CORRELATION STUDY BETWEEN STUDENTS' EXISTING KNOWLEDGE OF ACID AND BASE WITH ENVIRONMENTAL SUSTAINABILITY AWARENESS

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UNIVERSITI PENDIDIKAN SULTAN IDRIS

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THIS RESEARCH PROJECT REPORT IS SUBMITTED TO FULFILL PART OF THE REQUIREMENTS TO OBTAIN A DEGREE BACHELOR OF EDUCATION (CHEMISTRY) WITH HONOURS

FAKULTI SAINS DAN MATEMATIK
UNIVERSITI PENDIDIKAN SULTAN IDRIS

2024

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DECLARATION

UNIVERSITI PENDIDIKAN SULTAN IDRIS
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PERAKUAN KEASLIAN PENULISAN

Perakuan ini telah dibuat pada 28 hari bulan Februari 2024.

i. Perakuan Pelajar:

Saya, **Jacqueline Oon Zhi En** bernombor matrik **D20201095442** dari Jabatan Kimia, Fakulti Sains dan Matematik dengan ini mengaku bahawa tesis yang bertajuk **Correlation Study Between Students' Existing Knowledge of Acid and Base With Environmental Sustainability Awareness** adalah hasil kerja saya sendiri. Saya tidak memplagiat dan apa-apa penggunaan mana-mana hasil kerja yang mengandungi hak cipta telah dilakukan secara urusan yang wajar dan bagi maksud yang dibenarkan dan apa-apa petikan, ekstrak, rujukan atau pengeluaran semula daripada atau mana-mana hasil kerja yang mengandungi hak cipta telah dinyatakan dengan sejelasnya dan secukupnya.

(JACQUELINE OON ZHI EN)

ii. Perakuan Penyelia:

Saya, Dr. Mohamad Idris Bin Saidin dengan ini mengesahkan bahawa hasil kerja pelajar yang bertajuk **Correlation Study Between Students' Existing Knowledge of Acid and Base With Environmental Sustainability Awareness** dihasilkan oleh pelajar nama di atas.

28 Februari 2024
Tarikh

Dr. Mohamad Idris Bin Saidin

ACKNOWLEDGEMENTS

First and foremost, I would like to express my deepest gratitude to my supervisor, Dr. Mohamad Idris bin Saidin, for his unwavering support, guidance and mentorship throughout the entire process of completing this degree thesis. I am truly grateful for the time and effort he has dedicated for helping me navigate the complexities of academic research and for his unwavering belief in my abilities. I would also like to acknowledge the contributions of Dr. Mohamad Idris bin Saidin in providing valuable insights and direction that have significantly enhanced the quality of this thesis.

I would also like to extend my sincere appreciation to Dr. Siti Nur Akmar Mohd Yazid, whose assistance and support have been instrumental in facilitating the logistics of this study. Her organizational skills, attention to detail and willingness to provide assistance whenever needed have been crucial in ensuring the smooth progression of this thesis. I am grateful for guidance and support from Dr. Siti Nur Akmar Mohd Yazid in navigating the administrative aspects of this research, which has been essential to its successful completion.

I am also indebted to my father, Mr. Oon Peng Chuan and my mother, Mrs. Jenny Yeoh Poh Nee, for their unwavering love, understanding and encouragement throughout this academic journey. I am truly appreciating for their sacrifices and understanding during this demanding period. I would like to express my gratitude to family for their unwavering support and understanding.

Lastly, I would like to express my gratitude to all the individuals who have directly or indirectly contributed to the completion of this thesis. Their support, whether moral, intellectual or emotional, has been invaluable and deeply appreciated. I would like to Chemistry Department, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris for their contributions to this research. This thesis would not have been possible without the support and guidance of the aforementioned individuals and institutions and for that, I am sincerely thankful.

ABSTRACT

This study was conducted to justify the correlation between students' existing knowledge of acid and base with environmental sustainability awareness. A total of 100 form 4 science stream students were involved in this study. The research design was a correlational study and used quantitative analysis based on student performance test and environmental sustainability awareness questionnaire. Student performance test was used to examine the level of students' existing knowledge of acid and base. Meanwhile, environmental sustainability awareness questionnaire was applied to identify the level of students' environmental sustainability awareness. Expert validation was analysed using Cohen's Kappa. Kappa value for both instruments is 1.00 from two experts. In addition, reliability of the instruments was analysed using Cronbach's Alpha. The Cronbach's Alpha values for instruments of test and questionnaire are 0.724 and 0.785 respectively. Findings from the test conducted show that the students' existing knowledge of acid and base is at a high level, where the mean value obtained is 82.5. While the average mean and standard deviation of the questionnaire are 4.323 and 0.423 respectively. This represents the students have a high level of environmental sustainability awareness. Furthermore, Pearson correlation analysis reveal the of 0.755, demonstrates that there is a statistically significant positive relationship between students' existing knowledge of acid and base with environmental sustainability awareness. In conclusion, the levels of students' existing knowledge of acid and base with environmental sustainability awareness are high and these two variables are strongly correlated positively. This study gives implication to teachers to recognize the interconnectedness of these variables and strive to foster both knowledge acquisition and practical application of acid-base concepts in their pedagogical approaches.

Keywords: Correlational Study Pearson, Acid and Base, Environmental Sustainability Awareness

Kajian Korelasi antara Pengetahuan Sedia Ada Murid Mengenai Asid dan Bes dengan Kesedaran Kelestarian Alam Sekitar

ABSTRAK

Kajian ini dijalankan untuk menguji hubungan antara pengetahuan sedia ada murid terhadap asid dan bes dengan kesedaran kelestarian alam sekitar. Seramai 100 orang murid tingkatan 4 aliran sains terlibat dalam kajian ini. Reka bentuk kajian adalah kajian korelasi dengan mengaplikasikan analisis kuantitatif berdasarkan ujian prestasi murid serta soal selidik kesedaran kelestarian alam sekitar. Ujian prestasi murid digunakan untuk menguji tahap pengetahuan sedia ada murid terhadap asid dan bes. Malah, soal selidik kesedaran kelestarian alam sekitar digunakan untuk mengenal pasti tahap kesedaran kelestarian alam sekitar murid. Pengesahan pakar dianalisis menggunakan *Cohen's Kappa*. Nilai *Kappa* untuk kedua-dua instrument daripada dua orang pakar adalah 1.00. Tambahan pula, kebolehpercayaan instrumen dianalisis menggunakan *Cronbach's Alpha*. Nilai *Cronbach's Alpa* yang diperolehi adalah 0.724 bagi ujian dan 0.785 bagi soal selidik. Dapatan ujian menunjukkan pengetahuan sedia ada murid tentang asid dan bes berada pada tahap tinggi, di mana nilai min yang diperolehi adalah 82.5. Manakala purata min dan sisihan piawai yang diperolehi bagi soal selidik adalah 4.323 dan 0.423. Hal ini menunjukkan murid mempunyai tahap kesedaran kelestarian alam sekitar yang tinggi. Di samping itu, analisis korelasi *Pearson* menunjukkan nilai korelasi sebanyak 0.755. Hal ini membuktikan hubungan positif yang signifikan secara statistik antara pengetahuan sedia ada murid tentang asid dan bes dengan kesedaran kelestarian alam sekitar. Kesimpulannya, tahap pengetahuan sedia ada murid terhadap asid dan bes dengan kesedaran kelestarian alam sekitar adalah tinggi serta kedua-dua pemboleh ubah ini berkorelasi kuat secara positif. Implikasinya, guru dapat mengenali kesalinghubungan kedua-dua pemboleh ubah ini serta berusaha untuk meningkatkan pemerolehan pengetahuan dan aplikasi praktikal konsep asid dan bes dalam pendekatan pedagogi mereka melalui kajian ini.

Kata kunci: Kajian Korelasi *Pearson*, Asid dan Bes, Kesedaran Kelestarian Alam Sekitar

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LIST OF ABBREVIATIONS

STEM	Science, Technology, Engineering and Mathematics
PPPM	Malaysian Education Development Plan
MOE	Malaysian Ministry of Education
KSSR	Standards – Based Curriculum for Primary School
KSSM	Standards – Based Curriculum for Secondary School
DOE	Department of Environment
UPSI	Universiti Pendidikan Sultan Idris
SPSS	Statistical Package for Social Science
EPRD	Education Research and Planning Division
JPNPrk	Jabatan Pendidikan Negeri Perak

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The transfer of learning aims to enhance the understanding of current knowledge or learning by relating, connecting, or applying it to other tasks, even if done at different times but through related source domains. Edward Thorndike, an influential psychologist and founder of modern educational psychology, proposed that individuals identify the presence or absence of similarities or differences between previous learning and new learning situations to encourage learning transfer (Mangal & Mangal, 2019). Transfer of learning enables students to solve something in a logical and efficient manner and engage in conceptual discussions with the occurrence of learning transfer (Hosna, 2022). Torrey (2009) also suggest that learning transfer allows students to improve their learning methods from the knowledge and tasks they have learned. In

essence, learning transfer involves utilizing existing knowledge in new situations, such as justifying and overcoming constraints. Therefore, the characteristics and importance of primary knowledge or tasks are usually mapped to new tasks.

In the context of national development, a strong foundation in acid and base concepts equips students with the skills needed to pursue careers in key industries such as pharmaceuticals, agriculture and manufacturing (Wang, Nie, Jeronen, Xu & Chen, 2023). These industries rely on chemical principles related to acid and base for the production of essential goods and services. However, the development of industries gives impact on environmental sustainability (Olah, 2020). The concept of acid and base which related to sustainability extends to industries and technologies that impact the environment. For instance, in fields like agriculture and manufacturing, a profound understanding of acid-base chemistry is essential for developing environmentally friendly production processes and minimizing ecological footprints (Handoko, Nursanti, Tjahjadi, Hutabarat & Mulyadi, 2018). By implementing green productivity strategies that integrate sustainable environmental management, organizations can enhance their environmental capabilities and contribute to overall sustainability efforts (Baranova, 2022).

As a result, concept of acid and base is essential among the students as future leaders in this modern era of globalisation. Understanding acid and base concepts is fundamental for students as it has significant implications for various aspects of their education and future contributions to the country. Mastery of acid and base knowledge is crucial in fields such as chemistry, environmental science, medicine, and engineering, where these concepts form the basis for understanding chemical reactions, biological

processes and material properties (Debrah, Vidal & Dinis, 2021). By grasping theories of acid and base, students can comprehend complex scientific phenomena and make informed decisions in their academic and professional pursuits. Learning about acid and base is also crucial for promoting environmental sustainability due to its direct relevance to various environmental issues and solutions. Understanding acid-base chemistry is essential for comprehending phenomena such as acid rain, ocean acidification and soil quality, which have significant implications for environmental health (Eizenberg & Jabareen, 2017). Students can analyse and address these environmental challenges effectively, contributing to sustainable practices and policies after they handle the concept of acid and base. Students who are well-versed in acid-base chemistry can better comprehend those environmental issues, enabling them to develop innovative solutions to mitigate environmental degradation and contribute to sustainable development efforts (Akrofi, Antwi & Gumbo, 2019).

Furthermore, the integration of environmental sustainability awareness with students' knowledge of acid and base is important in promoting a holistic understanding of sustainability issues among students. The systematic review by Firmanshah, Abdullah and Fariduddin (2023) highlights the interconnected nature of environmental knowledge, attitude, behaviour and awareness in fostering environmental sustainability. This underscores the importance of incorporating diverse aspects of knowledge, including concept of acid and base to enhance students' environmental sustainability awareness. Innovative practices in higher education, as emphasized by Bustamante, Mihalj, Schmitz & Saltevo (2022), play a pivotal role in driving sustainable development. The connection of concept of acid and base to real-world environmental issues enable the students to develop a deeper understanding of the interconnectedness

between chemical processes and environmental outcomes. This holistic approach increases a sense of responsibility and empowers students to make informed decisions that promote environmental conservation and sustainability. By integrating acid and base knowledge with environmental sustainability awareness, educational institutions can cultivate a culture of sustainability through innovative teaching methods and curriculum design. This approach aligns with the theory of transfer of learning, as proposed by Nelson (2021), which advocates for the application of existing knowledge to new contexts, such as understanding the environmental implications of concept of acid and base. Besides, nurturing students' knowledge of acids and bases fosters critical thinking, problem-solving and analytical skills that are transferable to various fields beyond science (Rahmaningtyas, Joyoatmojo, Kristiani & Murwaningsih, 2023). These skills are invaluable for fostering a scientifically literate population capable of making informed decisions, engaging in evidence-based reasoning and contributing to the country's intellectual and economic prosperity (Rahmaningtyas et al., 2023).

Moreover, the correlation study aims to investigate the relationship between students' acid and base knowledge and their environmental sustainability awareness using Pearson correlation analysis signifies a structured approach to exploring these interconnected factors. By examining how students' understanding of acid and base concepts influences their environmental sustainability awareness, educators can tailor interventions to enhance sustainability literacy and foster pro-environmental behaviours among students. In conclusion, the combination of students' acid and base knowledge with environmental sustainability awareness is essential for nurturing environmentally conscious individuals. By leveraging innovative educational practices

and theories of learning transfer, institutions can empower students to apply their knowledge to address real-world sustainability challenges effectively.

1.2 Research background

Knowledge, level of understanding and experience in the field of science is very dominant to produce skilled human capital in the development of the country. Science, Technology, Engineering and Mathematics (STEM) education is one of the agendas enshrined and emphasised in the Malaysian Education Development Plan 2013-2025 (PPPM 2013-2025). The Malaysian Ministry of Education (MOE) strengthens STEM education at every school level through curriculum and co-curricular activities according to the Standards-Based Curriculum for Primary School (KSSR) and Standards-Based Curriculum for Secondary School (KSSM)

In addition, acid and base often used in daily lives. For example, orange juice contains citric acid as breakfast. Milk contains lactic acid if the milk turns sour. In petrochemical industry, the uses of hydrochloric acid are to dissolve asphalt in crude oil during matrix acidizing process (Shirazi, 2019). The medical sector also applies the concept of acid and base in treatment. For example, sodium bicarbonate used as a toothpaste in order to neutralise acid on human teeth. The farmers in agriculture sector will use the nitrate-based fertilisers to treat the soil acidity. However, the human activities will influence the quality of environment regarding the concept of acid and base. For instance, sulphuric acid is formed when sulphur-bearing minerals like calcium sulphate and barium sulphate are exposed to oxygen and water during mining activities.

Heavy metals such as arsenic and lead from mined materials will be dissolved by sulphuric acid, which is a strong acid (Iatan, 2021).

Regarding to Hussain (2021), environmental sustainability is the development of a sustainable economy for the purpose of maintaining economic stability and growth. A responsible relationship or interaction between humans and the environment will ensure the long-term quality of the environment and ensure its sustainability. Nevertheless, as a result of human development progress and modernization, climate change has occurred as well as environmental ecosystems and biodiversity over the last few decades (Hussain, 2021). Yaacob (2022) reports that Sungai Batu in Kedah has been contaminated with chemicals. The source of this contamination is the factory discharge of toxic waste, which has been going on for more than three years. As a result, the contaminated water is considered hazardous for human consumption and should not be used as a supply of water. As a consequence, environmental sustainability awareness is a contemporary issue in Malaysia and an essential element of this study. An essential element of the natural environment's sustainability is human perceptions and understanding of sustainability issues. Education is the best way for transferring knowledge about environmental conservation and preservation while modifying community attitudes towards environmental preservation. The importance of sustainable development in education has been highlighted, indicating the need for a systematic integration of social, environmental, and economic issues (Oluyomi, Ajayi, & George, 2021). Besides, environmental system knowledge has been found to promote students' environmental attitudes and pro-environmental behaviours, emphasizing the significance of environmental education in fostering sustainable practices (Janmaimool & Khajohnmanee, 2019). Hence, the Malaysian education system should be improved

to ensure that students truly understand the ways to preserve the environment in daily life (Amir & Chin, 2012 as referenced in Dato, Mahat, Hashim & Saleh, 2020).

Moreover, topic of acid and base stands out as the most suitable topic to measure environmental sustainability awareness compared to other chemistry-related topics, which are matter and the atomic structure, the mole concept, chemical formula and equation, the periodic table of elements, chemical bond, rate of reaction and manufactured substances in industry. Knowledge of acid and base is relevant in measuring environmental sustainability awareness directly due to its connection to environmental education and awareness programs. As example, the acidic soil encountered by the farmers can be solved by using nitrate-based fertilisers, sulphuric acid is one of the major components in acid rain which is also a strong acid can corrode the buildings and plants, as well as increase acidity of water bodies. Thus, understanding the concepts of acid and base is fundamental in comprehending environmental issues and their impact on sustainability (Aikowe & Mazancová, 2022). Environmental literacy, which includes knowledge of acid and base, plays a crucial role in increasing individuals' environmental awareness and sustainability practices, especially university students (Aikowe & Mazancová, 2022). For instance, the chemical substances must dispose in laboratory bin, especially the strong acid and alkaline, like hydrochloric acid and sodium hydroxide. This is because they can corrode the drainage system. While the weak acid like vinegar, also known as acetic acid can be thrown into the drain or ordinary bin.

In Malaysia, Form 4 science stream students' fundamental understanding of basic chemical concepts depends significantly on their learning of acid and base.

Knowledge for a broad spectrum of chemical reactions and processes requires a prior understanding of this topic. The students learn knowledge of the pH scale, the properties of acid and base and their applications. This knowledge is useful not only in chemistry but also in a variety of other fields of study, which include industry, biology and environmental science. Since acid and base are used in a variety of products and operation, figuring out them is necessary to make wise decisions in daily life. Once everything is taken into account, the study of acid and base among the students acts as a foundation for more complex scientific concepts and applications.

The relationship between knowledge of acids and bases and environmental sustainability awareness can be understood through studies that explore the connection between environmental knowledge, attitudes and behaviours. Dopelt, Radon and Davidovitch (2019) found that students with higher levels of environmental knowledge demonstrated more pro-environmental attitudes and behaviour, with attitudes mediating the relationship between knowledge and behaviour regarding environmental pollution caused by the livestock industry. Attitudes were identified as a mediator between knowledge and behaviour concerning environmental pollution caused by the livestock industry. This study underscores the importance of environmental knowledge in shaping students' attitudes and behaviours towards sustainability, highlighting the significance of knowledge in driving positive environmental actions among the students. Similarly, Firmanshah, Abdullah and Fariduddin (2023) conducted a systematic review that discussed the relationship between environmental knowledge, attitude, behaviour and awareness among students. This research contributed to elucidating how environmental knowledge, like topic of acid and base can impact individuals' awareness of environmental issues and sustainability practices. Among the 11 studies, there are

seven studies focused on the relationship of each domain (environmental knowledge, attitude, behaviour and awareness), while two studies discussed the relationship between environmental knowledge and environmental attitude. As example from these seven studies, there are three studies conducted by Hammami et al. (2017); Gao (2018) and Janmaimool and Khajohnmanee (2019) demonstrated positive correlations between environmental knowledge, environmental attitude, and environmental behaviour. In an earlier study, Hammami et al. (2017) discovered that students' environmental knowledge positively increases their environmental sustainability behaviour. Janmaimool and Khajohnmanee (2019) also displayed that environmental knowledge is significantly influence environmental sustainability attitudes and environmental sustainability behaviour among the students. While, the studies of Guven and Slum (2017) and Makhtar et al. (2021) are the two studies that discussed the relationship between environmental knowledge and environmental attitude. The Makhtar et al (2021) study demonstrated a positive correlation between environmental knowledge and awareness, and study of Guven and Slun (2017) also illustrated a significant correlation between knowledge and awareness of environmental issues. These studies suggest a deeper understanding of environmental issues, which may include knowledge of acid and base and their environmental impact, can influence individuals' attitudes and behaviours towards sustainability. By enhancing environmental knowledge, individuals are more likely to develop positive attitudes and engage in pro-environmental behaviours, ultimately contributing to increased environmental sustainability awareness. The understanding of acids and bases is fundamental for increasing environmental sustainability awareness as it plays a crucial role in science literacy and education. Knowledge of acid and base not only facilitates the comprehension of chemical processes but also forms the basis for understanding environmental issues and

their impact on sustainability (Pertiwi, Nurhayati & Saputro, 2022). Science literacy, which encompasses topics like acids and bases, is vital for fostering environmental awareness and sustainable practices among the students (Putra & Mitarlis, 2023). By improving understanding in this field, individuals can gain a deeper insight into environmental challenges, leading to heightened sustainability awareness and efforts towards achieving a sustainable environment.

Furthermore, according to study of Ismail and Rahmad (2022), students who has an excellent understanding of science and the environment are more inclined to foster environmental sustainability as well as concern environmental issues. However, the students frequently fail to make the connection between the knowledge they have learnt and environmental sustainability, despite having a high level of awareness (Hafizah et al., 2013 as referenced in Dato et al., 2020). There is a study states that the students in developing countries have deficient environmental awareness because of insufficient sustainable environmental knowledge (Debrah, Vidal & Dinis, 2021). In contrast to Denmark and Japan, Malaysia has not yet accomplished a noteworthy goal. The phrase "bending the bamboo let it be the bamboo" implies the belief that education is an effective way of strengthening children's understanding and awareness of environmental sustainability. Additionally, "awareness through the practices that students do themselves certainly has an impact on their lifestyle as well as the people around them" (Dato et al., 2020, page 5). As a result, a correlational study between students' existing knowledge of acid and base with environmental sustainability awareness was conducted.

1.3 Problem statement

The human activities are indeed the main cause of continuous global environmental changes. Open burning releases gases such as carbon dioxide and sulphur dioxide, resulting in the widespread occurrence of acid rain in (Malaysia Malaysian Meteorological Department, 2023). Improper disposal of domestic waste by local residents also pollutes the surrounding environment (Hasanuzzaman & Bhar, 2017). In agriculture sector, inadequate management of synthetic fertilizers in the agriculture sector leads to environmental pollution, particularly high soil acidity (Hasanuzzaman & Bhar, 2017). The Department of Environment (DOE, 2022) has maximized efforts to enhance knowledge and awareness of environmental sustainability by organizing programs such as Earth Day, Friends of the Environment, Environmental Debates and others across all community layers. However, the declining and continuous degradation of human activities is increasing (Kee, Lim, Wong & Chua, 2022). There are various factors contribute to this issue such as the inadequate mitigation measures for environmental degradation, expansion of the terrestrial human footprint, economic growth leading to increased energy consumption and carbon emissions, and threats to natural ecosystems and biodiversity (Hamid et al., 2022). These factors collectively contribute to the deterioration of the environment, including deforestation, pollution, habitat loss and the decline of natural resources.

Furthermore, Debrah et al. study (2021) demonstrates that knowledge is one of the factors affect environmental awareness among the residents, where their research result shows that the students in developing countries have deficient environmental awareness due to insufficient sustainable environmental knowledge. Therefore,

knowledge of acid and base contributes to the environmental sustainability awareness. Sulphur and nitrogen are the major components in the formation of acid rain (Malaysian Meteorological Department, 2023). The compounds consist of these two elements such as sulphur dioxide and nitrous oxide, react with water vapour in atmosphere will form sulphuric acid and nitrous acid, which is the formation of acid rain (Obebe, Kolo & Yusuf, 2021). According to KSSM Form 4 Chemistry Textbook (2019), sulphuric acid is a strong acid which is corrosive. Thus, the students may understand that sulphuric acid is a dangerous substance and avoid to release the sulphur gas or liquid to the atmosphere. Open burning activity, burning of fossil fuels like charcoal and motor vehicles will emit sulphur dioxide to the atmosphere. However, study Nurisa and Arty (2018) show that the students' knowledge of acid and base is in low category. Thus, they have not been able to link the concepts of acid and base to global context, which is acid rain. Other than that, there is also a study displays that the higher the level of knowledge, the higher the environmental sustainability awareness. The Dato et al study (2020) show that students' environmental knowledge significantly influences their recycling practices in daily lives, where the increase in environmental knowledge associated with the increase in recycling practices. In short, these studies clearly show that environmental knowledge or knowledge of acid and base among the students is the factor to influence their environmental sustainability awareness.

In response to the increasingly concerning environmental issues, the Malaysian Ministry of Education (MOE) is striving to impart environmental knowledge through Environmental Education in the Malaysian education system to cultivate responsible individuals who care for the environment (Kementerian Pendidikan Malaysia, KPM, 2013). The MOE collaborates with the JAS and non-governmental agencies to organize

environmental programs. The involvement of the MOE in addressing environmental issues is appropriate as education is intended to correct societal attitudes and enhance public awareness, especially among children (KPM, 2013). Children, being the younger generation, are suitable for instilling a love for the environment from an early age, enabling them to act positively and responsibly towards the environment in adulthood (Hasanuzzaman & Bhar, 2017). Additionally, the chemistry subject is intended to cultivate students who appreciate natural resources and the beauty of the environment (Sulistina, Rahayu, Dasna, & Yahmin, 2021). Sulistina et al. (2021) states that chemistry education is significant in enhancing students' understanding of the role of chemistry in society and their ability to evaluate business and chemical-related products. The study also highlights that the chemistry can contribute to a sustainable society and proper stewardship of natural resources, aligning with the intended goal of cultivating an appreciation for natural resources and the environment among the students. Meanwhile, acid and base often applied by human in daily lives (Kaçan & Çelikler, 2016). Various industries applied acid and base such as mining industry, agriculture industry, manufacture of food and beverage, manufacture of household cleaning and so on. The improper waste management will lead to water bodies contamination (Vera, 2023) and acid rain formation (Mohajan, 2018).

Nevertheless, the transfer of learning concepts of acid and base to real-world issues among the students is insufficient (Karpudewan et al., 2016). This limits the reference sources for researchers and teachers who require it for investigation and improvement purposes. There are few studies related to correlation between science knowledge and environmental sustainability awareness. The study of Nurisa and Arty (2018) has indicated that students have a moderate understanding of acid and base

concepts but demonstrate a weak ability to apply this knowledge to solve real-life problems related to environmental issues such as acid rain. The findings indicate that students encounter difficulties in transferring their theoretical knowledge of acid and base into practical solutions for environmental problems, highlighting a gap in their ability to apply knowledge in practical scenarios. This limitation could hinder their effectiveness in addressing environmental issues, particularly those related to acid rain. In addition, study of Asis, Marinsah & Ramlie (2021) found that there is no significant relationship between environmental awareness and practices on environmental culture among secondary school students, because the students lack of environmental knowledge from the schools. This factor can be supported by study of Mohiuddin, Mamun, Syed, Masud and Su (2018), which points that students' environmental knowledge is significantly influence their attitudes towards sustainable practices, such as favouring green vehicles and engaging in pro-environmental behaviours. As an example, Priambudi and Deliana study (2021) has conducted a study that showing the higher level of public knowledge about green packaging will have a good effect on the behaviour of using green packaging. So, the level of knowledge among the community gives a positive behaviour during shopping. Moreover, a literature review on international transfer of vocational education and training underscores the relevance of vocational education in promoting sustainable development (Li & Pilz, 2021). Motivation to transfer learning has been identified as a crucial factor in higher education, emphasising the need for students' motivation to apply their knowledge to real-world contexts (Bredenkamp, Botma & Nyoni, 2022). Policy transfers in vocational education and training has also been recognized as a significant aspect, highlighting the importance of effective policy implementation for sustainable education practices (Barabasch, Bohlinger & Wolf, 2021). Hence, it is crucial as it suggests that enhancing

students' knowledge of environmental concepts, such as acid and base, could positively influence their environmental awareness towards sustainability.

1.4 Research objectives

Knowledge and awareness among the students are dominant in applying it to the environmental sustainability sector. The research objectives in this study are as follows:

1.4.1 To identify the level of students' existing knowledge of acid and base.

1.4.1 To identify the level of students' environmental sustainability awareness.

1.4.2 To identify the relationship between students' existing knowledge of acid and base with environmental sustainability awareness.

1.5 Research questions

1.5.1 What is the level of science students' existing knowledge of acid and base?

1.5.3 What is the level of students' environmental sustainability awareness?

1.5.3 Is there a significant relationship between students' existing knowledge of acid and base with environmental sustainability awareness?

1.6 Research hypothesis

H_0: There is no significant relationship between students' existing knowledge of acids and base with environmental sustainability awareness.

1.7 Significance of study

Firstly, the study provides valuable insights for chemistry teachers regarding the level of understanding and awareness of students in applying the concept of acid and base in daily lives. By understanding the levels of existing knowledge and awareness of students, teachers can enhance their pedagogical strategies to better address students' needs and improve their understanding acid and base. This may involve the development of targeted instructional materials, interactive learning activities and real-world applications to bridge any gaps in understanding. By empowering teachers with research-based insights, the study contributes to the continuous improvement of chemistry education, ultimately benefiting students' learning outcomes and academic achievement.

Next, the study underscores the importance of self-awareness and responsibility among students in recognizing their weaknesses in understanding, connecting and applying the concept of acid and base in various situations or daily problems. By acknowledging these weaknesses, students can actively engage in targeted learning interventions and seek support to improve their conceptual knowledge and application skills. This self-awareness and proactive approach to addressing knowledge gaps are

essential for facilitating effective learning transfer processes and overcoming obstacles that may hinder students' academic progress. Additionally, students as agents of change and future leaders, they are encouraged to consider their individual responsibility in preserving the environment based on their understanding of acid and base. This awareness aligns with the broader societal goal of promoting environmental stewardship and sustainability, positioning students as informed and proactive contributors to environmental conservation efforts.

Furthermore, this study is expected to promote the importance of environmental sustainability. The Malaysian Meteorological Department (2023) has highlighted the impact of human activities on climate change, atmospheric acidification, species extinction and marine pollution, underscoring the requirement for environmental education in the chemistry curriculum (Kadhum, 2023). In developing countries, the students have low environmental awareness due to insufficient sustainable environmental knowledge, emphasizing the need for practical education to influence their environmental attitudes (Debrah et al., 2021). Moreover, students' attitudes and intentions towards sustainable practices are significantly affected by their environmental knowledge and awareness, such as when it comes to choosing green vehicles and engaging in pro-environmental behaviours (Mohiuddin et al., 2018). Environmental exposure and duration have also been identified as influencing factors in students' environmental knowledge, illustrating the importance of knowledge in developing sustainability awareness among the young generation. (Kuppusamy & Mari, 2017). Hence, it is crucial for the society to understand the importance to conserve and preserve the environment, and the factors influence environmental sustainability awareness.

Besides, this study is also expected to generate knowledge, attitudes, practices and awareness of environmental sustainability among the students regardless of academic streams, where it can indirectly increase the students' awareness of the interest in maintaining environmental sustainability. Young generation nowadays is required to be exposed to an attitude of concern in emphasizing the importance of environmental sustainability. They must realise their responsible to increase their knowledge of acid and base which is closely related to the environmental issues. Hence, they then come forward to assist the government and the community to guarantee a better environmental quality that can be maintained forever. The significance of studying the correlation between students' existing knowledge of acid and base with environmental sustainability awareness lies in its potential to inform educational interventions and promote sustainable behaviours among students. Therefore, the research findings enable various parties to understand the extent to which our society is aware and practices conservation and preservation of environment in daily lives.

Last but not least, this study is significant as a reference for future researchers. There is limiting references resources about correlational study between knowledge and awareness for investigation and improvement purposes. Hence, this study is looking forward to enable the future researchers investigate more deeply about the correlation between knowledge and awareness by adopting the instruments of this study. Future researchers can also use the findings from this study to design targeted educational programs that aim to improve students' environmental knowledge, eventually fostering a greater sense of environmental responsibility and sustainable behaviour.

1.8 Limitation of study

1.8.1 The study respondents were limited to 100 science stream students from a school in Taiping, Larut, Matang and Selama District, Perak.

1.8.2 The scope of this study emphasises the existing knowledge of acid and base among Form 4 science stream students based on the current curriculum system, which is KSSM.

1.8.3 The understanding of acid and base is limited to the syllabus prescribed by the Malaysian Ministry of Education (MOE).

1.9 Operational definition

1.9.1 Knowledge

The sensory process of curiosity results in the nature of knowledge. The sensory process describes the way individuals interpret physical energy from their surroundings through perception, convert it into meaningful intellectual signals, and then process the information (Dania and Novziransyah (2021). Knowledge is information known by individuals and is manifested when used to learn something new (Bartoszewicz, 2019). This study emphasises existing knowledge, which means existing knowledge among students regarding the basic knowledge of acid and base, such as the strength of acid and base, pH value and neutralisation as well as students' knowledge of the use of acid and base substances in daily lives.

1.9.2 Acid and base

According to KSSM Form 4 Chemistry Textbook (2019), the topic of acid and base is Chapter 6 in syllabus. There are 11 learning contents in this chapter. They are:

(a) 6.1 The role of water in showing acidic and alkaline properties

(b) 6.2 pH value

(c) 6.3 Strength of acids and alkalis

(d) 6.4 Chemical properties of acids and alkalis

(e) 6.5 Concentration of aqueous solution

(f) 6.6 Standard solution

(g) 6.7 Neutralisation

(h) 6.8 Salts, crystals and their uses in daily life

(i) 6.9 Preparation of salts

(j) 6.10 Effect of heat on salts

(k) 6.11 Quantitative analysis

This study includes five learning contents, which are 6.1: The role of water in showing acidic and alkaline properties, 6.2: pH value. 6.3: Strength of acids and alkalis, 6.4: Chemical properties of acids and alkalis and 6.7: Neutralisation. These five learning contents are applied are directly related to environmental issues. Learning content 6.1: The role of water in showing acidic and alkaline properties is to define acid and alkaline, learning content 6.2: pH value is to determine the pH values of various items, learning content 6.3: Strength of acids and alkalis is to define strong acid, strong alkaline, weak acid and weak alkaline, learning content 6.4: Chemical properties of acids and alkalis is to determine chemical properties of acid and alkaline through some

chemical reactions, such as reaction between acid and metal carbonate and reaction between alkaline and metal ion, and learning content 6.7: Neutralisation is to determine the reaction of acid and alkaline which will produce salt and water. The others learning contents are excluded because they are indirectly related to environmental issues. Learning contents 6.8: Salts, crystals and their uses in daily life, 6.9: Preparation of salts, 6.10: Effect of heat on salts and 6.11: Quantitative analysis are about salts. While learning content 6.5: Concentration of aqueous solution is to measure quantity of solute dissolved in a unit volume of solution and learning content 6.6: Standard solution is to prepare standard solution from solid and dilution of an aqueous solution.

1.9.3 Awareness

Awareness is the cognition or level of individual knowledge about something. An individual's sensitivity to issues, sectors or something also determines their level of awareness. The level in which an individual is aware of the impact of their decisions and behaviours had on the economy, society and the environment can be defined as sustainability awareness (Herremans & Reid, 2002). In this regard, this study examines the awareness of students about environmental sustainability in daily lives based on their existing knowledge of acid and base.

1.9.4 Environmental sustainability

According to Ene (2021), the environment is an ecosystem whereby both living and non-living things survive on the surface of the earth, whereas sustainability is the capacity to sustain. An ecosystem of life that depends on individuals or populations over a long duration of time can be referred as environmentally sustainable.

1.9.5 Aspect of basic ecological towards environmental awareness

Ecology examines the interrelationship between organisms and surrounding environment (Plutynski, 2009). While basic ecological refers to the basic of ecological sustainability, the living organisms (human) conserve the natural resources and sustain the structure or composition of ecosystems (Robertson, 2021). This is to preserve the ability of Earth to sustain all forms of living and non-living life. Thus, the standpoints of students on the common exploitation of the human activities that have long been dependent on the environment is examined in this aspect.

1.9.6 Aspect of environmental education across the curriculum and co-curriculum

Environmental education is a process where the individuals or community increase the understanding, knowledge and issues related to the environment. The goal of environmental education is to educate the public about the mechanisms of natural environments. Especially, how human can regulate their behaviour and ecosystems

(Boca & Sarach, 2019). They explore the solutions and take responsible actions subsequently to preserve and conserve the environment. Environmental education across the curriculum is defined as the environmental sensitivity and awareness of students are collaborated into academic curriculum and co-curriculum activities (Shaafi, Mohammad Khalipah, Shafie, & Mat Salleh,2021). This aspect is to justify motivation of students to improve the quality of environment throughout the activities inside and outside school among the students.

1.9.7 Aspect of environmental sustainability practices

Environmental sustainability is defined as the ability of living organism (human) to maintain an ecological balance of natural environment in order to preserve the well - being of current and future generations (Uralovich, 2023). This aspect is to identify the acknowledgement of students' environmental sustainability awareness through their attitude and behaviours.

1.10 Summary

This chapter explains the research to be carried out as a whole in nine small subtopic sections. The introduction explains the transfer of learning and the correlational study design of this study. The background of the study revolves around education issues in Malaysia in general as well as chemistry education issues and environmental education issues specifically in this chapter. In fact, the problem statement discusses the relationship between the transfer of learning of students studying chemistry by applying the concept of acid and base to the issue of environmental sustainability in Malaysia. This chapter also explains the objectives, questions and hypotheses of the correlation study. Next, the significance of the study explains the importance of the study from the perspective of teachers and students. Furthermore, this chapter also details the limitations of the study and operational definitions. Finally, this chapter concludes with a summary of the chapter.