

RESEARCH PAPER

Analysis of Green Chemistry Knowledge, Awareness and Practice Among the University Students

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Received: 11 January 2022; **Accepted:** 20 June 2022; **Published:** 28 June 2022

To cite this article (APA): Ghazali, M. Z., & Yahaya, A. (2022). Analysis of Green Chemistry Knowledge, Awareness and Practice Among the University Students. *Journal of Science and Mathematics Letters*, 10(1), 79-90. <https://doi.org/10.37134/jsml.vol10.1.8.2022>

To link to this article: <https://doi.org/10.37134/jsml.vol10.1.8.2022>

Abstract

This study aims to investigate the level of green chemistry knowledge, awareness, and practices among university students. This study also aims to analyze the relationship between green chemistry knowledge and awareness, green chemistry knowledge and practices, and also green chemistry awareness and green chemistry practices. This study employed survey as research design, and data was collected by distributing the questionnaires to 392 university students in Kuala Lumpur and Tanjung Malim by using the 44-questions questionnaire, which consists of 16 multiple-choice questions for green chemistry knowledge construct, and 14 questions which uses 5-point Likert scale questions for green chemistry awareness and practices respectively. Data were analysed descriptively to investigate the level of green chemistry knowledge, awareness and practices. This study has successfully revealed that the level of green chemistry knowledge and practices among university students is high, while the level of green chemistry awareness is very high. The correlation between the green chemistry knowledge, awareness and practice constructs seemed small when the data were analysed using the Pearson correlation coefficient. However, there seems to be no significant difference between education students and non-education students in their overall green chemistry knowledge, awareness and practices when the data was tested using Multivariate Analysis of Variance (MANOVA). The multiple-choice questions for the green chemistry knowledge construct have been converted into a new instrument to be used for analyzing the university students' knowledge levels, and further enables us to study the green chemistry knowledge, awareness, and practices using another factor.

Keywords: green chemistry, university students, knowledge, attitude, practice

Abstrak

Kajian ini bertujuan untuk menganalisis tahap pengetahuan, kesedaran dan amalan kimia hijau, mengenalpasti hubungan antara tahap kesedaran dan pengetahuan kimia hijau dalam kalangan pelajar universiti dan hubungannya dengan amalan kimia hijau. Kajian yang menggunakan tinjauan sebagai reka bentuk kajian, mengumpulkan data dari 392 mahasiswa universiti di Kuala Lumpur dan Tanjung Malim, dengan menggunakan instrumen soal selidik yang terdiri daripada 44 soalan yang mengandungi tiga konstruk. Soal selidik terdiri daripada 16 soalan objektif aneka pilihan untuk konstruk pengetahuan kimia hijau, dan 14 soalan masing-masing untuk konstruk kesedaran kimia hijau dan amalan kimia hijau yang menggunakan skala Likert 5-mata. Data telah dianalisis secara deskriptif untuk mengetahui tahap pengetahuan, kesedaran dan amalan kimia hijau para pelajar universiti tersebut. Kajian ini telah menunjukkan bahawa tahap pengetahuan dan amalan kimia hijau para pelajar universiti adalah tinggi, manakala kesedaran kimia hijau mereka adalah sangat tinggi. Hubungan di antara konstruk pengetahuan, kesedaran dan amalan kimia hijau juga adalah kecil apabila data diuji menggunakan pekali korelasi Pearson.

Tambahan pula, tiada perbezaan yang signifikan dalam tahap pengetahuan, kesedaran dan amalan kimia hijau secara keseluruhan di antara pelajar pendidikan dan bukan pendidikan apabila data diuji dengan menggunakan Analisis Multivariat Varians. Soalan objektif aneka pilihan untuk konstruk pengetahuan kimia hijau juga telah menyumbang kepada instrumen baru yang boleh digunakan, dan seterusnya membolehkan kajian menggunakan faktor lain dilaksanakan menggunakan instrumen ini.

Kata kunci: kimia hijau, pelajar universiti, pengetahuan, kesedaran, amalan

INTRODUCTION

The environment is threatened by many problems such as the greenhouse effect, global warming, and soil erosion that can give bad effects on humans itself. As we know, many of these problems are caused by humans that are using the environment without proper care. One of the examples that may lead to this problem is by disposing of mercury waste in the ocean, the mercury waste will be dissolved in water, thus penetrating the cells of aquatic lives. As a result, the small aquatic lives will be eaten by the larger aquatic lives, thus resulting in a high concentration of mercury in it. When the fish is being eaten by humans, the mercury content will have an adverse effect on humans.

Furthermore, the usage of hazardous chemicals has had a bad effect on humans. Hazardous chemicals like dichlorodiphenyltrichloroethane (DDT) that is used widely as an insecticide before, has given a very big dangerous effect when being absorbed in the soil, causing it to flow into the rivers and seas. Therefore, it could give a very hazardous effect on marine life, which can cause west bank migrant fishes with elevated DDT concentrations to not survive the journey downriver of Portland Harbor (Lundin et al., 2019).

Therefore, one concept is introduced by Anastas and Warner (1998), which is named Green Chemistry, to help humans to identify proper ways to safely use chemicals, and to dispose of it the correct way. According to the US EPA, Green Chemistry is defined as the design of chemical products and processes that is reducing or eliminating the usage of dangerous substances. The chemical processes that use dangerous chemicals can be changed by using safer chemicals, such as in the melting and boiling point experiment in schools, they used naphthalene as the chemicals before studying its melting and boiling point. However, now this experiment may be conducted using a more environmentally friendly chemical, such as lauric acid (Karpudewan, 2011).

Green chemistry has 12 basic principles has been pointed out by Anastas and Warner (1998), which consist of:

1. Prevent waste
2. Maximize atom economy
3. Design less hazardous chemical syntheses
4. Design safer chemicals and products
5. Use safer solvents and reaction conditions
6. Increase energy efficiency
7. Use renewable feedstocks
8. Avoid chemical derivatives
9. Use catalysts, not stoichiometric reagents
10. Design chemicals and products that degrade after use
11. Analyze in real-time to prevent pollution
12. Minimize the potential for accidents

Due to the reason that university students are able to handle their affairs themselves, often they are given the freedom to carry out their daily affairs. Hence, they have a wide choice on which car to use, and how they would dump their garbage, so this indirectly shows that they should have a green chemistry understanding so what is being done by them will not impose hazards to the environment. Hence, we must know their level of knowledge, their awareness, and the relevance of these things to their daily lifestyles and practices.

Green chemistry awareness of society is very crucial today. This is because of the water, soil, and air pollution that are happening around us. Therefore, university students are urgently needed to care about this pollution and consequently implement green chemistry practices for the preservation of the environment, as they will lead the country in the future and most of them will also be policymakers. This importance has been highlighted by Ghosh (2021) as mentioned in the article, that there is a very high urgency to instill green chemistry awareness in university students. However, university students living in the city are more likely to use vehicles and do waste disposal. If there is no green chemistry awareness in these students, this will result in environmental problems in the urban environment. This is clearly demonstrated by the flash flood happening at the university in Kuala Lumpur in 2016, where the university campus was flooded after heavy rain for over two hours. In addition to that, research findings by Ashraf et al. (2010) have proven that the oil and grease content found in water in the university lake shows a relatively high reading, indicating the lack of awareness of campus locals managing oily waste through drains. According to a study by Elsayed (2012), the production of heat islands in the city of Kuala Lumpur is due to the use of large vehicles and worsened by the haze problem that causes the health condition of Kuala Lumpur residents to be affected.

Not adequate studies have been done to gauge the levels of green chemistry awareness, knowledge and practice among university students as pre-service teachers formally (Akashah et al. 2019) said that most of green chemistry awareness studies in Malaysia only have been carried out in terms of environmental knowledge, awareness and practices. Thus, when we look into the study that environmental knowledge among student teachers in Spain, it is found to be inadequate as shown in a study by Finale and Massey (2012) when looking at the scope of universities that produce potential teachers to educate children on the environment. Therefore, a study on the awareness of green chemistry and practice among university students is highly needed. This can indirectly help them to understand the environmental problems that have hit, especially in urban areas, and thus assist in the preservation and conservation of the environment more effectively. Patonah et al. (2018) have stated that student teachers who are undergoing environmental education outside the classroom have higher environmental knowledge than student teachers who only learn theoretically. Indirectly, this finding can be applied to university students so that they know the exact nature of the environment through the study of this questionnaire. A study conducted by Alvarez et al. (2018) has shown inadequate environmental knowledge among the student teachers, making us wonder how the environmental knowledge of non-teachers. A comparison of education and non-education students will be very interesting to study.

Esa (2010) used 115 student teachers as a sample in her study. According to her, these teachers will implement ESD in high school in Malaysia when they graduate later. She found that this teacher's knowledge would be quite weak, but she also stated that they were interested in the pro-environmental attitude. Manchanayakage (2013) later conducted a study to integrate green chemistry into teaching for pure science students and social sciences. He has been using science and art students as samples and integrating green chemistry into the classroom through a green chemistry subject comprising classes and labs. He found that in his study after the implementation of the course, their knowledge of green chemistry was very positive and very encouraging. In addition to that, Mahat et al. (2014) used parents and students as a sample for ESD questionnaires. A total of 243 students and their parents participated to investigate the

relationship between parents' awareness, knowledge and behavior with students. Results have gathered that parental knowledge about ESD in the city was better than in rural areas.

On top of that, according to Burmeister and Eilks (2013), future knowledge of chemistry teachers in Germany is somewhat blurred in ESD in their ESD theory. Only a few are able to give a clear answer and an ESD concept supported by the right theory. Kanapathy et al. (2018) have found that the level of basic student knowledge of sustainable development was relatively high among the students, but this did not have a significant impact on their behaviors and attitudes towards sustainable development. In addition, a study done by Cheam and Ong (2018) has shown any indication that the academic achievement of these business students does not have a significant impact on their behavior towards environmental sustainability. Jayaraman et al. (2019) have been studying university pursuits on the subjects of their knowledge of the materials in their laptops and the effects of these materials on the environment when discarded. The results have shown that students who are aware of the computer component know the danger of removing the component at will.

Mohiuddin et al. (2018) conducted research on business students, by studying how the environmental knowledge of these students can affect the selection of green technology vehicles. They have found that environmental knowledge has a significant impact on students' preferences to prefer green vehicles, thus contributing to environmental sustainability. Sidiropoulos (2018) later conducted a study to see how Sustainability Education (SE) was able to form Inclusion of Nature in Self (INS) or Inclusive Feelings in Nature. His research has found that students' knowledge about Sustainability Education had a positive impact in the formation of INS in the students. As a result, students showed their love for nature after undergoing the pre and post-tests that have been carried out. Fang et al. (2018) also supported the study of Sidiropoulos (2018) earlier, in which environmental knowledge forms a clearer environmental attitude in a university student. Studies conducted on university students in China and Taiwan have supported links between students' knowledge and attitude towards the environment.

Yates et al. (2018) conducted a study that examines the need to conduct environmental education among prospective teachers in Kentucky, USA. As a result, from a questionnaire that has been conducted on 141 teachers and administrators, most of them admitted that they only experienced environmental education only after graduating from their university. This study also suggests that it is necessary to conduct environmental education as early as the university's environment to assist towards quality environmental education for their students. The results of this study supported the study conducted by Finale and Massey (2012), who conducted a study on prospective teachers at two universities in Spain and their findings have shown that these prospective teachers have low knowledge of the environment. However, the attitudes towards the environment shown are quite good and the pro-environmental action is also simple. Therefore, they argue that there is a need to train these teachers by increasing their knowledge of the environment. This study is also supported by Płotka-Wasyłka et al. (2018) which emphasized the need for the students to know about green chemistry on how to preserve the environment. They also suggested a curriculum change to curb the lack of green chemistry awareness problem.

Mahat et al. (2014) have also stated in their study that parents exist in the correlation between parental awareness and student awareness. Hence, in their opinion, parents should have high environmental awareness to ensure high environmental awareness among students. Additionally, according to Karpudewan et al. (2009), they stated that the prospective students will have high awareness and motivation in conducting pro-environmental action. Environmental value in itself has also experienced tangible changes. Elsayed (2012) also noted in his study that low awareness of weather management has led to an increase in heat island

problems in Kuala Lumpur. According to him, we must have high environmental awareness in order to build eco-friendly buildings that further reduce the heat island problem.

Nawi and Er (2018) conducted a study on campus sustainability of students and university staff at a public university in Sabah, Malaysia. As a result, even though these students and staffs have a high awareness of campus sustainability, their willingness to practice leading to the sustainability of the campus is still in moderation. This study is a bit contrary to the study conducted by Veisi et al. (2018), where their findings gathered that the respondents in their study have high sensitivity to the environment, and the attitude shown by these students is also quite high. However, this study also showed that although their sensitivity and attitude to the environment are quite positive and high, their knowledge of the environment is relatively low to moderate. Thus, Veisi et al. (2018) argued that environmental education needs to be applied in the education of these students in order to enhance the students' knowledge of the environment.

Ogunyemi and Ifegbesan (2011) conducted a study to examine the environmental literacy level of 199 prospective teachers in Nigeria. Studies have found that they have a high level of awareness and knowledge of local environmental issues, but they have less knowledge and awareness of global environmental issues. They also find that the level of awareness and knowledge of these teachers is different in gender, thus bringing to the conclusion that there is no difference in environmental literacy among male and female teachers. A study was conducted by Żuk and Żuk (2018) which was aimed at examining the different levels of awareness and attitudes of students in humanitarian and technical sciences in Poland. They defended their thesis by saying that the level of awareness of students in the humanitarian flow was higher than in the technical science stream. They also argued that environmental awareness is more conducive to humanitarian students. This study has also been carried out by distributing audit questionnaires to humanitarian science and technical sciences students. A study was also conducted by Mohamad et al. (2018) which has focused on how to preserve the sustainability of campuses at universities in Kuala Lumpur. As a result, they found that the high awareness of the students had led them to conserve the lakes of the campus which was quite rare due to the development of the campus. They also think that the misfortune, the value of the campus with all its heritage and the things that it has raised awareness of campus citizens to keep the campus on hold for the time to come. However, they think this awareness is only for a short period of time and something must be done to ensure that this awareness continues to be in the campus community in the future.

Olsson et al. (2016) mentioned in their study that the implementation of ESD in the Swedish curriculum has very little effect on students' attitude change to ESD. In addition to that, according to Burmeister and Eilks (2013), the prospective teachers will have a positive attitude towards the environment. Mahat et al. (2014) have also indicated that there is a significant relationship between the attitude of their parents and their children towards ESD which demonstrates that parents play a very important role in the formation of a child-sensitive attitude towards ESD. Esa (2010) on the other hand has also shown that teachers' attitude toward the environment is very positive but only a few are contributing to good environmental practices. However, they often recycle recycled materials like cans, paper, and others even if they do not recycle batteries.

Qablan and Al-Qaderi (2009) conducted a study to identify the attitudes and practices of environmental science faculty members regarding education for sustainable development. Their studies have shown that faculty members have a modest attitude towards this education, though they are keen to introduce them to the curriculum of the students. Sustainable development education practices are also seen as not being practiced high by these faculty members. This was demonstrated by the low score given by the faculty when answering questions about sustainable development practices in their class. Hence, they propose training on sustainable

development education pedagogy to faculty lecturers in order to incorporate the value of awareness and practice of sustainable development in faculty members. This study was also supported by a study conducted on 350 Nigerian youths conducted by Abiolu (2018), which found that youth there has high environmental knowledge, but they have low pro-environmental measures and moderate pro-environmental attitudes. Hence, he considered that the knowledge and attitude of the environment should be implemented through the appropriate media and the introduction of environmental education in schools. This study was also supported by Chen et al. (2020) who suggested that a change of curriculum to integrate green chemistry learning (GCL) with environmental study can improve environmental attitudes and awareness among students.

In conjunction with that, this study aims to identify the levels of green chemistry knowledge, awareness and practices among university students. Next, this study aims to identify the levels of correlation between green chemistry knowledge, awareness and practices. Finally, the study investigates the difference in the level of green chemistry knowledge, awareness and practice between education and non-education students.

MATERIALS AND METHODS

Research Design

This study is a quantitative study, which employed surveys as the research design. The research instrument used was a questionnaire. It conforms with the objective of the study as this study involves the level of knowledge, awareness, and practice of green chemistry in the daily life of the students. Surveys can be done in two different ways, namely interviewing subjects and questioning them to answer according to Noraini Idris (2013). This survey study comprises two phases, the first phase involves the construction of questionnaire instruments through expert validity and reliability testing conducted through pilot studies, and the second phase is the real field study survey. The contents of the instrument will be further described in the study instrument section.

The survey was conducted on 392 samples, which is more than needed according to Krejcie dan Morgan (1960) table which is 387, composed of education and non-education students that study in public universities in Tanjung Malim, Perak, and Kuala Lumpur, Malaysia. According to the statistics obtained from the universities, 14 749 (55.43%) were non-educational students and 11 857 (44.57%) of the population were educational students. The stratified random sampling that is carried out has shown that researchers need 217 samples from non-educational students and 175 samples from educational students. They have various backgrounds of studies that may affect their green chemistry knowledge, practice and awareness. The research was conducted according to this flow:

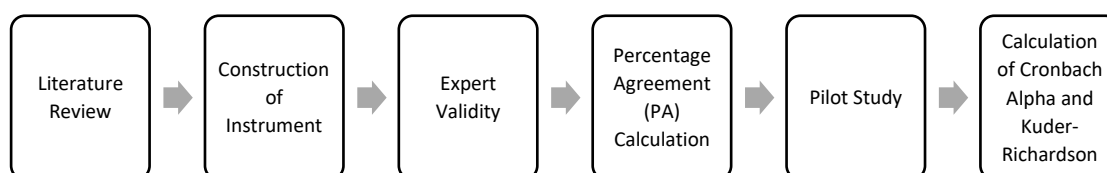


Figure 1. Flow Chart of Phase 1 Instrument Handling

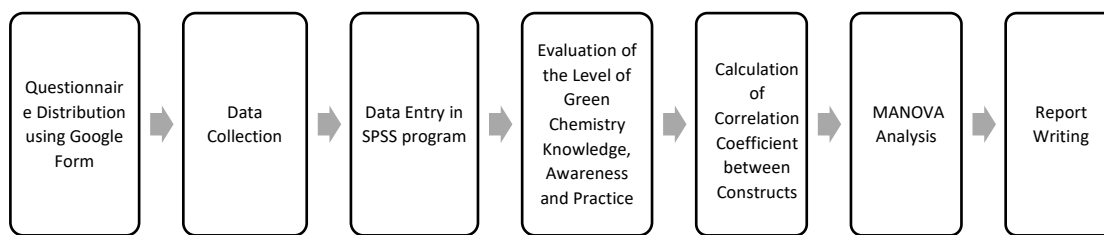


Figure 2. Flow Chart of Phase 2 Instrument Handling

Respondent's Characteristics

A total of 392 samples were obtained and according to Krejcie and Morgan tables, only a minimum of 387 samples is required. Researchers used stratified random sampling which only obtained 53.8% of the samples (211 samples) are students from non-education (medicine, science, dentistry, engineering, etc.), and 46.2% (181 samples) are students from education background, (chemistry, sports science education, Islamic education, etc.), although not exactly, but this following closely from ratio obtained for education and non-education students. In addition, demographic data showed that 138 (35.2%) samples were male and 254 (64.8%) were female. In addition, race demographic data showed that 349 (89.0%) were Malays, 29 (7.4%) were Chinese, 11 (2.8%) were Indians and 3 (0.8%) were other nations. Study year demographic data showed that 112 (28.6%) were first-year students, 101 (25.8%) were second-year students, 69 (17.6%) were third-year students, and 110 (28.1%) were fourth-year students. Stratified random sampling that has been carried out almost follows the real education ratio and the non-educational ratio of the population. The data is shown in Table 1.

Table 1. Sample Distribution According to Characteristics and Course Type

Characteristics	Education	Non-Education	Total	Percentage (%)
Gender				
Male	58	80	138	35.2
Female	123	131	254	64.8
Race				
Malay	155	194	349	89.0
Chinese	19	10	29	7.4
Indian	6	5	11	2.8
Others	1	2	3	0.8
Year of Study				
First Year	49	63	112	28.6
Second Year	64	37	101	25.8
Third Year	27	42	69	17.6
Fourth Year and Above	41	69	110	28.1

Instrument

The instrument for this study is a set of questionnaires, which consists of two parts. The first part is the section that identifies the demographic information of respondents which determines gender, stream, race, age, and education and non-education. All this is required to know their education flow and whether their level of education influence the results of this questionnaire. The second part is constructed using three main constructs, which contain a total of 44 questions. The first construct tests the knowledge of respondents on green chemistry consisting of 16 objective questions. Questions built by Anastas and Warner (n.d.) and Nooraqilah Ali (2017) cover almost all green chemistry principles and are able to identify the level of green chemistry knowledge the respondents tested. The reliability of this construct is tested using KR₂₀, with a value of 0.734. The KR₂₀ was used because the questions used in the first constructs are consists of test questions, which have only the right or wrong answers. The

second and third constructs assess the students' awareness and practice of green chemistry consisting of 14 questions for each construct. The question is built using a 5-point Likert scale. The validity of this instrument is validated by using face and content validity using the Approval Percentage (PA) between the appointed expert and its reliability tested using Cronbach Alpha. The Cronbach's Alpha value is obtained from the 30-sample pilot study and the values obtained are 0.817 and 0.808 for green chemistry awareness and practice construct respectively.

Data Analysis

The data obtained from the questionnaire are analysed by using IBM Statistical Package for Social Sciences (SPSS), to determine mean and standard deviation for each construct, Pearson correlation test to obtain about correlation, and one-way Multivariate Analysis of Variance (MANOVA) analysis to determine the difference present in the data obtained for education and non-education students.

RESULTS AND DISCUSSION

Green Chemistry Knowledge, Awareness and Practice Level Analysis

The analysis of the mean and standard deviation for each construct has been studied. The data in this section will be presented in the form of standard mean and deviation, to assess the level of knowledge, awareness and practice of the green chemistry of these students. For the knowledge construct, multiple-choice objective questions have been given, and for the green chemistry awareness and practice construct, their level of awareness and practice of green chemistry is tested using a 5-point Likert scale questionnaire. The results of respondents' responses to the knowledge, awareness and green chemistry constructs will be presented in percentage form. A study conducted by Che Ahmad et al. (2016), they have categorized the responses of respondents as 1 (Very Low), 2 (Low), 3 (Medium), 4 (High), and 5 (Very High), according to the Likert scale. Therefore, the researcher has changed this value to a percentage value, as shown below. Data obtained from mean analysis and standard deviation of all constructs were given as follows: green chemistry knowledge (mean = 66.33, SD = 13.24), green chemistry awareness (mean = 81.91, SD = 10.36) and green chemistry practice (mean = 77.98, SD = 10.04). Therefore, according to Table 2, the level of green chemistry knowledge and practice among university students is categorized as high, while the level of green chemistry is categorized as very high. This data is scheduled as in Table 3 below.

Table 2. Green chemistry knowledge, awareness and practice level scale (Che Ahmad et al., 2016)

Range	Interpretation
0-20	Very Low
21-40	Low
41-60	Medium
61-80	High
81-100	Very High

Table 3. Mean and standard deviation for green chemistry knowledge, awareness and practice construct.

Construct	Mean	Standard Deviation
Knowledge	66.33	13.24
Awareness	81.91	10.36
Practice	77.98	10.04

The findings were consistent with the findings of Cheam and Ong (2018), where they found that environmental behaviour of undergraduate students at a university in Malaysia was found to be high (mean = 3.36, SD = 0.62) which if converted in percentage value, the value to be obtained is (mean = 67.20, SD = 12.40), and also consistent with findings by Veisi, Lacy,

Mafakheri, & Razaghi (2018), which records the environmental knowledge of the students with (mean = 3.63, SD = 0.63) which if converted in percentage value, the value to be obtained is (mean = 72.60, SD = 12.60). In addition, the findings are also in line with the findings of the level of awareness of undergraduate students on the importance of preserving the environment by Cheam and Ong (2018), where they find that the level of awareness of undergraduate students towards the importance of preserving the environment is at a very high level (mean = 4.40, SD = 0.52), which if converted in percentage value, the value to be obtained is (mean = 88.00, SD = 10.40). This result is also consistent with the study by Fang et al. (2018), where they also show the level of awareness of undergraduate students towards the importance of preserving the environment is at a very high level (mean = 4.02, SD = 0.48), which if converted in percentage value, the value to be obtained is (mean = 80.40, SD = 9.60).

Correlation Analysis Between Variables

An analysis of the correlation between knowledge, awareness, and practice of green chemistry was carried out. Because the data satisfies the assumption to carry out parametric correlation analysis, that data is normal at $p = 0.05$ and all data is independent of each other, then this analysis will be carried out using Pearson (r) correlation analysis. The data obtained are as follows:

Table 4. Pearson Correlation Coefficient Between Constructs

Construct		Knowledge	Awareness	Practice
Knowledge	Correlation Coeff.	1.000	0.072	0.013
	Sig. (2-tailed)	.	0.152	0.798
	N		392	392
Awareness	Correlation Coeff.		1.000	0.225**
	Sig. (2-tailed)		.	0.000
	N		392	392

**Correlations are significant at 0.01 level (2-tailed)

As shown in Table 4, the relationship between the Green Chemistry Knowledge, Green Chemistry Awareness, and Green Chemistry Practice constructs has been investigated using the Pearson Product-Moment Correlation Coefficient. An initial analysis was conducted to ensure no violations in the normality, linearity and homoscedasticity assumptions. There is a small and positive correlation between the knowledge and awareness constructs, $r = 0.072$, $p = 0.152$, where high levels of green chemistry knowledge are associated with high levels of green chemistry awareness. Next, there is a small and positive correlation between the knowledge and practice constructs, $r=0.013$, $p=0.798$, where a high level of green chemistry knowledge is associated with high levels of green chemistry practice. And finally, there is a small and positive correlation between the awareness and practice constructs $r=0.225$, $p=0.000$, where a high level of green chemistry awareness is associated with high levels of green chemistry practice. This finding is also in line with the findings of Cheam and Ong (2018), who found that the relationship between environmental awareness and environmental behaviors recorded a low and positive correlation of 0.26. This is also in line with the findings by Veisi et al. (2018), which record the correlation between environmental knowledge with sensitivity and attitude with a low and positive correlation of 0.12 and 0.16 respectively.

Green Chemistry Knowledge, Awareness and Practice Level Comparison

A MANOVA analysis was carried out to know the green chemistry knowledge, awareness and practice differences between education and non-education students. First, homogeneity tests were carried out to ensure the data fulfils the assumption of the MANOVA. Box's test shows a significance level of 0.724, $p>0.05$, and Levene's test shows significant levels of 0.608, 0.072 dan 0.778 for green chemistry knowledge, awareness and practice constructs respectively,

$p > 0.05$, which shows that the data is homogeneous for all constructs and as a whole. Overall, according to Table 5, Pillai's Trace multivariate test results show that there is no effect of the type of course (education and non-education) on all three significant dependent variables [$F(1, 390) = 0.055, p > 0.05$]. Based on the results of this analysis, the researcher accepted the null hypothesis and reported that the type, of course, was not a factor for green chemistry knowledge, green chemistry awareness, and green chemistry practice at universities in Kuala Lumpur and Tanjung Malim. MANOVA's test analysis performed on all independent variables shows that there is no significant difference between the two categories of courses.

Table 5. Pillai's Trace Multivariate Test

Aspects	Value
Value	0.000
F	0.055
Hypothesis df	3.000
Error df	388.000
Sig.	0.983

CONCLUSION

As we can see in all literature, little research has been done on knowledge, awareness, and green chemistry among university students. Thus, with the high level of green chemistry knowledge, awareness and practice found in this research, it is hoped that these findings may help in instilling green chemistry awareness in the university students. A new type of instrument, which is objective questions, has been outlined to add to the types of instruments used to gauge the students' knowledge of green chemistry. For future study, the measurement of green chemistry knowledge, awareness and practices among university students are also worth investigating to see the comparison between science and arts stream students. Differences in their focus on science subjects can be a factor in their level of knowledge, awareness and practice of their green chemistry.

Acknowledgement

The researchers would like to thank all the respondents and relevant parties who have contributed greatly to this academic development.

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