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PISA AND SUSTAINABLE DEVELOPMENT GOALS: COMPARING SCIENCE CURRICULA IN SECONDARY SCHOOLS IN INDONESIA, SINGAPORE, AUSTRALIA, AND CANADA IN THE CONTENT ASPECT BASED ON THE PISA 2025 FRAMEWORK

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ABSTRACT

Continuous curriculum updates are crucial for enhancing the quality of education, improving citizens' global competitiveness, and supporting Sustainable Development Goal (SDG) 4, particularly the goal of achieving quality education for all. International studies, such as PISA, have attracted many researchers interested in comparative curricula across PISA-participating countries. Unlike previous studies, this research compares the science curricula of Indonesia, Singapore, Australia, and Canada based on the science content tested in the PISA 2015, PISA 2021, and PISA 2025 frameworks. The method used in this study is content analysis. We searched for documents from the four countries on their respective Ministries of Education websites. After obtaining the documents, two researchers independently conducted the coding analysis. After that, the researchers validated the content analysis through inter-rater agreement. The results show that the science curricula of Indonesia, Singapore, Australia, and Canada do not specifically cover all content in the PISA 2015, PISA 2021, and PISA 2025 frameworks. Specifically, Singapore's curriculum documents do not cover Earth and Space System content, while Labrador, Alberta, and British Columbia cover all themes. The Indonesian science curriculum encompasses all themes assessed in PISA questions and the PISA 2025 framework, although it does not yet cover all topics. However, it remains challenging to pinpoint the reasons for the differences in PISA results among the four countries in this comparative study.

Keywords: comparative study; curriculum Science; content; framework PISA 2025

INTRODUCTION

The Programme for International Student Assessment (PISA) is an international study conducted by the Organisation for Economic Cooperation and Development (OECD) to evaluate the abilities of 15-year-old students in Mathematics and Science. PISA is a key tool for monitoring progress towards Sustainable Development Goal 4 (SDG 4), which aims to ensure inclusive and quality education. PISA provides data to assess how well education systems prepare students for life and to monitor indicators related to SDG 4 targets, particularly minimum proficiency in reading and mathematics (OECD, 2023b).

The 2022 PISA results show that Indonesia ranks 67th out of 81 countries surveyed, below the OECD average (OECD, 2023b). Several factors influence a country's PISA results, including the socio-economic and family environment, the quality of learning and educational infrastructure, and the inadequacy of the curriculum in

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meeting the demands of the PISA test (Al-Ali & Wardat, 2024; Erdogdu & Erdogdu, 2025). A curriculum that is not aligned with PISA competencies is a crucial factor, as it directly affects students' scientific literacy (Cansiz & Cansiz, 2019). The curriculum determines the specific skills and knowledge that students must learn, as well as the pedagogical approaches used in the classroom. Therefore, an irrelevant science curriculum will directly affect science literacy outcomes.

There are three forms of curriculum, namely the planned curriculum, the implemented curriculum, and the achieved curriculum (Ni & Cai, 2011). The planned curriculum includes syllabi and textbooks issued by the Ministry of Education. A syllabus is a comprehensive course outline that includes teaching materials, objectives, and content (Yue & Cui, 2023). Given the importance of curriculum standards, several comparative studies of science curricula across countries have been conducted by various researchers, such as Amalina et al. (2023) comparing Indonesian and Hungarian mathematics and science curricula based on the International Standard Classification of Education (ISCED 2) framework, Syarif et al. (2023) who compared the science curricula of Indonesia and Turkey, Kyi & Isozaki (2023) who compared the science content in lower secondary textbooks in Myanmar and Japan; El Islami et al. (2022) compared the science curricula of Indonesia, Vietnam, and Thailand, including aspects of content, Michie (2017) compared the 2013 curricula of Indonesia and Australia, focusing on science, including science content at the lower secondary level.

Although several researchers have conducted comparative studies of science curricula across countries, most have directly compared the content of science lessons across curricula, without linking it to the science content tested in PISA and TIMSS questions. In fact, comparing the science and mathematics content in the curriculum with the mathematics content in the questions or frameworks of PISA and TIMSS (for example, studies by Veinović et al., 2018; Peduk & Ates, 2019; Safrudiannur & Rott, 2019) will undoubtedly be more helpful in understanding the differences in student achievement between countries in PISA and TIMSS. Wang & Lu (2018) argue that the content tested in TIMSS and PISA studies is what students need to learn in the curriculum. Therefore, the extent to which PISA-tested content is included in the curriculum needs to be evaluated. This is important so students can learn relevant material that meets international standards. Thus, curriculum improvements and adjustments can be made to enhance the quality of education and student achievement in international tests such as PISA and TIMSS (Auld & Morris, 2016).

This study compares the Indonesian science curriculum with those of several countries, such as Singapore, Australia, and Canada. There are several reasons for selecting these countries. First, Singapore, Australia, and Canada consistently score higher than Indonesia on the PISA (see Figure 1), achieving high science literacy scores on the PISA (ranking in the top quartile in 2022, 2018, and 2015). Second, the selected countries represent the continents of Asia, Australia, and America. Third, the science curriculum documents of Singapore, Australia, and Canada are in English, enabling comparative analysis to identify effective curriculum practices and strategies that can improve Indonesia's educational outcomes.

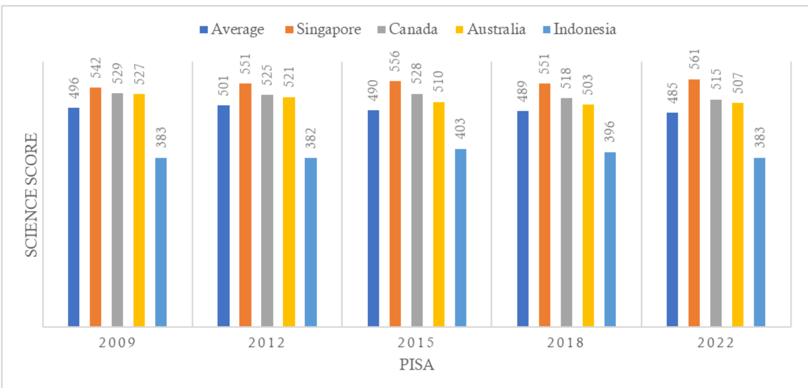

Figure 1. Average PISA science scores of Indonesia, Singapore, Australia, and Canada in 2009, 2012, 2015, 2018, and 2022 (summarised from OECD 2012, 2017, 2019, 2023)

This study will provide information. First, regarding the strengths and weaknesses of the Indonesian science curriculum compared to the curricula of other countries that have achieved better PISA results. Second, the weakness of the Indonesian science curriculum content compared to that based on the PISA 2025 framework. Comparing these countries' curricula will yield insights to enhance Indonesia's science curriculum and achieve higher standards. This study will also assist policymakers in improving the curriculum to enhance Indonesian students' performance in PISA tests.

The focus on content in this study provides a basic overview of the extent to which the curriculum provides the prerequisite knowledge to support science literacy competencies. Content forms the basis for the development of scientific process skills, whereby processes such as explaining phenomena scientifically, interpreting data, or designing investigations still require mastery of key concepts (Husaini et al., 2019). An individual with a good command of scientific concepts will be able to develop their scientific thinking process (Krell et al., 2023). In addition, it is important to know what content is being tested because only a sample of the science content domain is evaluated in PISA. The content evaluated is selected from the main fields of physics, chemistry, biology, and Earth and space sciences that are relevant to real-life situations and represent important scientific concepts or proven explanatory theories with sustainable uses (OECD, 2023c). Findings regarding content gaps can be used as a basis for further research.

METHODS

This study uses a case study design with content analysis to provide an in-depth understanding of a case and to compare several cases (Creswell & Creswell, 2018). Content analysis is a research technique for the objective, systematic, and quantitative description of the content of communication (Barelson, 1952). In this study, the author analyzed and compared the content of the science curricula of Indonesia, Singapore, Canada, and Australia. The following is an explanation of the stages of content analysis:

1. Preparing data sources. The data sources in this study are: (a) the national curriculum documents of Indonesia (Capaian Pembelajaran Pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah, 2025), Singapore (MOE, 2024a, 2024b), Canada (Alberta Education, 2014, Newfoundland and Labrador Government, 2013a, 2013b, 2013c, and British Columbia Ministry of Education, 2016), Australia (Australian Curriculum, 2022b), (b) the PISA framework (OECD, 2023c), and (c) the 2015 PISA test questions (OECD, 2016) and PISA 2025 (OECD, 2023c). The section of the curriculum document that was analyzed in this study focused on content-related learning outcomes. For example, in the Indonesian independence curriculum, the conceptual understanding element was used.

2. Create a table listing the content (physical systems, living systems, and Earth and space systems) described in the PISA 2025 framework (OECD, 2023c) and assign codes. A letter, word, or part of a sentence on a page can be a meaningful unit for selecting the appropriate unit of analysis (Elo et al., 2014). Coding units are curriculum standards and selected curriculum content. Sentences in the curriculum standards were selected as coding units following Porter (2002). In this study, the content list table uses the code' v 'for content included in the PISA 2025 framework and the code' x' for content not included in the PISA 2025 framework. (see Table 1). All of the curriculum documents used in this study are recent, including the Canadian science curriculum, which was updated several years ago and is still used and publicly available on the government's official website.

3. Matching codes. To ensure data reliability, two authors analyzed duplicate content and reached the same conclusions, resulting in identical coding patterns (Potter & Levine-Donnerstein, 1999). In this study, two lecturers (one in physics and one in science) independently coded each country, matching each country's science content to the PISA 2025 framework. After coding, the two authors analyzed and discussed the coding results together. If there were coding differences, the two authors analyzed and discussed them until agreement was reached.

4. Validate the content analysis in step 3 by calculating the inter-observer agreement percentage (Neuendorf, 2017). The percentages of agreement were 92.3% for Indonesia, 97.8% for Singapore, 90.1% for Australia, 90.7% for Labrador, 91.4% for Alberta, and 95.2% for British Columbia. Since the agreement percentage for each country exceeded 90%, we did not make any further revisions.

Reporting the coverage of science curriculum content in Indonesia, Singapore, Australia, and Canada (Labrador, Alberta, British Columbia) based on the PISA 2025 framework (OECD, 2023c). The presentation of results helps readers understand the findings in a clear and meaningful way (Holdford, 2008), with detailed reports presented systematically and logically for enhanced clarity and understanding (Elo et al., 2014), as well as comparisons of results (Kyi & Isozaki, 2023).

RESULTS AND DISCUSSION

As mentioned in the introduction, this curriculum comparison is part of a study that compares the strengths and weaknesses of the Indonesian science curriculum with those of other countries that have achieved better PISA results, such as Singapore, Australia, and Canada, using the PISA 2025 framework. Unlike other curriculum comparison studies that directly compare curriculum content, we compare the science content of the 2022 and 2025 Indonesian Curricula, the Singapore Curriculum, the Australian Curriculum, and the Canadian Curriculum, not with each other, but with science content based on the PISA 2025 framework.

Table 1. Example of the Coding of Physical Systems Topic in Indonesia, Singapore, Australia, and Canada Secondary Schools

No	Selected Topic [together with codes]
1	Indonesia (Document: Capaian Pembelajaran pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah 2025, p. 157-159; Capaian Pembelajaran pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah 2022, p. 190-191;195) Analyzing the particles that make up matter, analyze the classification, properties, and changes of materials [*Codes*: (*Structure and Properties of Matter*: *particle model* "v")] Applying the concept of stoichiometry in various quantitative aspects of chemical reactions, distinguishing between physical and chemical changes, and separating simple mixtures [*Codes*: (*Chemical changes of matter*: *chemical reactions* "v")] Analyzing movement, force, and pressure [*Codes*: (*Motion, Forces, and Action at a Distance*: *force* "v")] The relationship between work and energy [*Codes*: (*Energy and its transfer*: *energy* "v")]
2	Singapore (Document: MOE 2021a, p. 13; MOE 2021b, p. 12) Ray Model of Light, Model of Cells-the Basic Unit of Life, Model of Matter-The Particulate Nature of Matter, Model of Matter-Atoms and Molecules [*Codes*: (*Structure and Properties of Matter*: *particle model* "v")] Application of Forces and Transfer of Energy, Transfer of Heat Energy and its Effects, Chemical Changes, Interactions within Ecosystems [*Codes*: (*Chemical changes of matter*: *energy transfer* "v")] Application of Forces and Transfer of Energy, Transfer of Heat Energy and its Effects, Chemical Changes, Interactions within Ecosystems [*Codes*: (*Motion, Forces, and Action at a Distance*: *force* "v")] Application of Forces and Transfer of Energy, Transfer of Heat Energy and its Effects, Chemical Changes, Interactions within Ecosystems [*Codes*: (*Energy and its transfer*: *heat transfer* "v")] [*Codes*: *(Interactions between energy and matter*: "x")]
3	Australia (Document: Australian curriculum, 2022b, p.4-7, p.15-19, p. 25-29) Model of the Atom, Structure and Properties of Atoms, Particles in a Substance, Pure Substances and Mixtures [*Codes*: *(Structure and Properties of Matter*: *particle model* "v")] Synthesis, Decomposition, and Displacement Reactions, Energy Flow in Ecosystem [*Codes*: *(Chemical changes of matter*: *energy transfer* "v")] Represent Balanced and Unbalanced Forces, Newton's Laws of Motion, [*Codes*: *(Motion, Forces, and Action at a Distance*: *Force* "v")] Different Types of Energy [*Codes*: *(Energy and its transfer*: *energy* "v")] Energy Change in Chemical Reactions, Energy Flow in Ecosystem, Energy Transfer Through Different Media, The Law of Conservation of Energy [*Codes*: *(Interactions between energy and matter*: *heat transfer* "v")]

No	Selected Topic [together with codes]
4	Canada Labrador (Document: Newfoundland and Labrador Government, 2013a p. 7; 2013b p. 27; 2013c p. 14) List examples of physical changes in materials, including change of state (Grade 9) [*Codes*: *(Structure and Properties of Matter*: *change of state* "v")] Describe changes in the properties of materials that result from some common chemical reactions [*Codes*: *(Chemical changes of matter*: *chemical reactions* "v")] Describe the particle theory of matter, including the attractive forces between the particles [*Codes*: *(Motion, Forces, and Action at a Distance*: *electrostatic force* "v")] Describe the transfer and conversion of energy from a generating station to the home [*Codes*: *(Energy and its transfer*: *conversion* "v")] Describe different types of electromagnetic radiation, including infrared, ultraviolet, X-rays, microwaves, and radio waves [*Codes*: *(Interactions between energy and matter*: *radio waves* "v")] Alberta (Document: Alberta Education, 2014, p.7-37) Pure Substances, Mixtures and Solutions; Atoms and Molecules; Elements and Compounds [*Codes*: *(Structure and Properties of Matter*: *particle model* "v")] Acids and Bases [*Codes*: *(Chemical changes of matter*: *acids and bases* "v")] Structures and Forces [*Codes*: *(Motion, Forces, and Action at a Distance*: *Motion, Forces, and Action at a Distance* "v")] Heat and Temperature [*Codes*: *(Energy and its transfer*: *Heat transfer* "v")] Sources of Light; Microscopes and Telescopes; Contribution of Optical Technologies to Daily Living; Vision and Lenses; Reflection and Refraction [*Codes*: *(Interactions between energy and matter*: *light waves* "v")] British Columbia (Document: British Columbia Ministry of Education, 2016, p.14-19) Atomic Theory and Models; Elements and Compounds are Pure Substances [*Codes: (Structure and Properties of Matter: particle model* "v")] Chemical Changes [*Codes*: *(Chemical changes of matter*: *chemical reactions* "v")] Electricity [*Codes*: *(Motion, Forces, and Action at a Distance*: *electrostatic force* "v")] [*Codes*: *(Energy and its transfer*: "x")] Types and Effects of Electromagnetic Radiation Light [*Codes*: *(Interactions between energy and matter*: *light waves* "v")]

The Indonesian Education System and Science Curriculum Framework

The education system in Indonesia consists of three primary levels, namely six years of elementary school (SD), which provides the foundation for learning and prepares students for the next level of education, and three years of junior high school (SMP) (Marmoah et al., 2021). At the senior secondary level, there are Senior High School (SMA) and Vocational High School (SMK) with a duration of three years, where students can choose majors, projects, and problem-based learning in accordance with the Merdeka Curriculum (Rajagukguk et al., 2024). The curriculum aims to improve faith, devotion to God Almighty, citizenship, critical thinking, creativity, collaboration, independence, health, and communication, as well as to nurture the creativity, taste, and will of students as lifelong learners with Pancasila character through in-depth learning (Peraturan Menteri Pendidikan Dasar dan Menengah Republik Indonesia Nomor 13 Tahun 2025 Tentang Perubahan Atas Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 12 Tahun 2024 Tentang Kurikulum Pada Pendidikan Anak Usia Dini, Jenjang Pend, 2025).

In Indonesia, the science curriculum is developed by the Ministry of Education, Culture, Research, and Technology (Wahyudin et al., 2024). In this study, two levels of secondary education in Indonesia are analyzed: junior high school (Phase D) and senior high school (Phase E). Both levels differ slightly in their strategies for delivering science (Ulfah et al., 2025). In Phase D, science is delivered in an integrated manner (Capaian Pembelajaran Pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah, 2025). This is based on the understanding that natural phenomena and real-world problems are complex and interconnected, and cannot be neatly divided into the disciplines of physics, chemistry, and biology. For example, to understand climate change, students must integrate the physics concept of heat, the chemistry concept of greenhouse gases, and the biology concept of ecosystems. Thus, integrated learning encourages students to develop a comprehensive and meaningful understanding while also training their critical thinking and problem-solving skills in the face of actual real-world issues. However, in Phase E, science can be taught either separately through the courses of Physics, Chemistry, and Biology, or in an integrated fashion similar to Phase D. Units of inquiry, which are projects intended to address an environmental problem or issue from multiple angles, whether physical, chemical, or biological, are used to implement the science material presented in an integrated manner in Phase E (Anggraena et al., 2022). In implementing learning, process skills are the methods used to gain an understanding of science, so this understanding and these process skills are presented as a whole and are not broken down into separate learning objectives (Wahyudin et al., 2024; Wapa et al., 2024)

The Singapore Education System and Science Curriculum Framework

Starting from the 2024 Secondary 1 cohort, the Normal (Technical), Normal (Academic), and Express courses will be phased out. Two types of curricula for secondary schools in Singapore exist: Full Subject-Based Banding and Specialised Curriculum (Tan, 2025). Under Full Subject-Based Banding (Full SBB), students will be posted through Posting Groups 1, 2, and 3, respectively, instead, and have greater flexibility to offer subjects at appropriate subject levels. From the 2027 graduating cohort, students will sit for the new Singapore-Cambridge Secondary Education Certificate (SEC) examination, comprising different papers for each subject level. Students will receive an SEC that reflects the subjects and subject levels that students offer (Teo et al., 2023).

The science education framework provides students with a strong foundation in science for life, future learning, citizenry, and work. Built around three core principles represented by "IN": Inspire, Inquire, and Innovate. Students are to be inspired by science, finding it relevant and meaningful, and considering science-related careers. They should inquire like scientists, with a strong foundation and the ability to critically evaluate information based on scientific evidence. Students should innovate using science, applying its potential to solve real-world problems and contribute to STEM innovation. Establishing a solid scientific foundation requires a thorough understanding of core ideas, science practices, values, ethics, and attitudes (MOE, 2024a)

The Australian Education System and Science Curriculum Framework

In Australia, children are required to attend school until they complete Grade 10, and then they may pursue full-time education, training, or employment until the age of 17. Before the age of 6, Australia offers kindergarten or preschool education (Bahri et al., 2024). Based on the Australian Qualifications Framework (AQF) for the states of New South Wales, Victoria, Tasmania, and the Australian Capital Territory, primary school lasts for 7 or 8 years (Kindergarten – Grade 6), while secondary school starts in Grade 7 and extends to 10 (lower secondary). Senior High School lasts for 2 years (Grades 11-12), and Higher Education includes higher education and vocational education (Aussizz Group, 2025).

The education curriculum currently implemented in Australia is the Australian Curriculum, Assessment and Reporting Authority (ACARA). ACARA is an independent agency established in 2008 to implement policy directives from the Council of Australian Governments (COAG) and the Education Council on curriculum, assessment, and reporting at the national level. The Australian curriculum covers three dimensions: learning areas, generic skills, and cross-curricular priorities. In the Australian Curriculum, Science is organized into three interrelated areas: Understanding Science, Science as Human Endeavor, and Investigating Science (Australian Curriculum, 2022a).

The first element is understanding science. Understanding science studies Biology, Earth and Space Science, Physics, and Chemistry. The second element is Science as Human Endeavor, which highlights the role of science in contemporary decision-making and problem-solving. This field consists of two sub-fields: 1) The nature and development of science; 2) The use and impact of Science (Australian Curriculum, 2022b). The third area is Scientific Inquiry, which focuses on investigating ideas, developing explanations, solving problems, drawing valid conclusions, evaluating claims, and constructing evidence-based arguments. Students are challenged to explore the concepts, properties, and uses of science through a straightforward process of inquiry (Wernert & Thomson, 2020). This element consists of five sub-elements: 1) Questioning and predicting, 2) Planning and carrying out, 3) Processing, modeling, and analyzing, 4) Evaluating, and 5) Communicating (Australian Curriculum, 2022b).

The Canadian Education System and Science Curriculum Framework

In Canada, there is no Ministry of National Education. However, there is the Council of Ministers of Education Canada (CMEC), a collective body that serves as a forum for Canada's provincial and territorial education ministers. CMEC enables these ministers to discuss education issues of mutual interest and to collectively represent Canada's educational interests at both the national and international levels. Therefore, no national curriculum exists; each territory has the right to govern its educational policies (Kauts et al., 2025).

Labrador

Compulsory education in Labrador lasts approximately 12 years and consists of primary education, elementary school, junior high school, and high school. Primary education begins at age 5. After completing this stage, students enter grades 1-3 (still at the primary level) and continue through grades 4-6 (elementary school level). Next is junior high school, which is grades 7-9. Compulsory education ends at the senior secondary level, which is grades 10-12, also known as Level I (Grade 10), Level II (Grade 11), and Level III (Grade 12) (Council of Ministers of Education Canada, 2023; Kauts et al., 2025). The science curriculum implemented in Labrador is based on the Foundation for the Atlantic Canada Science Curriculum (FACSC). The science curriculum in the Atlantic provinces aims to develop science literacy. Therefore, science literacy in the science curriculum is defined as four general outcomes: Science, Technology, Society, and Environment (STSE); skills; knowledge; and attitudes (Goodnough & Galway, 2019; The Atlantic Provinces Education Foundation (APEF), 1998).

In Science, Technology, Society, and Environment (STSE), students learn about the nature of science and technology, their interactions, and their social and environmental contexts. In the skills aspect, students learn important skills for scientific and technical inquiry, problem-solving, communicating scientific ideas, collaboration, and decision-making. In terms of knowledge, students acquire information in biology, physics, and earth and space science. Finally, in terms of attitudes, students are encouraged to develop positive attitudes that promote the mastery and appropriate use of scientific and technological information for their own benefit, the benefit of society, and the benefit of the environment (Goodnough & Galway, 2019; The Atlantic Provinces Education Foundation (APEF), 1998).

Alberta

The Alberta education system, from Kindergarten to Grade 12 (K to 12), includes programs for preschool through high school students. Kindergarten is for children who will enter Grade 1 the following year. Then, Grades 1 to 6 (Elementary School) are for children aged 6 to 12, Grades 7 to 9 (Junior High School) are for children aged 12 to 15, and Grades 10 to 12 (High School) are for children aged 15 to 19 and offer various types of schools and learning environments (Webber & Nickel, 2020).

There are four pillars of science education in Alberta: Technology, Society (STS), where students will develop an understanding of the nature of science and technology, the relationship between science and technology, and the social and environmental context of science and technology. The second is knowledge; students will build and deepen their understanding of concepts in life sciences, physics, and earth and space sciences, and apply that understanding to interpret, integrate, and expand their knowledge. Third is Skills; students will develop skills to conduct scientific and technological investigations, solve problems, communicate scientific ideas and results, work collaboratively, and make informed decisions based on available information (Acut & Antonio, 2023). Finally, the last is Attitude; students will be encouraged to develop attitudes that support the responsible mastery and application of scientific and technological knowledge for their own well-being, for society, and for the environment as a whole (Pegg et al., 2019).

British Columbia

The Ministry of Education manages British Columbia's (BC) education system, which covers kindergarten through grade 12 (Boyer & Crippen, 2014). The system is divided into a 12-year (K-12) education pathway that encompasses primary and secondary education, followed by higher education options. The types of schools in BC consist of Public Schools (fully funded by the provincial government and managed by an elected school board) and Private Schools (partially funded by the government but privately owned (Lin, 2023).

The province provides a K-12 core curriculum that integrates three core competencies (communication, creative and critical thinking, and personal and social competencies) with two foundational skills (literacy and mathematics). The Science Education System in BC is designed to improve students' scientific literacy and critical thinking skills, preparing them for future challenges (Boyer & Crippen, 2014; Blades, 2019). The curriculum emphasizes discovery-based learning, allowing students to ask questions, consider different perspectives, and make logical decisions. The curriculum is organized around big ideas, curricular competencies, and content, covering biology, chemistry, physics, and earth and space science from kindergarten to grade 12 (British Columbia Ministry of Education, 2015).

The Comparison of Science Content

Results of a comparison of the science curricula of Indonesia, Singapore, Australia, and Canada from three provinces, namely Labrador, Alberta, and British Columbia, in terms of content in the PISA 2015 and PISA 2025 framework (see Table 2).

Table 2. The Percentage Alignment Comparison of Science Content in Indonesia, Singapore, Australia, and Canada Secondary Schools

Topics	Subtopics	In (22)	In (25)	Sin	Aus	Can-Labrador	Can-Alberta	Can-British Columbia
Physical Systems	Structure and Properties of Matter	80%	60%	60%	80%	100%	60%	40%
	Chemical changes of matter	75%	50%	50%	75%	75%	50%	25%
	Motion, Forces, and Action at a Distance	50%	50%	17%	67%	17%	17%	17%
	Energy and its transfer	25%	25%	50%	75%	25%	75%	0%
	Interactions between energy and matter	0%	0%	0%	57%	29%	29%	14%
Living Systems	The concept of organisms and microorganisms	17%	33%	0%	0%	0%	17%	50%
	Genes and their interaction with the environment	50%	50%	0%	75%	100%	100%	0%
	Cells	43%	0%	14%	86%	57%	71%	57%
	Plants, animals, and their inter-relationships	75%	13%	0%	38%	100%	100%	25%
	Biological evolution	17%	17%	0%	100%	0%	67%	83%
	Ecosystems	17%	17%	50%	67%	100%	67%	17%
	The Biosphere	0%	0%	0%	0%	33%	0%	33%
	Interactions of humans and their impact and effect on the environment, other species, and sustainability	0%	0%	0%	75%	50%	75%	0%
Earth and Space Systems	Structures of the Earth Systems	17%	17%	0%	100%	83%	50%	50%
	Energy in the Earth's systems	17%	0%	0%	50%	50%	33%	50%
	Water, supply, and conservation	0%	0%	0%	0%	67%	67%	0%
	Interactions and change among earth systems	17%	17%	0%	50%	33%	33%	17%
	Earth's history	0%	0%	0%	0%	100%	75%	25%
	Earth in Space	25%	25%	0%	100%	75%	75%	25%
	The origin of the universe and the solar systems	0%	0%	0%	100%	100%	0%	0%

In (22) Indonesian Science Curriculum in 2022*, In (25)* Indonesian Science Curriculum in 2025*, Sin* Singaporean Science Curriculum*, Aus* Australian Science Curriculum*, Can-Lab* Labrador (Canada) Science Curriculum, *Can-Alberta* Alberta (Canada) Science Curriculum, *Can-British Columbia* British Columbia (Canada) Science Curriculum.

There are 104 codes established from the PISA 2025 Framework and the PISA items analysis. The codes consist of three content areas: physical systems, living systems, and earth and space systems. Each topic also consisted of several subtopics and sub-subtopics. The sub-subtopics contain more specific content related to the relevant subtopics, and the number of subtopics and sub-subtopics varies.

The analysis results of the compatibility between content subtopics and science curriculum learning outcomes are shown in Table 2. A higher percentage indicates greater similarity between sub-subtopics within each subtopic and one country's science framework, while a lower percentage indicates less similarity.

The calculation results showed that several PISA content subtopics are missing from the Indonesian, Singaporean, and Australian science curricula: interactions between energy and matter, the biosphere, interactions of humans and their impact and effect on the environment, other species and sustainability, water supply and conservation, Earth's history, and the origin of the universe and the solar system.

There are three sub-subtopics within the biosphere: the biosphere, sustainability in the global ecosystem, and greenhouse gases. The curriculum analysis results indicate that these sub-subtopics have the least correspondence. If any correspondence exists, it is only found in two Canadian provinces: Labrador and British Columbia.

An interesting finding is found in the topic of Earth and Space. Indonesia and Singapore have low or almost no correspondence across almost every subtopic. This is in stark contrast to the Canadian and Australian science curricula. This discrepancy explains the low level of conformity between the science curricula of Indonesia and Singapore in the topic of Earth and space, as shown in Figure 2.

Indonesia

Several aspects were found in analysing the Indonesian Curriculum with the PISA Framework. First, the learning outcomes in Indonesia include several materials not included in the PISA framework, thereby broadening the Indonesian curriculum's scope in certain areas (OECD, 2023c). The PISA Framework covers broader and deeper material than the Indonesian Science Curriculum because it integrates concepts of physics, biology, and earth and space sciences with a more detailed focus on aspects such as particle structure, waves, interactions of energy and matter, and global environmental impacts that are not all present or described in detail in the Phase D Science Curriculum in Indonesia. The Indonesian Curriculum emphasises materials appropriate to the local context, such as the classification of living things, organ systems, environmental interactions, practical applications in everyday life, and strengthening character and cultural values. In the science curriculum, the learning outcomes in Phase D focus on a single subject. In contrast, in Phase E, the science understanding is divided into several subjects, such as Chemistry, Biology, and Physics, which cover broader aspects of the lesson (Capaian Pembelajaran Pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, Dan Jenjang Pendidikan Menengah, 2025).

Singapore

The Singapore Full Subject-Based Banding (Full SBB) secondary school science curriculum integrates physics, chemistry, and biology into one subject, namely science. Science learning practices in Singapore are based on scientific inquiry to provide students with a strong foundation in science for life, learning, citizenship, and work (MOE, 2024a). When comparing the Singapore secondary school science curriculum with the PISA 2015 and PISA 2025 frameworks, there is alignment between the PISA content and the material in the Singapore secondary school science syllabus. The Singapore secondary school science curriculum is designed based on themes linked to everyday life and frequently observed natural phenomena. Group G1 only covers two basic themes, namely Machines Around Us and Our Environment, while groups G2 and G3 cover the same themes and material: Diversity, Models, Interactions, and Systems. Explicitly, Earth and Space Systems material is not found in the syllabus document.

There are similarities between the Singaporean and Indonesian science curricula in terms of content: both curricula cover the material tested in PISA 2015 and PISA 2025. However, Earth and Space Systems material is not explicitly found in either country. There is a striking difference in the material on living systems: the Indonesian curriculum covers more material than the Singapore curriculum, especially on plants and animals and their relationships.

Australia

The Australian secondary curriculum organises science into three interrelated areas: Understanding Science, Science as Human Endeavour, and Scientific Inquiry Skills. If we compare this with the science content aspects of the PISA framework, PISA content relates to the Understanding Science domain. For Science Understanding, the content description of each sub-field is outlined. These sub-fields are Biological Sciences, Earth and Space Sciences, Physical Sciences, and Chemical Sciences. In the PISA science question framework, especially in 2025 and 2015, there is alignment between PISA content and the material taught in Australian Year 7–10. The topic of Physical Systems in PISA content is represented by several materials in the Physical Sciences and Chemical Sciences sub-strands. All subtopics in Physical Systems are covered by all sub-strands in the Australian science curriculum for Years 7–10 (Australian Curriculum, 2022b).

In contrast, the topic of Living Systems in the PISA framework is not always explicitly found in the Biological Sciences sub-strand; material on vaccines and greenhouse gases serves as an example. Similarly, not all subtopics in the Earth and Space Systems topic are found in Australia's Earth and Space Sciences sub-strand. For instance, material on Fossils, Origin and Evolution, Erosion and Deposition is not explicitly studied. Instead, the curriculum discusses how the Big Bang theory models the origin and evolution of the universe. The curriculum does not cover the subtopics of water supply and conservation.

There are differences in the structure and Curriculum between Indonesia and Australia, including the content of science lessons. Although there are differences, both systems aim to prepare students to address global challenges by fostering critical thinking (Bahri et al., 2024). The science content studied differs from the material covered in the PISA Framework. In the PISA Physical Systems topic, almost all content is included in the curricula of both countries, except for Interactions Between Energy and Matter, which is not in the Indonesian Curriculum but is in the Australian Curriculum. In Living Systems, only the topics Cells, Plants and Animals and Their Interrelationships, and Ecosystems are included in both countries' curricula. The concepts of Organism, Microorganisms, and the Biosphere are not found in the curricula of either country. Other topics, such as Genes and Biological Evolution, are included in the Australian Curriculum but are not taught in Indonesia. In Earth and Space Systems, only the topics Structures of the Earth Systems and Solar System are included in both countries' curricula. The topic of water supply and conservation is not found in the curricula of either country. The topics Energy in Earth Systems, Interactions and Change among Earth Systems, and The Origin of the Universe and the Solar System are included in the Australian Curriculum, but not in Indonesia. From this, it is evident that the science topics in the PISA framework are more numerous in the Australian curriculum than in the Indonesian curriculum.

Canada

The Canadian science curriculum, aligned with the PISA Question Framework, demonstrates significant continuity in efforts to enhance the quality of science education internationally. The Curriculum in Canada is designed to develop students' deep understanding of scientific concepts (Lee & Kim, 2024). In British Columbia, for example, the teaching and learning model focuses on scientific competencies such as questioning and predicting, planning and conducting, processing and analysing data and information, evaluating, applying and innovating, and communicating (British Columbia Ministry of Education, 2016). Meanwhile, the PISA framework emphasises the application of scientific concepts in real-world contexts and students' analytical skills (Khurma et al., 2025; Lailatul et al., 2025). The fields of science used in the framework are physical science, biological science, and earth and space science (OECD, 2023c). Although the Canadian science curriculum does not divide the fields of study into those three parts, the subjects taught there still cover all those fields. This indicates that the science curriculum in Canada has implemented science learning in line with the PISA framework. The Canadian science curriculum also focuses on developing students' analytical skills based on real-world problems. Of course, this is also evident in Canada's already high PISA scores.

a. Labrador

Based on three body of Knowledge in Labrador general curriculum outcome; physical science, life science, and earth and space science (The Atlantic Provinces Education Foundation (APEF), 1998), the analysis using the PISA framework in this study shows that several subtopics are not included in the learning content requirements taught in the country's intermediate level (equivalent to junior high school). In physical science, there are acids and bases, sound waves, and subtopics related to motion and forces, such as velocity, friction, and electrostatic forces. In life science, there are biological evolution, viruses, and bacteria. On the other hand, in earth and space science, climate change, global warming, and geochemistry are some examples.

A comparison of Labrador's and Indonesia's science curricula using the PISA framework yields several results. First, more topics in Labrador are introduced earlier, such as particle models, chemical reactions, and the geosphere and ecosystems. These topics are taught in intermediate schools in Canada, whereas in Indonesia, they are introduced in senior high school. Second, some topics are taught in Labrador but not in Indonesia, such as ocean acidification, fossils, earth history, fresh water, and aquifers. The Labrador curriculum comprises more PISA content than Indonesia at the intermediate level.

b. Alberta

Similar to the PISA framework, in Alberta, science knowledge is grouped into physical science, living science, and earth and space science (Alberta Education, 2014). Analysis of the science curriculum for junior high schools in Alberta also revealed that several PISA content areas are not included, such as the universe's origin and solar systems, energy in the Earth system, and several subtopics, such as viruses and bacteria.

The Alberta curriculum is more specific than Indonesia's and covers more PISA science content. Furthermore, some science content is taught earlier in Labrador, while in Indonesia, it is only introduced in senior high school. Examples of this content include biodiversity in grade 9 and the geosphere in grade 7.

c. British Columbia

The analysis of the science curriculum, particularly in Alberta and British Columbia, using the PISA framework in this research, indicates that several subtopics are not included in the learning content requirements for middle school in these regions. The content that has not been taught is distributed across the fields of physical science, biological science, and earth and space science. In physical systems, bones, energy transfer, velocity, magnetic force, dissipation, sound waves, seismic waves, and carbon dioxide emission exist. In living systems, there are animals, bacteria, and the biosphere. In contrast, in Earth and space systems, there is energy, the origin and evolution of Earth, the moon phases, and interactions and changes among Earth systems.

Based on the PISA 2022 results, Canada ranks in the top 6 with an average science score of 515 (OECD, 2023b). Meanwhile, Indonesia still lags significantly compared to Canada, ranking 62nd with an average science score of 383.

A comparison of Canada's and Indonesia's science curricula using the PISA framework yields some results. First, the Canadian science curriculum separates topics by grade, whereas the Indonesian curriculum separates them by phase. Furthermore, the Canadian and Indonesian curricula do not mention several topics, including the biosphere, greenhouse gas, and origin and evolution.

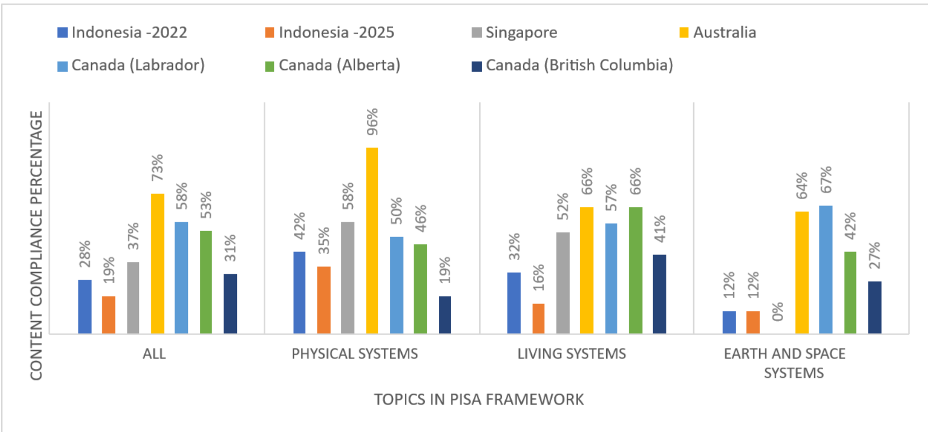

Figure 2. The Percentage of Science Curriculum Compliance with The PISA Science Content Framework

The Percentage of Science Curriculum Compliance with The PISA Science Content Framework

The percentage of each country's science curriculum that complies with the PISA science content framework is shown in Figure 2. Each country's percentage varies, but all scores are below 100%. This indicates that the science curricula in each country are not fully aligned with the PISA framework. However, the most outlined is Australia since it tends to have a high level of compliance across each topic, consistently exceeding 60%. This is particularly true for physical systems, where the compliance rate is the highest among other countries at 96%. The figure also shows that in almost all countries in this study, except for Labrador, Earth and Space Systems is the topic with the least compliance with their science curriculum. Even Singapore's science curriculum shows no demand for understanding of this topic, according to the subtopics specified in this study, with a percentage of 0% (see Table 1).

Another interesting finding is that Indonesia, Singapore, and Australia tend to have higher compliance rates for physical systems than for living systems, followed by earth and space systems. This is quite different from the Canadian provinces in the research sample, which, although not significant, are more suitable for the life system or the earth and space system.

Based on the analysis, the overall ranking of the percentage of science content matching between each country's curriculum and the PISA framework, from highest to lowest, is: Australia, Canada (Labrador), Canada (Alberta), Singapore, Canada (British Columbia), and Indonesia. When compared with PISA scores based on the most recent test data from 2009, 2012, 2015, 2018, and 2022, these results do not align perfectly with each country's rankings. The science scores for each country, from highest to lowest, are Singapore, Canada, Australia, and Indonesia. The only consistent ranking is Indonesia, which ranks last among the other three countries. There are several assumptions to this result. First, curriculum documents from some countries, such as Singapore, do not detail the science content students need to learn. This leaves little information available to confirm the inclusion of PISA-based science content in those countries' curriculum documents. Second, each school in the analyzed countries has the right to modify the national curriculum, including the science content taught in class. Therefore, it is highly likely that teachers are teaching more in-depth material aligned with the PISA test, but this is not explicitly stated in the country's national curriculum document.

CONCLUSION

Comparing the Indonesian science curriculum in terms of content with those of Singapore, Australia, and Canada is interesting because these countries have achieved significantly better PISA results than Indonesia. The science themes and topics for secondary schools in these four countries are essentially the same, with only a few notable differences, such as Physical Systems and the interactions between energy and matter. These topics are not explicitly included in the Indonesian and Singaporean curricula, but they are included in the Australian and Canadian science curricula. Based on this comparison, it was found that the Indonesian science curriculum covers all the PISA 2025 framework topics, but not all of them. We recommend integrating: First, the topic of physical systems with the subtopic Interactions between in Phase D. Second, the topic of living systems with the subtopic cells in Phase D. Third, the topic biosphere in Phase D or Phase E. Fourth, the topic interactions of humans and their impact and effect on the environment, other species and sustainability in Phase D or Phase E. Fifth, the topic earth and space systems with the subtopic structures of the earth systems in Phase D. Sixth, the topic energy in the Earth's systems in Phase E. Seventh, the topic water, supply and conservation in Phase E. Eighth, the topic interactions and change among earth systems in Phase D and Phase E. Ninth, the topic earth's history in Phase D, and the origin of the universe, and the solar systems in Phase E. The results of this study are helpful to policymakers in evaluating teacher performance to improve the quality of education, particularly in science, thereby enhancing Indonesian students' performance in PISA and encouraging the achievement of Sustainable Development Goal 4 (SDG 4), which focuses on inclusive and quality education. This study has several limitations. First, this study employs a qualitative analysis, yielding specific findings. Second, this study analyzes secondary school science curricula focusing on content. Further research is recommended to examine other aspects (e.g., contexts, science identity, procedural knowledge, and epistemic knowledge).

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