

INTEGRATING ENERGY SAVING AWARENESS THROUGH MATHEMATICS LESSON: A STUDY IN MALAYSIA SECONDARY SCHOOL

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ABSTRACT: Education is an essential factor in shaping students' citizenship competency. Integrating Global Citizenship Education (GCE) in mathematics will engage students' curiosity to use mathematics to explore and formulate ideas about raising global issues. The main objective of this study is to assess the awareness of energy saving through mathematics lessons in topic algebra. This study is based on design and development research (DDR) and quantitative research with the participants of 25 Form 2 students from a secondary school in Seremban. A questionnaire that consists of 6 items about energy saving was given to collect data. A descriptive, independent sample t-test and paired sample t-test were used to analyze the data using SPSS version 26. The findings indicated that there is a significant difference between a pre-and post-awareness survey with a t-value as $[t(24) = -2.133, p < .05]$. The result shows that the students' understanding of energy-saving is better after the mathematics lessons conducted in the classroom. There is no significant difference between a pre-and post-awareness survey on gender. In conclusion, the study contributes to the conceptual components of GCE by integrating energy-saving issues in mathematics lessons in the topic of Algebraic Formulae. Simultaneously, it helps in emphasizing the global issues that are addressed in mathematics class.

Keywords: Energy saving, Global Citizen Education, Mathematics, Algebra

INTRODUCTION

Global energy consumption is rapidly increasing due to the growth of economics and the modernization of living style. Household activities such as charging mobile phones frequently, watching television, or excessive use of the air conditioner will lead to a high amount of energy consumption. All these actions can be reduced by basic education and awareness such as switching off the lights when leaving a room or if the light is not in use. Hence, awareness of reducing electricity consumption should be taught through education. Basic human behavior starts from school. Behavior-based strategies always reward pathways for energy conservation. The integration of energy-saving elements in mathematics lessons is relatively inexpensive for schools to implement yet can yield significant results [1]. It may not be obvious that there is a direct connection between energy consumed and the environment in the short run, but the result will be apparent in the future.

This study was conducted to identify students' awareness of energy consumption by integrating GCE through mathematics lessons among Form 2 students in the topic Algebraic Formulae. The research questions formulated for this study are (i) is there any significant difference between pre-test and post-test results? (ii) is there any significant difference between post-test results with gender? The learning activity is carried out in the classroom through a sample of questions and games on the relevant topic. In mathematics, students often have trouble solving algebra problems [2]. Algebra is chosen in this study because it is often used in everyday life, where can represent the quantities in the energy formula [3].

1.1 RESEARCH HYPOTHESIS

Based on research questions (i) and (ii), below are the hypothesis formulated for this study.

H_1^1 : There is a significant difference between pre-and post-survey results of the student's energy-saving awareness in mathematics lessons.

H_1^2 : There is a significant difference between pre-and post-survey results and gender

1.2 GLOBAL CITIZENSHIP EDUCATION

GCE is a form of civic learning that comprises knowledge, values, competencies, and attitudes [4]. GCE is likely to enhance peace [5][6] and at the same time increase the respect for values such as truth-seeking, justice, and

equality within the learners as well as the teachers [5]. This global education may start from within the community as the values that come within this global education should be nurtured before it goes global [7][6]. For instance, Canada urges their students to be accountable in addressing global issues within their small community rather than to take part as a citizen of the world [7]. We can always start to raise awareness from within our class or households, such as reducing the use of electricity, recycling, water, and more.

1.3 GCE THROUGH MATHEMATICS LESSON

Mathematics is one of the core subjects in school, and Ernest [8] has listed out the aims in learning mathematics, which is to deploy numeracy skills in general employment and function basic mathematics in daily life. Yusof et al. [9] found that students have a positive experience in the GCE that they receive at school. Educators should take responsibility for embedding GCE in their school subject as it is useful to preserve the knowledge, skills, and values of the educations itself while ensuring sustainable development [10]. One of the advantages of teaching GCE in mathematics class is that the students gained more knowledge either directly or indirectly regards to global education and at the same time, it affects the students' skills and attitudes towards GCE [7] [9]. To make this informal activity to formal, it is proposed that the Ministry of Education (Malaysia) emulate [11], which provides guidelines for schools and teachers to conduct activities for GCE or adopt guidelines provided by UNESCO.

1. RESEARCH METHOD

This study is a design and development research (DDR) combined with quantitative research, which is the survey method. According to [12], design and development are described to establish new procedures, techniques, and tools to test the theory and validate the practicality. DDR used to develop a lesson plan to integrate GCE through mathematics lessons. A pre-and post-study was conducted using the survey method to determine the quality of the lesson plan. Based on Tuckman [13], the survey method is a very effective way to gather good data from the respondents. It is also efficient because of the ability to conduct surveys in a short time and/or low budget and easily access the audience [14]. This survey includes the findings on population, sample, creating the questionnaire,

spreading the questionnaire, pre, and post-awareness survey, analyzing the data, make a discussion and, conclusion.

2.1. POPULATION AND SAMPLE

The population for this study is Form 2 students from a school in Seremban District, Malaysia. The sample for this study is 25 students at age of 14 years old. A non-probability sampling method was used. The number of samples chosen is enough to do this survey based on Borg and Gall [15]. They suggest that the number of samples between 20 and 50 is high enough for the research. The respondents are required to answer questionnaires for pre-and post-survey.

2.2. INSTRUMENT

Instrument development can initiate in many ways. One of the ways to develop an instrument is by looking into the

module developed for a study. A total of 6 items were developed. All the items were developed and validated to measure the student's awareness of GCE in the mathematics education context. Students were asked to give an opinion on the extent to which they agreed with the statement in the form of a Likert scale of 5 points. The options are 1 (strongly disagree) to 5 (strongly agree).

2.3. VALIDATION OF INSTRUMENT

The students' awareness of GCE in the context of energy saving in mathematics lessons, the questionnaire was validated by two experts in the field of GCE and mathematics education. Experts accepted all the items with some minor amendments. The items were revised according to the experts' advice and comments. Table 1 shows the items in the questionnaires.

Table 1. Items on students' awareness on energy saving through mathematics lessons

Code	Items
E1	Mathematics lessons make me realize the importance of energy-saving.
E2	Mathematics lessons though me to save money by switching on the electric current when is necessary.
E3	Mathematics lessons create awareness that energy-saving helps us to save the world.
E4	Mathematics lessons create awareness that energy-saving helps me protect the world.
E5	Mathematics lessons make me realize to appreciate the energy sources.
E6	Mathematics lessons make me realize that energy-saving will help to reduce environmental issues.

2.4. PILOT STUDY

The pilot study was conducted by distributing 50 questionnaires to primary and secondary school mathematics students by simple random sampling from the Perak state in Malaysia. Cronbach's alpha coefficient procedure was used in the current analysis to determine the

sum of measurement error in the test. Cronbach's coefficient has a lower permissible limit of 0.72 in general [16]. The constructs of the pilot test are stable, as seen in Table 2 (alpha Cronbach is more than 0.7).

Table 2. Reliability of awareness of the students in energy-saving constructs in the pilot test

Global Citizenship Education	Number of items	Coefficient Alpha
Energy Saving	6	0.901

Table 3 indicates the rotated component matrix. The findings show that there are four factors, and all loading

factors are more than 0.5. As a result, there is no issue about the convergent validity of the pilot test' constructs.

Table 3. Rotated component matrix

Items	Global Citizenship Education
	E
E5	.909
E2	.902
E1	.880
E6	.872
E4	.783
E3	.767

Overall, the pilot study revealed that the alpha reliability coefficients for all the items are acceptable. Therefore, all these items remained for the main study. Thus, the questionnaire could be distributed to the targeted sample.

2. RESULTS AND DISCUSSION

A total of 25 respondents were selected from the Form 2 class, which consisted of 14 females (56%) and 11 (44%) of them were male. The mathematics lessons have been

conducted to study the student's awareness of energy saving through Algebraic Formulae. This topic was chosen because of the most understandable subject among high school students. Students have learned algebra from their primary level in schools [17].

a) Research question 1: Does mathematics lessons able to create awareness among the students on global issues?

Table 4. Paired-sample t-test results for pre-and post-awareness questionnaires

Pre & Post-awareness	N	SD	Mean	t value	Sig
Pre	25	0.7405	3.44	-2.133	0.043
Post	25	0.7409	3.91		

To explore the awareness of energy saving among students, the pre-and post-survey results were analyzed. The normal distribution test of pre-and post-awareness scores was tested. The results show that the pre-awareness score was not normally distributed by the Shapiro-Wilk test ($p = 0.005$). Still, the post-awareness was normally distributed by the Shapiro-Wilk test ($p = 0.185$). This shows that there is one abnormal distributed data in the pre-awareness score. To study the difference in students' awareness of energy saving through mathematics lessons on pre-and post-awareness is used in the paired sample t-test. The result showed in Table 4 have a statistically significant difference existed between pre-and post-questionnaires [$t(24) = -2.133, p < 0.05$]. There are improvements in the students' awareness of energy saving, as seen in the mean of the pre-and post-questionnaires. The mean of the pre-awareness questionnaires was 3.44, with an $SD = 0.7405$. The mean of the post-awareness questionnaires was 3.91, with an $SD = 0.7409$. As a result, the pre-and post-awareness of the online questionnaires reveal a significant difference in students' awareness of energy saving through mathematics

lessons. This indicates that the null hypothesis is rejected. The learning activity in the classroom has enhanced the students' awareness of energy consumption.

This supports the findings of Kishino and Takahashi [18], who determined that students became more globally competent by their study on the campus. It is because integrating GCE in lessons helped them to be good global citizens. Thus, students' knowledge and concerns for both local and international problems grew persuasive. Learning of GCE in the classroom allows students to explore worldwide issues and become more aware of the current global issues. The results correspond with the research study of [19]. The study focuses on integrating an energy-saving awareness by a marketing campaign on the campus through marketing class. The active involvement in the campaign showed that students were becoming increasingly conscious of the importance of energy-saving.

b) Research question 2: Will there be any significant difference in terms of gender on the awareness of the global issue in mathematics lessons?

Table 5. Post-awareness questionnaires by gender

Gender	n	SD	Mean	t value	Sig
Female	14	0.7938	3.95	-0.292	0.773
Male	11	0.7025	3.86		

A t-test was conducted to compare the post-awareness questionnaires by gender. Results are shown in Table 5. The mean score for female students of post-awareness was 3.95 ($N = 14, SD = 0.79$), which was slightly higher than the mean score of 3.86 ($N = 11, SD = 0.70$) obtained from male students. The t-test was used to further confirm the conclusion that there was no substantial difference between males and females in post-awareness surveys [$t = -0.292, p > 0.05$]. As a result, the null hypothesis was accepted. This might be due to similarities in pupils' educational backgrounds and fundamental mathematical understanding of energy conservation problems.

3. CONCLUSION

The research shows the students' involved actively in the mathematics classroom during the lesson. The students were aware of the global issue of electricity when integrated into the mathematics lesson. All the students regardless of gender, have almost the same view on the acceptance of GCE. The core conceptual dimensions of GCE are the cognitive, socio-emotional, and behavioral as promoted by [20]. By conducting this research, we provide data from the selected region to evaluate the understanding and critical thinking about energy saving among secondary school students. Hence, it helps to instill the values of GCE in the classroom and increase awareness through a possible act in achieving a peaceful and sustainable world. This research shows that global issues awareness can be conveyed through mathematics lessons and other core subjects in the classroom.

This study has shown that there are interconnections between the mathematics lesson carried out in the classroom and students' awareness of energy saving in households. These connections made the mathematics highly relevant to the Form 2 students and improved both their theoretical understanding and global issues. A wide variety of similar fields and topics engaged in global education could be used in any other subject.

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