

SCIENTIFIC PROCESS SKILLS IN MOROCCAN SIXTH-GRADE SCIENCE TEXTBOOKS: A CONTENT ANALYSIS

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Received: July 17, 2026

Accepted: October 4, 2026

Published: October 31, 2026

Suggested Citation:

Essalih, S., & Khzami, S. E. (2026). Scientific process skills in Moroccan sixth-grade science textbooks: A content analysis. *International Journal of New Trends in Arts, Sports & Science Education (IJTASE)*, 15(4), 284-292.



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Abstract

Textbooks are crucial in influencing how science is taught and how it is learned. In Morocco, recent reforms encourage inquiry-based and competency-based learning methods, but it is not clear to what extent these methods have been embraced in textbooks. This study investigates how the scientific process skills (SPS) are represented in three sixth-grade science textbooks in Morocco. A descriptive content analysis with 187 learning activities was done. The findings reveal that there is an uneven presence of SPS, where observation is the most prominent skill (36.4%) while key inquiry skills like measurement (1.1%), communication (0.6%), hypothesis formulation (5.1%), and control of variables (5.1%) are limited. In total, basic skills account for 58.8% of occurrences while integrated skills made only 41.2%. Moreover, inquiry-based methods are distributed unevenly across scientific subjects: physics has more inquiry-based activities compared to life sciences and environmental sciences. This means that the textbooks investigated do not do much to develop higher-order scientific reasoning skills.

Keywords: science textbooks, scientific process skills, inquiry-based learning, primary science education

INTRODUCTION

School textbooks are one of the most widely used educational tools in primary and secondary education systems (Lee et al., 2020). It is believed that such textbooks can be an essential source of knowledge in the classroom and significantly affect the way teaching takes place (Vera, 2018; Hansen, 2018; Catling & Lee, 2017). Textbooks are often used by teachers when designing lessons, so their role in determining students' learning is great.

In science education, the development of scientific process skills (SPS) is considered to be vital for students' comprehension of science. Scientific process skills can be understood as the abilities that enable learners to investigate scientific phenomena, analyze evidence, and construct explanations (Özgelen, 2012; Kruit et al., 2018; Maranan, 2017). These skills include observation, classification, measurement, hypothesis formulation, experimentation, and data interpretation. Developing these competencies enables students to engage actively in scientific inquiry and to better understand how scientific knowledge is constructed.

Previous studies have shown that scientific process skills contribute significantly to students' academic achievement and promote positive attitudes toward science learning (Aktamış & Ergin, 2008; Feyzioğlu, 2009; Bilgin, 2006). They also support the development of higher-order thinking skills such as problem solving, reasoning, and critical thinking (Tilakaratne, 2017; Darmaji et al., 2020). For this reason, many contemporary science curricula emphasize the integration of inquiry-based learning approaches that encourage students to actively participate in scientific investigations.

Inquiry-based science education aims to engage learners in questioning, investigating, explaining, and communicating scientific phenomena (Carlson, 2008; Harrison & Treagust, 2000). Through inquiry activities, students develop both conceptual understanding and scientific process skills, which are essential for scientific literacy. Consequently, learning activities presented in science textbooks should provide opportunities for students to practice these skills and participate in authentic scientific inquiry.

In Morocco, recent curriculum reforms have emphasized the importance of inquiry-based approaches and the development of scientific competencies in primary science education. Science textbooks used in primary schools are expected to reflect these pedagogical orientations and to promote the development of scientific process skills through various learning activities. However, student results in international assessments such as PISA (2018) and TIMSS (2015) indicate that the development of these skills remains relatively limited.

Textbooks have an important role to play in the classroom, but only a few studies have been carried out on how understanding of scientific processes may be reflected in Moroccan science textbooks. Most of the studies carried out in this area of research pertain to the representation of scientific skills in the textbooks from various countries like Turkey (Yıldız Feyzioğlu & Tatar, 2012, Önder et al., 2022), Greece (Sideri & Skoumios, 2021), and Bangladesh (Chakraborty & Kidman, 2022). However, no detailed study has been done on the analysis of Moroccan textbooks of sixth grade. This study fills the gap by bringing the first complete analysis of all three official sixth-grade textbooks of Morocco with the help of one unified framework of scientific skills.

Following this logic, the present study sets the aim to analyze to what extent scientific process skills are portrayed in Moroccan textbooks of science for sixth grade. This study will explore the following question:

To what extent are scientific process skills represented in Moroccan sixth-grade science textbooks?

Through the examination of the inclusion of scientific process skills in textbook activities, the study aims to find out how much these textbooks endorse inquiry-based science teaching in Moroccan primary schools. The study also provides valuable information on how to improve science textbook design and enhance the application of inquiry-based science education methods in primary science education.

Theoretical Framework

Textbooks in science education

The 17th century marked the beginning of the publishing of science textbooks due to the emergence of collective teaching methods and experimental science (Chartier, 2007). Nowadays, textbooks are an integral part of the education system and have a strong impact on the teaching and learning process (Lebrun et al., 2007). They usually reflect the changes in the school curriculum and the teaching approaches used in the educational system (Bruillard, 2005). In that sense, textbooks are used as a means of support for teachers and have an important impact on students' achievement.

It is claimed by Chevallard (1985, 1991) that textbooks are the outcome of didactic transposition of the official curriculum, which means that they determine what should be taught and how (Caravita et al., 2008). It should also be pointed out that textbooks serve two purposes: educational and institutional. However, it does not mean that textbooks can be used as the only educational resource since teachers should be able to analyze the information and use it alongside other materials and methods.

From a constructivist perspective, science textbooks constitute a mediating tool through which inquiry-based learning can be implemented in classrooms. By engaging students in observation, questioning, experimentation, and interpretation, textbook activities can create meaningful learning experiences that foster the development of scientific process skills. Consequently, the extent to which textbooks integrate these skills directly influences students' opportunities to develop scientific literacy and higher-order thinking competencies. (National Research Council, 2000; Kruit et al., 2018).

Scientific process skills

Scientific process skills (SPS) refer to the core skills employed by scientists when conducting scientific research, which aims to answer a scientific problem and provide explanations for phenomena in the natural world (Feyzioğlu et al., 2012; Kruit et al., 2018b; Maranan, 2017; Özgelen, 2012). Scientific process skills are cognitive and investigative abilities used to construct knowledge, solve problems, and draw evidence-based conclusions (Aydın, 2013). SPS are tools used by students to study the world around them and develop scientific concepts (Gultepe, 2016).

Scientific process skills refer to students' ability to apply scientific methods to explore, understand, and construct scientific knowledge (Hutagalung, 2013). Scientific process competencies (SPCs) are essential because they support science learning and the generation of scientific knowledge (Siachibila & Banda, 2018; Gusdiantini et al., 2017). Therefore, the definition of SPCs implies that every student who goes through the formal education system must possess scientific process competencies.

SPCs are composed of a variety of skills that are separated into two categories: basic or fundamental, and integrated (Bahtiar & Dukomalamo, 2019; Elfeky et al., 2020; Fitriani & Fibriana, 2020; Parmin et al., 2021). However, some researchers integrate these two categories into one (German et al., 1996; Yang et al., 2016). Table 1 presents these competencies along with a brief description of each. The development of basic scientific process skills (BSPS) should be considered a necessary building block for the development of integrated scientific process skills (ISPS) (Brotherton & Preece, 1995; Chabalengula et al., 2012; Padilla, 1990). Furthermore, Olufunminiyi & Afolabi (2010) confirm that basic scientific process skills provide the intellectual foundation for scientific research. Ango (1992) describes how basic scientific process skills provide a basis for learning integrated skills; thus, according to the author, BSPS are important for science learning and concept formation at primary and secondary levels, while ISPS are more challenging and appropriate for secondary and higher education levels.

Table 1. Description of scientific process skills (Yang & Liu, 2016)

Skills	Description
Observation	Use senses to retrieve information on an object or event
Deduction	Make an inference about an object or event based on available data.
Measurement	Use standard or non-standard measurements to determine the dimensions of an object or environment to determine the dimensions of the object or the environment
Communication	Use words or graphic symbols to create an action, an object or an event
Classification	Group or order objects or events into categories based on properties or criteria
Prediction	Declare the outcome of a future event based on a set of evidence
Variable control	Identify the variables that can affect an experimental result, keeping most constant while manipulating only the independent variable.
Operational definition	Indicate how to measure a variable in an experiment
Hypothesis formulation	State the expected outcome of an experiment
Interpretation	Organize the data and draw conclusions from it.
Questioning	Ask an appropriate question
Modeling	To create a mental or physical model of a process or event

Study Context

In Morocco, each academic curriculum has its own specific program. Every curriculum is developed by the Curriculum Directorate of the Ministry of National Education. Each textbook is produced by an educational team according to a set of guidelines provided by the Curriculum Directorate. The textbooks adopted by the educational system are those that meet the criteria outlined in these

guidelines and are thus approved by the Ministry. These textbooks must align with the curricular vision and pedagogical approaches adopted by the curriculum.

The science textbooks used in Moroccan primary schools typically consist of explanations of theoretical knowledge, followed by practical activities that reinforce learning, and finally, a conclusion. For each section, the authors of these textbooks provide questions to assess students' understanding. Science education is a compulsory subject for all primary school students. In the 6th grade, three science textbooks are approved, and each school can choose one of these three. Our study focuses on all the 6th-grade science textbooks approved by the Moroccan Ministry of National Education. All these textbooks used in the study were published in 2020 to accompany the science curriculum.

METHOD

The focus of this research is determining how much scientific process skills can be found within the content and activities of three science textbooks meant for the sixth grade. In fact, content analysis is a common methodology for textbook research that allows to explore the notions or skills contained in educational materials.

The three textbooks selected for the analysis represent all the science textbooks approved by the Moroccan Ministry of National Education for primary education in sixth grade. This means that by analyzing all the textbooks, the researchers will get an overall picture of the pupils' opportunities to acquire the skills of scientific processes. The unit of analysis here is all the activities and texts included in the textbooks, considering that the skills of scientific process are represented in these two components.

Each textbook is organized into six instructional units covering the sixth-grade science curriculum. The texts and learning activities were analyzed using a descriptive content analysis approach. In this analysis, we considered the codes, categories, and themes predetermined by the researcher or already existing in the theoretical framework (Glesne, 2013).

Each activity could contain more than one scientific process skill. Therefore, every occurrence of a scientific process skill was identified and coded independently according to the operational definitions presented in Table 1. This procedure allowed a single activity to be associated with multiple scientific process skills whenever appropriate, thereby providing a more comprehensive representation of the inquiry opportunities offered by the textbooks.

The analysis of the texts and activities in the science textbooks in terms of scientific process skills was conducted as follows: (1) The texts and activities of the three 6th-grade science textbooks were analyzed together by the researchers. (2) The textbooks were analyzed independently by different researchers and the analysis of the texts and activities for scientific process skills was conducted individually by the researchers; (3) The study's reliability analysis was conducted by having an expert, who was not involved in the ongoing study, examine the activities in each science textbook, for a total of 187 activities, in terms of scientific process skills. The study's reliability coefficient was calculated by comparing the researchers' analysis results with the expert's analysis. The reliability coefficient of the analysis was calculated to be 0.90 using the reliability coefficient formula determined by Miles and Huberman (1994).

RESULTS

This study analyzed the representation of scientific process skills (SPS) across three Moroccan sixth-grade science textbooks: FADAA, ALMOUNIR, and ATTAJDID. A total of 354 instances of SPS were identified across all textbooks.

Overall Distribution of Scientific Process Skills

Table 2. Comparative distribution of scientific process skills across the three textbooks

Scientific Process Skills	FADAA (n=124)	ALMOUNIR (n=107)	ATTAJDID (n=123)	Total (n=354)	% Total	Skill Type
Observation	39	44	46	129	36.4%	Basic
Deduction	19	4	13	36	10.2%	Basic
Measurement	3	1	0	4	1.1%	Basic
Communication	2	0	0	2	0.6%	Basic
Classification	6	15	16	37	10.4%	Basic
Controlling variables	8	5	5	18	5.1%	Integrated
Hypothesis formulation	6	6	6	18	5.1%	Integrated
Experimentation	13	11	16	40	11.3%	Integrated
Data interpretation	16	7	7	30	8.5%	Integrated
Modeling	12	14	14	40	11.3%	Integrated

Table 2 provides a global overview of the distribution of scientific process skills across the three textbooks, highlighting a clear predominance of basic skills over integrated ones. The five least represented skills together accounted for less than one fifth of all identified SPS occurrences.

The results reveal a clear imbalance in the distribution of scientific process skills. Observation is the most dominant skill, accounting for 36.4% of all identified instances. This is followed by experimentation and modeling (11.3% each), as well as classification (10.4%) and deduction (10.2%). In contrast, measurement (1.1%) and communication (0.6%) are almost absent across the three textbooks.

This distribution highlights a strong emphasis on basic-level skills, while several key inquiry-related competencies remain underrepresented.

Distribution of Basic and Integrated Skills

According to categories, basic scientific process skills comprise 58.8% of all occurrences while integrated skills only account for 41.2%. Even though some integrated skills like experimentation and modeling are somewhat represented, some of the more complex inquiry skills such as hypothesis formulation (5.1%) and control of variables (5.1%) are still very limited. This indicates insufficient support for building higher-order scientific reasoning skills in the analyzed textbooks.

Comparison Across Textbooks

An analysis in terms of comparing the three textbooks provides some similarities but also differences in the depiction of the scientific process skills.

All three texts demonstrate consistency in terms of being primarily focused on the observational skills. Yet, differences are also evident: ALMOUNIR puts more emphasis on the observation and classification than ATTAJDID, which stands out with the more equalizable distribution of skills, especially when it comes to such aspects as experimentation and modeling. The depiction of the deduction and data analysis, however, is higher in the case with FADAA.

Despite the differences in some aspects, the overall pattern does not contradict itself, with the presence of the predominating low-order skills and limited presence of high-order scientific inquiry.

Distribution Across Scientific Domains

Moreover, the analysis elucidates the irregular distribution of skills regarding scientific processes across various very different subject areas. For instance, the bulk of the activities that allow carrying out inquiry is confined to the lessons on Physics since they emphasize experimentation to a much

greater extent. On the contrary, the lessons related to life sciences and environmental education offer fewer opportunities for conducting a scientific inquiry.

This imbalance means that students get little chance to enhance their transferable scientific skills in different areas.

Sub-skills of Observation

Because observation is the most frequent sub-skill employed, a thorough investigation has been made to determine all of its sub-skills. According to the results of this study, the greatest percentage of occurrences relates to the skill of recognizing objects based on their properties; this skill accounts for more than 66% of all observation cases in various textbooks.

Analytical observation and description using simple scientific language have lesser representation among other sub-skills. At the same time, advanced types of observation, for example, those that require the use of measurement instruments, are involved only occasionally. This means that even within the skill of observation, the emphasis is on simple observations over any advanced scientific practices.

Summary of Key Findings

Overall, the results indicate that:

- Scientific process skills are not evenly distributed across the analyzed textbooks;
- Basic skills dominate over integrated skills;
- Higher-order inquiry skills are underrepresented;
- Inquiry-based activities are unevenly distributed across scientific domains;
- Observation is not only dominant but also limited to its simplest forms.

These findings point to a structural imbalance in the design of textbook activities, with potential implications for the development of students' scientific reasoning and inquiry skills.

DISCUSSION, CONCLUSION, and RECOMMENDATIONS

The analysis reveals that scientific process skills are not equally represented in sixth-grade science textbooks. Observation is the most frequently cited inquiry-based science process skill, whereas other important inquiry-related process skills, such as measurement, hypothesis creation, and controlled experimentation, are significantly less frequent and sometimes missing altogether. The lack of representation of these inquiry-related process skills suggests that students may not be able to take part in all of the different practices associated with scientific inquiry.

It may be possible that the reason for the emphasis on observation is due to the fact that the learners are at the primary educational level. Primary learners use observation as an entry point to developing scientific reasoning skills through exploration of their environment. According to Padilla (1990) and Turiman et al. (2012), basic process skills provide the basis on which higher order process skills will develop. However, if there is no gradual transition from using observation to using higher order scientific reasoning processes, such as experimentation, formulating hypotheses, and interpreting data, learners may have difficulty transitioning from simply describing an occurrence to reasoning about an occurrence scientifically.

An additional notable finding is the variation in the distribution of inquiry-based activities across diverse fields of science. In this study, inquiry-based activities are predominantly concentrated in physics units, with far fewer in Life and Environmental Sciences; this might restrict the potential for students to experience scientific inquiry across multiple contexts and establish transferable scientific skills. In fact, inquiry-based science education requires learners to question, investigate, and reason across multiple domains (Carlson, 2008; Harrison & Treagust, 2000).

These results are consistent with previous studies conducted in other contexts. For example, Sideri and Skoumios (2021) found that Greek primary science textbooks tend to emphasize basic skills such as observation, while giving limited attention to higher-order inquiry skills. Similarly, Chakraborty and Kidman (2021) reported that primary science textbooks often prioritize lower-level investigative processes at the expense of more complex inquiry practices. This convergence suggests that the limited representation of higher-level scientific process skills may be a broader issue in primary science education.

In the Moroccan context, these findings are consistent with previous evaluations of the national science curriculum, which indicate that although recent reforms promote competency-based and inquiry-oriented science education, textbook activities still provide limited opportunities for authentic scientific inquiry (USAID, 2021; OECD, 2018).

From a didactic perspective, these findings may reflect the persistence of content-centered teaching approaches, in which the transmission of knowledge is prioritized over the development of inquiry-based competencies. Since textbooks strongly influence classroom practices, an imbalance in the representation of scientific process skills may reinforce teacher-centered approaches and limit opportunities for active student engagement. In addition, the design and evaluation processes of textbooks may also play a role. As suggested by Peng & Huang (2012), the pedagogical beliefs of textbook authors and evaluators may shape the types of learning activities that are ultimately included.

Taken together, these findings suggest that improving inquiry-based science education in Morocco requires not only curriculum reforms but also a closer alignment between curriculum intentions, textbook design, and classroom implementation.

All things considered, these results show that science textbook learning activities need to be reconsidered. Students may have more opportunities to participate in real-world scientific research if scientific process skills—especially higher-order skills like hypothesis formulation, variable control, and data interpretation—are more evenly integrated. Consequently, this would enhance the growth of scientific reasoning, critical thinking, and problem-solving skills.

Lastly, these results also highlight the critical role that educators play. Teachers can modify and enhance learning activities to better support inquiry even in situations where textbooks have certain limitations. This emphasizes even more how crucial excellent teacher preparation is for inquiry-based science education.

Conclusion

The purpose of this study was to examine the representation of scientific process skills in the three official Moroccan sixth-grade science textbooks. The findings revealed that although a broad range of scientific process skills is represented, their distribution is uneven. Observation was by far the most dominant skill, whereas higher-order inquiry skills, such as hypothesis formulation, variable control, and data interpretation, were considerably underrepresented.

These findings suggest that the current textbooks only partially support the objectives of Morocco's competency-based and inquiry-oriented science curriculum. The limited representation of higher-order scientific process skills may reduce students' opportunities to engage in authentic scientific inquiry and to develop scientific reasoning, critical thinking, and problem-solving abilities.

This study contributes to the literature by providing the first comprehensive analysis of all officially approved Moroccan sixth-grade science textbooks using a unified scientific process skills framework. The findings offer practical guidance for curriculum developers, textbook authors, and teacher educators seeking to strengthen inquiry-based science education in primary schools.

The study is limited to textbook content and does not examine how teachers implement these activities in classrooms. Future research could investigate classroom practices, students' engagement with textbook activities, and the progression of scientific process skills across different primary grade levels.

Overall, a more balanced integration of scientific process skills into Moroccan science textbooks would better support inquiry-based learning and contribute to the development of scientifically literate learners capable of evidence-based reasoning.

Recommendations

The findings of this study lead to several recommendations for improving the integration of scientific process skills into Moroccan primary science textbooks.

One recommendation is that authors of textbooks or curriculum should create a balance of representation of the skills of the scientific process being taught throughout the different units, or domains of science. Authors should also pay particular attention to those higher-level science skills, such as hypothesis creation, management of variables, and interpretation of data, in order to promote inquiry-based learning for students.

Another recommendation is that learning activities designed in the textbook will effectively facilitate the gradual progression of students' science skills. Rather than providing students with the skills of observation as a foundational skill, then moving to the skills of developing an inquiry-based learning plan and having students develop hypotheses based on their investigation of the world around them (as seen in some of the textbooks), authors should provide students with gradually increasing levels of complexity in science skills so that students can move from simple description of a science phenomenon to more sophisticated scientific reasoning skills.

Finally, there should be a more equal distribution of inquiry-based activities throughout all domains of science (life sciences, earth and space sciences, and environmental education), since giving students an opportunity to participate in inquiry-based science, in a range of different science areas, will allow them to develop a set of transferable skills that can be applied to many different types of scientific investigations.

Teachers should receive more attention in their training programs regarding inquiry-based science teaching. Teachers need to learn how to evaluate the use of textbooks and how to modify the learning experiences provided within them so that they create a higher quality inquiry-based experience for students in their classrooms.

It is also important for state departments of education and textbook evaluation committees to have specific criteria about how well the scientific process skills are integrated into the textbook being evaluated and used. Having this established criterion will create a better alignment with the intended standards in science and the resources used by teachers.

Funding

No funding was received from any individual or institution for this research.

Ethics and Conflict of Interest

All ethical rules were observed at each stage of the research. The authors declare that he acted in accordance with ethical rules in all processes of the research. The authors declare that they do not have any conflict of interest with other persons, institutions or organizations.

Data Availability

The data that support the findings of this study are available on request from the author.

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