and industry, while practical workshop activities were facilitated by female undergraduate student facilitators from Quest International University, Malaysia. A total of 40 underprivileged urban secondary school girls participated in the program.

The findings demonstrated significant improvements in participants' knowledge and understanding of renewable energy technologies, specifically bioenergy, geothermal energy, and ocean energy. Additionally, results indicated significant enhancement in students' practical experimentation skills, prototype building skills and increased interest in pursuing engineering-related studies and careers. The outcomes suggested that structured experiential learning initiatives led by female role models could effectively enhance technical awareness and motivate underrepresented female students toward engineering pathways.

Keywords: Female in STEM, Renewable Energy, Women in Engineering, Empowerment of underprivileged girls

INTRODUCTION

The underrepresentation of women in engineering disciplines remains a persistent global challenge despite continuous efforts to promote diversity and inclusion within science, technology, engineering, and mathematics (STEM) fields (Shafiq et al, 2024). Studies have identified female students growing up in underprivileged urban environments as a particularly vulnerable group, facing increased risks of future unemployment or underemployment due to limited access to educational and economic opportunities (Ting et al, 2020; Khoo et al, 2018). Despite these constraints, underprivileged female students represent significant untapped human capital with strong potential for socioeconomic mobility when provided with equitable educational opportunities and appropriate institutional support.

Education has been widely recognized as a critical mechanism for empowerment and poverty alleviation among disadvantaged female populations (Othman et al, 2021; Vuluku et al, 2013). Access to quality education, mentorship, and structured learning experiences enables female students to develop competencies necessary for academic advancement and professional participation, including entry into engineering careers. Nevertheless, gender disparities continue to characterize the engineering profession, where male participation remains dominant across most technical disciplines (Idris et al, 2024; Megan, 2022). This imbalance is particularly evident among female students from low-income urban backgrounds who often experience limited exposure to engineering-related learning opportunities and career pathways during their formative education years (Nithiya et al, 2018). National statistics further highlight this issue, where male enrolment (139,225) exceeded female enrolment (79,899) by approximately 42% in engineering, manufacturing, and construction programs at Malaysian higher education institutions in 2022 (Ministry of Higher Education, 2023), suggesting an earlier divergence in STEM participation at the secondary education level.

Addressing this disparity requires collaborative engagement among educational institutions, industry stakeholders, and professional engineering bodies. Such engagements can work to establish effective platforms that empower female students and broaden participation in engineering fields (Allen, 2021). In response, targeted educational interventions are necessary to cultivate technical competencies, confidence, and positive engineering mindsets among underprivileged girls through inspirational and experiential learning approaches. Establishing a supportive ecosystem supported by mentorship and access to relevant resources can enhance students' readiness to pursue engineering education and career pathways, thereby contributing to long-term socioeconomic mobility and poverty reduction within their communities (Rashid et al, 2021; Elizabeth, 2023). Such initiatives are well aligned with national development priorities outlined in the Twelfth Malaysia Plan (2021-2025), which emphasizes women's empowerment as a key driver for increasing economic participation, strengthen gender equality and national growth (Economic Planning Unit, Prime Minister's Department, 2021).

The renewable energy sector is experiencing rapid global expansion and offers diverse employment opportunities across multiple engineering domains (Nwokediegwu et al, 2024). Early exposure to renewable energy concepts can motivate female students to consider careers in renewable energy and sustainable engineering practices (Sueanne & KaaVonia, 2017). Renewable energy education also promotes environmental responsibility by strengthening awareness of sustainable energy resources and the importance of reducing carbon emissions toward achieving long-term environmental sustainability. Furthermore, renewable energy initiatives contribute to community development through improved access to clean energy, enhanced public health outcomes, and local economic growth. Empowering female students with renewable energy knowledge and practical competencies enables inclusive participation in sustainable development initiatives and supports broader socioeconomic advancement (Muliyati et al, 2023). Consequently, integrating renewable energy education at the secondary school level, particularly with emphasis on female participation, represents an important strategy for fostering a sustainable and inclusive future workforce (Nurul et al, 2025; Ilbilge & Zeynep, 2022; Milagors et al 2022)

Motivated by these challenges, this study presents a structured outreach initiative aimed at promoting renewable energy awareness and engineering career aspirations among underprivileged secondary school girls in Ipoh, Malaysia. A training module and interactive hands-on workshop were developed using the ADDIE instructional design framework and implemented through collaboration between industry female engineers and university student volunteers. A pre-test and post-test research design was employed to evaluate the effectiveness of the intervention in improving participants' knowledge, practical skills, and engineering career motivation.

The main contributions of this study are as follows:

- Implementation of experiential hands-on learning facilitated by female engineering role models from academia and industry; and
- Quantitative evaluation of knowledge acquisition, skill development, and engineering career aspiration using a pre-test and post-test methodology.

The findings provide insights into how targeted educational interventions can effectively enhance technical awareness and inspire underrepresented female students toward engineering education and careers, contributing to gender inclusivity within the future renewable energy workforce

METHODOLOGY

Research Design

This study employed a quantitative pre-test and post-test research design to evaluate the effectiveness of a renewable energy educational intervention in improving knowledge acquisition, practical skills, and engineering career aspirations among underprivileged female secondary school students.

The intervention consisted of a structured training module integrated with experiential hands-on workshop activities. The project aimed to measure learning outcomes before and after participation in the program to further determine the impact of the implemented instructional approach.

Instructional Design Framework

The training module and corresponding workshop activities were developed and named **Renewable Energy Training Module (**REITMO) in the previous pilot study based on the ADDIE instructional design model, which consists of five systematic phases: Analysis, Design, Development, Implementation, and Evaluation (Chua et al, 2025).

Participants Selection and Programme Arrangement

The study involved 40 underprivileged female secondary school students from an identified urban school located in Ipoh, Perak, Malaysia. Participants were selected in collaboration school management based on socioeconomic background and limited prior exposure to engineering-related programs.

Instructional sessions were delivered by experienced female engineers from industry to provide professional exposure and role-model engagement. Hands-on workshop activities were facilitated by female undergraduate student volunteers from Quest International University, thereby fostering peer learning and mentorship.

The educational intervention consisted of two main components:

1. Instructional Session with Renewable Energy Training Module (REITMO):

Participants attended structured instructional sessions introducing fundamental concepts of renewable energy technologies, including principles, applications, and societal impacts using REITMO. Career pathways in engineering and renewable energy sectors were also highlighted. Figure 1 illustrates the printed copy of REITMO.

2. Hands-On Prototype Construction Workshop:

Interactive activities enabled students to construct, analyse and understand the core principle of simple renewable energy systems. These experiential learning activities were designed to reinforce theoretical understanding while enhancing problem-solving and experimentation skills. Figure 2 illustrates the completed prototypes.

Figure 1 REITMO

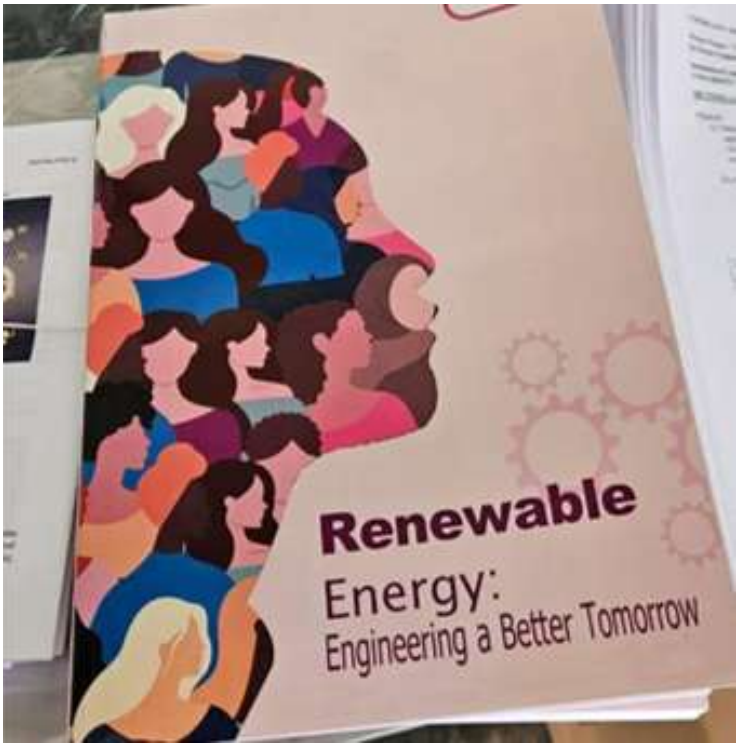
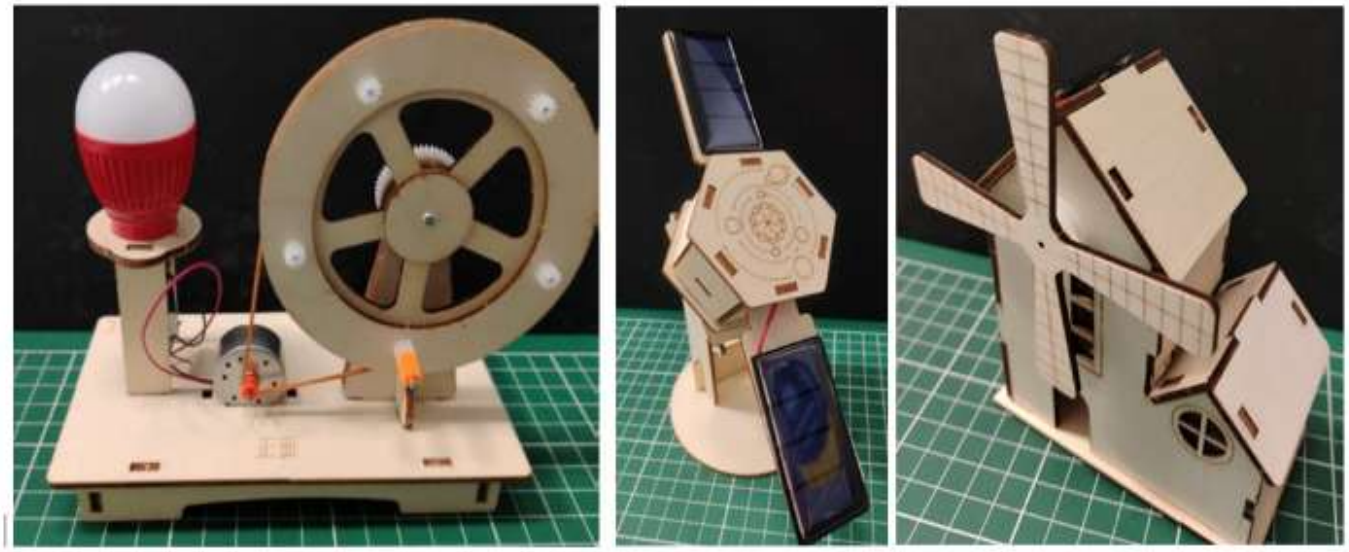


Figure 2: Completed Prototypes



Ethical Considerations

Consent was secured from relevant authorities, namely Perak State Education Department, Kinta District Education Office, and school administration. Informed consent was also secured from all participants, with written or oral consent obtained from their parents/guardians following explanation of the study's purpose, participants' rights, and uses of data. Confidentiality and anonymity were ensured through pseudonyms and participant codes throughout all data collection and reporting. Participation was entirely voluntary. All audio and video recordings and transcripts are stored on password-protected devices and will be retained for five years in accordance with university data management policy.

Data Collection

Data was collected using structured assessment instruments comprising:

Pre-Test and Post-Test Questionnaires:

Designed to measure participants' knowledge and understanding of renewable energy concepts before and after the intervention.

Skills and Perception Survey:

A Likert-scale questionnaire was used to evaluate students' self-reported confidence, experimentation skills, and interest in pursuing engineering-related studies and careers.

All instruments were reviewed and validated by subject matter experts to ensure clarity and suitability for secondary school participants.

Data Analysis

Collected data were analyzed using descriptive and inferential statistical methods. Pre-test and post-test scores were compared to determine improvements in knowledge acquisition and skill development following participation in the program. Mean score differences and percentage improvements were calculated to evaluate the effectiveness of the intervention. Survey responses were analyzed to identify changes in students' confidence levels and engineering career aspirations.

RESULTS AND DISCUSSION

The participants successfully underwent a session with experienced female engineers and a hands-on workshop session with facilitators from Quest International University. Figure 3 and Figure 4 illustrate the students working on the solar prototype and testing it under the sun.

Before the event and upon completion of the event, questionnaire were provided to the students to determine the effectiveness of the REITMO. Average scores were determined and the following results were obtained as illustrated in Table 1.

Figure 3: Students testing out their completed solar prototype under the sun

Figure 4 Participants proudly presented their completed solar-powered models.

TABLE 1. Results of Pre-Test and Post-Test

Attributes	Topic	Pre-Test	Post-Test
Knowledge	Renewable Energy	95%	100%
	Solar	100%	100%
	Wind	95%	100%
	Hydro	95%	97.5%
	Bioenergy	87.5%	95%
	Geothermal	77.5%	97.5%
	Ocean	77.5%	100%
Understanding	Renewable Energy	85%	100%
	Solar	95%	100%
	Wind	87.5%	100%
	Hydro	70%	95%
	Bioenergy	67.5%	95%
	Geothermal	62.5%	85%
	Ocean	77.5%	100%

Data collected and analysed illustrated a significant increment of more than 10% in the knowledge transfer in Geothermal and Ocean energy. The REITMO was also able to improve the level of understanding of students significantly on Renewable Energy, Wind Energy, Hydro Energy, Bioenergy, Geothermal Energy as well as Ocean Energy. These increment indicated that the knowledge as well as understanding of the students about other forms of renewable energy apart from solar energy is very limited. The REITMO module had successfully provided additional information regarding these renewable energy.

Further data analysis also indicated there is a significant increment in terms of enhancing the students' building and experimenting skills. The school has limited resources to cater to the teaching and learning about renewable energy, thus the school girls had not the opportunity to build, construct and test any working prototype related to solar powered kits. With the solar powered STEM kits hands on workshop facilitated by female undergraduate volunteers, these students were able to complete the task assigned with more confidence in building and experimenting. Table 2 illustrates the average score ratings by the students before and after the workshop in % achieved.

TABLE 2. Ratings received about the skills

Skills	Pre-Test	Post-Test
Building	7.5%	95%
Experiment	27.5%	100%

The results obtained from the survey also indicated that there was significant increment in the aspiration of the students to become an engineer in the future. The students were facilitated by female engineering undergraduate volunteers who provided peer guidance. Throughout the session, the underprivileged school girls were able to communicate well with these volunteers. It is during these communications that exchange of ideas and experience sharing occurred where the students enhanced their aspirations to become an engineer in the future. The average score rating received is illustrated in Table 3.

TABLE 3. Rating received about aspiration to be engineers

Aspiration	Pre-Test	Post-Test
Engineer	35%	82.5%

The other data collected from the survey also provided the following results:

a. **93.5%** of the students agreed that the event is very effective.

b. **66.5%** of the students were able to understand clearly about renewable energy after attending the workshop.

c. **91%** of the students agreed that the event is successful in raising awareness about Renewable Energy and its impact to society, economy and culture.

d. **93.5%** of students agreed that the workshop is beneficial to them and the school.

e. **92.5%** of the students agreed that the workshop had successfully brought about changes for the betterment of society and school.

CONCLUSIONS

Targeted and structured intervention using REITMO is very effective in improving the students' knowledge and understanding about the various other forms of renewable energy apart from solar and wind energy. The

enhancement is more than 10% increment when it comes to the knowledge in geothermal and ocean energy. Similar significant enhancement is achieved is the understanding of renewable energy, wind energy, hydro, bioenergy, geothermal and ocean energy.

The REITMO had also successfully enhanced the students confidence and skills in building the prototype by 87.5% and conducting experiment using the interactive Solar STEM Kits with 72.5% increment.

Apart from this, the programme was able to enhancing the interest of underprivileged girl to pursue a career in renewable energy engineering by 47.5%.

Findings from this research are bounded in external validity due to restricted participant variation. It is suggested that future sampling extend across numerous schools, wider geographic locations and diverse socioeconomic cohorts to enhance the transferability of study conclusions. More compelling evidence supporting intervention effectiveness can be attained in subsequent studies through the utilisation of control groups or quasi-experimental research arrangements.

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