

## Engaging the Practice of Recycling through Data Handling Topic: Batang Padang District

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### Abstract

*Global Citizenship Education (GCE) intends to provide global citizens with a number of coping skills to help them deal with global challenges. It is essential to create awareness about global issues through mathematics education. Waste management is not given enough priority, and irregular rubbish disposal to adjacent communities and dumping on soil and in water sources endangers the health of nature and the environment. Hence, the main objective of this study is to assess the awareness of recycling through mathematics lessons in the Data Handling topic. The research design used in this study is the Design and Development Research (DDR) approach and quantitative research with the participants of 30 students from one school in Batang Padang District, Perak. A questionnaire that consists of 7 items about recycling 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 first result showed a significant difference in recycling awareness before ( $M=2.65$ ) and after ( $M=4.67$ ) the lessons of Data Handling topic. The second result showed no significant difference in recycling awareness based on gender boys ( $M=4.73$ ) and girls ( $M=4.62$ ) after the Data Handling topic. The data revealed that students understand better data handling topics after a lesson with a recycling lesson plan. The implication of this study can act as guidance to educators, students, and the Ministry of Education to take the responsibility in practicing and spreading awareness of recycling in mathematics education.*

**Keywords:** Global Citizenship Education (GCE); Global issues; Mathematics; Recycling

### Introduction

#### Background of Study

The Ministry of Education in Malaysia makes mathematics as a compulsory subject in school. Mathematics plays a major role in our life, especially in developing the 21<sup>st</sup> century in global citizenship. Based on UNESCO (2015), implementation of GCE in mathematics education is important to create awareness about global issues. Hence, the global citizens with a number of coping skills to help them deal with global challenges. Mathematics education significantly impacts each individual in practicing critical, creative, and systematic thinking skills (Amalia et al., 2017).

Citizenship education is one of the crucial things in the education field. Citizenship education focus on national issues, whereas past 20 years ago, citizenship education was focusing more into the global perspective. Global Citizenship Education provides the values, skills, and knowledge to all ages. It raises awareness on global issues related to human rights, environmental sustainability, social justice, and many more for learners to be responsible citizens in promoting a better world. This study is carried out to raise awareness about waste management through mathematics education.

### **Problem Statement**

Waste has emerged as a significant environmental issue in global cities with high population density due to population growth and unplanned urbanisation. The huge volume of waste developed and disposed of annually is mostly due to urbanisation and changing human lives. Waste is also developed by social activities, product manufacture, and post-use (Awoyera & Adesina, 2020).

The Motivation To Learn Mathematics Increases When Students See The Relevance Of What They Are Learning To The World Outside The Classroom And To Other Subjects.

(Assessment and Analytical Framework Mathematics, PISA, 2012)

It is essential to maintain solid waste efficiently to ensure cleanliness in all locations. Therefore, Malaysia implemented a recycling program which is a significant approach to reduce solid waste disposal. The number of landfills in Malaysia is increasing in response to the growing amount of solid waste. It comes from a variety of sources, including households, industries, construction sites, and many more. Increased provision of landfills will be able to reduce environmental pollution (Abas, 2013). Few other mathematics contents that can be practiced in conjunction with global citizenship education are percentages, presenting and manipulating data, measurement and time, ordering and comparing numbers, ratio and fractions, probability, finance, and energy conservation (OXFAM, 2015). Learning about this content in mathematics could help the students to open up a new way of thinking that can eventually bring into practice everyday activities In England, Ofsted (2012) has called for “increased use of real-life contexts in maths education in schools, and a greater focus on building student's confidence in using data.” Mathematics: made to measure.

The good practices of solid waste will conserve water, soil, and air resources thereby also protecting the environment. According to Qazi et al. (2018), establishing a solid waste processing facility will make recycling waste and turning it into new items or products easier. The practice of a sustainable lifestyle is highly emphasized because it is the responsibility of all parties to ensure our environment is clean and free from pollution (Othman, 2012). Hence, the awareness of waste management or, in the simple term, recycling, must be practiced from pre-school to higher education level. The implementation of recycling concept in mathematics education especially through statistics field. Statistics were selected as a platform to explain recycling in the context of waste management is relatively easy to manage and interpret the data.

The issues associated with the rising volume of rubbish show the need for waste management aiming at production-consumption with very little waste or no waste at all (Byrne & O’regan, 2014). Waste management is not given enough priority, and irregular rubbish disposal to adjacent communities and dumping on soil and in water sources endangers the health of nature

and the environment (Zeynep & Dilek, 2019). According to Shultz and Elfert (2018), the application of global citizenship education provides a wide range of teaching and learning opportunities in schools. The integration of recycling in mathematics lessons through data handling topics is relatively by data display and data analysis. It's the combination of bar and pie chart with finding the average (mode, median, and mean). Data handling is a crucial part of mathematics because it allows students to make sense of information, identify patterns and trends and predict and plan (Abdul Halim et al., 2020). As a result, the teachers can provide fundamental education and awareness of current environmental issues to the students. One of the environmental pollution problems is excessive waste disposal in daily human activities. Inappropriate waste disposal practices can lead to infection and environmental pollution (Adilah & Faisal, 2017).

According to Elagroudy et al. (2016), children's awareness about recycling and environmental issues is develops when they are around 12 years old. It is insufficient that children should be taught critically regarding recycling and environmental issues from an early age of education (Janmaimool & Khajohnmanee, 2019). That's why William et al. (2017) mention a part of GCE integrating knowledge concerning the world's diversity and inequality. For example, environmental education, peace education, social education, and others. Thus, the researcher will integrate global citizenship education through mathematics lessons among year 4 students in the Data Handling topic. This research study is aimed at primary school students. According to Tikka, Kuitumen, and Tynys (2000), the majority of primary students are unaware of environmental issues and practice waste management in both school and home. Waste has emerged as a significant environmental issue in global cities with high population density due to population growth and unplanned urbanization (Vitorino, 2017). The topic of data handling is chosen in this study because it is often used in everyday life and data can be used to represent the quantities in the pie chart (Bravo & Castilla, 2016). In conjunction, data handling in the mathematics classroom helps enhance students' knowledge of environmental problems and waste management practices.

### **Research Objectives**

This study is carried out to raise awareness about waste management through mathematics education. The following are research objectives identified.

1. To design and develop a lesson plan to engage the students' awareness about recycling through the Data Handling topic.
- 2(a). To identify students' awareness of recycling before and after the lessons on the Data Handling topic.
- 2(b). To identify students' awareness of recycling after the lessons of Data Handling topics based on gender.

### **Research Questions**

1. Is there any significant difference in students' awareness about recycling before and after the Data Handling topic?
2. Is there any significant difference in students' awareness about recycling after the Data Handling topic based on gender?

## Research Hypotheses

H<sub>o(1)</sub>: There is no significant difference in students' awareness about recycling before and after the lessons on the Data Handling topic.

H<sub>o(2)</sub>: There is no significant difference in students' awareness about recycling after the Data Handling topic based on gender.

## Research Significance

In focusing on global education through a rights-based lens, this research acknowledges that universal children's rights have a significant role in preparing young people to reach their potential as global citizens. The project activities used a variety of educational approaches, including citizenship education, peace education, multicultural education, and learner-centered instructional practices in mathematics. The topic data handling can identify opportunities to implement some activities or lessons focusing on GCE. Teachers can also infuse Global Citizenship Education through mathematics lessons, especially in Data Handling, and raise awareness about recycling. This study can also guide the Ministry of Education in Malaysia to spread awareness of recycling through the syllabus in books and emphasize how important recycling is to the environment.

## Literature Review on Operational Definitions

### Global Citizenship Education

According to UNESCO (2014), GCE is UNESCO's response to global concerns such as human rights violations, inequality, and poverty that impact peace and sustainability. Therefore, it works by teaching students of all ages that these issues are global rather than local. In this study, recycling is one of the issues to be emphasized to engage the concept of sustainable living among students. Thus, Global Citizenship Education's primary goal is to raise global awareness among global society. Additionally, the researcher discovered that the level of awareness among high school students is lower than expected. According to the researcher, the study of the globalization phenomenon is still very much in its early stages and has a limited scope (Ferreira, 2011). Cho (2016) stated that Global Citizenship Education is a paradigm change from national-based identity education to education that promotes a sense of belonging in a global environment. The issues and difficulties of globalization need global awareness and action. As a result, one of the difficulties that must be addressed for Global Citizenship Education is raising awareness of global issues such as poverty, war, climate change, political sustainability, and stability.

### Recycling

According to Ezanee et al. (2016), recycling is processing waste materials to obtain materials that can be reused. Recycling can be classified into three ways; Reduce, Reuse and Recycle (Adilah & Faisal, 2017). Recycling systems and technologies need to be introduced to all students to improve management and practices in recycling (Kehmeyer et al., 2011). A recycling system is one of the methods of collecting recyclable items by using recycling bins (Wang, 2006). The use of three recycling bins, namely blue, brown, and orange, serves as a place for garbage disposal and is collected according to the specified materials or items such as plastic, glass, and paper (Abas, 2013). The concept of recycling can relate to how to handle and manage the waste into a specific type of bin. Hence, the awareness of recycling can apply through mathematics education, especially in statistics and probability fields.

## Data Handling Topic

Data Handling topic is one of the syllabus in the Mathematics Year 4 *Kurikulum Standard Sekolah Rendah* (KSSR) textbook. Students must read, obtain and compare information from pictograms, bar charts, and pie charts (*Bahagian Pembangunan Kurikulum*, 2013). The concept of recycling will be covered in the Data Handling topic.

## Development GCE in Curriculum

Statistics and probability are evolving in the mathematics curriculum in Malaysia from primary to secondary level. In 2017, the primary school curriculum was changed from KSSR to KSSR Semakan in order to meet the PPPM (*Pelan Pembangunan Pendidikan Malaysia*) 2013-2025 policy. The data management in statistics and probability has changed at KSSR Semakan even has been part of Mathematics curriculum since Year 1. Students need to collect data based on everyday situations, read and interpret pictograms as well as solve problems involving actual events (*Bahagian Pembangunan Kurikulum*, 2015). The learning standards designed for Year 2 are nearly identical to Year 1. The only difference is the data presentation used which has been switched from pictographs to bar charts (*Bahagian Pembangunan Kurikulum*, 2016).

According to Year 3 mathematics curriculum, students will be required to utilise pie charts to obtain information and relate each representation of data learned from Year 1 to Year 3, namely pictograms, bar charts, and pie charts (*Bahagian Pembangunan Kurikulum*, 2017). The curriculum of Year 4 which began to be implemented in 2021, pupils were required to construct and interpret uncollected data using pictograms and bar charts. At the same time students need to carry out problem-solving based on everyday situations (*Bahagian Pembangunan Kurikulum*, 2018). Students are taught to understand pie charts and solve problems based on daily situations in the Year 5. Hence, they are starting to have an exposure to mode, median, mean, and range in the data (*Bahagian Pembangunan Kurikulum*, 2019). In the year 2022, The KSSR Semakan Curriculum for Year 6 will be introduced. As a result, the content of Mathematics learning for Year 6 is currently uncertain.

Data Handling in the Form 1 *Kurikulum Standard Sekolah Menengah* (KSSM) curriculum deepens statistics learning in primary school. Hence, statistics and probability has been introduced in the KSSM curriculum to help students meet the needs of the 21st century in the term of technology and information and a line with the demands of today's world. Furthermore, the government intends to produce human capital that can think creatively and generate various ideas in problem-solving (*Bahagian Pembangunan Kurikulum*, 2015). The Form 1 curriculum emphasizes data collection, organization, and representation by students and making interpretations to data representation. Thus, students need to master the six learning standards outlined, namely the ability to generate statistical questions and make relevant data collection; classification of categorical data or numerical data and construction of frequency tables; construct data representations for uncollected data and provide appropriate justification for a data representation; change the form of data representation to other appropriate representations as well as justify; give interpretations to various data representations including making inferences or predictions; and discuss the importance of representing data ethically to avoid confusion (*Bahagian Pembangunan Kurikulum*, 2015).

Based on Form 2 curriculum, students need to master the topic of simple probability (*Bahagian Pembangunan Kurikulum*, 2018). Thus, students are exposed to Experimental Probabilities, Theoretical Probabilities Involving Equally Possible Endings, Complimentary Event



Probabilities, and Simple Probabilities. While in Form 4 and 5, students were exposed to unaggregated data scattering measures (*Bahagian Pembangunan Kurikulum*, 2018). The scattering and measurements of scattering includes the range, inter-quartile range, variance, and standard deviation. Students are also exposed to the probabilities of merging events which fall under topic of statistics and probability. In addition, students are exposed to the topic of permutations and combinations as well as Probability Distributions in Form 5 Additional Mathematics (*Bahagian Pembangunan Kurikulum*, 2018).

## Methodology

### Research Design

The research design used in this study is Design and Development Research (DDR) and quantitative research by using pre and post-survey. According to Collins (1990), DDR approaches are used to test theory and validate its practicality. Besides that, it is described as a way to establish new procedures, techniques and tools based on specific needs analysis (Richey & Klien, 2007). As a short, the use of DDR to facilitate the development of measurement tools, products and processes. Hence, it is 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 lesson plan. Based on Tuckman (2012), the survey method used in research study is efficient in terms of gathering the data from respondents. It is even the easiest way to access respondents with a short period time with low budget (Salih, 2018). The process in this survey included the finding population, sample, create the questionnaire, spread the questionnaire, pre and post-survey, analyse the data and make discussion then conclusion.

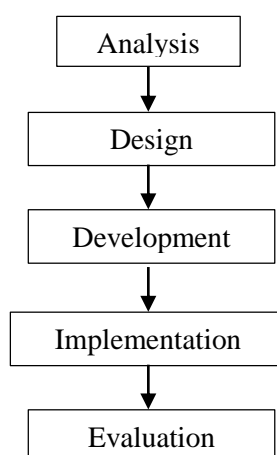
### Population and Sample

The population chosen for this study is Year 4 students from one school in Batang Padang, Perak district. The number of samples for this study is 30 students. The sample was selected by the convenience sampling method. According to Borg and Gall (1983), the number of samples between 20 and 50 is more than enough to run the survey studies. The respondents are required to answer questionnaires for pre and post-survey.

### ADDIE Model

The ADDIE model is used in this study as in Figure 1. According to Jamalluddin (2001), this model is the basis for other instructional design models with many advantages. It contains five phases which are analysis, design, development, implementation, and evaluation. These phases have their own meaning that can be referenced in arranging work steps during the module construction process (Jamalluddin, 2001).

Figure 1 ADDIE model



The concept of instructional design can be traced back to the 1950's. But it wasn't until 1975 that ADDIE was designed. ADDIE was originally developed by the Center for Educational Technology at Florida State University for the U.S. Army and later implemented in all branches of the U.S. Armed Forces. The ADDIE model is based on the early ID model, the five-step method developed in the United States (Aldoobie, 2015). Over the years, practitioners have made many revisions at various stages of the original hierarchical version. This makes the model more interactive and dynamic. A version similar to the current version appeared in the mid-1980s. Today, the impact of the ADDIE method can be seen on most of the ID models used. The ADDIE model relies on each stage completed in a given order, but focuses on reflection and iteration. This model provides you with a simplified, focused approach that can provide feedback for continuous improvement.

In the analysis phase, the survey was distributed to the respondents as a pre-survey to identify the respondents' awareness of recycling through mathematics lessons. In the design phase, the pre-survey data to know the material or product can be used for development. In the development phase, a lesson plan develops for the Data Handling topic. Global Citizenship Education (GCE) aims to empower learners of all ages to assume active roles, both locally and globally, in building more peaceful, tolerant, inclusive, and secure societies. Data Handling topic related to GCE is based on the three domains of learning-cognitive, socio-emotional, and behavioral (Teaching and learning transformative engagement, UNESCO 2019). The lesson plan includes the recycling concept for the Data Handling topic. The lesson plan developed is for one hour lesson. In the implementation phase, the teacher does the mathematics lesson by using the developed lesson plan. In the evaluation phase, the post-survey was distributed to analyze the respondents' awareness of recycling before and after the Data Handling topic.

### **Instrumentation**

Instrument development can be initiated in many ways. One of the ways to develop an instrument is by looking into a module designed for a study. A total of seven items were developed. All the items were developed to measure the students' awareness of Global Citizenship Education in mathematics education through Data Handling. 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). These items provide input about the student's awareness of Global Citizenship Education in recycling through the Data Handling topic.

## Validation of Instrument

The students' awareness of Global Citizenship Education in the context of recycling in the mathematics lessons, the questionnaire was validated by two experts in the field of Global Citizenship Education and mathematics education. Experts accepted all the items with some minor amendments. The items were revised according to the experts' advice and comments. The following Table 1 shows the items that are in the questionnaires.

Table 1 Items for Students' Awareness on Recycling

Number	Code	Statement
1	R1	I learned the importance of recycling during a mathematics lesson.
2	R2	I know how to recycle through mathematics lessons.
3	R3	I use recycling things for my mathematics lesson to improve my understanding of mathematics concepts.
4	R4	I encourage my family members to recycle after learning in a mathematics lesson.
5	R5	As exemplified in a mathematics lesson, recycling activity helps us to save the world from environmental issues.
6	R6	Mathematics lessons create awareness to save money by recycling.
7	R7	Mathematics lessons create awareness of the importance of a healthy lifestyle through recycling.

## Pilot Study

A pilot study is a smaller-scale version of research carried out prior to the main experiment to assess the study's feasibility, methodology, materials, and possible problems systematically (Thabane et al., 2010). The pilot study sample size was chosen according to literature standards, which recommended that the pilot study sample size be kept small, i.e., up to 100 respondents (Diamantopoulos & Sigauw, 2000). The pilot test of the instrument was conducted by distributing 50 questionnaires to primary and secondary school mathematics students by simple random sampling from Perak state in Malaysia. The 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. It may, however, be appropriate at 0.60. (Sekaran, 2003). The constructs of the pilot test are stable, as shown in Table 2 (with Cronbach's alpha that is more than 0.7).

Table 2 Reliability of Mathematics Homework Engagement Constructs in the Pilot Test

Global Citizenship Education	Number of items	Coefficient Alpha
Recycling	7	0.910

Table 3 indicates the rotated component matrix. The findings show that there are seven 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's constructs.

Table 3 Rotated Component Matrix

Items	Global Citizenship Education
	Recycling
R4	.919



Items	Global Citizenship Education
	Recycling
R5	.905
R1	.886
R2	.875
R7	.848
R6	.797
R3	.772

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.

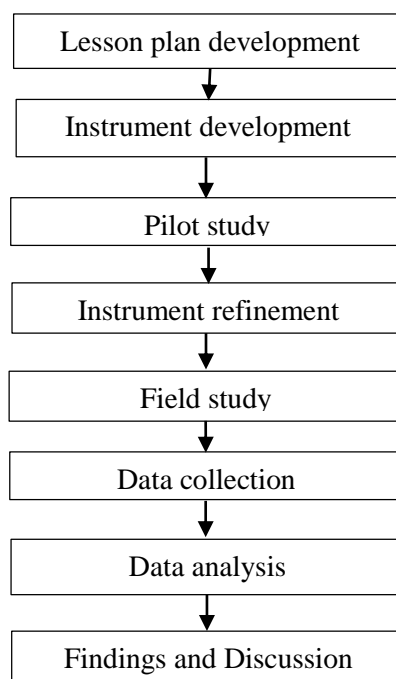
### Data Collection

The pre-survey was distributed to the respondents through Google Form to know their awareness of recycling before the lessons of Data Handling topic conducted in the classroom. The duration given to the respondent to answer the pre-survey is two days before the lessons started with the implementation of the recycling concept. After two days, the lessons on the Data Handling topic were started virtually through Google Meet. The respondents were taught about recycling in the Data Handling topic. Then, the respondents are required to answer the same survey as a post-survey.

### Research Procedure

A quantitative research is based on the measurement of student's awareness on recycling through mathematics lessons. Here a process in Figure 2 is expressed the flow chart of the research. It is a systematic way, how a research is to be carried out to answer the research questions set by the researchers.

Figure 2 Research procedure flow



## Data Analysis

The data collected in this study will be analysed using a quantitative analysis method. According to Cohen et al. (2011), quantitative data analysis is a strong research structure, which usually associated with major researches, but can fulfill smaller scale investigations such as experimental studies and correlation studies. Therefore, the data obtained from the instrument is analysed through descriptive statistics method (frequency and percentage), and inferential statistics method (paired sample *t*-test and independent sample *t*-test) using the SPSS software. To answer the research question one, paired sample *t*-test was used to identify differences of recycling awareness before and after the lessons of Data Handling topic. Apart from that, independent sample *t*-test was used to identify differences of recycling awareness after the lessons of Data Handling topic based on gender of second hypothesis.

## Results and Discussions

### Demographic

Table 4 showed the distribution of the respondents involved in this study. The total 30 respondents consist of 12 boys (40%) and 18 girls (60%). The number of boys is slightly lower than the number of girls.

Table 4 The Distribution of Respondents (n=30)

Gender	Frequency	Percentage (%)
Boys	12	40
Girls	18	60

**Research Question 1:** Is there any significant difference in students' awareness about recycling before and after the Data Handling topic?

Table 5 showed the result of paired sample *t*-test for research question one. There is a significant difference of recycling awareness before ( $M=2.65, SD=0.48$ ) and after ( $M=4.67, SD=0.32$ ) the lessons of Data Handling topic, [ $t(29) = -20.78, p < 0.05$ ].

Table 5 Paired Sample *t*-Test

Survey	<i>n</i>	Mean	<i>SD</i>	<i>df</i>	<i>t</i>	<i>p</i>
Pre	30	2.65	0.48	29	-20.78	0.000*
Post	30	4.67	0.32			

Note: *p* = Significant level, *t* = Value of *t*-test, \* = Significant level at below  $p < 0.05$ , *df* = Degree of Freedom, *SD* = Standard Deviation

The analysis shows that the level of significance is below 0.05. Hence the null hypothesis is rejected. The overall mean score for pre is 2.65. Masyuniza (2015), defines the mean score that falls between 2.00 and 2.99 as a low level of awareness. As a result, the pre-survey of recycling awareness among primary school students is at a low level. At the same time, the overall mean score for post-survey is 4.67. According to Masyuniza (2015), when the mean score falls between 4.00 and 5.00 is known as a high level. It shows that after the lessons on the Data Handling topic, the level of recycling awareness among students is at a high level. Hence, the mean score for the post ( $M=4.67$ ) is significantly higher than the mean score for pre ( $M=2.71$ ). Finally, the Data Handling topic in mathematics lessons can considerably boost recycling

awareness. As the outcome of integrating the GCE into the mathematics classroom, students' knowledge of recycling has improved. Zeynep and Dilek (2019) observed that when teachers implemented recycling, the students' awareness of recycling was relatively high. It means students can understand the concept of recycling through mathematics curricula, especially in the statistics field. The active involvement in the mathematics classroom showed that students were becoming conscious of the importance of recycling to save the environment. According to Camci (2012), interactive learning among students aids in the strengthening of everyday life problem issues. Environmental awareness has a significant effect on green consumer attitudes (Choshaly, 2017). In this case, people are encouraged to use recyclable materials such as plastics, glass, metal, and paper. As a result, learning this topic in mathematics classrooms raises students' awareness of their environmental responsibilities.

**Research Question 2:** Is there any significant difference in students' awareness about recycling after the lessons on the Data Handling topic based on gender?

Table 6 showed the independent sample *t*-test for post lessons of Data Handling topic for recycling awareness based on gender. It shows that there is no significant difference of recycling awareness based on gender boys ( $M=4.73$ ,  $SD=0.31$ ) and girls ( $M=4.62$ ,  $SD=0.32$ ) after the lessons of Data Handling topic, [ $t(28) = 0.904$ ,  $p > 0.05$ ]. The level of significance is exceeded 0.05. Hence, it was failed to reject the null hypothesis.

Table 6 Independent Sample *t*-test for Post Survey Based on Gender

Gender	<i>n</i>	Mean	<i>SD</i>	<i>df</i>	<i>t</i>	<i>p</i>
Boys	12	4.73	0.31	28	0.904	0.374
Girls	14	4.62	0.32			

Note: *p* = Significant level, *t* = Value of *t*-test, \* = Significant level at below  $p < 0.05$ , *df* = Degree of Freedom, *SD* = Standard Deviation

In conclusion, there is no difference between gender for recycling awareness after the lessons on the Data Handling topic. However, the mean for boys ( $M=4.73$ ) is slightly higher than the mean for girls ( $M=4.62$ ). It showed that the boys' awareness toward recycling after the lessons of Data Handling topic is slightly better than the girls. The results are contradicted to the finding of Sharifah et al. (2018). The researchers found that girls are more aware of recycling than boys. In addition, students were able to adapt new knowledge taught in mathematics lessons relating to GCE. This indicates that students start showing interest in global issues (Lee & Leung, 2006). Hence, further studies may focus on GCE with different topics in mathematics and improve their understanding of global issues.

## Conclusion

### Summary of the Study

This research study employs the ADDIE model. It contains five-phase which are analysis, design, development, implementation, and evaluation. This study aims to develop a lesson plan to identify students' awareness about recycling through Data Handling topics. The research design used in this study is Design and Development Research (DDR) approach and quantitative research. The findings showed a significant difference in recycling awareness

before ( $M=2.65$ ) and after ( $M=4.67$ ) the lessons of Data Handling topic. The second result revealed no significant difference in recycling awareness between boys ( $M=4.73$ ) and girls ( $M=4.62$ ). Finally, it has been shown that including recycling awareness in mathematics teaching eventually improves students' recycling awareness. Thus, teachers play an important role in raising knowledge of recycling and putting it into practice in the classroom.

### Implications and Future Direction

This study can guide educators, students, and the Ministry of Education to practice and spread awareness of recycling in education among youngsters. This study can assist teachers in implementing the developed lesson plan in their mathematics lessons. Students can utilize the concept of recycling at home, in public parks, and in other places. According to the Ministry of Education in Malaysia, this research can provide the foundation idea for introducing the recycling issue into mathematics curricula at all levels of education. Implementing the concept of recycling will help increase knowledge, attitudes, and responsibility to practice recycling among the students. These good practices will help the management in solving the issue of pollution caused by inappropriate garbage and waste disposal. This study is useful in that it influences other studies being conducted or proposed in the field of global citizenship education. Moreover, global concerns awareness can be taught through mathematics or other subjects, rather than limiting to civic learning. As a result, the Ministry of Education could develop a module or program for all the teachers in primary and secondary schools to enhance global citizenship education in every subject.

### Significance and Contribution in Line with Philosophy of LSM Journal

This article contributes by showcasing how Global Citizenship Education (GCED) could be infused in mathematics lesson using ADDIE model with research-based findings. Exemplar is illustrated on selected research items for assessing students' awareness on 'Recycling' (as part of Waste Management) through mathematics lessons in the Data Handling topic.

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