

Applying Recycling in Mathematics Education: A Study of Selected SJKT Schools in Seberang Prai District, Malaysia

Shalini Surianarayanan¹, Murugan Rajoo², Siti Fazlieya Jaffar³, Nurain Syafiqah Shukri⁴

^{1,2#,3,4} Fakulti Sains Matematik, Universiti Pendidikan Sultan Idris, Tanjung Malim, Perak.

#corresponding author <murugan@fsmt.upsi.edu.my>

Received first draft 8 July 2021. Received reports from first, second reviewers (21 July 2021 and 2 October 2021) and third reviewer (24 June 2022). Received revised draft 2 October 2022.

Accepted to publish 19 December 2022.

Abstract

Purpose and Research Question - Global citizenship education encourages all learners to be provided with knowledge and skills to promote sustainable developments, contributing to a more pleasant and tolerant society. As a result, this study was conducted to develop a proper lesson plan on recycling to increase student awareness; to identify students' awareness of global issues involving the application of the recycling method by comparing the data from pre-survey and post-survey lessons and to determine the students' awareness on recycling based on gender.

Methodology – The study sample involved 25 respondents from a primary school in the Seberang Prai district. A questionnaire adopted from Radhakrishna (2007) was used as the instrument for this study and the items were measured by using five-point scales. The instrument was distributed online before and after the lesson was conducted.

Findings – The data were analysed using descriptive analysis and a paired sample *t*-test, which revealed a significant difference in the students' awareness before and after the lesson ($p < 0.005$). The findings showed no significant difference in male and female students' awareness of recycling issues ($p > 0.005$).

Significance and Contribution in Line with Philosophy of LSM Journal – Thus, this finding implies that continuous efforts are required to encourage recycling among students and increase their awareness of the global issue.

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

Introduction

Background and Overview

Global Citizenship Education (GCE) has progressively become the centre of attention throughout the world. GCE has been proposed as a strategy by which learning institutions can recognise the need for students to participate in relevant and worthwhile activities, thereby broadening their global perspectives. This also assists them to contribute to a more pleasant and safe world (Jorgenson & Shultz, 2012).

Many countries, including Italy and South Korea, have incorporated GCE into their educational processes to teach students the importance of recognising global issues in daily life (Damiani, 2018; Pak & Lee, 2018). Global citizenship education involves culture, society, environmental, political and economic issues. According to Estelles and Fischman (2021), GCE is more than just a broader community or nation's citizenship education; it is a significant advancement in a citizenship necessity involving all citizens and focusing on developing cultural, national, and global recognition. Therefore, every learning centre must include GCE in its teaching process. Today, GCE has been implemented during the learning process in the classroom. Mathematics is one of the subjects which commonly involves the GCE in the learning process. Valoyes-Chavez and Martin (2016), in their research, mentioned that mathematics education might act as a social institution and a field of practice in prevailing issues such as multiculturalism issues. As a result, Malaysian schools must implement GCE in their classrooms, particularly in mathematics.

Problem Statement

Mathematics is a requirement for conquering the mathematical knowledge required daily, teaching how to solve problems, and providing learners with reasoning methods and skills (Peter, 2012). According to the Organization for Economic Cooperation and Development (OECD, 1999), mathematics is important in assisting individuals in making the right decisions and seizing mathematics in a way that corresponds to the needs of that individual's present and future life. This is consistent with the goal of global citizenship education, which aims to provide learners with the knowledge, values, attitudes, and skills they need to actively contribute to creating a secure world (Zahabioun et al., 2013). According to the research by Yusof et al. (2019), the relationship between knowledge, skill, and attitude towards global citizenship is high, positive, and significant. So, global citizenship education is important to equip students to understand global issues and become global citizens. GCE issues such as environmental issues, race and unity can be implemented in the learning process to teach citizens about the importance of acknowledging those issues and guiding them to practice the best approach to life. In other words, mathematics lessons and GCE are interrelated in providing a better and more pleasant country for each native (Evans, 2018). According to Bourn et al. (2017), mathematics could apply many global and sustainable topics such as mastering numeracy skills can enable students to understand the causes and impact of poverty in certain countries. Therefore, geometry, one of the topics learnt in mathematics primary school in Malaysia, has been a suitable topic to correlate with GCE in fulfilling the GCE objectives.

Geometry was added to the Malaysian lower primary school curriculum in 2011. Geometry is closely related to students' real lives and should be easier to understand. Some students, however, have a poor understanding of geometrical concepts, which leads to poor mathematics results (Bhagat & Chang, 2015). The work of Barret-Mynes (2013) discusses how the teacher

plays a crucial role in providing students with global issue knowledge. However, the study's findings revealed a lack of global issue application in mathematics education, resulting in less exposure to the issue for students (Barret-Mynes, 2013). As a result, this study was carried out to overcome this issue by engaging in a global issue that focuses on recycling methods in Mathematics lessons, specifically in Geometry topics, to improve student understanding of GCE and geometry.

The implementation of recycling issues could be a phenomenon affecting all teachers and pupils in Malaysian primary schools. Once a brand-new curriculum is implemented throughout the school system, it is expected that its effectiveness will increase as time goes by. It seems that though the pilot study has proven its effectiveness, a similar result might not be probable at the implementation stage. As a result, this study was carried out by developing a lesson plan on mathematics topics such as geometry to raise student awareness of recycling. Other than that, this research was done to identify students' awareness before and after implementing the GCE on recycling in mathematics lessons and to identify students' awareness of recycling in mathematics based on gender.

Purpose of Study

As mentioned in the abstract, this study involves global citizenship education in mathematics subjects, specifically in geometry topics. The goal of this study is to raise students' awareness of recycling. The learning standards in the mathematics classroom explore the awareness of recycling issues by acknowledging recycling-related activities in the geometry lessons. This course of study ensures that the student has at least a basic understanding of recycling.

Literature Review

Geometry in Malaysia Education

Malaysia is one of the countries that includes geometry as one of the mathematics topics taught in primary and secondary schools. Mathematics is an important part of one's daily life and can be a powerful tool for solving problems encountered in everyday life. Malaysia's education includes geometry in the primary school syllabus, proving that geometry has played an important role in the mathematics area. According to Effandi and Abdul Halim (2012), geometry, one of the crucial topics in mathematics, should be mastered by students as a basic skill in their academic learning process. In geometry, a shape can be defined as the form of an object or its outline, outer boundary or outer surface. A shape or figure is an object or its external border, outline, or external surface instead of other properties such as colour, texture, or material type. The shape is a subdomain of geometry taught in primary school as part of the Mathematics Standard Curriculum for Primary School (KSSR). However, a study from Hock et al. (2015) showed that teachers faced difficulties teaching the skills and knowledge in 'Shapes and Spaces'. This study also stated that the primary mathematics syllabus had evolved into the Standard Curriculum for Primary School (KSSR) based on the Malaysia Education Blueprint. Still, teachers seemed unfamiliar with the syllabus, especially with the topic of 'Shapes and Spaces'. An analysis of the Malaysian Primary School Achievement Test (UPSR) in 2008 and 2010 also resulted in poor performance in 'Shapes and Spaces'. Therefore, a refresher course on geometry theory for Malaysian educators has become important to increase geometry attainment, especially at the primary level (Hock et al., 2015).

Geometry as a Part of Mathematics

Nowadays, mathematics is essential in almost all professions. Agah (2020) stated that mathematics is not only a theoretical concept to be learnt, but it is also closely related to the process of handling problems in life. Mathematics is defined as "the study of all structures and forms that can be expressed in symbols," as well as "the grammar of all symbolic systems" (Ugwu, 2011). Mathematics is now required in many classes, including science, engineering, and philosophy, which has evolved from the basic calculation, estimation, and basic shapes. In mathematics, the 19th century saw an uncommon increment in the difficulty of mathematical concepts. Joseph Fourier's study discusses infinite sums in which the terms are trigonometric functions. The definition of proofs as "self-evident facts" was increasingly abandoned in favour of a reliance on logical principles such as continuity and correctness in the twentieth century, continuing the nineteenth-century trend toward growing generalisation and abstraction in mathematics. Mathematics involves many different topics learnt globally in school today, such as algebra, statistics, and geometry. As a part of history, geometry began around 3000 BC, where basic knowledge was applied widely among the Egyptians. They used geometry in constructing the building, which is a pyramid with four triangles and a square base to make it stable. The Egyptians also use the idea of areas to solve growth-related problems. Nowadays, the picture of the area is also learnt in primary school in which they calculate the area of certain shapes (Winarti et al., 2012). Then, among ancient Babylonians, the measurement of quadrilaterals was introduced, which included many different shapes with for instance, the rectangle, parallelogram, trapezium, and rhombus. The usage of quadrilaterals in daily life is widely used, but not many learners can realise their application in real life (Asnawati, 2018). Quadrilateral shapes can be found in our everyday surroundings, such as laptops, dining tables, and smartphones.

Global Citizenship Education

For several decades, global citizenship education has been a major focus of educational institutions. The 'global' term is related to the whole world or the whole of something, while citizenship brings the meaning of an individual's involvement with the nation's state (Engel, 2014). According to Sant and Valencia (2018), the citizenship term can be elaborated as a matter of one's fixed lawful and political status and a sense of acceptance. On the other hand, global citizenship education can be defined as an educational practice that requires learners to fully participate in both a globalised society and the economy, with a focus on knowledge and understanding, skills, values, and attitudes (Goren & Yemini, 2016). Myers (2016) stated that GCE is an addition to the existing curriculum to fortify the current education structures.

Global citizenship education, also known as civic learning, encourages students to participate actively in various projects dealing with global issues of a social, political, economic, and environmental nature (Grobbaauer & Winstersteiner, 2017). This statement corresponds with the meaning of GCE defined by UNESCO (2017), which stated that GCE refers to "a sense of belonging to a broader community and common humanity in which the focus is on political, economic, social and cultural interdependency and interconnectedness between the local, the national and the global". This learning system has been widely applied across many countries. In Brazil, for example, educators are encouraged to focus on the benefits of African and indigenous cultures to Brazil, as this will help students understand the concept of 'race' (Sant & Valencia, 2018). In other words, students are expected to appreciate the variety of races and cultures in their country. The GCE program benefits society in various ways, including promoting peace among citizens, increasing humanity's esteem for one another, and thus providing a better world for future generations (Farahani, 2014).

Global Citizenship Education in Mathematics Lesson

Globalisation had a significant impact on educational systems in many countries around the world. Gajardo (2011) mentioned that several modifications had urged the education system to be reorganised. Besides, the article also stated that the current system also highlights the requirement for standards and equity in educational access and results. Education for global citizenship is emphasising the development of awareness among students. According to Estelles and Fischman (2021) education for global citizenship is specifically concerned with understanding the nature of global issues and taking an active role in addressing them. This was supported by Pak (2013), which stated that the purpose of education in these modern days has become more extensive to incorporate peace, human rights, equity, and also sustainable development issues.

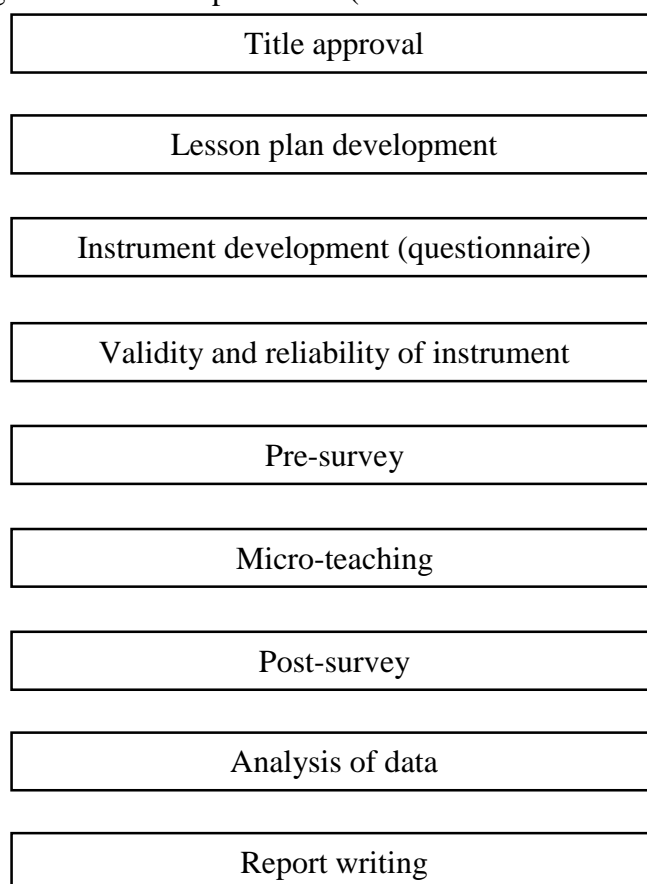
In recent years, global citizenship education has been applied in almost all disciplines, including mathematics, which is often overlooked in integrating global issues. However, according to NGA (2010), mathematics standards are outlined in the common core state standards. Mathematics is also one of the closely related subjects to human daily life and society, which is why it is regarded as a focal point in today's educational system. Some countries have incorporated global citizenship education into their mathematics lessons; for example, Bedouin teachers used embroidery from the Bedouin culture to improve students' understanding of mathematical and geometrical subjects (Fouze & Amit, 2017). The study also shows that this teaching method makes it easier and more interesting for students to absorb information, resulting in a better understanding of the topics covered. Involvement of cultural values in mathematics lessons indirectly promotes cultural values among students. As a result, teachers must use appropriate learning methods to improve students' understanding of the subject and raise awareness of specific global issues.

Methodology

Research Design

This study was conducted using three research methods: quantitative methods, Design and Development Research (DDR), and experimental techniques. According to Apuke (2017), a quantitative research method deals with computing and analysing variables to obtain a result. This method required the implementation and analysis of numerical data using specific statistical procedures to answer several questions, such as who, how what, and where. Thus, a quantitative method is a suitable method to be applied in this research since it involves analysing numerical data. Design and development research (DDR) was initially suggested by Brown and Collins in the 1990s and is widely applied in educational research. This method is used to test theory and validate its practicability (Sahrir et al., 2012). In this study, DDR was applied by testing the lesson plan's effectiveness produced involving the micro-teaching process. Besides, the research experimental methods implemented in this research referred to the causes of environmental conversion, which can be related to the term 'treatment' (Ross & Morrison, 2013). This study implements the experimental method during the pre-survey and post-survey. The research procedure for conducting this research can be summarised as illustrated in the following Figure 1.

Figure 1 Research procedure (insert arrows to show the flow?)



Note. The overview of the research procedure

Population, Research Sample and Sampling Method

A convenient sampling technique was used to obtain the respondents for this study. This type of sampling is a non-probability sampling method which is the most applicable and most widely used method in research (Elfil & Negida, 2017). According to the study, this method has several advantages that may benefit the researcher, including that it is not a time-consuming or low-cost method. The term "convenient" refers to the method's ease of selecting samples for research. The sample selection can be made by choosing a group of people who are easier to contact or reach. Therefore, in this study, the convenient sampling method was applied to collecting respondents consisting of primary students. The respondents including 25 year-six students from SJKT school in the Seberang Prai district in Penang.

Instrumentation

Instrument development can initiate 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. 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 the context of recycling.

In the development of a valid and reliable questionnaire, several steps need to be taken into account. The five sequential steps involved in developing questionnaires and testing as adopted from (Radhakrishna, 2007). In this initial stage, the researcher identified the purpose, objective, research questions, and hypothesis. Besides that, the researcher also determined the respondents (students who attended the GCE lessons in mathematics). The next step is to generate statements for the questionnaire. In this step, content (from theoretical framework/literature/module) is transformed into statements or questions. In this study, the researcher used contents from the module developed by researchers to generate items (Radhakrishna, 2007; Hinkin et al., 1997). In the third step, the concern is writing the statements, selecting appropriate scales of measurement, the questionnaire layout, format, order of questions, font size, font and back cover, and the proposed data analysis. Scales are devices used to quantify a subject's response to a particular variable (Radhakrishna, 2007). It was suggested that the new items be scaled using five- or seven-point Likert scales (Likert, 1932). Measures with five- or seven-point scales have been shown to create variance necessary to examine the relationships among items and scales and create good coefficient alpha (internal consistency) reliability estimates (Lissitz & Green, 1975). Therefore, in this study, the researcher used five Likert scales to measure students' awareness of Global Citizenship Education in the context of recycling.

Validation of Instrument

The students' awareness of Global Citizenship Education in the context of the recycle questionnaire was validated by two experts from public university in 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 items are in the following Table 1.

Table 1 Students' Awareness of Recycles

Num	Code	Students Awareness on Recycle Statement
1	R1	I learnt the importance of recycling during a mathematics lesson
2	R2	I know how to recycle through mathematics lesson
3	R3	I use recycling things for my mathematics lesson to improve my understanding of mathematics concept
4	R4	I encourage my family members to recycle after learning in a mathematics lesson
5	R5	Recycling activity as exemplified in a mathematics lesson help 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.

Note. The survey item about the students' awareness of recycling before and after the lessons conducted.

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 & Siguaw, 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. In the purification step of the instrument, the next level after content validity is the instrument's reliability, which guarantees that steps are unbiased and thus produce accurate data (Peterson, 1994). 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). This study (pilot test) constructs both constructs are stable, as seen in Table 2 (Cronbach's Alpha is more than 0.7) showing that the instrument was highly reliable for being carried out in the research.

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

Global Citizenship Education	Number of items	Alpha Coefficient
Recycle (2)	7	0.910

Note. Cronbach's alpha was analysed using Statistical Package for the Social Sciences (SPSS) 23.0, and the coefficient alpha obtained is 0.910.

Data Analysis and Findings

Data analysis could be a significant segment of the study. Data analysis systematically applies statistical or logical approaches to describe and illustrate, condense and summarise, and evaluate data. The accurate and appropriate analysis of research findings is a critical component of ensuring data integrity (Durcevic, 2020). This research uses descriptive analysis, a paired sample *t*-test and an independent sample *t*-test.

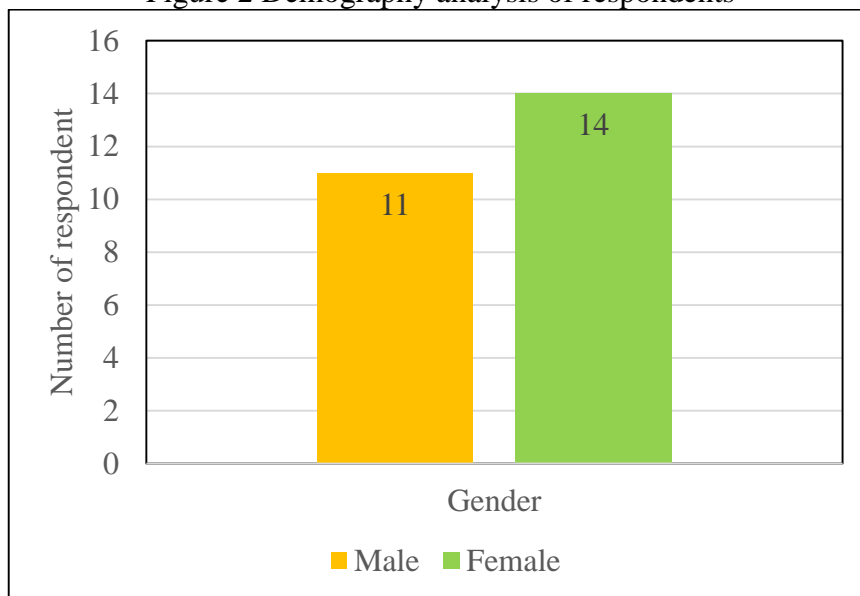
Descriptive analysis is the type of data analysis that helps describe, show, or constructively summarise data points. Patterns might emerge that fulfil every condition of the data (Durcevic, 2020). The paired sample *t*-test is then used to compare two population mean in which observations in one sample can be paired with observations in the other (Creswell & Creswell, 2009). In this data analysis, an independent *t*-test was also used. A statistical test is applied to determine whether the difference between the means of two groups is statistically significant (Johnson & Christensen, 2019). This data was analysed using the Statistical Packages for Social Sciences (SPSS) 23.0.

As mentioned in the research aims and significance of the study, the goal of this research is to raise students' awareness of recycling. The data was analysed based on pre-survey and post-survey results obtained before and after the micro-teaching was conducted. The result was also analysed by comparing the pre-survey and post-survey data based on gender, which was then presented in the figure and the table. This chapter also discusses the results obtained, and the previous research statement was provided to support the results from this study.

Demographic Analysis Based on Gender

The demography analysis for respondents was shown in Figure 2.

Figure 2 Demography analysis of respondents



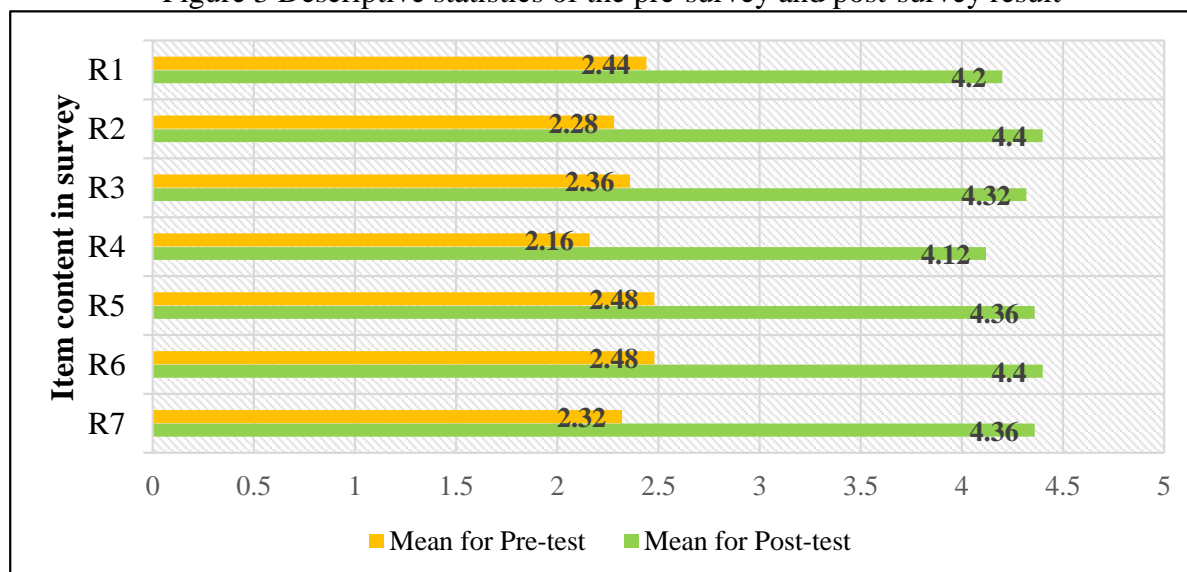
Note. The graph shows the percentage of respondents based on gender, which stated that male is 44 percent while female is 56 percent from the total respondents.

Figure 2 shows the percentage of the respondents who answered the questionnaires regarding awareness of the recycling issue during the mathematics class on the polygon's topic. Females made up 56% of the respondents or 14 of the 25 students. Males have fewer than females, with approximately 44%, or 11 out of 25 students.

Descriptive analysis of item

The descriptive analysis for the pre-survey and the post-survey result was shown in Figure 3.

Figure 3 Descriptive statistics of the pre-survey and post-survey result



Note. The graph indicates the mean result for each survey item by comparing the result before and after the lesson conducted.

Figure 3 depicts how students' awareness of recycling issues has grown significantly following their exposure to recycling issues in Mathematics class. As for Item 2, the mean difference showed a significant increase after the lessons, which was 2.12. For items 3 and 4, the mean difference was similar, which is 1.96. Other than that, items 1, 5, 6 and 7 showed a difference of 1.76, 1.88, 1.92 and 2.04. This data acknowledged the research question 1 that there is an increasing of awareness among students towards recycle after the implementation of recycling lesson plan in Mathematics lessons. The significant difference between pre-survey and post-survey lessons is presented in Table 3, while the significant difference for both males and females is shown in Table 4.

Analysis of pre-survey and post-survey result

Table 3 Paired Sample *T*-test for the Mean Difference of Pre-survey and Post-survey

	Mean difference	Standard deviation	<i>t</i>	<i>df</i>	<i>Sig</i> (2 tailed)
Post-survey – Pre-survey	1.94857	0.11481	44.905	6	0.000

Note. The table showed the result of paired sample *t*-test for pre-survey and post-survey data, which was analysed using SPSS 23.0.

Table 3 shows that the significance level was less than 0.05, indicating a significant difference in the students' awareness of the recycling issue before and after the implementation of the GCE on recycling lesson plan in the Mathematics lesson which answered the research question 2. According to this result, the application of recycling related activities may improve their knowledge of the issue. Therefore, the hypothesis (H_{01}) is rejected.

Analysis of respondents based on gender

Table 4 The post-survey difference in male and female students' understanding of the recycling issue

	Mean difference	Standard deviation	<i>t</i>	<i>df</i>	<i>Sig</i> (2 tailed)
Post-survey	0.26260	0.32073	0.819	20.264	0.422

Note. The table showed the independent sample *t*-test for post-survey data based on gender, which was analysed using SPSS 23.0.

The results involved 11 male students and 14 female students. Table 4 showed that the significance level was higher than the level ($0.422 p > 0.05$), indicating no significant difference in male and female students' awareness of recycling issues after the lesson was done. This result acknowledged the research question 3 that, the students' awareness after the implementation of GCE on recycling lesson plan in Mathematics lessons based on gender is invariant. Therefore, the hypothesis (H_{02}) is accepted.

Discussion

The awareness of recycling in Mathematics education

Global citizenship education can be implemented in mathematics by using some special methods in teaching, which are applicable in the pedagogical domains for the improvement of curriculum practices. Solid waste management has been a great challenge in modern areas globally (Wilson & Velis, 2015). The authorities have played a critical role in proper waste management. This requires all citizens from different hierarchies to work together to solve this problem. As for Malaysia, in 2012, the waste produced exceeded 3000 tonnes and where it is projected to reach 30,000 tonnes by 2020. However, approximately 33,000 tonnes of wastage were made during 2012 (Choon et al., 2017).

This study was carried out to meet the requirement of educating citizens about waste management issues at a young age. This study aims to change students' attitudes toward waste management issues, specifically recycling methods. As for the result obtained in Figure 3, item 2, which I know how to recycle through mathematics, showed a huge mean difference for pre-survey and post-survey. This indicated that students might have improved their knowledge and become more aware of recycling issues after the lesson. The findings were consistent with previous research by Tikka et al. (2010), who found that education significantly impacts environmental awareness and attitudes.

Other than that, item 3, which stated *I use recycling things for my Mathematics lessons to improve my understanding of Mathematics concepts*, proved that activity-based learning might enhance students' knowledge of certain subjects. A wide difference of mean for pre-survey and post-survey, which is 1.96, is strongly compatible with the study conducted by Celik (2018), which mentioned that activities-based learning produces great achievement in the subject. According to this study, interactivity among students is the most important factor in successful learning. Camci (2012) mentioned in his research that this kind of learning method concerns the outcomes and behaviours of the students yet aims to vitalise daily life's problem situations. The statements agreed with the outcome of item 4, which stated that students might encourage their family members to recycle after learning in a mathematics lesson.

According to one study, environmental concerns positively affect green purchasing intentions (Choshaly, 2017). This statement is related to this research, since recycling is one of the elements that can contribute to green purchasing behaviour. Concerning recycling, people are advised to use recyclable materials such as plastics, glass, metal, or paper. Therefore, learning about this issue in mathematics class increases students' concern about their responsibility to the Environment. As shown in Table 4, the findings of this study also revealed a significant difference in students' awareness of the recycling issue before and after the lesson.

Gender-based differences towards the awareness of recycling issues

As shown in Table 5, the findings of this study show that there is no statistically significant difference in male and female students' awareness of the recycling issue. However, this finding is contradicted by the previous work done by Venkatesh et al. (2012), which stated that demographic variables, including gender, played a vital role in recycling behaviours. Another study found that, when compared to males, most female respondents recycle in their daily lives (Choon et al., 2017). Besides, in their research, Oztekin et al. (2017) also stated that females have more positive attitudes and retain greater levels of determination to recycle than males.

All the studies concluded that females have a higher awareness of recycling than males, which is against this research finding. Students were able to adapt new information that taught them relating to global citizenship education in mathematics. The study by Brunell (2013) stated that students believe that they care about global issues. The reasons stated in the survey for teaching global citizenship are also very significant.

Implications and Suggestions for Further Study

This study focused on the application of the recycling issue in mathematics education, with the main goal of educating students about this global issue and also improving their academic performance in the subject. The results showed that after the lessons, students' knowledge and awareness of the recycling issue had increased. This demonstrates that students are aware of global issues, particularly those concerning recycling. However, they tend to ignore the importance of practicing recycling as there is a lack of exposure to this issue during their lessons. Therefore, this study was done to prove that appropriate lessons could increase their knowledge of global issues and foresee a better education for our future generations. This study acknowledges that attractive and fun learning may improve student understanding of mathematical topics in mathematical areas. As a result, producing a considerate and educated generation might benefit society as well.

Other than that, this research only considers students from SJKT in one district and the data collected is not reliable since only a small number of respondents were used. Therefore, other research can be conducted with better and more reliable data and also includes another class of students from different districts in Malaysia. This upcoming research might be useful for education field and for Malaysia also since it is related to the lessons done during academic class.

Conclusion

This study has outlined and highlighted the main objectives of this research, which is examining students' knowledge and understanding of the recycling issue that has been implemented in the Year six Mathematics classroom in a national type of primary school. Another goal is to investigate students' awareness of recycling issues in the mathematics classroom. The results obtained showed an increase in the students' level of knowledge and understanding of this issue following the lesson. Aside from that, students' awareness of recycling has increased as a result of the lesson. By using global citizenship education, teachers can teach students to recycle the problems in micro-teaching, and students obtain better results in the post-survey. Finally, it is critical to conduct better lessons for students to educate them about the issues surrounding us while also improving their academic performance.

References

- Agah, M. P. (2020). The relevance of mathematics education in the Nigerian contemporary society: Implications to secondary education. *Journal of Education, Society and Behavioural Science*, 36-43.
- Apuke, O. D. (2017). Quantitative research methods: A synopsis approach. *Kuwait Chapter of Arabian Journal of Business and Management Review*, 33(5471), 1-8.

- Asnawati, R. (2018). Redefinition of the kinds of quadrilateral based on the angles and sides. *In Journal of Physics: Conference Series* (Vol. 1028, No. 1, p. 012121). IOP Publishing.
- Barrett-Mynes, J. (2013). Literacy instruction in the wake of Common Core State Standards.
- Bhagat, K. K., & Chang, C. Y. (2015). Incorporating GeoGebra into geometry learning: A lesson from India. *Eurasia Journal of Mathematics, Science and Technology Education*, 11(1), 77-86.
- Bourn, D., Hunt, F., & Bamber, P. (2017). A review of education for sustainable development and global citizenship education in teacher education.
- Brunell, L. A. (2013). Building global citizenship: Engaging global issues, practicing civic skills. *Journal of Political Science Education*, 9(1), 16-33.
- Camci, F. (2012). Effects of activity-based teaching grounded on active learning on students' academic skills and learning process. Adiyaman University, Institute of Sciences.
- Çelik, H. C. (2018). The effects of activity-based learning on sixth-grade students' achievement and attitudes towards mathematics activities. *EURASIA Journal of Mathematics, Science and Technology Education*, 14(5), 1963-1977.
- Choon, S. W., Tan, S. H., & Chong, L. L. (2017). The perception of households about solid waste management issues in Malaysia. *Environment, development, and sustainability*, 19(5), 1685-1700.
- Choshaly, S. H. (2017). Consumer perception of green issues and intention to purchase green products. *International Journal of Management, Accounting and Economics*, 4(1), 66-79.
- Creswell, J. W., & Creswell, J. D. (2009). Research design: Qualitative, quantitative, and mixed methods approach. Sage publications.
- Damiani, V. (2018). Introducing global citizenship education into classroom practise: A study on Italian 8th-grade students. *Center for Educational Policy Studies Journal*, 8(3), 165-186.
- Diamantopoulos, A., & Sigauw, J.A. (2000), Introducing LISREL. London: Sage Publications.
- Durcevic, S. (2020). Your modern business guide to data analysis methods and techniques. Incomplete reference.
- Effandi, Z., & Abdul Halim, A. (2012). The activities based on van Hiele's Phase-Based learning: Experts' and preservice teachers' views. *Journal of Mathematics and Statistics*, 8(3), 385-395
- Elfil, M., & Negida, A. (2017). Sampling methods in clinical research: An educational review. *Emergency*, 5(1), 51-62.
- Engel, L. C. (2014). Global citizenship and national (re) formations: Analysis of citizenship education reform in Spain. *Education, Citizenship and Social Justice*, 9(3), 239-254.
- Estellés, M., & Fischman, G. E. (2021). Who needs global citizenship education? A review of the literature on teacher education. *Journal of Teacher Education*, 72(2), 223-236.
- Evans, K. (2018). Investigating the relationship between mathematics education and global citizenship education through k-12 mathematics teacher perspectives.
- Farahani, M. F. (2014). The role of global citizenship education in world peace and security. *Procedia-Social and Behavioral Sciences*, 116, 934-938.
- Fouze, A. Q., & Amit, M. (2017). On the importance of an ethnomathematical curriculum in mathematics education. *EURASIA Journal of Mathematics, Science and Technology Education*, 14(2), 561-567.

- Gajardo, M. (2011). Education after Two Decades of Change. What have we learned? What should we transform? In quality, equity and reforms in teaching (pp. 59-76). Madrid: OEI – Santilana Foundation.
- Goren, H., & Yemini, M. (2016). Global citizenship education in context: Teacher perceptions at an international school and a local Israeli school. *Compare: A Journal of Comparative and International Education*, 46(5), 832-853.
- Grobbauer, H., & Wintersteiner, W. (2017). Global citizenship education. *Handlexikon Globales Lernen*, 2, 115-119.
- Hinkin, T. R., Tracey, J. B., & Enz, C. A. (1997). Scale construction: Developing reliable and valid measurement instruments. *Journal of Hospitality & Tourism Research*, 21(1), 1997, 100-120.
- Hock, T. T., Yunus, A. S. M., Tarmizi, R. A., & Ayub, A. F. M. (2015). Understanding Primary School teachers' perspectives of teaching and learning in geometry: Shapes and Spaces. In *2015 International Conference on Research and Education in Mathematics (ICREM7)* (pp. 154-159). IEEE.
- Johnson, R. B., & Christensen, L. (2019). Educational research: Quantitative, qualitative, and mixed approaches. Sage publications.
- Jorgenson, S., & Shultz, L. (2012). Global citizenship education (GCE) in post-secondary institutions: What is protected and what is hidden under the umbrella of GCE. *Journal of Global Citizenship & Equity Education*, 2(1), 1-22.
- Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, 140(1), 44-53.
- Lissitz, R. W., & Green, S. B. (1975). Effect of the number of scale points on reliability: A Monte Carlo approach. *Journal of Applied Psychology*, 60, 10-13.
- Myers, J. P. (2016). Charting a democratic course for global citizenship education: Research directions and current challenges. *Education Policy Analysis Archives/Archivos Analíticos de Políticas Educativas*, 24, 1-19.
- NGA. (2010). Common core state standards for mathematics. Washington DC: National Governors Association and the Council of Chief State School Officers.
- OECD, (1999). Measuring Student Knowledge and Skills: A New Framework for Assessment. Paris: Organisation for Economic Cooperation and Development (OECD).
- Oztekin, C., Teksöz, G., Pamuk, S., Sahin, E., & Kilic, D. S. (2017). Gender perspective on the factors predicting recycling behavior: Implications from the theory of planned behavior. *Waste Management*, 62, 290-302.
- Pak S.Y. (2013). Global citizenship education: Goals and challenges in the new millenium. *Asia-Pacific Centre of Education for International Understanding (APCEIU)*.
- Pak, S. Y., & Lee, M. (2018). Hit the ground running: Delineating the problems and potentials in State-led Global Citizenship Education (GCE) through teacher practices in South Korea. *British Journal of Educational Studies*, 66(4), 515-535.
- Peter, E. E. (2012). Critical thinking: Essence for teaching mathematics and mathematics proble solving skill. *African Journal of Mathematics and Computer Science Research*, 5(3), 39-43.
- Peterson, R. A. (1994). A meta-analysis of Cronbach's coefficient alpha. *Journal Of Consumer Research*, 21(2), 381-391.

- Radhakrishna, R.B. (2007). Tips for developing and testing questionnaires/instruments. *Journal of Extension*, 45(1), 1- 4.
- Ross, S. M., & Morrison, G. R. (2013). Experimental research methods. In Handbook of research on educational communications and technology (pp. 1007-1029). Routledge.
- Sahrir, M. S., Alias, N. A., Ismail, Z., & Osman, N. (2012). Employing design and development research (DDR): Approaches in the design and development of online arabic vocabulary learning games prototype. *Turkish Online Journal of Educational Technology-TOJET*, 11(2), 108-119.
- Sant, E., & Valencia, G. G. (2018). Global citizenship education in Latin America. In The Palgrave handbook of global citizenship and education (pp. 67-82). Palgrave Macmillan, London.
- Sekaran, U. (2003). Research methods for business: a skill-building approach. 4th Edition, John Wiley & Sons, New York.
- Thabane, L., Ma, J., Chu, R., Cheng, J., Ismaila, A., Rios, L. P., & Goldsmith, C. H. (2010). A tutorial on pilot studies: What, why and how. *BMC medical research methodology*, 10(1), 1-10.
- Tikka, P.M., Kuitumen, M.T., & Tynys, S.M. (2010). Effect of educational background on students' attitudes, activity levels and knowledge concerning the Environment. *J. Environ. Educ*, 31, 12–19.
- Ugwu P.N. (2011). Reappraising the current national policy on education for functionality and self-reliance: Issues and challenges for mathematics education. *Journal of Qualitative Education*, 7(1), 143–144.
- UNESCO. (2017). *Education Transforms Lives*. Retrieved <http://www.unesco.org>
- Valoyes-Chávez, L., & Martin, D. B. (2016). Exploring racism inside and outside the mathematics classroom in two different contexts: Colombia and the USA. *Intercultural Education*, 27(4), 363-376.
- Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 157-178.
- Wilson, D. C., & Velis, C. A. (2015). Waste management - Still a global challenge in the 21st century: An evidence-based call for action. *Waste Management and Research*, 33(12), 1049–1051.
- Winarti, D. W., Amin, S. M., Lukito, A., & Van Gallen, F. (2012). Learning the concept of area and perimeter by exploring their relation. *Indonesian Mathematical Society Journal on Mathematics Education*, 3(1), 41-54.
- Yusof, H., Noor, M. A. M., Mansor, M., & Yunus, J. (2019). Knowledge, skills, and attitudes of Malaysian students on global citizenship education. *Jurnal Cakrawala Pendidikan*, 38(3), 426-437.
- Zahabioun, S., Yousefy, A., Yarmohammadian, M. H., & Keshtiaray, N. (2013). Global citizenship education and its implications for curriculum goals at the age of globalisation. *International Education Studies*, 6(1), 195-206.