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A Comparative Analysis of Lower Secondary Chemistry Textbook Components: A Study Involving the Chinese Communities of China and Malaysia

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ABSTRACT

Chemistry textbooks serve as the primary reference for teachers and students during teaching and learning. The textbook details the learning content and knowledge covered within a particular subject. Chemistry is more effective in raising awareness of people's behavior and its impact on the surrounding environment, so it receives more research attention. This study investigates the chemistry content covered in Malaysian Independent Chinese Secondary School and lower secondary science textbooks published by Chinese People's Education Press. The comparative method, which includes description, interpretation, juxtaposition, and comparison, was employed in this study. The authors compared lower secondary science textbooks used in most regions of China and Malaysian Chinese schools. Results showed some similarities in the chemistry contents; for instance, they are arranged from fundamental concepts to a broader perspective. However, differences were found in the sequence in which the chemistry concepts and their application to Nature were introduced in both textbook versions used in this study. It was discovered that the organization of chemistry textbooks used in most regions of China was more scientific than the book used in Malaysia. It was relatively basic in comparison and only presented the concepts required for secondary school subjects. The findings of this study suggest that it might be appropriate for 21st-century chemistry concepts to be

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integrated into the curriculum to address the need for education in environmental and sustainability issues from the perspective of education in chemistry.

Keywords: Chemistry Education, China, comparative study, lower secondary, Malaysia, textbook analysis

INTRODUCTION

The plural society in Malaysia denotes the multi-linguistic nature of its people, which has resulted in several types of schools in the country (Hoque et al., 2020; Sharma & Al-Sinawai, 2019). There is "Sekolah Kebangsaan," which primarily uses bahasa Melayu as the medium of daily instruction; vernacular schools, which use respective mother tongues (namely Mandarin Chinese and Tamil) as the medium of instruction, and Malaysian Independent Chinese Secondary Schools (MICSS), which use Mandarin and simplified Chinese in teaching and daily communication. The existence of MICSS itself has been a long and arduous struggle between Malaysian Chinese communities and the Malaysian government (Siah et al., 2015) to preserve and transmit the culture of their mother tongue in Malaysia.

It was due to the solidarity and continued resistance of the Malaysian Chinese in meeting wave after wave of government modular educational policies that have preserved Chinese primary schools, secondary schools, and colleges, where Mandarin and simplified Chinese were the primary medium of teaching instruction, and this has made Malaysia the sole country outside of China with a comprehensive Chinese education system (Peng, 2019). Malaysia has also been recognized as a model of overseas Chinese education, with the existence of MICSS being viewed as crucial as a cultural bastion for the Malaysian Chinese for the completion of their 12-year foundation education program in their mother tongue. It has therefore received the attention of many researchers, which is the primary reason for conducting this research.

Nowadays, in line with the global economic and technological development trend, MICSS emphasizes enhancing students' learning in mathematics and science while simultaneously transmitting their mother tongue culture. Within the integrated lower secondary sciences, chemistry is considered essential and compulsory, due to its close connection to people's daily life, such as food, clothing, transportation, hygiene, drugs, and personal health (Middlecamp, 2019; Set et al., 2015). Similar to Physics and Biology, Chemistry also raises awareness of people's behavior and its impact on the surrounding environment to strive towards the creation of a more friendly and healthy living environment (Bodlalo et al., 2013; Kubiatko et al., 2017). Therefore, regardless of the region, school chemistry plays a critical role in further training students to become professional chemists, educating them to become competent citizens and building a scientifically healthy lifestyle in the future (Jegstad & Sinnes, 2015; Wei, 2019; Yunus & Ali, 2013). Furthermore, as a bridge between primary science and upper secondary chemistry, lower secondary chemistry is responsible for providing students with a strong foundation in chemistry to support their further studies (Okunuga & Ajeyalemi, 2018). For the reasons mentioned above, lower secondary chemistry was selected from the various compulsory courses for secondary school students as the focus of this study.

Among the factors that may influence student learning outcomes, it can be argued that textbook content is the first to attract criticism when the results do not meet initial expectations (Vojíř & Rusek, 2021). However, it is accepted that different structures and educational orientation transfer different views of chemistry into their textbooks (Chen et al., 2019; Eilks & Chen, 2019; Wei et al., 2019), so rather than the unified curriculum standards themselves, it seems to be the corresponding textbooks and their content that may contribute to students' negative attitudes towards chemistry (Rusek & Vojíř, 2019; Yunus & Ali, 2013), which may also directly reduce students' learning outcomes in the subject. In addition, for teachers, the content of the textbooks may directly affect their choice of teaching methods (Lepik et al., 2015), their design of teaching procedures (Rusek & Vojíř, 2019; Wei et al., 2019), and the assessment of their students' learning outcomes (Bakken, 2019). Furthermore, the analysis of textbooks is considered to be critical, as textbooks may inform teachers' teaching and provide direction for students' pre-reading and post-course review (Rusek & Vojíř, 2019), which is why this study decided to compare the lower secondary school chemistry component in science textbooks.

One point that needs to be mentioned is that chemistry is studied in Chinese lower secondary schools from Grade 9 and is taught independently from physics and biology in separate textbooks, unlike at MICSS, where physics, chemistry, and biology are taught in unison, and this is referred to as Unified Science. Chemistry in the MICSS educational system is only a component of Science and is taught in Grade 8 or Form 2 (for the majority) and Grade 9 or Form 3 (for a small minority). Therefore, this study utilizes the theory of comparative analysis defined by Bereday (1967) to identify the similarities, differences, strengths, and weaknesses of the 9th-Grade chemistry textbook, as published by the Chinese People's Education Press (PEP), and the chemistry sections used by MICSS lower secondary, published by United Chinese School Committees' Association of Malaysia (Dong Zong), and draws on the lower secondary science textbook published by Zhejiang Education Publishing Group, to learn from each other through macroscopic comparison and analysis.

METHODS

This study was a qualitative, non-experimental comparative study that aimed to compare the PEP edition chemistry textbook with the chemistry section of the MICSS science textbook from a macro perspective so that the two textbook versions could be enhanced to improve their users' chemistry learning outcomes, especially those of the lower secondary students in MICSS. Documentation was applied as the primary data collection method, and Bereday's (1967) comparative method with four steps: description, interpretation, juxtaposition, and comparison (Adick, 2018) was also employed to achieve the research purpose.

The following actions were completed within each stage based on the research purpose. In the descriptive phase, the available data that met the requirements and purpose of the study was systematically listed to prepare for the interpretive phase that followed. In the interpretation phase, all the data was analyzed and interpreted based on the research purpose to present the primary content of the lower secondary school science textbooks (Chemistry sections) used by MICSS and the version employed by most regions in the People's Republic of China (abbreviated as China). In the juxtaposition phase, the conclusions obtained from the first two phases were examined to fulfill the research purpose and then compared directly and simultaneously, which comprised the final phase, the comparison phase.

With regard to the final documents, only the two sets of textbooks were selected from several textbook versions as the sample for the study to achieve the research purpose. These were Grade 9 PEP chemistry textbooks and the lower secondary level science textbooks used by MICSS. This sample selection was based on convenience (Merriam, 2009), which meant that the final sample selected for this study was more accessible than others. The choice of comparing MICSS science and PEP chemistry textbooks was primarily made to explore the rationale for the Dong Zong curriculum team not preparing science textbooks for lower secondary level MICSS students in line with the PEP chemistry textbook version, even though the PEP edition chemistry textbooks were used in most regions of China.

RESULTS

This section presents the results related to the four steps: description, interpretation, juxtaposition, and comparison. In the first step, the authors describe the final documents based on the information they obtained from various sources. To have a deep understanding of the content of the textbooks, the authors examined the primary content of each textbook version separately in the interpretation step (the second step). In the third step, the information obtained from the first two steps was juxtaposed, and a framework was provided to pave the way for a comparison of the similarities and differences between the two textbook versions.

Description

At this stage, combined with the research purpose, all the relevant documents were collected and presented in tables to facilitate further analysis at a later stage.

More specifically, in China, in many regions, chemistry is taught in Grade 9 and is split with physics (arranged for Grade 8 and Grade 9 students) and biology (arranged for Grade 7 and Grade 8 students). Although there are integrated science editions, they are not widely adopted compared to other separately published chemistry textbooks.

As presented in Table 1, different textbook versions for Grade 9 lower secondary school chemistry have been produced by various publishers according to their regional development requirements; among them, the PEP Edition produced by Chinese People's Education Press (PEP) is used in most regions of China, and it is, therefore, this version that was selected as the sample for this study. The analysis of contents for the PEP Chemistry textbook is presented in Table 2. Based on the analysis, the chemistry contents are further divided into two volumes with 12 chapters (7 chapters for volume 1 and 5 for volume 2).

However, it is interesting to note that the MICSS lower secondary school uniformly uses a comprehensive science textbook prepared by the Curriculum Department of the MICSS Working Committee, based on the science textbooks published by Zhejiang Educational Publishing House. Table 3 lists the chemistry sections in this set of science textbooks, together with the corresponding grade. There are 9 chapters covered in Grade 8 and 6 chapters for Grade 9, respectively. The chemistry concepts only start to introduce to MISCC students in the second year of lower secondary study.

Interpretation

At this stage, all the information obtained from PEP and MICSS textbook was interpreted in detail. The textbook's content was further divided into smaller segments to allow for easier analysis. When analyzing and interpreting the content, it should be viewed from the macroscopic level to gain a broader view of how the contents of the chemistry textbooks were organized. It provides a more general impression of what is covered in the lower secondary level chemistry course.

By systematically listing the contents of the two different versions of textbooks that

Table 1
Information on chemistry (science) textbooks published in China

Version	Subject for Grade 9	Press
PEP Edition	Chemistry (Two volumes)	Beijing: People's Education Press
Hujiao Edition	Chemistry (Two Volumes)	Shanghai: Shanghai Educational Publishing House
Lujiao Edition	Chemistry (Two Volumes & one volume)	Jinan: Shandong Education Press
Renai Edition	Chemistry (Two Volumes)	Beijing: Science and technology of China press
Keyue Edition (Yuejiao Edition)	Chemistry (Two Volumes)	Guangzhou: Guangdong Educational Publishing House & Beijing: Science Publishing
Beijing Edition	Chemistry (Two Volumes)	Beijing: Beijing Publishing Group
Kepu Edition	Chemistry (Two Volumes)	Shanghai: Popular Science Press
Zhejiao Edition	Science (Two Volumes)	Hangzhou: Zhejiang Educational Publishing House
Huashida Edition	Science (Two Volumes)	Shanghai: East China Normal University Press

Table 2
Contents of the PEP edition Chemistry textbook

Volume	Chapter	Title	Topics
One	1	Enter the World of Chemistry	1.1 Changes and Properties of Matter 1.2 Chemistry is an experiment-based science 1.3 Enter the chemistry laboratory
	2	The Air Around Us	2.1 Air 2.2 Oxygen 2.3 Oxygen production Experiment 1: Production and Properties of Oxygen
	3	The Mystery of the Composition of Matter	3.1 Molecules & Atoms 3.2 The Composition of Atoms 3.3 Chemical Elements 3.4 Ions
	4	Water in Nature	4.1 Caring for Water Resources 4.2 Water Purification 4.3 Composition of Water 4.4 Chemical Formula and Valence
	5	Chemical Equations	5.1 Law of Conservation of Mass 5.2 How to Write Chemical Equations correctly 5.3 Simple Calculations using Chemical Equations
	6	Carbon and Carbon Oxides	6.1 Diamond, Graphite, and C60 6.2 Research on Carbon Dioxide Production 6.3 Carbon Dioxide and Carbon Monoxide Experiment 2: Lab Preparation and Properties of Carbon Dioxide
	7	Fuels and their Utilization	7.1 Combustion and Fire Fighting 7.2 Rational Utilization and Development of Fuels Experiment 3: Conditions of Combustion
Two	8	Metals and Metallic Materials	8.1 Metallic Materials 8.2 Chemical Properties of Metals 8.3 Use and Conservation of Metal resources Experiment 4: Physical Properties and some Chemical Properties of Metals
	9	Solutions	9.1 Formation of Solutions 9.2 Solubility 9.3 Concentration of a Solution Experiment 5: Preparation of a Solution of Sodium Chloride with a Certain mass Fraction of Solute
	10	Acids and Bases	10.1 Common Acids and Bases 10.2 Neutralization Reactions of Acids and Bases Experiment 6: Chemical Properties of Acids and Bases Experiment 7: Test of Acidity and Alkalinity of Solutions
	11	Salt and Fertilizers	11.1 Common Salt in Life 11.2 Chemical Fertilizers Experiment 8: Removal of Insoluble Impurities from Crude Salt
	12	Chemistry & Life	12.1 Important Nutrients for Humans 12.2 Chemical Elements and Human Health 12.3 Organic Synthetic Materials

Source: http://www.dzkbw.com/books/rjb/chuzhong-huaxue/

Table 3
Information on the science textbooks in MICSS

Grade	Volume	Chapter	Title	Topics
8 **(Form 2)**	1	1	Water in Life	1.1 The Importance of Water 1.2 Common Properties of Water 1.3 Water Cycle on Earth 1.4 Composition of Water Molecules 1.5 Water for our Living
		3	Solubility of Water	3.1 Dispersion of Substances in Water 3.2 Dissolution and Dissolution of Substances 3.3 Concentration of Solution 3.4 Crystallization of Substances in Water
		5	Atmospheric Pollution and Protection	5.1 Earth's Coat——Atmosphere 5.2 Air Pollution 5.3 Prevention and Control of Atmospheric Pollution
	2	1	Model of Particles	1.1 Atomic Doctrine and Structure of Atoms 1.2 Ions
		2	Elements and Elemental Symbols	2.1 Elements and their Distribution 2.2 Elemental Symbols 2.3 Periodic Table of Elements 2.4 Active Elements in Fertilizers
		3	Composition and Chemical Formula of Substances	3.1 Classification of Substances 3.2 Separation of Mixture 3.3 Chemical Formulas 3.4 Valence 3.5 The Quantity Represented by the Element Symbol 3.6 Organics
		4	Air	4.1 Composition of Air 4.2 Nitrogen 4.3 Rare Gases
		5	Oxygen and Carbon Dioxide	5.1 Properties of Oxygen 5.2 Oxidation 5.3 Oxygen Production and Use 5.4 Properties of Carbon Dioxide 5.5 Production and Use of Carbon Dioxide 5.6 Combustion and Fire Extinguishing
		6	Chemical Reactions and the Law of Conservation of Mass	6.1 Law of Conservation of Mass 6.2 Chemical Equations 6.3 Heat-Absorbing and Exothermic Reactions
9 (Form 3)	1	1	Acid and Hydrogen	1.1 Change of Substance 1.2 Exploring the Properties of Acids 1.3 Several Common Types of Acids 1.4 Properties and Uses of Hydrogen 1.5 Hydrogen Production
		2	Salts and Bases	2.1 Exploring the Properties of Bases 2.2 Several Common Bases 2.3 Neutralization Reaction 2.4 Common Salt

Table 3 *(continue)*

Grade	Volume	Chapter	Title	Topics
		3	Metals and Non-Metals	3.1 Physical Properties of Metals and Non-Metals 3.2 Reaction of Metals and Non-Metals 3.3 Reactive Order of Metals 3.4 Corrosion and Rust Prevention of Metals 3.5 Basic types of Chemical Reactions
		4	Development and Utilization of the Earth's Mineral Resources	4.1 Forms of Mineral Presence 4.2 Identification of Minerals 4.3 Properties and Applications of Silicon Compounds 4.4 Properties and Uses of Calcium Compounds 4.5 Utilization of Mineral Resources
	2	9	Sustainable Use of Earth's Resources	9.1 Human use of Substances 9.2 The Various Resources on Earth 9.3 Water Resources 9.4 Purification of Drinking Water 9.5 Wastewater and its Treatment 9.6 Biological Resources
		10	Sustainable Use of Energy	10.1 Energy 10.2 Renewable and Non-renewable Energy 10.3 Energy Saving

Source: http://smchpd.synology.me/my/

met the requirements and purpose of the study, the authors summarized their design ideas, which were presented in Figure 1. The PEP chemistry textbooks have been arranged using an inductive approach, beginning with examining and learning from a specific to a more general arrangement. For instance, the PEP curriculum starts with an introduction to the air, the composition of matter, and chemical equations. Then it moves towards a broader perspective, with topics such as acids and bases, salt fertilizers, and chemistry and life. In such an approach, students are exposed to the fundamental concepts of chemistry, such as understanding particles (atoms, molecules, and ions), and then progress toward the interaction between particles and the writing of chemical equations. Chemistry concepts then examine how they may be applied to different areas, such as industry, health, and daily life applications. Through this, students are expected to learn and apply chemistry concepts to various areas. Similarly, the curriculum in MICSS has also been arranged in almost the same pattern as the PEP curriculum.

The MICSS chemistry components also commence with the more fundamental chemistry concepts, such as the model of particles, elements, and their symbols. The chemistry sections later proceed to a more general application component, for instance, the development, and utilization of earth minerals, sustainable use of earth's resources, and sustainable energy.

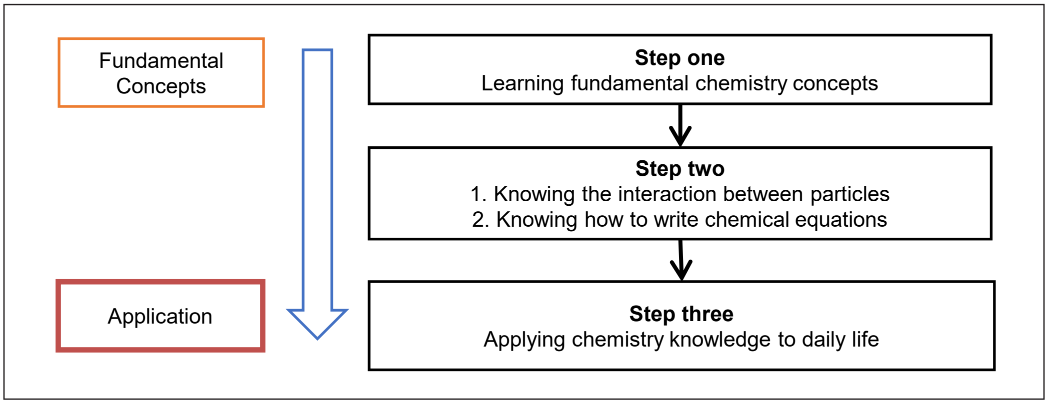

Figure 1. The design of PEP and MICSS textbooks

The chemistry concepts in MICSS are arranged so that students are introduced to the fundamental concepts that serve as the foundation to help them understand the basic concepts of chemistry. It later progresses to a broader spectrum, where students need to relate the fundamental concepts learned in the earlier topics and apply them to different aspects of life, in addition to daily life application. Such an inductive approach in the MICSS chemistry curriculum provides a platform for students to understand fundamentally and master chemistry knowledge and further enlarge the scope of chemistry in various fields that directly connect with the chemistry concepts previously learned. It not only provides the students with opportunities to understand chemistry concepts but also raises their awareness that chemistry is an essential component of their lives.

Juxtaposition and Comparison

At this stage, two chemistry curriculums were compared to determine their similarities and differences in the content studied. Since both curricula use Mandarin Chinese as the medium of instruction, it was believed that this comparison could provide insightful information on how different Chinese communities constructed their lower secondary level science curriculum, particularly for chemistry. Based on the analysis of the learning contents, a small number of chapters appear to be similar for both chemistry textbooks. Table 4 presents similar topics included in both the PEP and MICSS curriculums.

Although the chemistry contents in both textbooks are similar, the sequence of introducing the various chemistry concepts is different. For instance, the topic “Air” is introduced at the beginning of Volume I in the PEP Grade 9 chemistry textbook; however, the introduction of the topic of “Air” is only included in Volume II of the MICSS Form 2 (Grade 8) textbook. Such differences in the content arrangement can be found throughout the PEP and MICSS curriculums. Based on the analysis of the textbooks, it was found that content also varies within similar topics. For example,

Table 4
Similar topics in the PEP textbook and MICSS textbook

PEP	MICSS
The air around us	Air Oxygen and carbon dioxide
The mystery of the composition of matter	Model of particles
Water in Nature	Water in life Solubility of water
Chemical equations	Composition and chemical formula of substances Chemical reactions and the law of conversion of mass
Carbon and carbon dioxide	Oxygen and carbon dioxide
Acid and bases, Salt fertilizer	Acid and hydrogen, Salt and bases
Metal and metallic materials	Metals and non-metals

in the PEP textbook, "Carbon and Carbon Dioxide" is integrated into a similar topic, where elements such as diamond, graphite, C60, the production of carbon dioxide gas, and the concepts of carbon dioxide and carbon monoxide are covered. However, in the MICSS textbook, the concept of "Carbon Dioxide" is included together with "Oxygen," and "the concept of Carbon" is entirely excluded from the curriculum. Similar trends are found in several other topics: acids and bases, salts, and metal and non-metal, to name a few.

During analysis, some chemistry content contained within the two textbooks was found to be entirely different, primarily related to content on applying chemistry concepts to Nature. When investigating PEP textbooks, it was discovered that topics such as (I) Enter the world of chemistry, (II) Fuels and their utilization, (III) Solutions, and (IV) Chemistry and Life were covered in the PEP curriculum, but not in the MICSS curriculum. In the MICSS textbook, "Entering the World of Chemistry" is not taught explicitly, which seems to be mainly due to the nature of the curriculum arrangement. In MICSS, chemistry concepts are integrated and introduced into all study grades for lower secondary students. In other words, the introductory concepts have already been covered in the introduction of science in Form 1 (Grade 7). The PEP curriculum emphasizes the interaction between humans and chemistry, for instance, nutrients for humans, chemical elements and human health, and organic synthetic materials. These concepts are closely related to daily human life and difficult to separate. The symbiotic relationship between chemistry and humans has long existed, with humans relying heavily on chemistry to improve their lifestyles in modern society. Meanwhile, upon investigating the MICSS textbook, the focus was on chemistry concepts related to Nature, the environment, and sustainability. The topics included in the MICSS curriculum are (1) Atmospheric Pollution and Protection, (2) Development and Utilization of the Earth's Mineral Resources, (3) Sustainable Use of Earth's Resources, and (4) Sustainable Use of Energy. Although the MICSS curriculum focuses primarily on the interaction of chemistry and Nature, upon closer examination of the content introduced in the textbook, the main underlying concepts still focus on the interaction between humans and chemistry.

DISCUSSION

A chemistry textbook is an official document for school use and is considered an essential resource for students and teachers (Chiappetta & Fillman, 2007; Österlund et al., 2010). It aids teachers in preparing their classroom instruction and acts as a reference, which meets curriculum standards, for students studying chemistry. As a result, it can be said that the textbook may be students' primary source of chemistry knowledge and acts as a guide in their acquisition of chemistry knowledge.

Chemistry is a subject that contains numerous abstract concepts that require students to gain mastery in three different stages. In the first stage, students are expected to understand that chemical phenomena can be observed and symbolized in their daily lives at the macro-level of learning. In the second stage, students are required to understand what is actually in everyday life but is too small to be seen at the submicroscopic level of learning. In the third stage, students are urged to recognize that regardless of whether things can be observed, they all possess their symbols and that memorizing symbols is also important for enhancing their chemical learning efficacy (Treagust et al., 2003). Therefore, it is suggested that students first understand the concepts at the macroscopic level and further enhance their understanding of them through microscopic and symbolic explanations found within textbooks during the learning process (Chen et al., 2019). With regard to this, it was discovered that both textbooks in this study comprehensively address the macroscopic, microscopic, and symbolic representation, which are often emphasized in the teaching and learning of chemistry (Johnstone, 1991). More specifically, because the concept learning arrangement from microscopic to macroscopic often causes students to struggle with conceptualizing chemistry concepts and their application, it is critical for chemistry textbooks, particularly lower secondary level chemistry textbooks, to arrange their contents from fundamental concepts to more abstract ones.

This study agrees with the conclusions reached by Rusek and Vojíř (2019) and Vojíř and Rusek (2021), which maintain that textbook content needs to be organized in accordance with the notion of moving from the concrete to the abstract, which may not only alleviate the difficulty students encounter in comprehending chemistry concepts, but may also pique students' interest in continuing their chemistry learning journey in their upper-secondary level education. It seems that regardless of whether the chemistry textbook used is published by PEP or used by MICSS, the content arrangement of the chemistry textbook does serve to support the development of chemistry knowledge mastery, interest, and motivation to learn chemistry at lower secondary level students; however, the PEP chemistry textbook version is more clearly organized than the MICSS textbook.

Textbooks often reflect a country's dominant ideology (The Chinese emphasis on notions of collectivism and cooperation), identity, and areas requiring particular attention (Environmental Protection, Healthy Living). On that note, chemistry education, specifically chemistry textbooks, may differ between countries, cultures, geographical areas, and instructional language (Mahaffy, 2011). This phenomenon may be reflected through the introduction of specific chemistry content in textbooks, and this is one of the reasons that the Dong Zong curriculum team regards the science textbook published by Zhejiang Education Publishing Group as their reference for designing science textbooks for lower secondary school students in MICSSs. Furthermore, the decontextualization of chemistry content is common in most textbooks, and this situation has also been highlighted by Sjostrom and Talanquer (2014). The introduction of topics, such as fuels and their utilization, chemistry, and life, atmospheric pollution and protection, development and utilization of the earth's mineral resources, sustainable use of earth's resources, and sustainable use of energy, is introduced in the curriculum. Such topics may assist students in linking what is happening in their community to the chemistry concepts they have learned.

It may not only enhance students' conceptual understanding but also raise their awareness of real-world issues and how they, as students, may become involved. Chen et al. (2019) also mention that the overall discipline structure is fundamental in outlining chemistry textbook content. This study consistently concluded that the content of a textbook should be arranged in such a way that it primarily focuses on the fundamental, theoretical, and abstract concepts that represent the macroscopic, microscopic, and symbolic levels. Such a conventional arrangement has tended to make chemistry study highly abstract, dry, and factually based. Consequently, students may have difficulty relating the chemistry concepts learned from their textbooks to real-life situations, regardless of whether they use the PEP version or the textbooks supplied by MICSS.

The study of chemistry involves understanding natural phenomena occurring in Nature, and students need to be able to form connections to explain these phenomena scientifically. However, this study determined that the apparent lack of relevance to students of the PEP chemistry textbook and the textbook version employed at MICSS could potentially lead to low levels of creativity among students in terms of their application of scientific concepts to the solution of problems they encounter in daily life. This finding is consistent with Eilks and Hofstein (2013), who also state that scientific learning should start from a context familiar and closely connected to the learners' previous experience or areas of personal interest to them and that this may result in improved academic performance in science. Therefore, a textbook's contextualization of concepts and examples is critical. It may help motivate students to pursue knowledge, as they are more likely to view it as relevant and applicable to their lives. Although the contextual concepts are essential and have been introduced in both textbooks, further inclusion is required, as compared to the other conventional concepts within the textbooks, these features only minimally.

The application of chemistry concepts to daily life and industrial activity has been the cause of much debate, particularly when it is linked to the environment and human health. Overuse of chemicals, improper disposal of used industrial chemical waste, unclean and toxic drinking water, and the usage of herbicides and pesticides are controversial issues within the scope of chemistry. These environmental and sustainability issues significantly impact human life, flora, fauna, and Nature in general. The results of these issues include long-term negative effects, such as serious health issues and the destruction of the planet's resources. These are likely to continue unless major action is undertaken to address them. However, there is little content related to these issues in either of these two chemistry textbooks, and the existing content is only at the level of "what," namely, to help students understand what pollutes the environment, leaving little room for students to think about "why" and "how."

Thus, it is high time to integrate education on sustainability within the chemistry curriculum in the textbooks rather than merely presenting chemistry concepts. For instance, some of the 21st-century chemistry concepts, such as green chemistry, green technology, Nanochemistry, and socio-scientific issues, could be introduced into the curriculum to encourage students to think creatively and to make judgments and decisions based on the chemistry knowledge and scientific facts they learn from the curriculum. 21st-century chemistry concepts not only combine chemistry and society but may also promote higher-order thinking in learners and foster the development of global citizenship. It is apparent that content on sustainability and environmental issues is still inadequate in the two chemistry textbook versions selected for this study. Integrating content related to sustainability and environmental issues into secondary-level chemistry textbooks should be a priority to enhance the learning experience of secondary-level students.

CONCLUSION

In this study, the authors intended to study the content of chemistry textbooks (Particularly what students may learn from them) from two different Chinese communities that use the same language of instruction. Although there was little research related to chemistry textbook comparison (Chen et al., 2019; Eilks & Chen, 2019), the focus was on upper-secondary-level chemistry. In other words, the study did not include comparative examinations of chemistry textbooks from the standpoint of lower secondary science structural design. As a result, the findings of this study may provide some insight and reference for future scholars interested in understanding chemistry textbook content material based on two different cultures, specifically the two different Chinese communities of China and Malaysia.

Although both samples of this study were Asian with similar cultures and employed the same language of instruction, clear differences were still discovered. The main purpose of this study was not to assess the quality of the textbooks or to identify which of the textbooks most effectively presented chemistry knowledge to lower secondary school students. The aim was to exemplify how chemistry content is presented in different national contexts and determine the most important and relevant concepts students need to learn. It was the position of the authors that there was no "right" or "wrong" when determining which concepts to include in chemistry textbooks, providing that the content could meet the nation's requirements in terms of student learning outcomes, knowledge construction, and human capital development.

The analysis and comparison of chemistry textbooks in this study were limited to two Chinese communities and only included lower secondary school levels at a certain grade level (Grade 9 in China; Form 2 and 3 in MICSS). Furthermore, the data obtained in this study only addressed a single aspect of the textbook, i.e., how the chemistry curriculum was arranged within the textbook. Hence, how the textbook was used in the teaching and learning process did not fall within the scope of this study. Further research is needed to determine how textbooks are used by chemistry teachers in the teaching of chemistry concepts to lower secondary-level students. Topical analysis of certain chemistry concepts might be relevant to determine how certain concepts are taught from the perspective of different countries. It also creates opportunities for further study into how lower secondary chemistry textbooks have evolved and developed over time to cater to various countries' needs for advancement in science and technology. Thus, analyzing the textbook currently used in both countries has provided a timely overview of how the chemistry curriculum is currently organized. It also points to the need for regular review of textbook content after the new curriculum is reformed and implemented.

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Trustworthiness Statement

The data were collected by documentation and analyzed by the comparative method defined by Bereday (1967), and all the data were obtained from the official website designated by the in-service chemistry teacher. The results of this paper were double-checked by the two authors and confirmed by the in-service chemistry teachers (member checking).

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