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Integrating Science Process Skills in Secondary Education of Odisha: A Content Analysis of the Class IX Physical Science Textbook

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Abstract: The cognitive and psychomotor skills and students employ to examine, research and comprehend scientific phenomena are known as science process skills (SPS). The objectives of the study are (1) To identify different types of science process skills in Class IX physical science textbook. (2) To investigate the extent in which science process skills are incorporated in the Class IX physical science textbook. (3) To investigates to what extent the content of Class IX physical science textbook consistent with the inclusion of science process skills. A qualitative content analysis approach was adopted. A researcher developed checklist, based on established SPS frameworks (e.g., Harlen & Qualter, 2009; Elmas et al., 2018), was utilized as the primary data collection tool. Textual explanations, illustrations, exercises and suggested student activities were systematically coded and analysed. The findings reveal that all six core SPS are present in the textbook, with observation (67.25%) being the most prominently featured, followed by communication (52.86%) and inferring (48.67%). Prediction (42.47%) and measurement (34.51%) are moderately represented, whereas classification (23.89%) is the least addressed. And, the integration of these skills is uneven across chapters, indicating a fragmented approach to skill development.

Keywords: *Science Process Skills (SPS), Physical Science Textbook, Inquiry-Based Learning, National Education Policy 2020 (Nep 2020), Qualitative Content Analysis, Secondary Education.*

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I. INTRODUCTION

In the twenty-first century, science education places an emphasis on developing scientific habits of thinking as well as fact acquisition. These are referred to as Science Process Skills (SPS) and comprise observation, analysis, reasoning and questioning. These abilities are essential to scientific literacy and enable students to solve real-world issues, make wise judgments and interact meaningfully with scientific phenomena. Textbooks are essential in forming students' scientific knowledge and thought processes at the secondary school level. As a result, how SPS are incorporated into textbooks has a big impact on both instructional strategies and student results. Students' fundamental knowledge of physics and chemistry is largely based on the Class IX Physical Science textbook, which taught in the Odisha Board of Secondary Education. For science instructors, it also acts as a main resource, directing class ideas and evaluations. To assess this textbook's teaching effectiveness, the researcher make a thorough content analysis, particularly in light of its integration of fundamental SPS including observing, classifying, measuring, inferring, predicting and communicating.

Despite curriculum principles that support inquiry-driven and activity-based learning, research indicates that many textbooks continue to place more emphasis on memorization than on developing students' skills. Therefore,

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the purpose of this study is to ascertain the degree and kind of SPS representation in the Class IX Physical Science textbook by a content analysis. This study is helpful for teachers and policymakers who want to match instructional materials with national education goals like those listed in the NEP 2020, in addition to being pertinent for textbook authors and curriculum developers. And also the research helps to improve science instruction that encourages kids to be curious, think critically and learn throughout their lives by pointing out areas of strength and weakness.

II. JUSTIFICATION OF THE STUDY

In the context of 21st-century education, scientific literacy is regarded as an essential competency for individuals to function effectively in a technologically advanced and knowledge-driven society. One of the foundational elements of scientific literacy is the development of Science Process Skills (SPS) skills that enable students to engage in inquiry-based learning, critical thinking and evidence-based reasoning. These skills include observing, classifying, predicting, inferring, measuring and communicating scientifically, which are crucial for understanding the processes of science rather than merely memorizing its content (Bybee & DeBoer, 1993; Harlen, 1999).

There is pivotal role of school textbooks in shaping both instructional practices and student learning outcomes, it is imperative to evaluate whether these materials are adequately fostering the development of SPS. Several studies have revealed that while curricular reforms often advocate for inquiry-oriented education, actual classroom materials including textbooks tend to emphasize factual knowledge over skill development (Elmas et al., 2018; Sideri & Skoumios, 2021). In many cases, SPS are either underrepresented or inconsistently integrated into textbook content, leading to missed opportunities for nurturing scientific reasoning and learner autonomy (Senem, 2013).

Specifically, in the Indian context, the Class IX Physical Science textbook, as prescribed by the Board of Secondary Education (BSE), Odisha, is a crucial pedagogical resource for introducing foundational concepts in physics and chemistry. However, there exists a research gap in examining the degree to which this textbook integrates SPS in a structured and meaningful way. Prior content analyses in other countries (e.g., Turkey, Indonesia, Jordan) have demonstrated the efficacy of such studies in identifying strengths and limitations in textbook design (Alayasrah & Yahyaa, 2017; Antrakusuma et al., 2017).

Thus, this study is justified in its aim to critically analyse the presence and depth of SPS within the Class IX Physical Science textbook. The findings will have significant implications for textbook authors, curriculum planners, teacher educators and policymakers seeking to align instructional content with the goals of NEP 2020, which emphasizes experiential, discovery-oriented learning approaches in science education.

➢ *Objectives of the Study*

- To identify different types of science process skills in Class IX physical science textbook.
- To investigate the extent in which science process skills are incorporated in the Class IX physical science textbook.
- To investigates to what extent the content of Class IX physical science textbook consistent with the inclusion of science process skills.

➢ *Research Questions*

- Which categories of science process skills are reflected in the content of the Class IX Physical Science textbook?
- How extensively are science process skills embedded throughout the Class IX Physical Science textbook?
- To what extent the content of class IX physical science textbook is consistent in terms of science process skills?

III. RESEARCH METHODOLOGY

➢ *Research Design*

In this study, the selected textbook the Class IX Physical Science textbook prescribed by the Board of Secondary Education, Odisha is examined in detail to identify and categorize the types and frequency of science process skills embedded in the content. Both textual and activity-based components such as chapter explanations, illustrations, exercises and suggested experiments are analysed. A coding framework based on widely accepted SPS indicators (e.g., observing, classifying, inferring, predicting, measuring and communicating) is used to guide the content analysis.

➢ *Population and Sample*

The class IX physical science textbook from the Board of Secondary Education in Odisha serves as the population and sample for this study.

➢ *Tools and Technique for Data Collection*

In this study the researcher used the self-made checklist tool to analyse the contest of class IX physical science textbook.

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IV. DATA ANALYSIS AND INTERPRETATION

Analysis of Objective 1 (Table 1 To Identify Different Types of Science Process Skills in Class IX Science Textbook)

Basic Science Process Skills	Present or Not
Observing	Yes
Communicating	Yes
Measuring	Yes
Predicting	Yes
Inferring	Yes
Classifying	Yes

➢ *Interpretation*

Analysis of the present investigation was made in conformity with the objectives and hypothesis as formulated by the investigator. The main purpose of the study to know the amount of basic process skills present in the class IX physical science textbook. After collection of data, it was found that all the basic science process skills like observing, communicating, classifying, predicting, inferring and measuring are present in the class IX physical science textbook.

Analysis of Objective 2 (Table 2 To Investigate the Extent in Which Science Process Skills are Incorporated in the Class IX Physical Science Textbook.)

	No. of Observation Skill	No. Of Communication Skill	No. of Classification Skill	No. of Measurement Skill	No. of Prediction Skill	No. of Inferring Skill
UNIT 1	14	16	4	7	5	10
UNIT 2	10	12	6	2	9	9
UNIT 3	5	5	3	5	0	5
UNIT 4	4	5	1	1	2	2
UNIT 5	11	6	3	7	9	6
UNIT 6	7	3	1	2	8	7
UNIT 7	9	7	1	6	6	7
UNIT 8	9	4	5	6	6	4
UNIT 9	7	4	3	3	3	5

➢ *Interpretation*

From the above compiled table, it was found that the total number of observation skill is 76 whereas the percentage of observation skill present in the class IX physical science textbook was calculated to be 67.25%.

- The total number of communication skill = 62 whereas the percentage of communication skill present in the class IX physical science textbook was 52.86%.
- Total number of classification skill = 27 whereas the percentage of classification skill present in the class IX physical science textbook was 23.89%.
- The total number of measurement skill = 39 whereas the percentage of measurement skill present in the class IX physical science textbook was 34.51%.
- The total number of prediction skill = 48 whereas the percentage of prediction skill present in the class IX physical science textbook was 42.47%.
- The total number of inferring skills =55 whereas the percentage of inferring skill present in the class IX physical science textbook was 48.67%.

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Analysis of Objective 3 (Table-3 To Investigates to What Extent the Content of Class IX Physical Science Textbook Consistent with the Inclusion of Science Process Skills.)

Name of Science Process Skills	Percentage of Appearing in the Class IX Physical Science Textbook
Observing	67.25%
Communicating	52.86%
Inferring	48.67%
Predicting	42.47%
Measuring	34.51%
Classifying	23.89%

➢ *Interpretation*

The content of class IX physical science textbook is not consistent in inclusion of science process skills that is observation is highly appeared followed by communication, inferring, predicting and measuring. Whereas the appearance of classification skill is limited.

V. FINDINGS

The analysis of the Class IX physical science textbook indicates that all six fundamental science process skills namely observation, communication, measurement, prediction, inference and classification are included within its content. This shows that the textbook provides students with basic opportunities to engage in scientific inquiry. However, the extent of integration of these skills varies significantly across different units. Among all the skills, observation is the most prominently featured, representing approximately 67.25% of all identified instances. This suggests that the textbook places considerable emphasis on encouraging students to notice and describe phenomena, which forms a foundation for scientific exploration.

Communication and inferring skills are moderately represented, with percentages of 52.86% and 48.67% respectively. This indicates that some attention is given to helping learners express their understanding and draw logical conclusions based on evidence. Prediction and measurement skills appear less frequently, accounting for 42.47% and 34.51%, respectively, pointing to a need for greater emphasis on forecasting outcomes and handling quantitative data. The classification skill is the least incorporated, occurring in only 23.89% of the analyzed content. As classification is crucial for organizing information and identifying patterns, its minimal inclusion suggests a potential gap in fostering higher-order thinking.

Furthermore, the presence of these skills is not uniformly distributed across the textbook. While some units exhibit a richer presence of science process skills, others include them sparingly. This uneven distribution indicates that the integration of these skills is not consistently aligned with the overall structure of the curriculum. As a result, students may not receive balanced exposure to the full range of scientific practices. The findings highlight the importance of revising textbook content to ensure a more comprehensive and evenly spread inclusion of science process skills, thereby supporting the development of well-rounded scientific competence among learners.

VI. CONCLUSION

The content analysis of the Class IX Physical Science textbook prescribed by the Board of Secondary Education, Odisha, reveals that while all fundamental science process skills (SPS) namely observing, communicating, measuring, predicting, inferring and classifying are present, their integration is notably uneven. Among these, observation emerged as the most frequently emphasized skill, suggesting a strong focus on empirical engagement. Skills such as communication and inferring were also moderately represented, whereas predicting and measuring appeared with less consistency. Notably, classification was the least emphasized, indicating a significant gap in fostering students' ability to organize and categorize scientific information. The findings further suggest that the representation of these skills varies considerably across different textbook units. This inconsistency points to a lack of structured alignment between content and the development of inquiry-based competencies. Although the textbook does make efforts to include SPS, the fragmented distribution limits students' holistic engagement with scientific processes. This misalignment contradicts the pedagogical principles promoted by national frameworks such as the NEP 2020, which advocates for experiential and inquiry-driven learning. In light of this, it is recommended that future revisions of the textbook ensure a more balanced and intentional integration of all SPS across chapters. Such an approach would not only enhance students' scientific reasoning and critical thinking abilities but also contribute to the broader goals of fostering scientific literacy and lifelong learning. The study underscores the critical role of textbook design in shaping science education and offers valuable insights for curriculum developers, educators and policymakers committed to improving the quality of science instruction at the secondary level.

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