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An Analysis of Second Grade Primary Science Textbooks Based on Argumentation-Driven Inquiry Skills in Iran and Malaysia

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ABSTRACT

This study aimed to determine and compare the extent to which argumentation-driven inquiry skills are incorporated into the chemistry sections of second-stage primary science textbooks in Iran and Malaysia. By analyzing science textbooks, the research evaluates the extent and significance of these skills using the Shannon entropy method. Results indicate that the amount of mean entropy weight in the chemistry section of Iranian science textbooks is higher than in Malaysia. However, the number of skills used in the content of the Malaysian book is very high and it has been more suitable than Iran. It was found that the chemistry section of Malaysian science textbooks has used inquiry skills in a better way than Iran. It is recommended that Malaysian science textbooks be revised to ensure that inquiry skills are properly incorporated into the textbooks. It is also necessary to include the correct and balanced number of all inquiry skills in Iranian science textbooks.

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1. Introduction

The field of chemistry, recognized as multidisciplinary within the realm of science, holds significant value in educational curricula, as it encompasses a wealth of essential knowledge (Aldahmash & Omar, 2021; Park, 2020). Despite its importance, recent studies shed light on concerning trends regarding the learning of chemistry and science among students, particularly those in primary education, revealing widespread disinterest (Wen et al., 2020; Stone, 2020; Noor et al., 2015, Murphy et al., 2021). This lack of enthusiasm poses a significant challenge, as students are not sufficiently engaged in the process of learning chemistry (Murphy et al., 2020). Recognizing this issue, educators have turned to encouraging active participation and emphasizing the construction of arguments based on evidence.

The abstract nature of chemistry renders it prone to misconceptions among students, thereby impeding effective learning and comprehension. These misconceptions can persist unless actively identified and corrected, posing a formidable barrier to mastering chemical concepts. It is the responsibility of both students and teachers to actively identify and correct misconceptions, thereby fostering a more accurate understanding of chemistry textbook concepts. In addition, chemistry education extends beyond mere memorization of facts; it involves cultivating skills and thinking processes crucial for comprehending the world (Maleki et al., 2023). To achieve this understanding, students must acquire the inquiry skills emphasized in chemistry textbooks (Noor et al., 2015). Through inquiry-based learning, students develop the ability to pose questions, collect evidence, analyze data, and formulate arguments, all of which are integral to critical thinking skills (Pamela et al., 2020).

Science textbooks should lead students to discover the concepts. This leads to the students acting as scientists, which may enable them to play the role of scientists in the future. Many of textbooks fail to prioritize the cultivation of the crucial skill of constructing and defending scientific arguments, which are fundamental components of robust scientific inquiry. This deficiency can severely impede students' ability to engage in meaningful scientific discourse and critically analyze complex concepts. Furthermore, the integration of inquiry-based activities, particularly those centered on argumentation, within the chemistry sections of textbooks may be insufficient.

Most textbooks do not provide adequate guidance or resources for evaluating students' abilities to construct and defend arguments, complicating the assessment of their progress and understanding. Addressing these challenges requires a thorough examination of the content within the chemistry sections of science textbooks through the lens of argumentation-driven inquiry skills.

By analyzing the textbook content based on argumentation-driven inquiry skills, we can enable targeted revisions to ensure learning.

Recently, the contents of the secondary schools of chemistry textbooks in Iran and Malaysia have been examined regarding attention to occupational readiness components (Maleki et al., 2023). In the Iranian and Malaysian curricula, these skills are referred to as science inquiry skills and encompass the understanding of "science" and the "nature of science" (NOS) (Sumarni et al., 2022). Science inquiry skills offer structured processes for students to learn and providing a framework for comprehending science content. Science inquiry skills are linked to learners' thoughts of science content because they provide the structures for which science content can be included (Yang et al., 2019). Science inquiry skills are important in the teaching of science books, and content of science supports learners to employ, iteration and improve their skills (Wen et al., 2020). With instructional support, students in the early years can develop a sound understanding of science inquiry skills. It has also been found that the use of argumentation drive inquiry skills in the textbook can help students develop scientific knowledge as they provide a common structure and way of thinking during science activities (Murphy et al., 2021). With a greater emphasis on argumentation drive inquiry skills, learners can find out about the world around them through investigations (Bai & Song, 2018; Chua et al., 2018).

Education is viewed as an inquiry when the paramount of the study relies on the main consequences (Baroudi & Rodjan Helder, 2021; Kaçar & balım, 2021). The task of teaching becomes one of supporting inquiry skills, and the focus of education becomes learning. It can be said that inquiry and argumentation are closely linked, in that the skills and experiences necessary for both are nearly identical. Therefore, students must be proficient in argumentation and inquiry to understand science meaningfully. Argumentation is defined and recognized as a process that encompasses several skills. Argumentation skills can include the ability to reasonably rebut, the mental ability to recognize counter-arguments, and identifying evidence (Stone, 2020).

Scientific inquiry refers to the systematic approach of investigating phenomena, formulating hypotheses, conducting experiments, and analyzing data to gain understanding and knowledge about the natural world. On the other hand, argumentation involves presenting and defending claims using evidence and reasoning to persuade others of a particular viewpoint or interpretation. These two concepts are intrinsically linked, as argumentation often arises from the process of scientific inquiry, where researchers construct and debate hypotheses based on empirical evidence. Integrating argumentation into textbooks can strengthen scientific inquiry skills by challenging students to justify their viewpoints, consider alternative explanations, and refine their ideas through structured dialogue and debate, thereby enhancing their ability to engage meaningfully with scientific concepts and contribute to the advancement of knowledge (Hamed et al., 2020).

The National Science Teaching Association (NSTA) emphasizes the importance of aligning instructional materials such as textbooks with educational goals and standards. According to this, the Next Generation Science Standards (NGSS) highlight the analysis of textbook content to assess the effectiveness of communicating complex scientific concepts through the teaching of argumentation-driven inquiry skills. By carefully examining the content of textbooks, it is possible to assess whether these skills are adequately addressed (Penn et al., 2021).

The American Chemical Society (ACS) recommends that researchers compare the results of content analysis between textbooks from different countries. Also, this standard suggests comparing textbooks of countries with educational commonalities such as similar curricula and cultures such as religion because this type of comparison promotes global competition in science education by understanding and learning from different perspectives and will lead to the identification of differences in emphasis on specific scientific concepts and inquiry skills (Wen et al., 2020).

Indeed, the textbooks of Iran and Malaysia present an ideal opportunity for content analysis and comparison. Regardless of the geographical distance, Iran and Malaysia share numerous educational and cultural similarities. The Iranian National Curriculum Framework and the Malaysian Education Blueprint in science education have been developed based on foundational skills and competencies outlined in the NGSS standard. Consequently, both curricula emphasize the cultivation of 21st-century skills such as critical thinking, creativity, communication, collaboration, digital literacy, and notably, argumentation-driven inquiry skills. Additionally, both curricula are grounded in Islamic teachings and aim to incorporate local perspectives, values, and traditions, referred to as Cultural Heritage in science education, to enhance meaningful learning experiences and relevance to students' lives (Baroudi & Rodjan Helder, 2021; Kaçar & balım, 2021; Karim & Hue, 2021). Despite these similarities, the extent to which argumentation-driven inquiry skills are covered in the textbooks of both countries remains ambiguous, and there is a noticeable absence of studies examining the emphasis placed on these skills in science or chemistry textbooks.

The significance of the study is further underscored by the importance of inquiry skills, which theoretical studies highlight as crucial. This study is in line with the Malaysian Ministry of Education's plans to align textbooks with curricula, as it is important in identifying school outcomes (Maleki et al., 2023). Also, this study aims to assess the incorporation of argumentation-driven inquiry skills in the second stage primary textbook units recently approved by Iran's Ministry of

Education. It is worth mentioning that for the first time, Iranian education intends to include inquiry skills in science textbooks. This study is intended for the first-time using Shannon entropy to know the inclusion of argumentation-driven inquiry, which examines this goal and these scores. This response provided many previous studies examining barriers to students' understanding of science and the content of school textbooks as a major reason for barriers to students' understanding. The results of this study may prompt researchers to conduct further studies on school textbook evaluation.

2. Literature Review

After searching within the previous studies in the framework of science textbook analysis, it was found that researchers have been particularly concerned with argumentation-driven inquiry skills. Jeskova et al. (2018) evaluated the level of development of students' inquiry in Slovakia, focusing on argumentation skills. They identified five inquiry skills including observation, prediction, experiment, conception, and communication within the students' textbooks and meticulously scrutinized how these skills were addressed. Their findings revealed varying degrees of emphasis on different inquiry skills within the textbooks. In a similar study, Yang et al. (2019) categorized inquiry skills and identified their representation in Chinese biology textbooks. They found that the coverage of six skills in the relevant textbook was unbalanced, with some skills that effectively emphasize cognitive, creative, and interpersonal competencies being generally neglected; therefore, they recommended integrating skills such as evidence and analysis into the textbook.

By expanding the scope to include an additional skill, Pamela et al. (2020) focused on the science textbook, and analyzing with seven inquiry skills provided a more nuanced understanding of how inquiry-based learning is implemented within the science curriculum. Also, the importance of fostering students' ability to construct and defend arguments-based evidence in their research was highlighted. Gradually, inquiry skills were integrated with argumentation and received the attention of researchers. For example, the findings of Halawa et al. (2022) study showed that argumentation-driven inquiry skills are unbalanced in textbooks, and some skills are emphasized more than others, this imbalance leads to the neglect of learning certain skills and the inability of students to Form hypotheses and provide discrete explanations.

According to the positive results obtained from the content analysis of Saudi Arabian chemistry textbooks based on argumentation-driven inquiry skills, students showed increased engagement and critical thinking abilities (Aldahmash & Omar, 2021). Furthermore, integrating argumentation into the curriculum facilitated a deeper understanding of scientific concepts and promoted collaborative learning environments (Bansal, 2021; Bansal & Ramnarain, 2021).

To provide a broader perspective, researchers conducted cross-national comparisons, examining how argumentation-driven inquiry skills were addressed in textbooks across different countries. For example, the study by Sumarni et al. (2022) conducted in Indonesia and Singapore shows that while textbooks include elements of the NOS, they often lack depth in their coverage and do not fully integrate argumentation-driven inquiry components. The analysis indicates that Singaporean textbooks generally score higher in incorporating argumentation-driven inquiry skills aspects compared to Indonesian textbooks, although the latter has more instances of the NOS representation. Hendratmoko et al. (2024) compared physics textbooks in Indonesia and South Korea focusing on integration inquiry and debate as strategies to enhance students' scientific argumentation skills. Their research highlighted that inquiry and debate activities, which involve supporting arguments with evidence and reasoning, can significantly improve students' abilities in scientific argumentation. After analyzing Life Sciences textbooks content in Turkey and Russia, Ütkür Güllühan and Guseinova (2021) proved that argumentation-driven inquiry skills enhance students' critical thinking abilities, deepen their grasp of scientific principles, and facilitate the application of these principles in real-world scenarios by integrating argumentation activities within the learning framework.

Previous research has analyzed the content of textbooks based on a limited number of skills, leading to a fragmented understanding of the subject matter. For example, the study of Jeskova et al. (2018) included five inquiry skills, Yang et al. (2019) covered six skills, and Pamela et al. (2020) analyzed textbooks with seven inquiry skills. In contrast, this study aims to take a more comprehensive approach by examining all eight science process skills listed in the NGSS.

Several content analysis studies, particularly those of a comparative nature, lack a clear justification for the selection of textbooks from specific countries. For instance, Sumarni et al. (2022) selected textbooks from two neighboring countries for analysis primarily due to their geographical proximity, but it did not offer a detailed rationale for this selection. Similarly, Ütkür Güllühan and Guseinova (2021) analyzed textbooks from two countries without offering any justification for selecting those particular nations. Likewise, Hendratmoko et al. (2024) focused on textbooks from two countries within the Asia, again without explaining the basis for this selection. This trend indicates a necessity for more stringent criteria in selecting countries for comparative textbook analysis to improve the validity and relevance of such studies. Hence, in the current study, accounting for both educational and cultural aspects, specifically the alignment of curricula and the shared influence of Islamic teachings in the content, textbooks from Iran and Malaysia were chosen for content analysis.

This study derives its significance from the importance of Inquiry Skills, which academic analyzes emphasize their significance for the study, which seeks to determine the extent to which Inquiry Skills are included in textbooks. So far, no research has been done regarding the investigation of these skills between Iran and Malaysia, so this research aims to investigate argumentation-driven inquiry skills in elementary school books for the first time. In this research, textbooks have been evaluated in a comparative manner to respond to previous studies about the barriers to students' understanding of science and the content of school textbooks.

3. Research Method

The aim of this study was to investigate the extent and level of inclusion of argumentation-driven inquiry skills in the chemistry section of the 4th, 5th and 6th primary science textbooks by using Shannon entropy. For this purpose, science textbooks of Iran and Malaysia, both of which are considered Muslim countries in Asia, were selected. In addition, the centralized education system and the existence of a single textbook for all schools in Iran and Malaysia have led us to compare argument-based inquiry skills in the textbooks of the two countries. This study employs content analysis as its primary research methodology and then determines the importance of the indicators using Shannon's entropy method. In content analysis, an indicator is selecting for review, and the analysis involves weighing and scoring its sign in the text of the book. The main objective is to examine the occurrence of chosen terms in the data and compare it with other data.

A) Population and Sample of the Study

Researchers selected fourth, fifth, and sixth grades science textbooks from elementary schools in Iran and Malaysia to assess the extent of argumentation-driven inquiry skills and their significance using the Shannon method. We decided to analyze these books because they are taught in the last years of elementary school, which prepares the student for the high school level. This choice was based on the importance of the fourth, fifth and sixth years as the year of transition to a higher level. The chemistry section of the science textbooks was first separated from the rest of the book and then reviewed.

This analysis included a science textbook in all three grades for both Iran and Malaysia. Students use one textbook each school year. In Iran, the chemistry section of the fourth, fifth and sixth-grade science textbooks is 20, 10, and 18 pages, respectively; Additionally, in Malaysia, the chemistry section of the fourth, fifth, and sixth-grade science textbooks is 13, 50, and 12 pages, respectively. Table 1 shows the titles of the units related to the chemistry section, their order and the number of courses in each science textbook in the two countries.

Table 1: Title of the units of science textbooks that were analyzed in Iran and Malaysia

Science Textbook for	grade	Title	No. of pages
Iran	Fourth	Lesson 2: Mixtures in life	10
		Lesson 5: Heat and material	10
	Fifth	Lesson 2: Material changes	10
	Sixth	Lesson 2: The destiny of my notebook	10
		Lesson 3: Paper factory	8
Malaysia	Fourth	UNIT 8: Materials	13
	Fifth	UNIT 8: Heat	14
		UNIT 9: Matter	28
		UNIT 10: Acid and Alkali	8
	Sixth	UNIT 9: Waste	12

B) Study Instrument

The content analysis form was used as a study instrument so that codes were assigned to each skill. Argumentation-driven inquiry skills used in content analysis include 1. Questions, 2. Evidence (Data and patterns), 3. Students' explanations, 4. Scientific theories or models, 5. Argumentation, communication & justification, 6. Analysis, 7. Connection and 8. Reflection.

To start a content analysis, first, the research question is recognized and samples are extracted for analysis. Next, the text must be coded into content sections. This is a manner of selective reduction. By decreasing the text to sections, the researcher can code for specific terms or words that notify the research question. During the content analysis, data sources, as well as the logical structure, can be used to explore the representation of the argumentation-driven inquiry in the chemistry section of science textbooks.

The following is the coding scheme along with the procedural definitions based on which the coding was done.

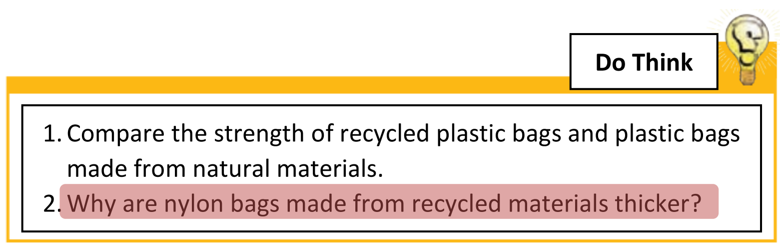
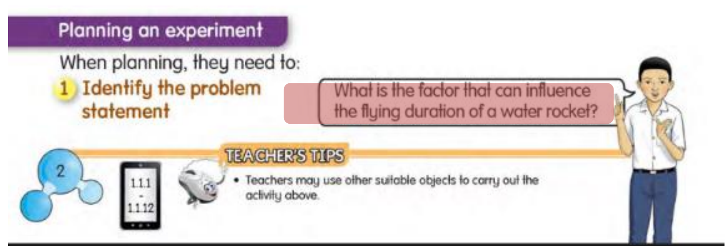
Table 2: Argumentation-Driven Inquiry Skills coding scheme

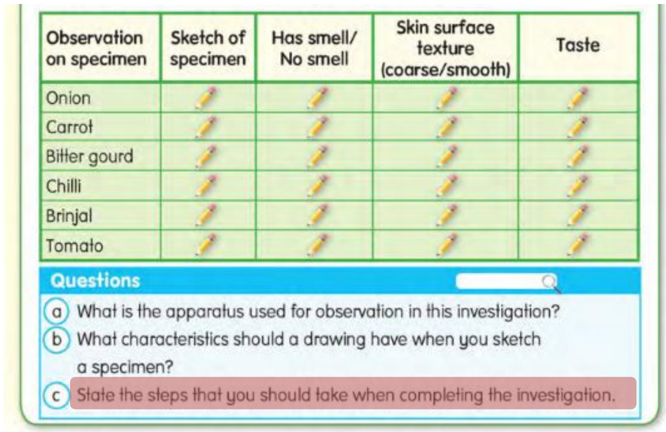
Code (Skill Name)	Description	Examples
Questions	Content attracts students' attention to scientifically oriented questions.	Why do plants need sunlight to grow? What happens to water when it freezes?
Evidence	Content attracts students' attention to give priority to evidence in responding to questions.	The graph shows that as the time increases, the plant's height also increases. Another student says: "the pattern in the sky suggests that it might rain later today".
Students' explanations	Content attracts students' attention to formulating explanations from evidence.	Explain why certain materials float while others sink in water. Describe the process of photosynthesis based on observed changes in plants.
Scientific theories or models	Content attracts students' attention to connecting explanations to scientific knowledge.	Explore Newton's laws of motion and apply them to real-world scenarios. Learn about the cell theory and its implications for understanding living organisms.
Argumentation, communication, and justification	Content attracts students' attention to communicate and justify explanations.	Debate the impact of human activities on climate change based on scientific evidence. Justify conclusions drawn from a controlled experiment on plant growth.
Analysis	Content attracts students' attention to analyzing evidence.	Analyze data from a survey on favorite habitats to identify trends and preferences. Interpret graphs depicting population changes in an ecosystem over time.
Connection	Content attracts students' attention to connecting explanations to scientific knowledge.	Connect the structure of the human respiratory system to the process of cellular respiration and energy production. Explain the relationship between predator-prey dynamics and

		population stability in an ecosystem.
Reflection	Content attracts students' attention to reflecting on the argumentation and inquiry process and their learning.	Reflect on the process of designing and conducting a controlled experiment, considering areas for improvement. Evaluate the effectiveness of collaboration in achieving scientific inquiry goals, identifying strengths and areas for growth.

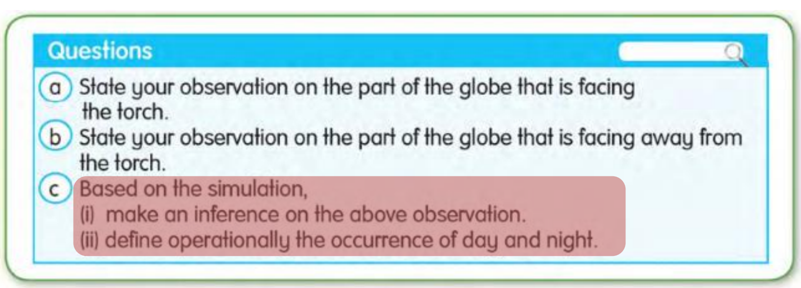
Some of the skills identified in the textbooks of the two countries are shown in Table 3. These examples serve to illustrate how argumentation-driven inquiry skills are incorporated into the content of primary-grade science textbooks. Science textbooks for grades four, five, and six in public schools in Iran and Malaysia have specific editions adopted from the 2022/2023 and 2023/2024 school years. According to Table 2, the study analyzes these textbooks by examining sentences, defined as the smallest meaningful units ending with punctuation. Pictures, shapes, and end-of-unit questions are excluded from this analysis.

Table 3: Some of the basic skills identified in the textbooks of the two countries

Skill	Country	Textbook page (code is marked with a red bar on the text)
Questions	Iran[a]	
	Malaysia	

<table>
<tr><td rowspan="2">Students' explanations</td><td>Iran</td><td></td></tr>
<tr><td>Malaysia</td><td>

Observation on specimen	Sketch of specimen	Has smell/ No smell	Skin surface texture (coarse/smooth)	Taste
Onion				
Carrot				
Bitter gourd				
Chilli				
Brinjal				
Tomato				

Questions
(a) What is the apparatus used for observation in this investigation?
(b) What characteristics should a drawing have when you sketch a specimen?
(c) State the steps that you should take when completing the investigation.</td></tr>
<tr><td rowspan="2">Argumentation, communication, and justification</td><td>Iran</td><td>
The effect of adding gypsum to water</td></tr>
<tr><td>Malaysia</td><td>
Questions
(a) State your observation on the part of the globe that is facing the torch.
(b) State your observation on the part of the globe that is facing away from the torch.
(c) Based on the simulation,
(i) make an inference on the above observation.
(ii) define operationally the occurrence of day and night.</td></tr>
</table>

The entropy method is one of the multicriteria decision-making methods for calculating the weight of frequencies. This method was illustrated in 1974 by Weaver and Shannon. Entropy represents the amount of uncertainty in a continuous probability distribution. The main idea of this method is that having more frequencies in the index values, the more important in the index we have. Shannon showed that events with a high probability of occurrence provide less information, and conversely, the lower the probability of an event occurring, the greater the information obtained from it. With the acquisition of new information, in fact, uncertainties are reduced and the value of new information is equal to the amount of uncertainty is reduced. As a result, uncertainty and information are interrelated parameters (Gumilar & Ismail, 2021).

The first step in the entropy method is to form a decision table. Therefore, to calculate the weight of indicators using the entropy method, we must first form a decision table, which is the frequency of each skill, because the decision table is considered as the input of the Shannon entropy method. Formula 1 decision matrix of the problem is as follows.

$$X_{ij} = \begin{bmatrix} X_{11} & \cdots & X_{1n} \\ \vdots & \ddots & X_{2n} \\ X_{m1} & X_{m2} & X_{mn} \end{bmatrix} \qquad (1)$$

The second step of the entropy method is to normalize or scale the decision table. Formula 2 shows the simple normalization relationship.

$$P_{ij} = \frac{X_{ij}}{\Sigma_{i=1}^{m} X_{ij}} \qquad j = 1, \dots, n \qquad (2)$$

In the third step, the entropy of each indicator must be calculated using Formula 3.

$$E_j = -k \sum_{i=1}^{m} P_{ij} \times Ln\, P_{ij} \qquad i = 1,2, \dots, n \qquad K = \frac{1}{Ln\, m} \qquad (3)$$

In this formula, the closer E_j, i.e. the entropy of the j[th] indicator, to one, the effect of the said indicator on the prioritization of the options will decrease and close to zero. Therefore, such an indicator will have no role in choosing the option. That is, such an indicator is one hundred percent entropy and has no role in the choice of options, and its weight is zero. In Formula 3, the value of K causes the entropy value of each indicator to remain between zero and one.

In the fourth step, we must obtain the distance of each indicator from its entropy value, which was calculated in the previous step. Formula 4 is used for this purpose.

$$d_j = 1 - E_j \qquad (4)$$

In the last step, we calculate the weight of each indicator using Formula 5.

$$W_j = \frac{d_j}{\sum d_j} \qquad (5)$$

After that using Shannon entropy, the weights were indexed, and based on the weights of the indices, a comparison was made between the two countries of Iran and Malaysia.

C) Instrument Reliability

The coding process usually involves some degree of mental judgment by the coders. Inter-coder reliability is when two researchers begin to study independently, obtain the same information and quantitatively observe the coding reliability. Gumilar & Ismail, (2021) said "text analysis can yield multiple interpretations", so two researchers independently analyzed textbooks after intensive training to ensure reliability. One researcher has a Master of Science in chemistry with extensive lab experience, while the other has a Ph.D. in science education and specializes in inquiry skills. Both researchers coded sample parts of the analysis to identify inquiry skills, and the kappa formula was used to measure agreement, with acceptable values ranging from 0.40 to 0.75 (Cohen, 1990).

Kappa coefficient and statistical analysis based on it are numerical values between (-1) to (+1), which the closer to (+1) indicates the existence of a proportional and direct agreement and close to (-1) indicate the existence of the inverse agreement and vice versa, and close to zero indicate disagreement, so when the number of observed agreements is equal to the number of possible random agreements, the kappa coefficient will be zero. When the number of agreements observed is less than the number of possible random agreements, the kappa coefficient will be slightly negative and there is a complete agreement between the two judgments when the kappa coefficient will be one.

Table 4: Inter-code reliability between chemistry textbook researchers

Skills of argumentation driven inquiry	kappa	Sig
1. Questions	0.834	0.000
2. Evidence	0.854	0.000
3. Students' explanations	0.765	0.000
4. Scientific theories or models	0.901	0.000
5. Argumentation, communication, and justification	0.678	0.000
6. Analysis	0.642	0.000
7. Connection	0.882	0.000
8. Reflection	0.632	0.000

Table 4 indicates strong inter-researcher agreement on all eight inquiry skills analyzed from the textbooks, with kappa values ranging from 0.632 to 0.901. This demonstrates a higher-than-acceptable reliability between the two researchers in evaluating the levels of argumentation-driven inquiry skills.

The research aimed to identify and compare argumentation-driven inquiry skills in the chemistry section of science textbooks of the second three grades in Iran and Malaysia by using Shannon method. To answer the study questions, frequencies and ratios were used. Also, Minitab version 24.1 software was utilized to conduct inferential statistical tests. The study does not expect all inquiry-based skills in the textbook to achieve high scores. Instead, it aims for a balanced arrangement of these skills to facilitate a proper understanding of scientific research.

4. Findings

We selected the chemistry sections of the science textbooks and analyzed them, so all the data are related to the content related to chemistry. Each inquiry skill based on argumentation was coded; then, the frequencies and ratios of each of them related to both countries were calculated. Table 5 provides information on the frequencies and ratios of each inquiry skill.

Table 5: Frequencies, and ratios for inclusion of argumentation-driven inquiry skills for textbooks in both countries

Skill		Iran					Tot.	Malaysia					Tot.
		4th		5th	6th			4th	5th			6th	
		L.[a] 2	L. 5	L. 2	L. 2	L. 3		U.[b] 8	U. 8	U. 9	U. 10	U. 9	
Questions	F	5	4	2	2	5	18	18	9	11	13	8	59
	R	27.8 %	22.2 %	11.1 %	11.1 %	27.8 %	6 %	30.5 %	15.3 %	18.6 %	22.0 %	13.6 %	15 %
Evidence	F	5	10	12	10	8	45	10	9	8	12	9	48
	R	11.1 %	22.2 %	26.7 %	22.2 %	17.8 %	16 %	20.8 %	18.8 %	16.7 %	25.0 %	18.8 %	12 %
Students' explanations	F	10	11	5	4	8	38	10	3	2	5	16	36
	R	26.3 %	28.9 %	13.2 %	10.5 %	21.1 %	13 %	27.8 %	8.3 %	5.6 %	13.9 %	44.4 %	9 %
Scientific theories or models	F	3	5	4	4	1	17	11	14	19	13	10	67
	R	17.6 %	29.4 %	23.5 %	23.5 %	5.9 %	6 %	16.4 %	20.9 %	28.4 %	19.4 %	14.9 %	17 %
Argumentation, communication, and justification	F	6	7	7	10	10	40	8	8	7	12	8	43
	R	15.0 %	17.5 %	17.5 %	25.0 %	25.0 %	14 %	18.6 %	18.6 %	16.3 %	27.9 %	18.6 %	11 %
Analysis	F	6	10	5	10	6	37	6	6	6	10	10	38
	R	16.2 %	27.0 %	13.5 %	27.0 %	16.2 %	13 %	15.8 %	15.8 %	15.8 %	26.3 %	26.3 %	10 %
Connection	F	10	10	4	8	8	40	10	10	10	10	8	48
	R	25.0 %	25.0 %	10.0 %	20.0 %	20.0 %	14 %	20.8 %	20.8 %	20.8 %	20.8 %	16.7 %	12 %
Reflection	F	8	10	8	12	10	48	12	10	8	7	10	47
	R	16.7 %	20.8 %	16.7 %	25.0 %	20.8 %	17 %	25.5 %	21.3 %	17.0 %	14.9 %	21.3 %	12 %

[a]Lesson

[b]Unit

As seen in the table above, descriptive data show the extent to which argumentation-driven inquiry skills are included in the chemistry section of the two countries' science textbooks. Frequencies and ratios show that in Iran, the "Reflection" skill has the highest frequency (48) and ratio (17%), and the two skills of "Questions" and "Scientific theories or models" have the lowest frequency (18 and 17) and ratio (6%), respectively; It seems that the two skills of "Questions" and "Scientific theories or models" in the chemistry section of Iranian science textbooks have not been given enough attention. Including these two skills in the book in a balanced way with other skills is essential for learning science as a question because students in fourth, fifth, and sixth grades are preparing for middle secondary school and are expected to do research activities in an inquiry manner. Therefore, it can be concluded that these textbooks do not allow students to practice the argumentation-driven inquiry skills required to teach high school science. Therefore, Iranian textbooks should be revised in such a way as to enable students to master scientific education at the high school and higher levels, as well as to prepare for their future scientific life.

In elementary school classrooms, it's not advisable to include many tasks that don't help build concepts or require significant thinking skills. Current textbooks' inquiry-based tasks don't sufficiently develop students' cognitive abilities. Therefore, it's necessary to design an appropriate number of challenging inquiry-based tasks to better foster these skills.

In Malaysia, the skill of "Scientific theories or models" has the highest frequency (67) and ratio (17%) and the "Students 'explanations" skill has the lowest frequency (36) and ratio (9%). These learners should be able to suggest their query, discover what creates evidence and obtain it, formulate explanations after summarizing evidence, communicate and justify explanations, analyze evidence, connect explanations to scientific understanding, and follow the inquiry process and their education. Therefore, it is necessary to pay proper attention to "Students' explanations" skill in Malaysian books, because otherwise, students will not be able to master higher-level skills such as "Scientific theories or models", "Argumentation", etc. An additional concern regarding inquiry-based tasks in contemporary science textbooks pertains to the uneven utilization of process skills. It is imperative for these skills to be integrated in a balanced arrangement with content, devoid of any omissions, to comprehensively bolster students' capacities for scientific inquiry. Given that scientific research entails the systematic collection of evidence to address inquiries about the natural world, the prevalent inclusion of "Questions" and "Scientific theories or models" data in current textbook tasks suggests that they marginally orient students toward the procedural aspects of scientific inquiry. In order to compare skills between the two countries, the data in Table 5 are shown in Figure 1 for a better understanding.

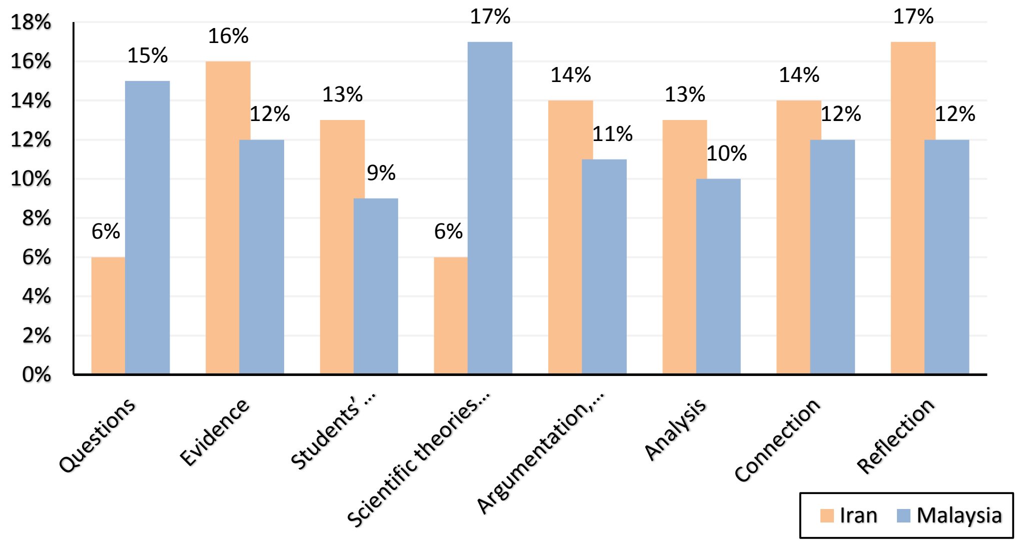


Figure 1. Ratios of argumentation-driven inquiry skills in Iran and Malaysia

It is noticed from the data of Figure 1 that "Questions" skill in the chemistry section of Iran textbooks has the lowest rate, while this skill has a significant ratio in Malaysia. Additionally, "Questions" and "Scientific theories or models" skills have the lowest rate, while "Scientific theories or models" skills in Malaysia, have the highest share compared to other skills. Therefore, there should be a balanced ratio of skills allocation in the textbooks of the two countries, and the closer the percentage of skill in the two countries is to each other, it indicates that the authors have acted correctly and written a successful textbook.

So far, data related to argumentation-driven inquiry skills in both countries have been determined and analyzed. As mentioned, the entropy method is one of the multi-criteria decision-making methods for calculating the weight of frequencies. Therefore, to determine the entropy weight of the data, we first normalize or scale the data. For normalization, the simple normalization method is used, which is the same as the arithmetic mean method. In order to weigh the data, the pages of each lesson are written to be weighted correctly; For example, in Iran, each lesson consists of approximately 10 pages and in Malaysia, each lesson consists of approximately 13 pages. The normalized data are given in Table 6.

Table 6: Normalized frequency inclusion of inquiry skills for textbooks in both countries

Skill	Iran					Malaysia					
	4th		5th	6th		4th	5th				6th
	5-15	33-43	7-17	13-23	22-32	141-154	128-141	143-156	157-170	171-184	149-162
Questions	0.094	0.060	0.043	0.033	0.089	0.212	0.130	0.154	0.156	0.159	0.101
Evidence	0.094	0.149	0.255	0.167	0.143	0.118	0.130	0.128	0.094	0.146	0.114
Students' explanations	0.189	0.164	0.106	0.067	0.143	0.118	0.043	0.026	0.031	0.061	0.203
Scientific theories or models	0.057	0.075	0.085	0.067	0.018	0.129	0.203	0.256	0.281	0.159	0.127
Argumentation, communication, and justification	0.113	0.104	0.149	0.167	0.179	0.094	0.116	0.077	0.125	0.146	0.101
Analysis	0.113	0.149	0.106	0.167	0.107	0.071	0.087	0.077	0.094	0.122	0.127
Connection	0.189	0.149	0.085	0.133	0.143	0.118	0.145	0.179	0.094	0.122	0.101
Reflection	0.151	0.149	0.170	0.200	0.179	0.141	0.145	0.103	0.125	0.085	0.127

The data in Table 6 were placed in Formulas 3, 4, and 5 and the entropy (E_j) and its weight (W_j) were obtained. Then, for the final analysis, the mean entropy and weight were calculated and placed in Table 7. In this part, the closer the mean E_j, i.e., entropy j^{th}, is to number one, the effect of the mentioned indicator will decrease and close to zero, so if a phenomenon or indicator is equal in probability from the point of view of all options, its entropy will be one hundred percent and one. Therefore, such an indicator will have no role in choosing the option, which also seems obvious. According to this point, the higher the weight of entropy or W_j, the greater the effect of the desired indicator and the easier it is to keep the content in the minds of students.

Table 7: Normalized frequency inclusion of inquiry skills for textbooks in both countries

Categories	Iran					Malaysia					
	Fourth		Fifth	Sixth		Fourth	Fifth				Sixth
	5-15	33-43	7-17	13-23	22-32	141-154	128-141	143-156	157-170	171-184	149-162
E_j	0.969	0.976	0.945	0.943	0.950	0.978	0.968	0.928	0.933	0.981	0.987
W_j	0.069	0.054	0.126	0.130	0.113	0.049	0.072	0.162	0.152	0.043	0.031
Mean E_j	0.957					0.963					
Mean W_j	0.098					0.085					

The data in Table 7 show that the amount of mean entropy (E_j) in Malaysia is higher than in Iran and closer to one, followed by the amount of mean entropy weight (W_j) in the chemistry section of Iranian science books is higher than in Malaysia so Iran is somewhat more successful in this area than Malaysia science book.

It should be noted that entropy is a way to determine the importance of an indicator in the content of the book based solely on its dispersion and does not overshadow other features of the content. These characteristics, such as profound and rich issues, purposefulness, up-to-date, simple content, layout, and aesthetics in a textbook are important, so in order to judge a textbook, we must consider everything together. Based on the scatter of indicators, it is better not to consider one textbook to be successful and another textbook to be unsuccessful. Although the Iranian book is more successful in terms of Shannon method, we cannot assume that the content of the Iranian textbook in the field of chemistry is profound and richer than Malaysia because in practice, the number of skills used in the content of the Malaysian book is very high and it has been more suitable than Iran.

5. Conclusion

This research aimed to determine and compare the extent to which 4^{th}, 5^{th} and 6^{th} grades of Iran and Malaysia chemistry section of science textbooks included argumentation-driven inquiry skills. Also, the weight of the indicators and their degree of importance has been calculated in the textbooks of the two countries by using Shannon Entropy method.

Results indicate that the two skills of "Questions" and "Scientific theories or models" in the chemistry section of Iranian science textbooks have not been given enough attention. Therefore, Iranian textbooks should be revised in such a way as to enable students to master scientific education at the high school and higher levels, as well as to prepare for their future scientific life. In Malaysia, the skill of "Scientific theories or models" has the highest frequency and "Students 'explanations" skill has the lowest frequency. As scientific research involves gathering evidence to answer questions about the natural world, the frequent use of questions and data related to scientific theories or models indicates that inquiry-based tasks in current textbooks could help students understand the process of science better.

"Questions" skill in the chemistry section of Iran textbooks has the lowest rate, while this skill has a significant ratio in Malaysia. Also, "Questions" and "Scientific theories or models" skills have the lowest rate, while "Scientific theories or models" skill in Malaysia, has the highest share compared to other skills. Emphasis on the skills expressed is consistent with the results of Pamela et al. (2020), Hendratmoko et al. (2024), Yang's et al. (2019) study, but not consistent with the findings of Halawa et al. (2022), Sumarni et al. (2022), Jeskova et al. (2018).

The amount of mean entropy weight (W_j) in the chemistry section of Iranian science books is higher than in Malaysia. Also, we cannot assume that the content of the Iranian textbook in chemistry section is profound and richer than Malaysia because in practice, the number of skills used in the content of the Malaysian book is very high and it has been more suitable than Iran. It was found that the chemistry section of Malaysian science books has used inquiry skills in a better way than Iran. Also, according to Shannon's entropy method, science textbooks in Iran include argumentation-driven inquiry skills with more appropriate dispersion, which was obtained by calculating entropy weight.

It is recommended that Iranian science textbooks be revised to ensure that inquiry skills are properly incorporated into the book. It is also necessary to include the correct and balanced number of all inquiry skills in Iranian science textbooks because it enables learners to acquire scientific ways of thinking and practicing. In addition, paying attention to the dispersion and appropriate number of inquiry activities based on textbook research strengthens the development of knowledge and skills needed to create a meaningful understanding of scientific concepts and enables students to understand the information contained incorrect the flow of interaction with their peers or with social media. Based on the results attained, the recommendation followed as:

- When argumentation-driven inquiry skills are properly implemented in the curriculum, further studies should examine the impact of students' critical thinking skills. Further studies are also needed to examine the types of activities that can enhance reasoning-based skills among high school students.
- The inclusion of argumentation-driven inquiry skills in the textbooks of the second three grades in an organized balanced way.
- Suggesting the conducting of a study about students' ability to perform argumentation-driven inquiry skills in the 4th, 5th and 6th grades in Iran and Malaysia.
- Investigating science teachers' perceptions of the modifications made to the science curricula in the second three grades in both Iran and Malaysia.

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