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# Awareness on the Energy Saving Behaviour Among Students: Gamification Approach

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**ABSTRACT**

*The study explores the awareness and engagement levels concerning energy-saving behavior among students, employing a gamification approach. However, the strategy used by researcher is the use of gamification to provide awareness for energy saving. In this study, researchers focus on obtaining information based on game design elements based on the researcher's objective which is what are the game design elements that are needed to improve learners' understanding of the content of energy-saving behavior. Descriptive quantitative analysis methods help measure the effectiveness of incorporating gamification elements in studying energy-saving behavior, providing numerical evidence of its impact on the awareness among the students. As a result of the study conducted, the reliability coefficients obtained for all five constructs in the assessment instrument for Bachelor of Design students were found that Cronbach Alpha values range from 0.955 to 0.984. The findings aim to shed light on the potential of gamification strategies in fostering greater awareness and active participation in energy conservation initiatives among student populations. Results show that the gamified approach could lead to heightened awareness among students regarding energy-saving practices, fostering a better understanding of the significance of energy conservation.*

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## 1. INTRODUCTION

Recently, the issue of energy has become a problem that exists, especially in addressing the challenges of an increasingly vibrant world. This includes Malaysia using the main sources of natural gas and coal. This is because this resource is non-renewable. However, there are also renewable resources such as wind, solar and hydro energy. This situation worries us because if left unchecked, of course this will increase the waste that will occur. Therefore, all parties need to play a role that should strive to solve this problem.

Malaysia is one of the major energy-consuming countries. Like most developing countries, Malaysia has experienced economic growth. The building consumes up to 48% of electricity generated in the country (Chua and Oh., 2011). Additionally, 80% to 90% of the energy used in a building is consumed by Malaysians for their activities of daily living (KeTTHA, 2011). The fact shows that an effort to reduce energy consumption by improving energy-saving attitude and behavior among Malaysians is a very crucial solution to address these issues. Billions of ringgit have been invested by the government to reduce the energy consumption of this country including by enforcing the Renewable Energy Act in 2011, introducing the Feed-in Tariff (FiT) mechanism to accelerate renewable energy (RE) growth, implementing Sustainability Achieved via Energy Efficiency (SAVE) Program in 2011 and many more to increase the use of energy-efficient, clean and environmentally friendly sources [1][2]. Unfortunately, the energy-saving behavior among Malaysians is still lacking. Much needs to be done to come up with effective and reliable solutions.

In Malaysia, energy resources are used directly or indirectly for our daily use. This is because it can speed up the process or make it easier for us to get the job done. However, there are also very significant disadvantages with the wastage of energy resources. According to a study by [3]. Since 2011, Malaysia has used about 40% of its natural gas for electricity generation, while the other 40% is contributed by coal generation and 10% is generated by electricity generation by hydropower plants, while the remaining percentage is contributed by other combinations of fuels such as diesel and fuel oil. Therefore, renewable energy will occur to increase the percentage of power generation to higher electrical systems by 2030.

Gamification is high potential technology for Education. Non-traditional activities can change the activity of the learning system based on their experience When playing with gamification and Cognitive theory can be activated. This is because like observation skills, improving one's memory, and solving problems or tasks [4-7]. Past studies on [8] After using gamification in the Education workshop they showed an increase in consolidation. Changing gamification has a positive effect on the retention of student knowledge, regardless of age and gender. Objective to reduce energy wastage rate. The effect of rain house and renewable energy. Objective to increase energy consumption awareness.

Gamification is a learning method that combines educational content and learning principles into games [9]. Many studies prove that gamification is a more effective way to


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improve learners' knowledge and understanding of education content [10-12]. However, lack of study on integrating gamification and understanding the importance of energy saving.

Due to this gap, research is needed to improve learners' understanding of energy-saving behavior through gamification. Gamification is gaining popularity with its potential to improve the user experience and user engagement in many applications. It is also proven as a new way to shape user behavior [13]. Blohm and Leimeister suggest that "gamification attempts to influence user behavior by activating individual motives via game-design elements" [14]. Therefore, the capabilities of gamification usage will contribute to improving energy-saving attitudes and behavior among the users.

The finding will contribute to the body of knowledge through the development of a framework for gamified the learning experience of energy-saving behavior to improve learners' understanding of the content by a thorough examination of the game design elements.

This section discusses the literature study that is past studies and applications related to the objective studied. Literature review is the process of analysis, evaluating and summarizing scientific materials on a particular topic. The results of the literature review can be used as part of the journal research reference.

The purpose is to explain to the reader about the elements that should be in the journal. It can also help strengthen the study as well as determine past studies, etc. related to the topic. The important thing for the study of literature is about the features that must be present in the gamification.

Among the steps that need to be taken when conducting a literature review is to find scholarly writings on the purpose of design elements that have been used in the application. The main source should be based on the writings published in the journal and recognition of the scholarly writings. Scientific writing also needs to be evaluated to ensure the suitability of the source from the gamification to be developed.

The conclusion is that in-depth discussions are also made in reviewing and identifying the features, advantages and strengths of the products developed compared to the current design elements as well as the implications of the survey on the design elements developed in more detail. Thus, a good new design elements can be developed to develop gamification in energy saving approach.

Energy-saving refers to efforts made to reduce energy consumption and is one of today's most prominent issues in energy markets. It involves a reduction in energy consumption with a change in consumer behavior and in conjunction with the increment use of energy-efficient appliances [15-17]. The International Energy Outlook report on the current position of global energy consumption reveals that energy will continue to grow by 56% between the years 2010 and 2040. Moreover, the total global energy will increase from 524 quadrillion British thermal units (Btu) in 2010 to 630 quadrillion Btu in 2020. This will continue to increase to 820 quadrillions Btu in 2040. Like most developing countries,

Malaysia has experienced very rapid growth in urbanization. The population of Malaysia increased from 18 million in 1990 to 30 million in 2016. Based on the Department of Statistics, Malaysia is expected to have a population of about 33.3 million by 2020. The expectation is that 75% of this population will live in urban areas [18]. The rapid growth of urbanization in Malaysia has not only a great impact on national development but also increases the energy demand [19]. Statistical record by Suruhanjaya Tenaga shows that 94% of electricity generated in the country is by fossil fuels and it is expected that the figure will be unchanged over the next decade [20].

In the Eleventh Malaysia Plan, 2016-2020, the government has set to reduce GHGs emission intensity of GDP by up to 40% compared to 2005 levels by the year 2020, in line with the voluntary target announced by the Prime Minister at the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change in 2009. To achieve these, fundamental transformations are needed, especially in guiding Malaysian residents to make energy-saving behavior such as in purchasing decisions and in managing the nation's energy and natural resources. In the Eleventh Malaysia Plan, green growth will be a fundamental shift in how Malaysia sees the role of natural resources and the environment in its socio-economic development, protecting both development gains and biodiversity at the same time [4]. Several acts and policies had been enforced by the government to reduce energy consumption and reduce GHGs emissions of this country such as the Renewable Energy Act 2011 (Act 725), National Climate Change Policy 2009, and National Green Technology Policy 2009.

Electricity is the main form of energy consumption in Malaysia. Chua and Oh (2010) reveal that the total electricity generation and consumption in Malaysia are expected to increase more in the near future. The energy generated in 2000 is 69,280 Gwt. In the year 2010, the energy generated increased to 137,909 Gwt. This is because of the country's increasing energy demand from 1243.7 to 2217.9 Pascal joules (PJ). The rate of energy consumption increased due to the usage of modern home appliances, particularly air conditions and refrigerators. Furthermore, lighting becomes the second electric power consumption after air conditioning and refrigerator [21]. Residents have been identified by researchers as an essential target group for energy conservation. Energy is used for cooling and lighting homes and buildings, operating electrical appliances and machines, water heating, and cooking. These daily consumer activities and the use of these appliances at least in part can contribute to the increasing emissions of greenhouse gases. In terms of electricity consumption, the use of electricity in Malaysia has increased year by year. The increment in the electricity use attributed mainly to the increasing use of electrical appliances such as washing machines, TV, refrigerators, air-conditioner, refrigerator and many more. The major energy-consuming appliance is refrigerator-freezer followed by an air conditioner, washing machine, fan, rice cooker, and iron [22]. Research by Kavousian [23] found that individuals' behavior towards energy consumption is one of the major categories of determinants that influence energy use; besides of weather and location, the physical


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characteristic of the building and appliance and electronics stock. It was found that programs related to energy saving have been developed in hundreds and are in use for the last five decades. However, much need to be done to come up with effective and reliable solutions. Human activities and economic development with increased energy consumption, high demand for natural resources, and land are raising environmental issues [24]. The behavior of occupants plays a vital role in determining the energy used in a building. An appropriate behavior guide could help occupants use energy efficiently [25].

According to Gandhi and Brager and Jackson found desktops that are left overnight consumed more energy than a laptop that tends to be brought home by occupants. This might suggest that occupants have less knowledge regarding phantom loads that required occupants to plus off devices from the electrical outlet. Though, energy consumption for laptops and desktops is found higher during a non-working hour on weekends suggesting that occupants do leave these devices switched on during weekdays [26]. Due to this, research is needed to improve learners' understanding of energy-saving behavior through gamification. Gamification is gaining popularity with its potential to improve the user experience and user engagement in many applications. Gamification has also emerged as a tool for increasing residential customers' engagement in energy systems.

## 2. RESEARCH METHOD

### 2.1. Design of Questionnaire and Selection of Respondents

Descriptive quantitative research had been conducted in order to achieve the research objective. The study reported in this paper employed a convenient sampling using questionnaires to 100 respondents who were students from Bachelor of Design with Honors. The main purpose of the survey is to look at the efficient behaviors contributing to lessening the electric consumption in a building. A set of questionnaires had been developed and adapted from Software Usability Measurement Inventory (SUMI) method. The Likert scale with a scale from 1 to 5 (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree) was used in the questionnaire. The questionnaire is divided into 2 parts. Part (A) consists of Demographic Information including gender, education, current semester and place of residence, while Part (B) contains 23 questions in each section which is consists of game design elements including information provision, rewarding system, social connection, user interface and performance status. The questionnaire had been distributed online among 100 students of Bachelor of Design with Honors from the Universiti Pendidikan Sultan Idris.

Explaining research chronologically, including research design, research procedure (in the form of algorithms, Pseudocode, or other), how to test, and data acquisition [5]–[7]. The description of the course of research should be supported by references so the explanation can be accepted scientifically [2], [4]. Figures 1-2 and Table 1 are presented

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center (10 pt), as shown below and cited in the manuscript [5], [8]–[13]. Figure 2(a) shows single and ternary ion solutions. Figure 2(b) shows the electrolyte effect.

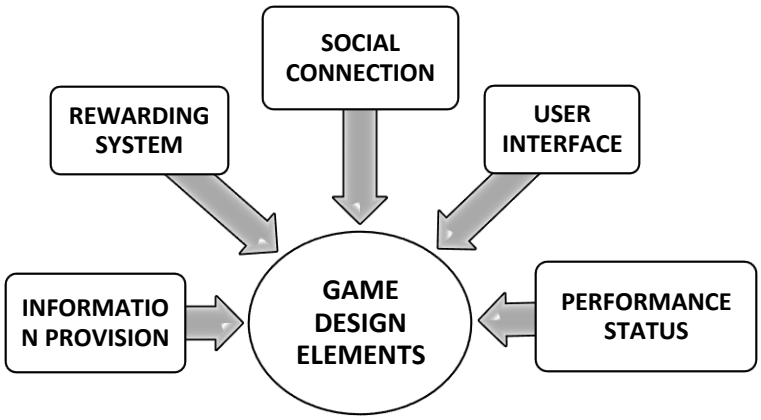


**Fig 1.** Game Design Elements in Developing a Framework of the Awareness of Energy Saving

Fig 1 show the incorporation of five pivotal game design elements—information provision, rewarding systems, social connection, user interface, and performance status—forms a comprehensive framework, fostering engaging and immersive gameplay experiences that captivate users and enhance overall interaction and satisfaction within the gaming environment.

## 2.2. Procedure and Setup for Testing

Distribution has been completed online by using google form developed based on the questions set in section A and part B. Respondents need to answer all the questions found on the google form.

## 2.3. Pilot test

Pilot test is the initial process to test the reliability of each item in the appropriate question or not before the actual test is performed. In addition, the reason why researchers do a "pilot test" is due to see the time taken by respondents to answer the questions given. Pilot test had been conducted among 37 respondents from the same sample.

For reliability testing, Cronbach's alpha was used to measure internal consistency between items under the same dimensions and the Cronbach's alpha coefficient of this survey can be seen in Table 1. In this study, the researcher used Cronbach's Alpha coefficient as a tool to measure the internal consistency of the instrument. The justification for Cronbach's Alpha used in this study is as a measurement for an instrument that uses a Likert scale so that its ability to measure latent variables is reliable.

The purpose of the pilot study was to obtain the level of reliability of the evaluation instrument by determining the value of Cronbach's alpha from Cronbach, L. J. (1951). Table 1 below shows the Cronbach's alpha coefficient value score interpretation table.


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**Table 1**: The Value of Cronbach's Alpha Value

| Reliability coefficient | Reliability Interpretation |
|---|---|
| 0.90 or more | Very good |
| 0.80-0.89 | Good |
| 0.60-0.79 | Acceptable |
| 0.40-0.59 | Doubted |
| 0.00-0.39 | Rejected |

Therefore, to ensure the reliability of the instrument, the researcher conducted a pilot study on 37 samples to allow the researcher to identify the weaknesses and strengths of the study instrument and improve them if necessary. Then the researcher checked the questionnaire to determine the clarity of each item of the questionnaire using Statistical Package for Social Science Version 23.0 (SPSS) software.

In Table 2, the researcher has obtained the value of Cronbach's Alpha coefficient of each item construct based on the predetermined study objectives. The data showed that each construct, which are: information provision, rewarding system, social connection, user interface and performance status showed a reliability value exceeding the value of 0.6, which is between the range of 0.955 to 0.984. This indicates that all items in the study construct are consistent and can be used as research instruments.

**Table 2:** Reliability statistics for each construct

| Construct | Reliability score (Cronbach's Alpha) |
|---|---|
| Information Provision | 0.955 |
| Rewarding System | 0.974 |
| Social connection | 0.974 |
| User interface | 0.976 |
| Performance Status | 0.984 |
| **Overall mean score** | **0.973** |

For Cronbach's Alpha values for all items on the adapted instrument, the researcher obtained a value of 0.973 (*Table 2*). This indicates that each item in the questionnaire has high validity and reliability and this questionnaire form can be used as an instrument.

## 3. RESULTS AND DISCUSSION

These findings involved a total of 100 students from Bachelor of Design with Honors at the Sultan Idris University of Education as respondents for this research. This section discusses the descriptive results of the questionnaire. There are five constructs of game

design elements which are (i) information provision, (ii) rewarding system, (iii) social connection, (iv) user interface and (v) performance status. *Table 3* presents the summary of the mean score for every section in the questionnaire. Based on *Table 3*, the mean obtained is between 4.10 to 4.19.

**Table 3**: Mean of Game Design Elements

| No. | Game Design Elements | Mean |
|---|---|---|
| 1. | Information Provision | 4.19 |
| 2. | Rewarding System | 4.13 |
| 3. | Social Connection | 4.18 |
| 4. | User Interface | 4.17 |
| 5. | Performance Status | 4.10 |
| | **Overall Mean** | **4.15** |

Based on Table 3 above, the results show the mean for the game design elements obtained. The item with the highest mean value is "information provision" (M = 4.19), followed by the item "social connection" (M = 4.18), "user interface" (M = 4.17), "rewarding system" (M = 4.13) and the last is "performance status" (M = 4.10). For the entire game design element, the mean obtained was (M = 4.15). This result shows that majority of the respondent are agree that information provision, rewarding system, social connection, user interface and performance status are the game design elements that are needed to improve learners' understanding of the content of energy-saving behavior.

For every construct of game design elements, the are six items that are being tested which are a) lighting, b) air conditioner, c) elevator, d) computer, e) printer, scanner and photocopier machine and f) low carbon product consumption. The following are the details for each item in each construct of game design elements:

### 3.1. Information provision

The example of information provision like figures, hints or tips, will offer the users a perfect sight of their energy-related behavior and let them to identify how their actions affect the amount of electricity they used before they leave hostel or their apartment to the college.

**Table 4.** Information Provision

| No. | Information Provision | Mean |
|---|---|---|


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| | | |
|---|---|---|
| 1. | Lighting | 4.41 |
| 2. | Air Conditioner | 4.07 |
| 3. | Elevator | 3.93 |
| 4. | Computer | 4.19 |
| 5. | Printer, Scanner and Photocopier Machine | 4.30 |
| 6. | Low Carbon Product Consumption | 4.23 |

Based on Table 4 above, the results show the mean for information provision obtained. The item with the highest mean value is "lighting" (M = 4.41), followed by the item "printer, scanner and photocopier machine" (M = 4.30), "low carbon product consumption" (M = 4.23), "computer" (M = 4.19), "air conditioner" (M= 4.07) and the last is "elevator" (M = 3.93).

## 3.2. Rewarding System

Rewarding residential customers based on their energy consumption behavior, effort and impact, can benefits them to take specific actions and increase satisfaction. This can be practically achieved by assigning a number of credits that is proportional to customer efforts for instance.

**Table 5**. Rewarding System

| No. | Rewarding System | Mean |
|---|---|---|
| 1. | Lighting | 4.30 |
| 2. | Air Conditioner | 4.06 |
| 3. | Elevator | 3.85 |
| 4. | Computer | 4.08 |
| 5. | Printer, Scanner and Photocopier Machine | 4.22 |
| 6. | Low Carbon Product Consumption | 4.22 |

Based on Table 5 above, the results show the mean for rewarding system obtained. The item with the highest mean value is "lighting" (M = 4.30), followed by "printer, scanner and photocopier machine"; "low carbon product consumption" (M = 4.22), "computer" (M = 4.08), "air conditioner" (M = 4.06) and the last is "elevator" (M = 3.85).

### 3.3. Social Connection

The example of social connection such like social competition, collaboration or energy community. Competition could be by enabling a hostel to compare his/her energy performance with another college mate of similar household size.

**Table 6.** Social Connection

| No. | Social Connection | Mean |
|---|---|---|
| 1. | Lighting | 4.32 |
| 2. | Air Conditioner | 4.14 |
| 3. | Elevator | 3.90 |
| 4. | Computer | 4.13 |
| 5. | Printer, Scanner and Photocopier Machine | 4.22 |
| 6. | Low Carbon Product Consumption | 4.24 |

Based on Table 6 above, the results show the mean for social connection obtained. The item with the highest mean value is "lighting" (M = 4.32), followed by the "low carbon product consumption" (M = 4.24), "printer, scanner and photocopier machine" (M = 4.22), "air conditioner" (M = 4.14), "computer" (M= 4.13) and the last is "elevator" (M = 3.90).

### 3.4. User Interface

The interface of the system would directly influence the users. The design should be very attractive, easy to use in order to engage the users. This is achieved through an attractive user interface with stimulating visuals and exciting interaction concepts, such as dashboards, message box, notifications, progress bar and leaderboards

**Table 7**. User Interface

| No. | User Interface | Mean |
|---|---|---|
| 1. | Lighting | 4.31 |
| 2. | Air Conditioner | 4.11 |
| 3. | Elevator | 3.94 |
| 4. | Computer | 4.16 |
| 5. | Printer, Scanner and Photocopier Machine | 4.22 |


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| | | |
|---|---|---|
| 6. | Low Carbon Product Consumption | 4.17 |

Based on Table 7 above, the results show the mean for user interface obtained. The item with the highest mean value is "lighting" (M = 4.31), followed by the item "printer, scanner and photocopier machine" (M = 4.22), "low carbon product consumption" (M = 4.17), "computer" (M = 4.16), "air conditioner" (M= 4.11) and the last is "elevator" (M = 3.94).

### 3.5. Performance Status

Users' performance status and progress can be tracked using game components such as points, badges, and levels, with the goal of changing how they behave and interact with a specific application. Each level can be linked to a title that virtually represents the application's user involvement. Badges are visual indicators that represent accomplishments and development. Levels are ranks achieved via experience that are related to the number of points earned.

**Table 8.** Performance Status

| No. | Performance Status | Mean |
|---|---|---|
| 1. | Lighting | 4.24 |
| 2. | Air Conditioner | 4.03 |
| 3. | Elevator | 3.84 |
| 4. | Computer | 4.07 |
| 5. | Printer, Scanner and Photocopier Machine | 4.21 |
| 6. | Low Carbon Product Consumption | 4.21 |

Based on **Table 8** above, the results show the mean for performance status obtained. The item with the highest mean value is "lighting" (M = 4.24), followed by the item "printer,

scanner and photocopier machine"; "low carbon product consumption" (M = 4.21), "computer" (M = 4.07), "air conditioner" (M = 4.03) and the last is "elevator" (M = 3.84).

From the previous result, the findings show a consistent trend for the highest mean score and the lowest mean score. Findings show that item "lighting" obtained the highest mean score for the five aspects of game design elements. Next, the findings also show that the item "elevator" obtained the lowest mean score for the five aspects of game design elements.

### 3.6. Summary of the analysis

Overall, a gamification approach targeting energy-saving behavior among students has the potential to create a more engaged and environmentally conscious generation, fostering a culture of sustainability and responsible energy use. These findings collectively demonstrate that incorporating these game design elements effectively within a gamified approach to energy-saving behavior can lead to increased knowledge, sustained engagement, social interaction, usability, and motivation among students toward adopting and practicing energy-efficient habits.

## 4. CONCLUSION

In conclusion, based on the results of the actual study findings, the Bachelor of Design student assessment instrument can be said to have a very satisfactory value, acceptable, and suitable to use in this study. There are some positive impacts of the studies on this research such like increase engagement - gamification can enhance student involvement by making energy-saving education interactive and enjoyable, fostering active participation and interest in sustainable practices. Besides that, heightened Awareness - Utilizing gamified elements could result in greater awareness among students about the importance of energy conservation, leading to a deeper understanding of its impact on the environment. The researcher recommends future research to carry out the production of game prototypes to strictly ascertain the suitable game design elements for the application of gamification in an energy-saving framework. Hence to examine the efficacy of pertaining gamification to stimulate and increase users' engagement in sustaining energy.


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