Improving energy literacy among Kuwaiti university students with a tailored course on sustainable energy practices

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ABSTRACT: In this article, the authors explore the impact of an energy literacy course tailored exclusively for Kuwaiti students, designed to align with Kuwaiti social norms and culture. The course's objective is to enrich students' cognitive comprehension, affective attitudes, and behavioural practices related to energy consumption and conservation. This study used a comprehensive approach that combines quantitative and qualitative survey methods, including focus group discussions and observations to assess the course's effectiveness. The results showed that the energy literacy course was successful in improving students' energy-related knowledge, affective attitudes and behaviours. The findings show that students who participated in the course demonstrated greater cognitive gains, particularly on items related to more practical topics, and a more positive attitude towards energy conservation as compared to their levels before the course. Overall, the tailored energy literacy course proved to be an effective intervention, successfully enhancing students' cognitive understanding, cultivating positive affective attitudes and promoting sustainable energy-related behaviours.

Keywords: Energy literacy course, Kuwaiti students, course's effectiveness, cognitive, affective, energy conservation behaviours

INTRODUCTION

Energy literacy is essential for making informed decisions about energy consumption and conservation, helping to reduce carbon footprint and promote sustainability. It is a multifaceted concept beyond just knowing about the different energy sources available. It also encompasses attitudes and behaviours of people toward energy consumption and their understanding of the economic, social and environmental impacts of energy use [1]. Experts and organisations have created many models to possibly increase the energy literacy of people throughout the past two decades [2][3].

Educational programmes have played a vital role in the widespread promotion of energy literacy [4]. Educational institutions worldwide have included energy education in their academic programmes, including subjects, such as renewable energy, energy preservation, and the global energy panorama [5]. Interactive programmes and workshops have been specifically developed with the intention of actively involving students and the public in experiential learning opportunities, hence facilitating a more profound comprehension of ideas connected to energy [6].

Several studies have analysed the energy literacy levels of people on various scales. First, the paradigm developed by DeWaters has given other researchers a common framework for assessing and contrasting the growth of energy literacy in several nations [7]. Lee et al [8] and Yeh et al [9] examined the energy literacy levels of students in Taiwan; Lee et al [10] in Vietnam; Huang and Gao [11] in China; Akitsu and Ishihara [12] in Japan; Białynicki-Birula et al [13] in Poland.

The structure of the components that make up energy literacy courses, however, has only been presented in a few studies. Hoople et al developed the *An Integrated Approach to Energy* course for undergraduate students [14]. It consists of four components: the basis of energy, energy production, energy policies, and energy use. DeWaters et al designed an engineering course, called *Introduction to Energy Systems*, which emphasises the intricate relationships between energy technology and sustainability factors, approaching energy education from a socio-technical viewpoint [15].

The course's content and learning activities are organised around learning objectives that call for students to acquire both technical knowledge and an understanding of the larger consequences of energy use and preservation. It includes several topics: prospects for the development of clean energy, systems of energy and the basics, the fundamentals of energy and systems, energy sources and energy use, electrical power, non-renewable energy, energy for transportation, and all forms of energy resources.

Even though there have been several research studies on energy literacy [16] and the factors that influence energy-saving behaviour [17][18], relatively few have concentrated on the needs and motivation of university students to improve their energy literacy, particularly in the Gulf nations. Kuwait is one of the largest producers and exporters of oil with around 7% of the world's oil reserves [19]. However, the country is also facing significant energy challenges, such as rising energy demand, increasing energy costs and environmental concerns [20]. Hence, it is imperative that Kuwaiti students possess the requisite information and abilities to comprehend and effectively tackle these difficulties.

The inclusion of an energy literacy course is of utmost importance for Kuwaiti students due to its capacity to facilitate informed decision-making regarding energy consumption and conservation. Additionally, such a course provides students with the requisite skills to pursue careers in the expanding energy sector, which is projected to experience substantial growth in the foreseeable future. Moreover, it fosters an understanding among students about their potential contributions towards Kuwait's transition to a more sustainable future. The primary objective of this research is to fill the existing knowledge gap by examining the effects of a customised energy literacy programme on the cognitive, emotional and behavioural aspects of Kuwaiti students in relation to energy use and conservation. The results of this research will provide significant contributions towards the establishment of efficient energy education initiatives for students in Kuwait, hence aiding in the realisation of sustainable development objectives.

TAILORED ENERGY LITERACY COURSE

To mitigate the escalating energy challenges faced by Kuwait, a customised energy literacy course was designed specifically for university students with the aim of fostering energy literacy on the basis of the findings of energy literacy by Alomari et al [21][22] and the factors that influence conservation behaviour by Alomari et al [16][17]. The curriculum of this course has been meticulously crafted to correspond with the prevailing social norms and cultural values of Kuwait. Its primary objective is to augment students' cognitive comprehension, emotional attitudes, and behavioural practices pertaining to energy use and conservation. The curriculum of the course included a diverse array of energy-related subjects, such as energy consumption, conservation practices and the principles of sustainability. To effectively include students and encourage the adoption of sustainable energy practices, the course used a diverse range of pedagogical strategies. The approaches used included several instructional formats, such as lectures, awareness workshops, social media postings and experiential learning exercises. The use of a diversified approach in instruction accommodated the various learning styles of students, hence promoting sustained engagement throughout the duration of the course.

To provide students a realistic learning experience, the course included hands-on activities, including the implementation of building energy audits and smart meter monitoring. These activities provided students with opportunities to apply the academic information they acquired in practical, real-world contexts. The training provided participants with an enhanced comprehension of Kuwait's distinct energy problems, possibilities and possible solutions, with a special emphasis on topics pertaining to the country's energy sector. The implementation of this localised strategy has provided students with the ability to make well-informed choices and actively participate in the promotion of sustainable energy practices in Kuwait.

METHODOLOGY

To assess the efficacy of the energy literacy course, a research methodology including both quantitative and qualitative methods was used.

Quantitative Methodology

The chosen methodology for this study was a pre-test post-test design, which falls under the category of quantitative research. The administration of the pre-test took place at the commencement of the course, while the post-test was delivered at the conclusion of the course. The primary objective of the pre-test was to establish a foundational level of knowledge and attitudes pertaining to energy-related subjects among the student population. Conversely, the post-test was used to assess the efficacy of the energy literacy education course in effecting changes in these knowledge and attitudes. Three hypotheses were developed. The null hypotheses are stated below.

- H1: There is no significant difference between the *cognitive* mean scores of the pre-course and post-course.
- H2: There is no significant difference between the *affective* mean scores of the pre-course and post-course.
- H3: There is no significant difference between the *behaviour* mean scores of the pre-course and post-course.

The survey instrument used in the quantitative methodology is the questionnaire. The questionnaire was developed based on DeWater's framework on energy literacy [15]. The questionnaire consisted of four sections: 1) Demographics; 2) Cognitive; 3) Affective; and 4) Behaviour. Table 1 shows the distribution of questions based on each section, its content and type. Demographics collected were gender, nationality and age. Cognitive questions were multiple-choice questions (MCQs) and were categorised into four sub-sections which are: 1) General knowledge (GK); 2) Technical knowledge (TK); 3) Country-specific knowledge (CSK); and 4) Environmental knowledge (EK). On the other hand, affective and behavioural questions were based on a Likert scale that ranges from 1 from *strongly disagree* to 5 for *strongly agree*.

Table 1: Questionnaire design.

Section		Number of questions	Content covered	Type
1. Cognitive	GK	4	• Basic scientific facts • Smart meters • Energy audit	MCQ
	TK	4		
	CSK	4		
	EK	4		
2. Affective		10	• Attitude towards energy usage • Concerns about energy misuse • Efficacy beliefs	Likert scale
3. Behaviour		10	• Daily activities related to energy usage • Willingness to work towards better energy usage • Willingness to change behaviour	Likert scale
Total of three sections		36		

The questionnaire was designed to suit the cultural context of Kuwait. Moreover, questions related to scientific facts were developed to align with the current standards and systems in Kuwait. For example, instead of referring to a 120 V, 60 Hz supply voltage, the questionnaire accurately reflected the Kuwaiti standard of 240 V, 50 Hz. In addition, to ensure that students could answer to the best of their ability the language used was kept straightforward and easy to understand. Arabic translations were also provided for added clarity.

To assess the clarity and comprehensiveness of the questionnaire, a pilot study was conducted involving three randomly selected students who were asked to review the questionnaire and provide feedback on its clarity and need for potential corrections. Feedback from the pilot study was incorporated to enhance the questionnaire's clarity.

Initially, an updated version of the questionnaire was created using Google Forms, and the link to access the questionnaire was distributed resulting in 56 responses collected prior to the students in the energy literacy course. The questionnaire was designed to ensure that only Kuwaiti respondents could proceed to complete the survey. Additionally, the questionnaire included an inquiry of whether the students were interested in participating in an upcoming energy literacy training course. Out of the 56 collected responses, 45 respondents expressed their interest in attending the course. Due to the limited seat availability, only 30 randomly selected respondents were admitted to the energy literacy course. After the energy literacy course along with its hands-on activities had been completed, the selected respondents were asked to complete the same questionnaire. All 30 participants responded to the survey.

Data collected from the pre- and post-course were transferred to SPSS 29. Initially, descriptive analysis and frequencies were generated to assess the value of mean and percentages. Then a paired sample *t*-test was conducted to compare the means of the two samples pre- and post-course attendance.

Qualitative Methodology

After the quantitative data was collected and analysed, a qualitative methodology was followed for an in-depth exploration and understanding of the observed phenomenon. Randomly selected participants in the energy literacy course were invited to respond to three main questions to gain a rich understanding of the underlying meanings, contexts and experiences they gained from the course. Interview questions were sent by e-mail, and ten respondents replied using the same method. Text collected from the interviews was analysed using NVivo 14 through systematically identifying and categorising key themes, concepts or ideas within the data, enabling the uncovering of patterns and connections.

The randomly selected ten participants were asked questions after they had completed the energy literacy course. The three questions are listed below:

1. Cognitive theme: a) How has your understanding of energy-related terms and symbols improved after completing the energy literacy course? And b) Can you provide specific examples of energy-related terminologies that you have become more aware of as a result of the course?
2. Affective theme: a) In what ways has the energy literacy course empowered you and increased your confidence in dealing with energy-related matters? And b) How has the course enhanced your self-efficacy in adopting sustainable practices and thinking positively towards energy?
3. Behavioural theme: a) Can you share any specific changes you have made in your energy habits as a result of completing the energy literacy course? And b) How has the course influenced your daily energy practices, and what improvements have you observed?

These interview questions aim to delve deeper into the experiences and perspectives of the participants regarding the cognitive, affective and behavioural impacts of the energy literacy course. For simplicity of understanding, the word knowledge has been used to replace the word cognitive, while the word attitude has been used to replace the word affective.

RESULTS AND ANALYSIS

Quantitative Results and Analysis

Data was collected from 56 Kuwaiti respondents with only 45 expressing willingness to participate in the energy literacy course. Out of this group, 30 respondents were randomly selected and participated in the post-course survey following their participation in the energy literacy course. Data collected from the same respondents during the pre-course was only used for the analysis. Pre-course respondents were able to be identified through an automatically generated ID. During the post-course, respondents were instructed to enter the same ID they provided in the pre-course survey. Of the 30 respondents, 60% were male and 40% were female. Table 2 presents the descriptive results of pre-course and post-course for the 30 respondents. The percentage for the cognitive part represents the portion of correct answers marked by the students who correctly answered a particular question from the 16 multiple-choice questions. The means for the affective and behaviour parts represent the mean of responses ranging from 1 to 5 collected from the 30 respondents through the 20 questions with ten questions for each part respectively.

Table 2: Descriptive results - pre-course and post-course.

		Pre-course			Post-course				
		Mean	Percentage	SD	Mean	Percentage	SD	% Increase	Ranking as per increase
Cognitive	GK	--	41.25%	5.61	--	70.63%	4.95	71.22%	2
	TK		43.75%	11.57		76.46%	6.74	74.77%	1
	CSK		49.38%	9.68		68.96%	8.29	39.65%	3
	EK		55.42%	7.25		67.29%	7.51	21.42%	4
Affective		3.23	--	0.89	4.13	--	0.61	27.86%	
Behaviour		3.14	--	0.62	3.89	--	0.52	23.89%	

As seen from Table 2, technical knowledge revealed a remarkable 74.77% increase from pre-course and post-course enrolment results. This substantial improvement can be attributed to the fact that the technical content that was covered in the course and demonstrated to the participants has positively enhanced their knowledge due to the use of smart meters and energy auditing sessions. Students became more competent in identifying and responding to technically based questions. Their exposure to hands-on activities and practical demonstrations has made them more engaged with energy concepts and applying their knowledge in real-world scenarios. Building and testing energy models, conducting energy audits of buildings, and participating in energy conservation practices provided participants with invaluable practical experiences that solidified their technical knowledge and understanding.

The second most significant improvement was observed in general knowledge, with an impressive 71.22% increase between pre-course and post-course assessments. This increase can be attributed to the well-structured course material covered which effectively stimulated the student's critical thinking, problem-solving and creativity. The course promoted critical thinking skills by encouraging students to analyse energy-related issues from multiple perspectives. Moreover, problem-solving activities embedded in the course have challenged students to find innovative solutions to energy challenges, fostering creativity and empowering them to think critically about sustainable energy practices. Country-specific knowledge demonstrated a significant increase of 39.65%, ranking third among the assessed areas. This increase can be justified by the fact that the course was specifically designed for the Kuwait context, enabling participants to gain a comprehensive understanding of energy-related concepts within their own country.

The least-ranked increase was in environmental knowledge with an increase of 21.42%. This can be explained that the course has contributed to raising students' awareness of environmental issues related to energy consumption and conservation by deepening their understanding of energy sources, efficiency and conservation practices. Accordingly, students developed a stronger environmental consciousness and the ability to make informed decisions regarding energy consumption and conservation. Moreover, the results of Table 2 show that there is also an increase in the means of affective and behaviour questions as responded to by the same participants. The affective as well as behaviour questions have revealed an increase in means of 27.86% and 23.89%, respectively.

Following the mean analysis, a paired *t*-test for pre- and post-means was used to determine whether there is a significant difference between the means of the two dependent variables measured before and after the energy literacy course delivery to the participants. Table 3 shows the results of the paired *t*-test for the three variables: cognitive, affective and behavioural.

Since the *p*-value of all items and sub-items is less than the significance level (0.05), the null hypothesis is rejected. This means that there is enough and significant evidence to suggest that there is a significant difference between the mean scores of the paired variables before and after the intervention by introducing the energy literacy course. Moreover, since all *t*-values are positive, this explains that the significant increase is in the post-intervention scores. This confirms the assumptions that the energy literacy levels shown in Table 2 have not increased from the pre-course scores by chance but by the intervention, and the results indicate that the increase is significant.

Table 3: Paired samples statistics.

Item	Sun-Item	Mean difference (post-pre)	*t*-value	Sig. (2-tailed)
Cognitive	GK	29.38	3.15	0.000
	TK	32.71	3.82	0.003
	CSK	19.58	2.98	0.000
	EK	11.87	2.74	0.002
Affective		1.9	1.98	0.012
Behaviour		0.75	1.42	0.001

Qualitative Results and Analysis

All text collected from the ten respondents through e-mail has been entered into NVivo software. Accordingly, themes have been created, and a code map has been generated. The code map shows the relationships between different codes related to energy literacy. The codes are represented by nodes, and the relationships between them are represented by links. A frequency table has been extracted to show the percentage coverage of every node following thematic coding as shown in Table 4.

Table 4: Thematic coding percentage table.

Item	Node	Percentage Coverage
Cognitive	Improved understanding	62.3%
	Increased awareness and knowledge	25.9%
Affective	Empowerment and confidence	31.6%
	Increased self-efficacy	14.6%
Behaviour	Better energy habits	41.7%
	Improved energy practices	32.9%

As seen from Table 4, three themes were developed based on the three questions that have been asked during the interviews and shared by e-mail. The three themes are cognitive, affective and behaviour. Thematic coding has been run in NVivo and the mostly and highly referenced two codes are only displayed. For the cognitive item, two nodes were highly referenced, which are: 1) improved understanding; and 2) increased awareness and knowledge. One of the interviewees mentioned in his reply that …*After finishing the energy literacy course, my understanding became way better than before with regards to energy terms. I am now able to identify many energy symbols.*… Another interviewee mentioned that her …*awareness has increased of energy related terminologies*. This goes in harmony with the results obtained in the quantitative results.

On the other hand, two nodes emerged in relation to the affective item which are: 1) empowerment and confidence; and 2) increased self-efficacy. Many interviewees' responses were linked to improved confidence and self-efficacy. Self-efficacy gained by the students has encouraged them to be more sustainable and think positively towards energy and hence improve their energy literacy. Finally, with regards to the behavioural item, the nodes that emerged are: 1) better energy habits; and 2) improved energy practices. One of the interviewees mentioned in her response that …*I have better energy habits now. When I leave the house, I make sure that all light switches are off. Also, I do not keep my computer screen on all time.* Another interviewee reported that the energy literacy course had improved his energy practices related to his daily life.

DISCUSSION AND CONCLUSION

The study's findings underscore the effectiveness of culturally tailored energy literacy courses in enhancing student energy literacy. The research findings indicated that the educational programme not only enhanced cognitive comprehension, but also resulted in favourable emotional and behavioural consequences pertaining to energy use and preservation. The research revealed that the course significantly improved cognitive comprehension of energy-related technical concepts, general knowledge and information relevant to the nation in question. The modular form of the course facilitates a full comprehension of energy-related topics and their connection with the environment, therefore promoting energy literacy. The students indicated an enhanced comprehension of energy terminology, symbols and ideas. Furthermore, they demonstrated the capacity to recognise and use energy-conserving strategies in their everyday routines. The training facilitated favourable emotional results, enhancing students' belief in their abilities and effectiveness in relation to energy saving. The students expressed a heightened sense of empowerment in relation to their ability to effect change in their own energy consumption behaviours. Furthermore, there was a higher propensity among individuals to hold the belief that their activities have the potential to yield favourable outcomes for the environment.

The efficacy of the course is derived from its customised methodology, which uniquely caters to the distinctive energy difficulties and prospects inherent to Kuwait. Through the integration of local case studies, debates and practical exercises, students are able to acquire a more profound comprehension of the significance of energy in their everyday

lives and the broader advancement of the country. The course has been recognised as an effective mechanism for promoting conscientious energy consumption behaviours among university students in Kuwait, leading to their transformation into proponents of sustainable energy practices within their country.

In general, the outcomes of the research indicate that the energy literacy education course has the potential to be an effective instrument in fostering energy literacy and encouraging sustainable behaviour among students in Kuwait. By incorporating local cultural contexts and norms, these programmes have the ability to actively involve students and foster the adoption of sustainable energy practices. By imparting extensive information, cultivating favourable attitudes and promoting behavioural modifications, the course has the capacity to significantly contribute to the attainment of a more sustainable future for Kuwait.

ACKNOWLEDGEMENTS

This project was completed with the support of the Electrical Engineering Department, IT Department, facilities, and our colleagues at the Australian University, Kuwait.

FUNDING

This work was supported by the Kuwait Foundation for the Advancement of Sciences (KFAS) under project code PN19-15EM-02.

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