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## Secondary Students' Awareness on Renewable Energy: A Comparison Between Malaysia and Oman



**Abstract:** - This study responds to the critical imperative of strengthening renewable energy (RE) education and fostering sustainable development awareness among secondary school students in Malaysia and Oman. It investigates the feasibility of using the mobile learning module named "MyREL" to enhance students' understanding, awareness, and interest for RE and sustainable development. The research findings underscore significant improvements in students' knowledge levels post-implementation of the "MyREL" module, with a more substantial increase observed in Oman. Developed content within "MyREL" plays a pivotal role in enhancing students' awareness of RE and climate issues, addressing the initial low levels of awareness in both countries. Notably, the study reveals a remarkable boost in students' interest in pursuing higher education and careers in the RE sector, highlighting the module's effectiveness in nurturing interest. While acknowledging study limitations, such as a small sample size and a brief intervention period, the research encourages future exploration to refine content, employ diverse teaching strategies, and conduct long-term assessments for knowledge and interest retention. Ultimately, this feasibility study underscores the significance of technology-enhanced learning, exemplified by "MyREL," in advancing RE literacy and advancing global efforts to combat climate change while facilitating the transition to cleaner energy sources.

**Keywords:** Education for Sustainable Development, Secondary School, Mobile Learning, Awareness, Renewable Energy

### Introduction:

In recent times, the world has seen a rapid advancement in terms of social and technological aspects, which will only gain more fraction and acceleration in the upcoming years. To maintain this rapid growth the energy demands around the world have skyrocketed which is directly responsible for the current global environmental and climate crisis we are facing today (Khairudin et al., 2020; Vanegas Cantarero, 2020; Zainal Ariffin et al., 2022). To overcome these issues the United Nations (UN) has come up with the Sustainable Development Goals (SDGs) aiming to mitigate global environmental issues with 17 interlinked goals. One of the primal goals of the SDGs is Clean and Affordable Energy (Goal 7) which is highly dependent on the Goal 4 Quality Education for all (Osborn et al., 2015). When it comes to transition to a more cleaner and sustainable energy consumption route, awareness amongst the public in society is of paramount importance. Recent studies across various countries have seen that the public perception, knowledge and awareness about Sustainable Energy, Renewable Energy (RE) concepts are very low, which causes barriers for societies to implement and innovate RE technologies in their current energy production field. Thus, affecting the targeted goals of RE production and reduction in fossil fuel dependency of many countries, specifically in developing and underdeveloped countries (Çakırlar Altuntaş & Turan, 2018; Derasid et al., 2021; Gielen et al., 2019; Islam et al., 2009; Khairudin et al., 2020; Moorthy et al., 2019; Nasirov et al., 2015; Paravantis et al., 2014; Zainal Ariffin et al., 2022; Zakaria et al., 2019). To overcome these barriers, education plays a critical role in creating more awareness about RE and environmental issues, dissemination of knowledge about RE technologies and creating more holistic citizens equipped with the knowledge and interest and skills to be part of the RE industry and develop more innovative technologies in the RE sector to make cleaner energy more affordable (Azil Illias et al., 2020; Blechinger et al., 2015; Hoque et al., 2022; Mahalik et al., 2021; Revák et al., 2019; Zyadin et al., 2014). Thus, this study aims to use a developed mobile learning module with the theme of RE and Education for Sustainable Development (ESD) to test its feasibility in enhancing students' knowledge, awareness about RE and interest in pursuing higher education and career in the RE sector. The study aims to compare the feasibility results acquired from this experimental study in different countries which includes Malaysia and Oman.

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### 1.1 Background of Secondary School syllabus in participating countries

Introducing RE education and ESD in the secondary curriculum will have a positive impact on future citizens of a country to be more aware and interested in those subjects according to past research. Various past research has outlined that the subjects taught in secondary schools directly influences student's interest in those particular subjects at the tertiary and higher education level (Chen et al., 2015; Grossman & Stodolsky, 1995; Hoque et al., 2022; Iroaganachi et al., 2021; Sund & Gericke, 2020). According to various researchers, the presence of structured, detailed and interactive subjects in secondary level of education equips students early with the basic knowledge, future implications, limitations and gaps and career opportunities in those subjects' fields thus allowing them to gain interest and motivation to pursue those subjects in their higher education and career (Grossman & Stodolsky, 1995; Kleespies & Dierkes, 2022). Similarly having RE education and ESD in the current secondary school curriculum will play a pivotal role in enhancing students' interest in pursuing higher education and career in the RE sector.

The secondary schools in Malaysia follows the Malaysian National Curriculum, Kurikulum Standard Sekolah Menengah (KSSM). According to research conducted on the current KSSM syllabus and contents using qualitative and quantitative research designs, it was found that there a very few scattered presences of RE, environmental issues, energy literacy and sustainability topics in the syllabus. But the content depth is very shallow and is present only as a cross curricular element. Also, the teachers have no fixed guidelines on the implementation method to implement RE and ESD learning thus making the overall elements less impactful. The quantitative analysis of the study found that the level of knowledge of teachers and students about RE, Solar Energy and technologies is very weak (Rabiatuladawiyah Bt et al., 2022).

The secondary school that participated in the study in Oman followed the Pearson International General Certificate of Secondary Education (IGSCE). During analysis of the IGSCE syllabus it was found that there is a very minimal presence of RE or environmental issues or RE technologies as a whole. Furthermore, none of the syllabus KSSM and IGSCE provide detailed, structured knowledge about RE, Environmental issues, various types of RE technologies or sustainable energy literacy as a whole. Few elements of RE and climate issues or ESD are present in various cross-sectional subjects in a very unstructured format, making the overall impact on students' attributes less impactful. According to a survey conducted by Pearson, where they interviewed teachers on the content and teaching method of Sustainability and climate issues as key factors, it was found that teachers showed positive enthusiasm to the introduction of specific subject about Sustainability and RE literacy, but it also highlighted the lack of existing content in the current syllabus (Evren Alibaba, 2023). Thus, there is a gap found in both the syllabuses where there is a clear lack of subject specific curriculum with structured and detailed knowledge of RE, Environmental and Climate issues and Energy literacy as a whole.

### 1.2 Mobile learning in Malaysia and Oman

Mobile learning (M-learning) is the new age phenomenon that has seen rapid popularity in recent years with the advancement in mobile technologies seen throughout the world. This advancement in cutting edge mobile and software technologies is impacting various aspects of life including the educational sector in a positive and impactful way (Nikolopoulou & Kousloglou, 2019; Rafiq et al., 2021). M-learning exhibits immense potential in conducting effective learning, distant learning and providing quality education for aspects of the society due to its advantages like portability, collaboration, ease of communication, active learning and availability (Keskin & Metcalf, 2011; Nor Fadzleen Sa'don et al., 2014; Uvarov Alexander et al., 2019). Thus, to equip the current generation of students with the technological literacy and also the 21<sup>st</sup> century skills, M-learning is at the core of many educational policies across various countries across the globe including Malaysia and Oman.

Malaysia has a population that is well versed and accustomed to the usage of mobile technologies as 88.79% of its population have access to smartphones and 96.85% have access to internet. Amongst the population that possesses a smartphone 13.5% and 24.5 % belong to the age group 15-19 and 20-24 respectively thus allowing smooth implementation of M-learning method of learning and teaching (Hoque et al., 2023). Also, the government has implemented various policies like the Malaysian Education Blueprint 2013-2025, which consists of 11 shifts in transforming the education sector of the country and amongst those shifts two shifts particularly emphasizes on the usage of ICT devices and technologies to conduct teaching and learning and another shift focuses on providing

quality education for all with the usage of mobile technologies to conduct distant learning (Ministry of Education, 2013).

Oman is a country which has a huge population of expats currently residing in the country earning a livelihood across various industries (Jomar Mendoza, 2023). According to data from the Ministry of Technology and Communications 95% of the population possess smartphones and 94% of the population have access to quality internet services (refer to Figure 1).

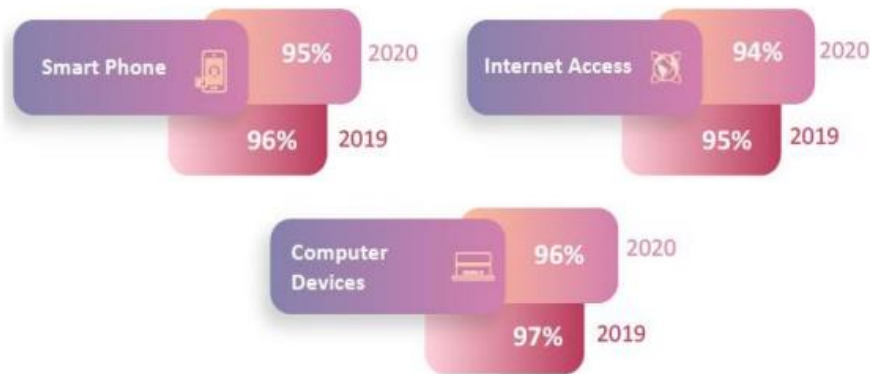


Figure 1: Statistics of population with access to smartphones and Internet (2020)

The estimates also included the families of the expats who have access to the internet (refer to Figure 2). With a population well versed and adapted to the usage of mobile technologies, Oman also encourages the usage of ICT based learning through government intervention and policies with 87% of the secondary schools in Oman have access to internet infrastructure and are conducting ICT based and M-learning in small scale for their daily teaching and learning activities (Ministry of Technology and Communications, 2020). Also, according to various other public based research, it was seen that teachers, educators and students responded positively on the implementation of M-learning for their learning activities in secondary and tertiary level of education (Al-Emran & Shaalan, 2017). Thus, M-learning is quite a useful and effective method to allow for ESD and RE education in both the countries as a mode of learning.

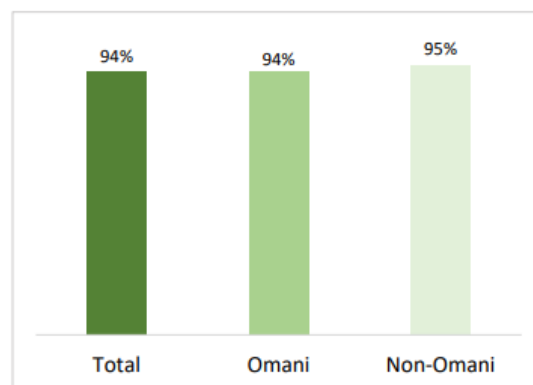


Figure 2: Distribution of access to Internet based on citizenship (2020)

## 2. Aim of the paper

This study is a continuation of a study which was aimed at developing a mobile learning module focusing on RE education and energy literacy as a whole. This paper highlights the implementation and feasibility testing of the developed module in Malaysia and Oman and analyzes and compares the result obtained in both the countries in terms of how the developed module performs in enhancing secondary school students' knowledge, awareness about Renewable Energy and climate issues, and enhancing their interest towards higher education and career in

the RE industry. This study will answer the following research questions and compare the results of each question in both the selected countries.

R1: Did the students' score on knowledge about RE and climate issues increase after using the module and the system?

R2: Did the students' awareness level on RE and climate issues increase after using the module and system?

R3: Did the students' interest level in RE education and career increase after using the module?

### 3. Methodology

This study is a continuation of a larger project which followed the ADDIE Instructional Design (ID) to develop the module and the m-learning system and followed the phases of ADDIE to implement and evaluate the data. ADDIE is an ID that consists of 5 stages Analysis, Design, Development, Implementation and Evaluation (Peterson, 2003). Based on past research and educational designers, ADDIE is very effective in developing and testing the quality and efficiency and feasibility of the developed module. Due to its easy to comprehend instructions and stages ADDIE can be used to develop modules, courses for any sort of educational methods (Siri et al., 2022; Spatioti et al., 2022). This paper focuses on the last two stages of the ADDIE model which is Implementation of the developed module and system and evaluation of its feasibility.

#### 3.1 Implementation in Malaysia and Oman

The developed module was implemented in two schools in Malaysia between the age group 10-17 on students in the secondary level of education. Purposive Random Sampling technique was used to select the participants as this technique based on literature allows to select the participants that can exhibit the best results for this quasi-experimental (cause and effect) study (Campbell et al., 2020). A total of 69 students participated in the study from both the schools and 3 teachers were also involved in the study to help facilitate and supervise and provide collaborative learning opportunities to the students using the developed module and system. The system was developed in the form of web application and the contents were made in digital format and uploaded in the system for the students to interact, download and use at their own pace. The contents included slides, articles, interactive videos and quizzes with topics ranging from current environmental issues, introduction to RE and RE sources, SE and Solar PV cells and how each component in various renewable energy technologies work and also career opportunities in the field of RE.

The study was conducted for weeks in all the schools where initially a pretest survey was conducted online to collect data on the three attributes of students that we were measuring to answer the three research questions mentioned above. Then the intervention (developed module and system) was conducted for four weeks as part of co-curricular activities outside the school's formal learning hours. Then the posttest survey was conducted to collect the data for analysis.

In Oman, the same implementation strategy was used to collect the data. One school was selected to participate in the study. The school selected was a community school consisting of majority of students who belong from the expat family of that country ranging from students of various South Asian nationalities. Since the school consists of a huge number of students, 65 students were selected from this school itself who participated in the study belonging to age groups of 10-17. Two teachers also assisted in providing the necessary facilitation and supervision to go inline with the steps conducted in Malaysian schools.

#### 3.2 Evaluation of the data

The collection of the data was conducted online via google forms to collect students' pretest and posttest data from the survey. The survey questionnaire was developed and validated with the help of experts in the field of education and RE. The survey questionnaire was divided into three sections, the first section collecting the knowledge score of the student which included 8 multiple choice questions. The questions tested the students' basic knowledge on RE, types of RE, Environmental and climate issues, and differentiation between RE and Non-RE sources. The awareness section consisted of 12 questions with three options "yes", "no" and "maybe". The awareness section tested the students' awareness level on RE issues, government initiatives, their personal

perspectives on RE and its implementation, and their willingness to use and learn about RE technologies. The knowledge and awareness section of the survey was developed by taking inspiration from the work done by Serpnil Onder's (2006) questionnaire used in his study (Onder, 2006). The interest section of the survey was developed based on the Theory of Planned Behavior and its guidelines for developing the questionnaire (Ajzen, 2006). According to the Theory of Planned Behavior (TPB), human behavior is influenced by three types of considerations: beliefs regarding the expected outcomes of the behavior (behavioral beliefs), beliefs about the social expectations of others (normative beliefs), and beliefs about the presence of factors that may facilitate or hinder the performance of the behavior (control beliefs). When these beliefs are combined, they form attitude towards the behavior, subjective norm, and perceived behavioral control. These factors collectively contribute to the formation of behavioral intention or interest (Ajzen, 2006). Thus, the interest section consisted of 22 questions with Likert 7-scale bipolar options for each of the questions.

The analysis of each of the attributes of the students was done using descriptive statistical analysis in Ms. Excel and SPSS software. For the knowledge section, each correct answer was given 1 point and the mean score of the students was calculated for the pretest and posttest and the mean difference was also calculated. Then a paired t-test was conducted on the set of data to see if the difference is significant or not. To analyze the awareness variable, the answers were divided into positive answers if the student answered "yes" in their response and negative answers if the student answered "no" or "maybe". Then the percentage of positive and negative answers were calculated for pretest and posttest and finally analyzed if the percentage of positive answers were increased or not which will result in increase of awareness of the students. For the interest attribute, initially a Cronbach's Alpha testing was conducted to verify the reliability of the Likert Scale answers and once verified the mean score of the pretest and posttest was calculated and put under a paired t-test again to see if the interest is significantly increased or decreased. The data was divided based on the two countries and compared in the next section.

#### 4. Results

The data was collected via online survey in both the countries' schools. The pretest survey was conducted initially and then the intervention was conducted for four weeks to allow the students to interact with the developed module and web application. After the end of the intervention period, the posttest survey was conducted via online, and the data was recorded and analyzed to answer the following research questions.

##### 4.1 Did the students' score on knowledge about RE and climate issues increase after using the module and the system?

After analyzing the data collected from Malaysian schools, it was seen that the score of students' knowledge was increased after the intervention. Based on the pretest score it was seen that the level of existing knowledge of students was relatively high with more than 70% of the students correctly answered all the 8 questions. The pretest scores for each question was 86.9%, 97.1%, 82.6%, 86.9%, 78.2%, 85.5%, 82.6% & 75.3% of the students answering correctly and in the posttest it was seen that the percentage of correct answers for each questions increased to 92.7%, 98.5%, 86.9%, 89.8% 84%, 91.3%, 91.3% & 82.6% respectively (mean increase = 5.25%) (refer to Table 1).

Table 1: Students score on knowledge during pre and posttest in Malaysia

Questions	Pre-Test (%)	Post-Test (%)	Difference (%)
1	86.9	92.7	5.8
2	97.1	98.5	1.4
3	82.6	86.9	4.3
4	86.9	89.8	2.9
5	78.2	84	5.8
6	85.5	91.3	5.8
7	82.6	91.3	8.7
8	75.3	82.6	7.3
	Mean Difference (%)		5.25

To check whether the increase was significant, a paired t-test was conducted on the total scores of the students in pretest and posttest and it was seen that the p value was less than 0.05 ( $p = 0.01$ ), thus it can be confirmed that the difference in score was significant and the knowledge score of students was increased significantly after using the module and the system (refer to Table 2).

Table 2: Paired t-test result on the mean knowledge score in Malaysia

	<i>Pretest Score</i>	<i>Posttest Score</i>
Mean	6.76	7.16
Variance	1.28	1.27
Observations	69	69
Pearson Correlation	0.25	
Hypothesized Mean Difference	0	
Df	67	
t Stat	-2.36	
P(T<=t) one-tail	0.01	
t Critical one-tail	1.66	
P(T<=t) two-tail	0.02	
t Critical two-tail	1.99	

In analyzing, the data from Oman, similar result was seen where the students' scores were increased after the intervention compared to their pretest scores. The pretest scores for each question were 89.2%, 93.8%, 86.2%, 84.6%, 83.1%, 76.9%, 90.8% & 86.2% respectively for the percentage of students who answered correctly. The posttest scores were 96.9%, 96.9%, 92.3%, 92.3%, 92.3%, 86.1%, 96.9% & 95.3% respectively and the mean difference in percentage was 7.27% (refer to Table 3). Thus, it was clearly seen that the level of increase in Oman was greater than that was visible in Malaysia.

Table 3: Students knowledge score during pre and posttest in Oman

Questions	Pre-Test (%)	Post-Test (%)	Difference (%)
1	89.2	96.9	7.7
2	93.8	96.9	3.1
3	86.2	92.3	6.1
4	84.6	92.3	7.7
5	83.1	92.3	9.2
6	76.9	86.1	9.2
7	90.8	96.9	6.1
8	86.2	95.3	9.1
	Mean Difference		7.275

To check the significance of the increase between pretest and posttest results, the paired t-test result highlighted a p value ( $p = 0.003$ ) of less than the significance level (0.05), thus it can be concluded that the students' score increased significantly after using the module (refer to Table 4).

Table 4: Paired t-test result for knowledge mean score in Oman

	Pretest	Posttest
Mean	6.90	7.24
Variance	0.58	0.75
Observations	65	65
Pearson Correlation	0.57	
Hypothesized Mean Difference	0	
df	64	
t Stat	-3.6	
P(T<=t) one-tail	0.003	
t Critical one-tail	1.66	
P(T<=t) two-tail	0.006	
t Critical two-tail	1.99	

**4.2 What is the students’ awareness level on RE and climate issues after using the module and system?**

The pretest awareness level of students from Malaysia was quite low, with less 50 percent of the students responded positively to the survey questions. After the intervention there was an increase in students’ percentage in positive answers with 53% of the students responded positively to questions testing their awareness level on RE, Climate issues, government policies on RE and SDGs and their own perspective on these issues (refer to Figure 3).

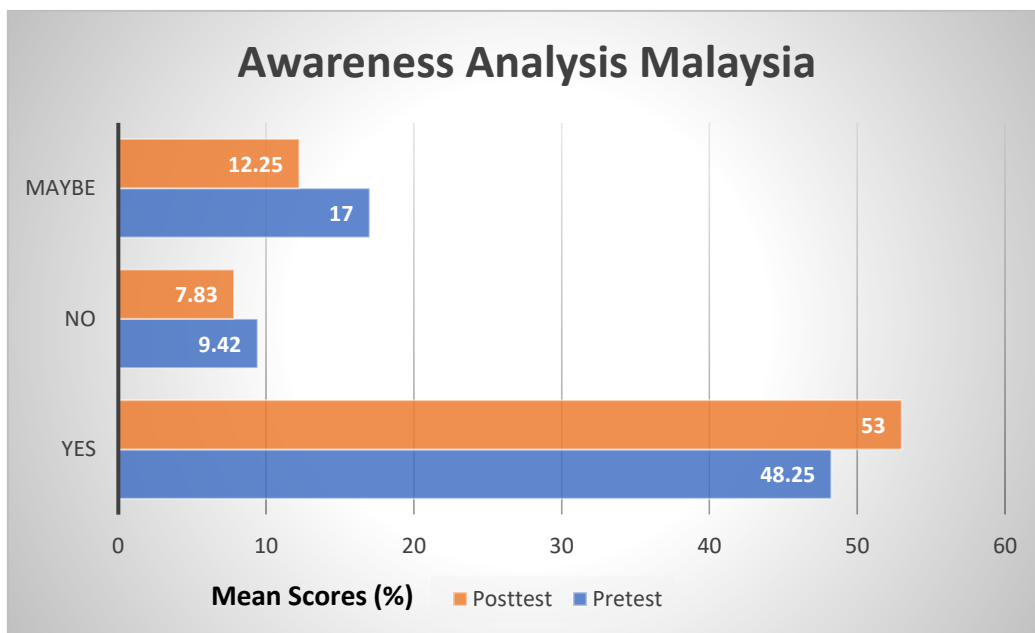


Figure 3: Awareness level result comparison in Malaysia

In Oman it was seen that the students’ level of awareness on RE and climate issues were even less than that seen in Malaysia. Only 42% of the students responded positively to awareness questions during the pretest and after the intervention the percentage increased to 49.33% during the posttest survey. In both cases, the awareness level of students was increased after using the module and the system but the level of pre-existing awareness on RE and climate issues is a worrying sign in both the countries (refer to Figure 4).

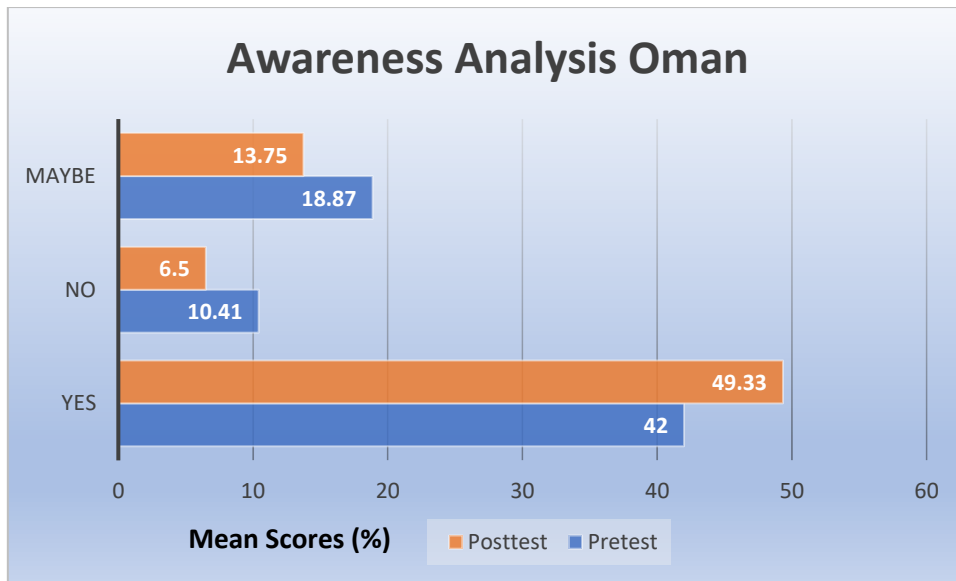


Figure 4: Awareness level result comparison in Oman

**4.3 What is the students’ interest level in RE education and career after using the module?**

In the survey, the interest section consisted of questions with Likert -7 scale bipolar options. Thus, to analyze the data a reliability testing was needed to check if the data collected for this section are reliable to be analyzed. For each question a score of minimum 1 and maximum 7 was allocated and the Cronbach’s Alpha testing was conducted for both the pretest and posttest data. The  $\alpha$  scores for the pretest and posttest in Malaysia were  $\alpha = 0.92$  and  $\alpha = 0.91$  respectively. Thus, making the data highly reliable based on the Cronbach’s Alpha reliability range (refer to Table 5).

Table 5: Cronbach’s Alpha test result for Malaysian data

Variables	Description	Pretest	Posttest
K	# of students	69	69
$\Sigma S^2y$	sum of the student's Variance	47.00	39.39
$S^2x$	Variance of Total Score	549.74	404.55
$\alpha$	Cronbach's alpha	0.92	0.91

Then the mean scores of the pretest ( $\mu = 20.87$ ) and posttest ( $\mu = 22.35$ ) were calculated and it was seen there is an increase in the mean interest score of the students in the posttest (refer to Table 6).

Table 6: Comparison of mean values between pre and posttest in Malaysia

Mean Values Comparison				
	Attitude	Subjective Norm	PBC	Interest
Pretest	36.4	37.99	29.13	20.87
Posttest	36.94	39.33	29.67	22.35
Scale Range	[6]-[42]	[7]-[49]	[5]-[35]	[4]-[28]

The paired t-test conducted on the mean scores exhibited a p value of 0.03 which is less than the significance level, thus it can be concluded that the interest was significantly increased in Malaysian students after the intervention (refer to Table 7).



Table 7: Paired t-test result for interest score in Malaysia

	Pretest	Posttest
Mean	20.8	22.34
Variance	28.99	21.70
Observations	69	69
Pearson Correlation	0.14	
Hypothesized Mean Difference	0	
Df	68	
t Stat	-1.86	
P(T<=t) one-tail	0.03	
t Critical one-tail	1.66	
P(T<=t) two-tail	0.04	
t Critical two-tail	1.99	

In Oman, the same steps were conducted to check the reliability of the answers and the  $\alpha$  scores were  $\alpha = 0.88$  and  $0.83$  respectively for pre and posttest (Table 8). Then, the mean scores were calculated to be  $\mu = 19.80$  for pretest and  $\mu = 22.63$  for posttest (Table 9). The paired t-test result was  $p = 0.001$ , thus making the overall increase in interest significant for students in Oman after using the developed module and system (Table 10).

Table 8: Cronbach's Alpha test result for Omani data

Variables	Description	Pretest	Posttest
K	# of students	65	65
$\Sigma S^2y$	sum of the student's variance	61.96	35.16
$S^2x$	Variance of TotalScore	469.15	199.56
A	Cronbach's alpha	0.88	0.83

Table 9: Comparison of mean values between pre and posttest in Oman

Mean Values Comparison				
	Attitude	Subjective Norm	PBC	Interest
Pretest	33.32	34.66	26.58	19.81
Posttest	35.49	38.93	29.5	22.63
Scale Range	[6]-[42]	[7]-[49]	[5]-[35]	[4]-[28]

Table 10: Paired t-test result for interest score in Oman

	Interest Pretest	Interest Posttest
Mean	19.80	22.63
Variance	21.22	13.64
Observations	65	65
Pearson Correlation	0.06	
Hypothesized Mean Difference	0	
Df	64	
t Stat	-3.99	
P(T<=t) one-tail	0.001	

t Critical one-tail	1.66
P(T<=t) two-tail	0.002
t Critical two-tail	1.99

## 5. Discussion

Education will play a fundamental role in the progress of any nation to a more sustainable and cleaner energy route. Great importance and innovation are needed to allow students at an early age to be exposed to detailed and structured energy literacy, RE and ESD courses, to enhance students' awareness and understanding of the importance of RE in the global future (Chergui et al., 2017; García-Ferrero et al., 2021; Hoque et al., 2023; Mahalik et al., 2021; Sattar et al., 2016). This study aimed to test the feasibility of a developed mobile learning module in enhancing students' knowledge and awareness about RE and climate issues and enhancing their interest in pursuing higher education and career in the RE sector. The results of the study after implementation in Malaysia and Oman highlighted that the developed module is feasible in improving these students' aspects in both the countries in various degrees.

The preexisting knowledge about RE and climate issues were almost similar in both the countries with an average of 84.38% of students responded correctly to all the pretest knowledge questions in Malaysia and 86.35% in Oman. But the level of increase was significantly higher in Oman compared to Malaysia where the mean difference of percentage of correct answers between pretest and posttest is 7.25% as compared to Malaysia's 5.25%. There could be many factors at play one being the IT infrastructure in the school in Oman was better than the schools in Malaysia as one of the schools that participated in the study in Malaysia was situated in a rural setting outside the main urban areas. This allowed, the students in Oman to participate and interact with the m-learning system much more easily than the school in rural Malaysia which may have caused the assimilation of knowledge for students in Oman much effective compared to Malaysia. Another, important factor that was seen during the analysis was the level of pre-existing awareness in Malaysian students was higher than the ones in Oman. This is because, the students of Malaysia were citizens of the country itself and were exposed to various government policies and awareness campaign initiated by the Malaysian government (Islam et al., 2009; Khairudin et al., 2020; Moorthy et al., 2019; Zakaria et al., 2019). But the students in the school in Oman were children of expats in the country thus they may not have been easily exposed to the Omani government's campaigns and advertisement regarding RE and SDGs, because the governments' mode of language for exposure to these concepts were Arabic whereas majority of the expats' children are not accustomed or literate in that language (Al-Issa, 2020). This could play an important factor in the low level of awareness seen in the Omani school's student. In comparing the interest level of the students, it was seen both the countries exhibited a significant increase in interest in pursuing higher education and career in the RE sector. Thus overall, it can be concluded that the implementation of mobile learning techniques and educational intervention to promote education for RE, energy literacy or ESD can be achieved with the usage of technology-based approaches.

The results of the study can also be used by policy makers across the globe to be used as a foundation and implement technology-based teaching and learning for sustainable development, RE and energy literacy education (Crompton, 2013; Mohamed Dahlan et al., 2014; Schuck et al., 2017). The observed increase in knowledge, awareness, and interest in Renewable Energy education indicates that the mobile learning module holds promise as an effective tool to foster sustainable attitudes and behaviors among students. This highlights the importance of integrating technology-enhanced learning approaches within national education frameworks to address the pressing need for renewable energy literacy. The study can also promote technological literacy and familiarization for teachers to equip themselves with the skills and experience needed to conduct their teaching and learning activities using ICT based technologies and devices which is a fundamental skill required in the modern 21<sup>st</sup> century and Fourth Industrial Revolution learning environments (Mohamed Dahlan et al., 2014).

## 6. Limitation and Suggestions for future research

As a feasibility study, the selected schools and participants in this study is very low which can act as a limitation into observing the effectiveness of the developed module and system. Also, the topics covered in the module were introductory at a minimum, which may have a negative impact on the overall effectiveness of the module. Also,

the feasibility study was conducted on a short-term basis to assess the immediate impact of the module, but it is important to conduct long-term study on the module to determine the sustainability of the observed changes. Follow-up assessments conducted over a more extended period would provide valuable insights into the persistence of the gained knowledge and sustained interest in Renewable Energy education. Malaysia and Oman have distinct cultural, social, and educational contexts that may have influenced the outcomes of this study. Future research should delve deeper into these factors to explore their potential impact on the effectiveness of mobile learning modules for Renewable Energy education. Additionally, this study utilized self-report questionnaires to measure knowledge, awareness, and interest. While self-reports are commonly used, they may be subject to response biases or inaccuracies. Future research could incorporate additional objective measures, such as practical assessments or behavioral observations, to provide a more comprehensive evaluation of students' knowledge and engagement in Renewable Energy education.

Thus, this study can be carried forward by other interested researchers in this topic to enhance the functionalities of the system, develop and integrate more topics into the content and add more educational strategies like flipped learning, game-based learning and other techniques that goes in line with m-learning.

## 8. Conclusion

This study conducted a feasibility testing in Malaysia and Oman to determine if the developed m-learning module based on RE and ESD topics can enhance students' knowledge and awareness about RE and climate issues and also enhance their interest in pursuing higher education and career in the RE sector. The results of the feasibility study showed that the module is feasible in its target to enhance the students' three attributes significantly in both the countries. There were visible differences in the level of pre-existing knowledge and awareness between the two countries' students, which can be caused by a variety of different factors like cultural differences, language proficiency, IT infrastructure of the schools, teachers' technological literacy and many more. Overall, the feasibility study was successful in enhancing the students' attributes and create more awareness and interest amongst the students towards RE and SDGs, which can be transferred to their family members and society as a whole, promoting awareness and dispersion of knowledge and interest amongst the society about the importance of RE and climate issues. All of which is essential across the globe to combat the upcoming arduous fight against climate change and transitioning to a more cleaner and affordable energy consumption for all.

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