# Designing an effective energy literacy course: a multi-phase approach tailored to Kuwaiti students' needs

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ABSTRACT: This study aims to develop a highly efficient energy literacy course respecting Kuwaiti cultural values and addressing the diverse needs of learners. A comprehensive approach was implemented, accompanied by a range of integrated mixed methods, including quantitative questionnaires, focus group discussions and observations, to assess the effectiveness of the course among 30 Kuwaiti students. The course remarkably improved the students' technical knowledge and overall energy literacy by combining various pedagogical tools and methods. Moreover, it positively influenced participants' attitudes and behaviours, fostering a greater sense of responsibility and awareness of energy conservation practices. Other universities and institutions in the Gulf region can adapt the model that is provided in this study to develop energy literacy courses that enhance students' energy knowledge and skills.

## INTRODUCTION

Energy is the major challenge today, having consequences across ecological, economic and academic domains. There are some studies that constantly emphasise the shortcomings of traditional methods for affecting the attitudes and behaviours of students in energy-related problems [1-3]. Adequate knowledge influences the awareness of energy-related problems, affecting students' propensity to take action for a better future even though the link between understanding and action remains ambiguous [4][5].

The significance of education as a pivotal mitigation strategy for energy-related problems, such as climate change and sustainability, has been emphasised by numerous studies [6-8]. Energy education must integrate diverse disciplines to serve as a mitigation driver, effectively communicate and contextualise energy science for clarity and credibility, enhance energy literacy, and empower both teachers and students, as tackling energy-related problems necessitates energy-literate public and students across all sectors of society worldwide [1][9].

To ensure that students are equipped with responsible behaviours, such as energy consumption and renewable energy use in the era of climate change, developing an energy literacy course is a necessity [10-13]. Various factors such as socioeconomic situation, geography and educational background affect energy literacy [14-16]. Therefore, while considering cultural and national factors, educational programmes catered to increase energy literacy need to be designed [17].

With the emergence of this need, a literature gap is observed where few studies examine energy literacy in the Gulf region. Alghamdi and El-Hassan assessed the energy literacy of university students in Saudi Arabia [18], while Akinwale conducted a study examining Saudi university students' energy knowledge [19]. On the other hand, Altassan created a comprehensive model for enhancing students' energy knowledge according to Saudi Arabia's 2030 vision. This shows a gap in designing an energy literacy course that exceeds the basics in the Gulf region [20].

As global environmental issues escalate, educational institutions play a critical role in developing environmentally aware individuals and supporting sustainable practices. Energy literacy initiatives are essential for equipping students with the knowledge and skills needed to tackle these challenges, allowing them to make informed energy use decisions and contribute to a sustainable future [10][13]. Several factors influence the effectiveness of energy literacy initiatives, including cultural values, educational approaches and individual characteristics. Tailoring programmes to these factors ensures their success in different contexts [21].

However, there is a lack of research assessing energy or sustainability literacy levels among students despite a growing interest in sustainability in the Gulf region. While recent studies highlight the benefits of incorporating environmental

themes into university curricula [22], research also reveals limitations. For instance, a study in Saudi Arabia found a lack of knowledge about environmentally friendly practices although they have improved climate change knowledge among final-year students [18]. Similarly, another study in Saudi Arabia reveals that although students were indifferent due to limited understanding and awareness, they have moderate knowledge about energy conservation and renewable energy [19]. These findings highlight a need for more comprehensive energy literacy education that goes beyond basic knowledge.

This study is focused on creating a course about energy literacy, evaluating how well it works and sharing the results to help schools teach energy-related topics. Universities play an important role in promoting energy education among students and helping them to overcome any challenges in this area [17]. However, there has not been an effort to design an energy literacy course that reflects the unique social and cultural values of the Gulf region, including Kuwait, at universities. To fill this gap, the authors of this article conducted a study at Australian University - Kuwait to explore how to develop such a course. The goal of this study is to create an energy literacy course specifically for Kuwaiti students. This course will be designed using effective teaching methods and will include a variety of activities to help students better understand energy concepts and learn how to use energy responsibly. By blending traditional teaching approaches with modern techniques, the course aims to provide a relevant and engaging learning experience that resonates with students from Kuwait.

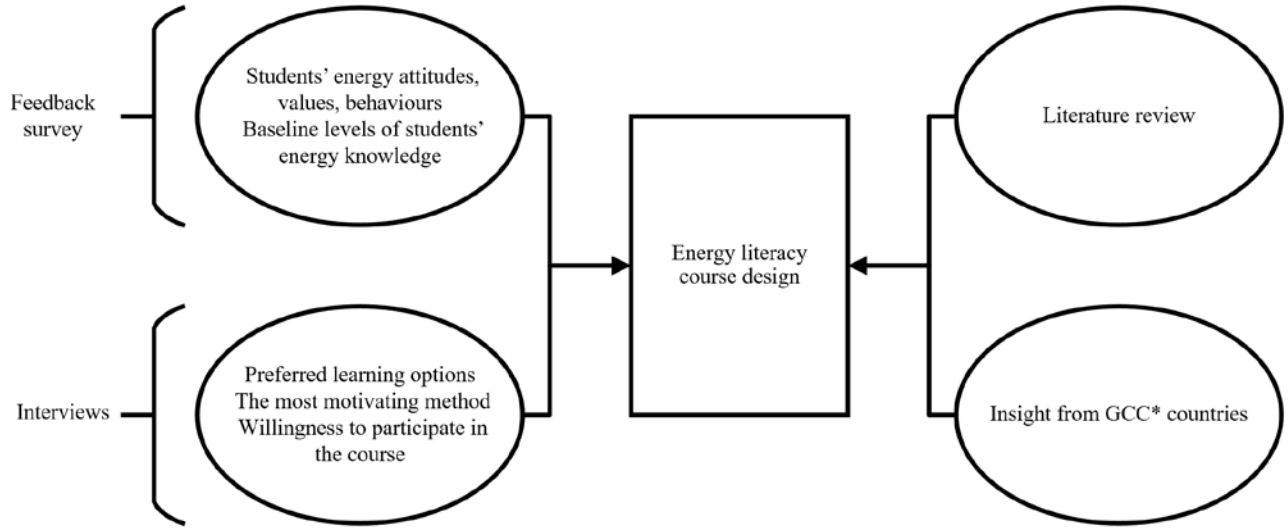
## COURSE DESIGN AND IMPLEMENTATION: DETAILS OF THE ENERGY LITERACY COURSE'S DESIGN, CONTENT AND DELIVERY

Key features of the course include:

- A focus on cultural relevance: The course content and delivery are tailored to Kuwaiti students' specific needs and cultural values.
- A combination of traditional and modern teaching methods: The course integrates various teaching approaches, including lectures, discussions, group work and technology-enhanced learning activities.
- A focus on hands-on learning: The course includes practical activities, such as energy audits, simulations and case studies to help students apply their knowledge and skills.
- A focus on critical thinking and problem-solving: The course encourages students to develop and apply critical thinking skills to real-world energy challenges.
- A focus on sustainability: The course emphasises the importance of sustainable energy practices and the impact of energy consumption on the environment.

### Course Format

A multifaceted approach was employed to develop an energy literacy course that meets Kuwaiti students' unique needs and cultural context. Instructors leveraged a range of pedagogical tools and methods to deliver the course and achieve the educational objectives, as depicted in Figure 1.




*Note: GCC - The Gulf Cooperation Council

Figure 1: The framework for energy literacy course design.

### Energy Literacy Course Content

The Energy Literacy course is grounded in Energy Literacy: Essential Principles for Energy Education framework, which provides a comprehensive overview of the key concepts and skills necessary for energy literacy. The course is structured into modular units. Energy conservation practices, renewable energy sources, energy-efficient technologies

and the environmental impact of energy consumption are the essential topics. Each module is designed to progressively build upon previous knowledge, incorporating interactive activities, assessments and assignments to engage students. As depicted in Table 1, the purpose of the course is to adapt to diverse learning styles and proficiency levels. The 12-week course is divided into modules, each taking approximately one week to complete. This flexible design enables students to progress independently and deepen their understanding of energy literacy principles.

Table 1: The modules of the Energy Literacy course.

| Module | Activity | Assessment method | Outcome |
|---|---|---|---|
| Module 1: Introduction. | Lecture on energy literacy concepts and definitions. | Pre- and post-course survey on energy literacy. | Measure changes in student understanding of energy literacy concepts and definitions. |
| Class discussion on the benefits of energy conservation and efficiency. | Student reflection paper. | Assess student comprehension and engagement with course content. | Measure changes in student understanding of energy conservation and efficiency |
| Module 2: Energy sources. Research assignment on a specific alternative energy source. | Group activity on different energy sources and their impact on the environment. Written report and presentation. | In-class quiz on energy sources. Assess student research and presentation skills. | Measure student understanding of different energy sources and their impacts. |
| Module 3: Energy consumption. Debate on the pros and cons of different transportation modes. | Analysis of energy consumption patterns and trends. In-class debate. | Data collection and analysis on energy consumption patterns and trends. Assess students' ability to form arguments and support claims with evidence. | Evaluate students' ability to collect and analyse data related to energy consumption. |
| Module 4: Energy efficiency. In-class quiz on energy-efficient technologies and practices. | Group project to design an energy-efficient building. In-class quiz. | Peer evaluation and feedback on a group project. Measure student understanding of energy-efficient technologies and practices. | Assess students' ability to work collaboratively and design energy-efficient buildings. |
| Module 5: Energy conservation. Debate on the effectiveness of energy conservation policies and regulations. | Community service project to promote energy conservation. In-class debate. | Reflection paper and peer evaluation. Evaluate students' ability to form arguments and support claims with evidence. | Assess student engagement with energy conservation practices and their ability to promote them. |
| Module 6: Smart grid and energy management. Research assignment on the benefits of energy storage and distribution. | Simulation of the energy management system. Written report and presentation. | In-class observation and feedback. Evaluate student research and presentation skills. | Assess students' ability to use energy management systems and technologies. |
| Module 7: Renewable energy systems. Group project to design a renewable energy system for a specific location. | Field trip to a renewable energy facility. Peer evaluation and feedback on a group project. | Reflection paper and discussion. Assess students' ability to work collaboratively and design a renewable energy system. | Assess student understanding and engagement with renewable energy systems. |
| Module 8: Energy and the environment. Class discussion on the role of energy in sustainable development. | Research assignment on the relationship between energy consumption and climate change. In-class discussion. | Written report and presentation. Assess student understanding and engagement with the topic. | Evaluate student research and presentation skills. |

Learning Strategies Teaching and Learning Principles and Methods

Teaching energy literacy effectively requires active learning, collaborative learning, inquiry-based learning, multimedia learning, feedback and reflection, which are just a few examples of effective methods. Additionally, students can be assisted via developing a strong foundation in energy literacy strategies, such as monitoring energy use, setting goals, using energy-efficient technology and conducting energy audits.

To enhance students' energy literacy, several approaches have to be employed, including lectures, awareness sessions, social media posts, practical energy audits and smart meter monitoring. In order to promote awareness and reduce consumption, the course incorporated various educational methods effectively. Students participating in the inspection process and raising their awareness of energy consumption, while promoting energy efficiency and conservation practices, were through energy audits, which involved students visiting offices and classrooms, where they observed, identified energy-wasting areas and provided recommendations.

Allowing students to monitor and analyse energy consumption in academic buildings was another hands-on activity using smart meters. Students gained unprecedented accuracy and valuable insights into electricity consumption by measuring electricity usage in short intervals using the meters. Through these activities, students developed a deeper understanding of the impact of their energy consumption behaviour on building energy consumption. They also became aware of the environmental effects of electricity consumption and their contributions to it. In order to improve educational outcomes and cater to students' diverse learning preferences, the authors of this article designed the appropriate methods.

## ANALYSIS METHODOLOGY

A mixed-methods approach that combined quantitative and qualitative data was designed to evaluate the effectiveness of tailored sustainable energy practices among 30 Kuwaiti students. The assessment involved a quantitative questionnaire, focus group discussions and observations. A previous study by Alomari et al surveyed Kuwaiti students to gauge their energy literacy before introducing educational methodologies to enhance it [23]. The results showed that students had the highest scores in technical knowledge, followed by general and country-specific knowledge, with the lowest scores in environmental knowledge.

A total of 30 students interested in the Energy Literacy course were selected and committed to completing it. After completing the course, the same survey was administered again to assess participants' energy literacy, following extensive training incorporating innovative teaching methods. The results indicated significant improvements in all areas of knowledge, with technical knowledge experiencing the most significant increase at 74.77%. This increase is likely due to the technical nature of the course content. General knowledge also increased by 71.22%, attributed to the diverse teaching methods employed.

A quantitative approach was used to evaluate the effectiveness of these methodologies. A post-training survey was administered to gauge participant satisfaction with each teaching method and gather feedback. The survey consisted of four sections. The first section collected demographic data, including age, gender and education level. The second section included five Likert-scale questions that assessed participants' satisfaction with specific teaching methods or tools: educational lectures, awareness sessions, social media posts, practical energy audits and smart meter monitoring. The third section consisted of five open-ended questions that asked participants to describe the advantages and effectiveness of each teaching method. The final section included a single open-ended question, allowing participants to provide additional feedback.

## RESULTS

The survey data was analysed using XLSTAT for Microsoft Excel. The sample comprised a nearly equal proportion of males (46.67%) and females (53.33%). The age distribution showed that most participants were 18-20 (56.67%), followed by those aged 21-23 (36.67%), and only 3.33% were 24-26 or older. The breakdown by academic year revealed that 46.67% were seniors, 33.33% were juniors, 13.33% were sophomores and 3.33% were first-year students.

Table 2 presents the distribution of responses regarding assessing the educational lectures (TT1) on a seven-point scale. Most respondents (66.67%) strongly agreed that the lectures impacted on their awareness and behaviour. Additionally, 16.67% agreed, 10% somewhat agreed, 3.33% were neutral and 3.33% somewhat disagreed. The average response score was 6.4, indicating strong agreement with the statement.

Table 2: Descriptive statistics of TT1, TT2, TT3, TT4 and TT5.

| | TT1 | | TT2 | | TT3 | | TT4 | | TT5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| TT1 | Cnt | % | Cnt | % | Cnt | % | Cnt | % | Cnt | % |
| Strongly Disagree | 0 | 0.00% | 0 | 0.00% | 2 | 6.67% | 0 | 0.00% | 0 | 0.00% |
| Disagree | 0 | 0.00% | 2 | 6.67% | 2 | 6.67% | 0 | 0.00% | 0 | 0.00% |
| Somewhat Disagree | 1 | 3.33% | 1 | 3.33% | 1 | 3.33% | 0 | 0.00% | 0 | 0.00% |
| Neutral | 1 | 3.33% | 1 | 3.33% | 1 | 3.33% | 0 | 0.00% | 0 | 0.00% |
| Somewhat Agree | 3 | 10.00% | 3 | 10.00% | 3 | 10.00% | 3 | 10.00% | 0 | 0.00% |
| Agree | 5 | 16.67% | 5 | 16.67% | 5 | 16.67% | 2 | 6.67% | 1 | 3.33% |
| Strongly Agree | 20 | 66.67% | 18 | 60.00% | 16 | 53.33% | 25 | 83.33% | 29 | 96.67% |
| Mean | 6.4 | -- | 6.07 | -- | 5.67 | -- | 6.73 | -- | 6.97 | -- |
| Total | 30 | 100% | 30 | 100.00% | 30 | 100% | 30 | 100.00% | 30 | 100.00% |

In addition to the educational lectures, Table 2 illustrates the distribution of responses across seven agreement levels for evaluating the awareness sessions (TT2), social media posts (TT3), practical energy audits (TT4) and smart meter reading (TT5). For TT2, 60% of the respondents strongly agreed that the awareness sessions enhanced their awareness and behaviour, with 16.67% agreeing, 10% somewhat agreeing, 3.33% remaining neutral and 6.67% disagreeing. The mean response was 6.07, indicating general agreement.

For TT3, 53.33% strongly agreed on the positive impact of social media posts, while 16.67% agreed, 10% somewhat agreed and 6.67% disagreed. The mean response was 5.67, indicating a tendency towards agreement. TT4 saw a strong agreement rate of 83.33%, with 6.67% agreeing and 10% somewhat agreeing. The mean response was 6.73, indicating a solid agreement. For smart meter reading (TT5), an overwhelming majority (96.67%) strongly agreed that these activities enhanced their consciousness and conduct, with only 3.33% agreeing. The average response mean was 6.97, indicating robust concurrence.

Regarding qualitative analysis, data from survey parts III and IV were analysed using NVivo 12.0 for thematic coding, which involves identifying patterns and themes in the data. This method is crucial for discovering key themes. By running a query in NVivo, several nodes were mapped to three primary themes: culture, engagement and learning style. Culture was the most referenced theme across all five teaching tools, ranging from approximately 40% to 44%. Engagement followed closely, ranging from 28% to 35%, while learning style had the lowest coverage, ranging from 25% to 29%.

## DISCUSSION

The course's primary objective is to empower Kuwaiti students with the knowledge, skills and attitudes necessary to make informed decisions about energy consumption and advocate for a more sustainable future. To achieve this, the course provides a structured learning experience, covering fundamental concepts, such as current and voltage, which builds upon more complex concepts like power and power factors. This structured approach is linked to increased general knowledge, as demonstrated by the practical demonstrations reinforcing basic and technical concepts.

In addition, the course has led to a significant increase in country-specific knowledge, with a 39.65% boost, resulting from students' engagement in group discussions and activities that focused on Kuwait-specific energy-related topics. For example, students learned how to calculate their energy consumption and link it to the Ministry of Water and Electricity's calculations. Furthermore, the course has also increased environmental knowledge, with a 21.42% increase, demonstrating the effectiveness of the energy literacy programme.

However, the course's benefits extend beyond mere knowledge acquisition. The programme has also positively impacted the participants' affective and behavioural dimensions. The affective dimension has increased by 27.86%, while the behavioural dimension has increased by 23.89%. The course's focus on awareness-raising and a sense of responsibility has directly influenced participants' affective responses and boosted their confidence in making informed energy-related choices.

For instance, participants have become more mindful of energy conservation practices, such as turning off lights before leaving a room or replacing old light bulbs with energy-efficient alternatives. At the beginning of the course, many participants believed it was not their responsibility to turn off lights or change light bulbs; however, by the end of the programme, they had developed a greater sense of responsibility and self-efficacy in making energy-conscious choices.

## CONCLUSIONS

This study successfully achieved its objective of establishing an energy literacy course that aligns with Kuwaiti cultural values and effectively addresses the diverse needs of students. The primary goal of the course is to enhance participants' knowledge, attitudes and behaviours regarding energy conservation.

The results are significantly positive, showing a 74.77% increase in technical knowledge, a 71.22% improvement in general understanding and a 21.42% boost in environmental awareness. Additionally, there was a 23.89% increase in behavioural changes and a 27.86% uplift in students' attitudes toward energy-related issues.

Using a multi-phase design that incorporated cultural relevance and diverse teaching methods, the course provided students with both theoretical and practical understanding. Activities such as energy audits (83.33% strong agreement), renewable energy projects and smart meter monitoring (96.67% strong agreement) were particularly effective in helping students understand energy principles and adopt sustainable practices in their daily lives.

The positive impact of this course on both technical knowledge and behavioural change demonstrates its effectiveness as an educational approach. It could serve as a model for other universities in similar cultural contexts, particularly in the Gulf region. The favourable feedback on the teaching methods emphasises the importance of combining technical knowledge with engaging and culturally sensitive instruction. Together, these elements provide a solid foundation for improving energy literacy and promoting sustainability education.

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