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# Inquiry Scientific Reflections in High School Biology Textbooks in South Sulawesi: A Study of Inquiry-Based Task Design Evaluation

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**ABSTRACT**

Textbook studies require a focused examination, especially regarding the emphasis on inquiry in science education. Despite the widespread adoption of inquiry-based tasks, there is a notable delay in evaluation efforts. The Merdeka and 2013 curriculum actively inquiry approaches in biology learning, emphasizing the imperative role of inquiry in biology textbooks and assignments, warranting thorough evaluation. This research aims to assess learning task quality in high school biology textbooks in South Sulawesi from an inquiry perspective. Employing quantitative descriptive methods and cluster random sampling, textbooks were chosen from representative districts/cities. The most frequently used books from each class were analyzed. A total of 51 inquiry tasks were examined using the Inquiry-based Tasks Analysis Inventory (ITAI), known for its robust validity and reliability. Adapted for this study, results underscore an imbalance in inquiry process skills in one textbook and a prevalence of assignments providing activity guidance, impacting students' opportunities to practice process skills and deepen their understanding of inquiry. The findings carry implications for the limited chances students must practice process skills and enhance their comprehension of inquiry.



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## 1. INTRODUCTION

Textbooks are one of the important teaching materials needed by students to help understand biology. Textbooks become a source of learning in the learning process, both for teachers and students (Fajriana et al., 2016; Irawati Sinombing et al., 2017). Textbooks have a huge influence in science classes (McDonald, 2016; Yang & Liu, 2016). Textbooks become a significant part in the application of teaching and learning activities in schools (Jatmika, 2014; Sinambela et al., 2020). Textbook studies deserve serious attention especially if the inquiry should be contained (Meyer et al., 2013; Yang & Liu, 2016). Inquiry-based textbooks are widely developed and adopted; however, their evaluation efforts have lagged (Yang & Liu, 2016). KemendikbudRistek (2022, 2017) The Merdeka curriculum and the 2013 curriculum demand a learner-centered contextual and inquiry approach to biology learning. Inquiry is very important contained in the textbook and its tasks and needs to be evaluated. The results of observations from searching the Google Scholar database regarding the quality of biology textbooks in terms of inquiry in South Sulawesi are still very minimal. Only the analysis of content-related misconceptions by Syahyani, (2018); Agustina et al. (2016); Nugroho, (2016); Ramadhan (2016); Azulianingsih et al., (2018); Triasfifah & Lestari, (2022); Astuti et al., (2018); Fajriana et al., (2016); Marlina et al., (2018); dan Rintonga et al., (2022).

There is very little data on the quality analysis of biology textbooks and their comprehensive tasks, especially on inquiry. Research results Yang et al. (2019) The quality of biology textbooks in China is still inadequate in terms of inquiry. The problem became universal in biology textbooks. The lowest level of learner inquiry is found in making hypotheses and reflective evaluation performance (Zheng et al., 2022). The skills of predicting, operationally defining, formulating hypotheses, and asking questions on biology textbook tasks are rare (Chakraborty & Kidman, 2022; Dogan, 2021; Halawa et al., 2022, 2023; Hunegnaw & Melesse, 2023; Ongowo & Indoshi, 2013; Sideri & Skoumios, 2021; Sukma et al., 2022). Lederman et al. (2019) stated that the ability of inquiry of students almost all over the world is still very minimal, only 17.33% of students have a good understanding. The knowledge and inquiry ability of students is very close to science literacy (Komalasari et al.,

2019; Mutasam et al., 2020; Saefullah et al., 2017). For almost 20 years since PISA released the results of the science literacy skills of students around the world, Indonesia has always been at the bottom of the list (Fuadi et al., 2020). This shows that the quality of science learning in Indonesia is far below OECD member countries (Fuadi et al., 2020; Setiadi, 2014). Data from TIMSS Indonesia in 2015 was ranked 44 out of 49 participating countries with an average score of 397 out of an average international score of 500 (Hadi & Novaliyosi, 2019; Suparya et al., 2022). This shows that literacy learning by applying inquiry is still very behind. Inquiry has evolved into active teaching and learning, constructivism, and the idea that students should have more control and be more responsible for their own learning (Bevins & Price, 2016).

The implicit inquiry in textbooks and the imbalance of inquiry process skills in textbooks will result in students not having an adequate overall understanding of inquiry, both teachers and students will not have good information about inquiry which can lead to misconceptions about inquiry (Lederman et al., 2019). The high-quality inquiry-based tasks in textbooks are the paradigms and practical guides of inquiry-based instruction. Therefore, it is necessary to study the quality of the design of these inquiry-based tasks in biology textbooks (Yang et al., 2019; Yang & Liu, 2016).It is important for students to engage in inquiry practice and to be the best instructional means for students to reflect on how science is developed (Lederman et al., 2019). Well-designed inquiry-based assignments in science textbooks play an important role in supporting students' experience with scientific inquiry and developing an understanding of scientific ideas (Yang & Liu, 2016). Inquiry is an excellent way for students to draw on existing knowledge and hone their investigative skills to discover, and internalise, new knowledge and solutions to questions they have formulated (Bevins & Price, 2016). Until now, there is still very little information and research on the quality of biology textbooks and their tasks in terms of inquiry in Indonesia and how well these tasks perform their functions well.

## 2. RESEARCH METHOD

Quantitative descriptive methods were used in this study. This research is oriented towards meticulously detailing and describing the characteristics of a phenomenon or population by utilizing quantitative data. Research data were obtained directly from Biology textbooks class X, XI, and XII. Cluster random sampling was used to find out the biology textbooks of each district / city representative in South Sulawesi. The frequency with which each textbook appears is calculated. The book with the highest frequency of each class will be analyzed. Inquiry-based assignments are features in textbooks in the form of practicum activities in the classroom, in the laboratory, and in the field to apply the material learned which is usually labelled with investigation, practice, activities, laboratory work and others. Inquiry-based Tasks Analysis Inventory (ITAI) is used to analyze the design of inquiry-based tasks in textbooks. ITAI was developed by Yang & Liu (2016) and has strong validity and reliability for analyzing inquiry-based task design (Yang et al., 2019; Yang & Liu, 2016). ITAI has adapted updated validity and reliability to ensure consistency of interpretation in the study. ITAI consists of 3 dimensions, namely: (1) Assignments created or designed to help students build an understanding of science concepts (2 items). (2) Assignments are created or designed so that students can apply some science process skills (12 items). (3) The text of the assignment reflects an understanding of inquiry science (8 items). Descriptive statistics are used to describe and examine each learning task contained in biology textbooks using ITAI. Researchers then calculated the frequency and percentage of each item contained in ITAI.

## 3. RESULTS AND DISCUSSION

The results of a survey on the use of biology textbooks in South Sulawesi Province showed that books published by Erlangga dominated. Interestingly, only a few books published by the Ministry of Education are used by teachers in South Sulawesi. The reason is that books published by the Ministry of Education are printed using low-quality paper. As a result, the images in the textbook become blurred and cannot function properly as illustrations. In biology, many concepts are abstract, so high-quality images in textbooks are essential as a tool to understand them. Another reason why Erlangga's published books dominate is because Erlangga collaborates with schools to market their textbooks compared to other publishers. The survey results of biology textbooks for class X showed a greater level of diversity compared to textbooks for classes XI and XII. There are 12 different types of textbooks from various publishers and authors for class X. Meanwhile, classes XI and XII have 7 and 8 types of textbooks respectively. It was found that Irnaningtyas writers dominated all grade levels with publisher Erlangga having significant dominance. Due to the dominance of the same author and publisher, the researcher chose to analyze the book rather than the book published by the Ministry of Education, because the book has a greater influence in learning. Table 1 shows the textbooks with the highest frequency of each class based on the survey results. The class X textbook has 10 chapters on various topics and 15 inquiry assignments. The class XI book consists of 11 chapters with 20 inquiry assignments. The class XII textbook has 9 chapters with a total of 16 inquiry tasks. Thus, the total number of inquiry tasks analyzed was 51 tasks.

Table 1. Textbook Survey Results with The Highest Frequency in Each Class

| Class | Writer | Year published | Book title | City published | Interest Group | Number of Pages |
|---|---|---|---|---|---|---|
| X | Irnaningtyas | 2018 | Biologi untuk SMA/MA Kelas X Jilid 1 | Jakarta | Peminatan Matematika dan Ilmu-ilmu Alam | 472 |
| XI | Irnaningtyas | 2018 | Biologi untuk SMA/MA Kelas XI Jilid 2 | Jakarta | Peminatan Matematika dan Ilmu-ilmu Alam | 494 |
| XII | Irnaningtyas | 2018 | Biologi untuk SMA/MA Kelas XII Jilid 3 | Jakarta | Peminatan Matematika dan Ilmu-ilmu Alam | 406 |

**a. Comparative Analysis of Each Dimension In ITAI**

Textbook inquiry assignments are an attempt to implement inquiry-based learning in the classroom. Inquiry tasks have the potential to be an early driver of how inquiry learning is carried out (Dogan, 2021; Yang et al., 2019; Yang & Liu, 2016). Although inquiry learning depends on how teachers carry out inquiry-based tasks in the classroom, the quality of its design plays an essential role in supporting its implementation (Yang et al., 2019). The design of inquiry-based tasks in the analyzed textbooks is almost all very poor and lacks the potential to implement good inquiry learning. This is evident through the analysis of two dimensions (inquiry process skills) and three dimensions (understanding scientific inquiry) in the ITAI instrument, where each item statement is found to be unbalanced and cantered on a particular item. It is not expected that all items in ITAI are in one task but should be found equally in one textbook so that students have the full opportunity to apply each inquiry process skill and understand inquiry comprehensively. The comparison of the results of the analysis of each class based on ITAI dimensions can be seen in Figure 1 below.

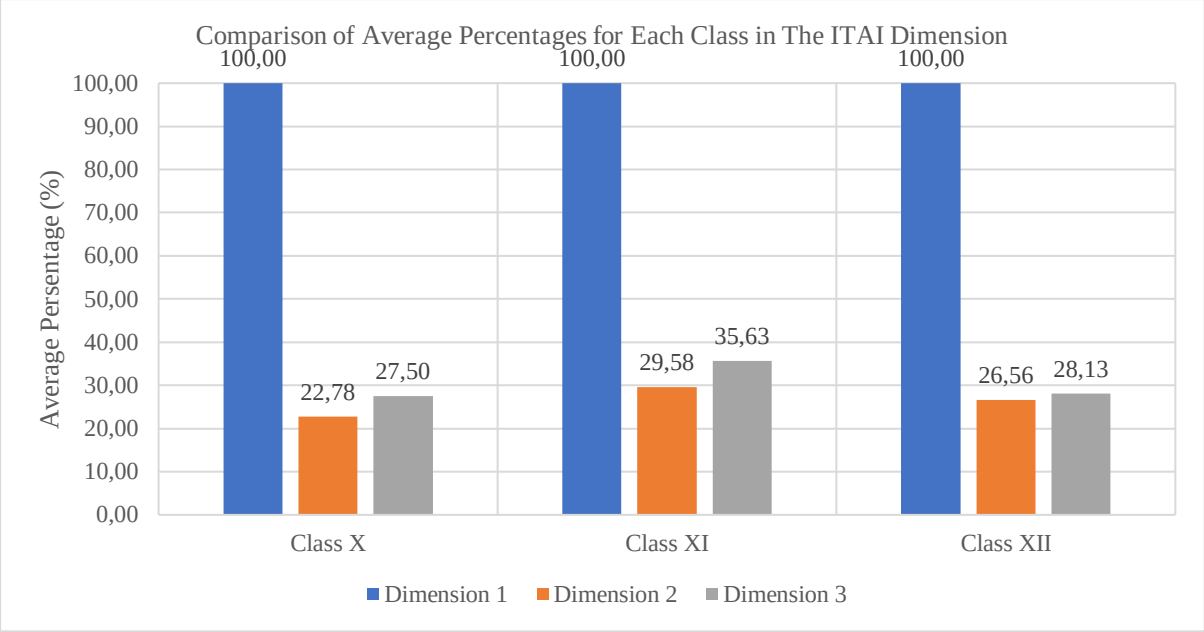


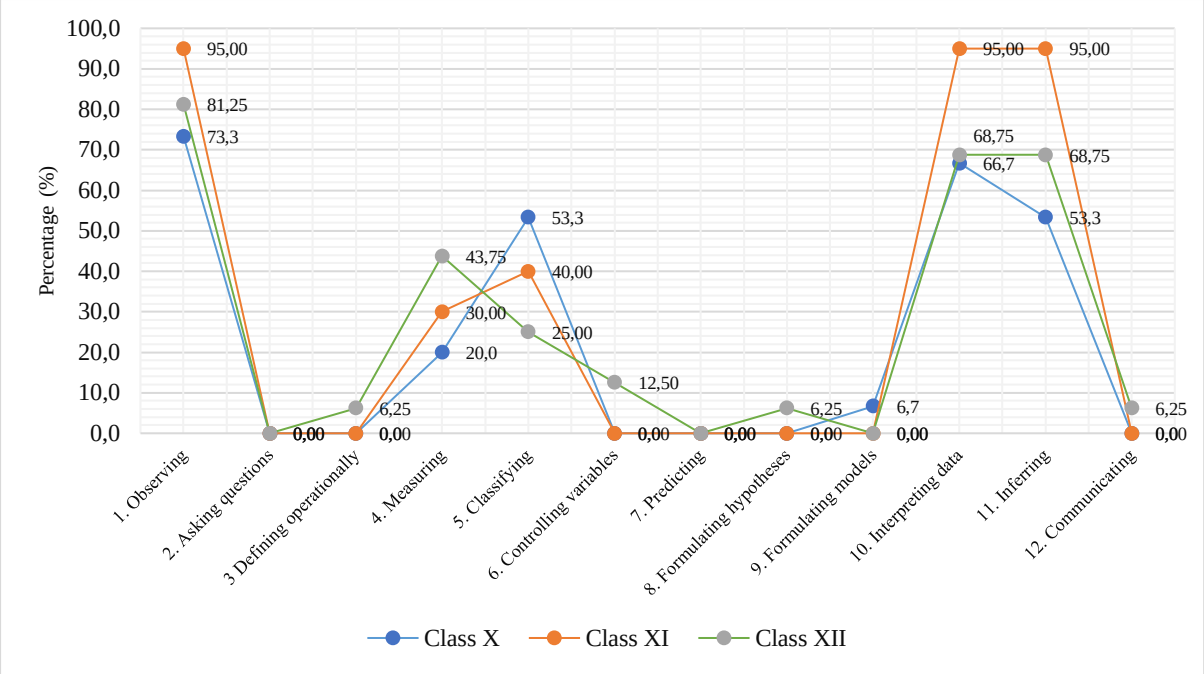

Figure 1. Comparison of Average Percentages for Each Class in The ITAI Dimension

Figure 1 indicates that tasks focused on understanding concepts (dimension 1) were the most dominant in all classes, while tasks that emphasized inquiry process skills (dimension 2) and tasks aimed at improving understanding inquiry knowledge (dimension 3) were not yet the focus of the authors. One of the functions of inquiry-based tasks is to give students the opportunity to understand the concepts taught in accordance with the curriculum. The results of the analysis of three textbooks showed that inquiry-based tasks in all three were good enough to help students build an understanding of scientific concepts. The compatibility between assignments and basic competencies in the 2013 curriculum is very good. This is reflected in the percentage probability in ITAI dimension one which reaches 100%, both in items 1 and 2. Conditions like this will encourage understanding of the nature of science (NOS) Students. In the end, students have science literacy (Muna et al., 2017; Mutasam et al., 2020). Previous research on the assessment of inquiry tasks has shown that few inquiry tasks in textbooks aim to improve understanding of scientific concepts (Dogan, 2021; Yang et al., 2019).

**b. Inquiry Process Skills Analysis Details (Second Dimension ITAI)**

A comparison of indicators of the inquiry process (dimension 2) in each textbook is presented in Figure 2. The uneven use of inquiry process skills in the analyzed textbooks is a serious problem. This imbalance occurred not just in one textbook, but in all the textbooks analyzed. These findings indicate that students are less likely to

practice applying all the skills of the inquiry process. This can be seen from the dominance of the use of indicators to observe and interpret data than other indicators. Similar findings were also found by other researchers and are a prevalent problem in the design of inquiry-based tasks (Dogan, 2021; Halawa et al., 2022, 2023; Hunegnaw & Melesse, 2023; Sideri & Skoumios, 2021; Sukma et al., 2022; Yang et al., 2019). Observing is an early stage in the scientific method that has a major role in gathering evidence or information necessary to improve understanding and answer scientific questions. Harnessing the senses to explore data regarding objects or events is the essence of observing (Dogan, 2021; Hunegnaw & Melesse, 2023; Ongowo & Indoshi, 2013; Yang et al., 2019).




The inquiry process skill that most often appears in the analysis of three textbooks is the ability to observe. In addition, the ability to interpret data and make conclusions is also often found. Data interpretation involves analyzing data to identify patterns that potentially lead to conclusions or assumptions (Duruk et al., 2017; Hunegnaw & Melesse, 2023; Yang et al., 2019). Data interpretation is influenced by variations in data types (Prihatiningsih, 2022). Students should use tables and graphs for data analysis and organization (Duruk et al., 2017; Yıldırım & Hasan Şimşek, 2013). Inference is the interpretation of data based on the information collected (Duruk et al., 2017; Ongowo & Indoshi, 2013; Yang et al., 2019). This means using data obtained through observation to make logical conclusions. Scientific research involves scientists in gathering evidence to answer questions of nature (Budiyono et al., 2015; Ulfa, 2018). Therefore, inquiry-based tasks in textbooks today tend to provide a rough guide in understanding the development of science with the presence of indicators of observing, interpreting data and concluding (Yang et al., 2019). Inquiry is designed to train students to investigate phenomena (Muakhirin, 2014) And work like a scientist (Komalasari et al., 2019; Tan & Kim, 2012). The three indicators of the inquiry process that are dominant in textbooks have been able to make students to investigate phenomena and work like scientists but have not been able to maximize the empowerment of their thinking skills and work like a real scientist.

Inquiry process skills that are rarely found in analyzed textbooks are, asking questions, defining operationally, measuring, classifying, controlling variables, predicting, formulating hypotheses, formulating models, and communicating. Asking questions and predicting are indicators of inquiry process skills not found in all textbooks. Predicting is revealing outcomes that may occur in the future based on patterns of evidence (Chakraborty & Kidman, 2022). Operationally defining, controlling variables, formulating hypotheses, and communicating are found only in class XII textbooks. Operationally defining indicates a method for measuring a variable in an experiment (Ongowo & Indoshi, 2013). Controlling variables involves identifying variables that might affect experimental results and ensuring that those variables remain stable and manipulated. Formulating models is only found in class X textbooks. Formulating hypotheses and formulating models including higher order thinking skills (HOTS) in bloom taxonomy level C6 (create) (Anderson & Krathwohl, 2001). Formulating a hypothesis means stating the expected outcome of an experiment (Anderson & Krathwohl, 2001; Yang et al., 2019; Yang & Liu, 2016). Formulating a model means Forming a mental or physical representation of a process or event (Ongowo & Indoshi, 2013).

Classifying was found concentrated in class X textbooks and decreased in percentage on class XI and XII assignments. Classifying means grouping objects or events into categories based on their properties or criteria (Ongowo & Indoshi, 2013). The process skills of classifying, predicting, making hypotheses, and formulating models will help students develop scientific reasoning and decision-making abilities, which are characteristic of individuals who have higher-order thinking skills (Yang et al., 2019). The absence of some inquiry process skills results in students losing the opportunity to practice all inquiry process skills. The absence of hypothetical and model formulation skills will neglect their development of higher order thinking skills (HOTS). This happens because the skills of the inquiry process are closely related to the higher-order thinking skills of students. Not all inquiry process skills are expected to appear in a single task, but what is expected is that all inquiry process skills are in one textbook and are available equally without focusing on multiple indicators of inquiry process skills.

The absence of questioning skills in all textbooks indicates the absence of assignments at the open inquiry level, even though this is an excellent approach to empowering critical and creative thinking skills. Students who ask questions show open-ended inquiry (Bulunuz et al., 2012). It is not expected that all inquiry tasks are at the open inquiry level but at least all inquiry levels are present in one textbook (Yang et al., 2019). Open inquiry is effective for developing critical and scientific thinking (Spektor-Levy et al., 2013; Yang et al., 2019). Asking questions means that students are asked to formulate appropriate research questions (Yang et al., 2019; Yang & Liu, 2016). Measuring skills were found most in class XII assignments and decreased in percentage in grades XI and X. Measuring is the estimation of the dimensions of objects or events with standard or non-standard tools, such as length, volume, mass, pH, and temperature (Hunegnaw & Melesse, 2023; Yang & Liu, 2016). Using words or symbols to describe something is the essence of communicating (Ongowo & Indoshi, 2013; Yang et al., 2019; Yang & Liu, 2016). Such process skills are only found in class XII textbooks with a very small relative percentage.

**c. Inquiry-Based Tasks Have Not Been Able to Increase Inquiry Knowledge (Third Dimension ITAI).**

Textbook analysis in the third dimension is like the second-dimension analysis of ITAI, namely imbalances in various statement items in ITAI The results of the analysis in the third dimension of ITAI can be seen in Figure 3. The highest percentages are found in item 20 (conclusion and data), item 21 (data and evidence) and item 22 (explanations). Item 20 asks students to draw conclusions based on the data collected. Item 21 asks students to describe observations, analyze and interpret data. Item 22 asks students to expand the questions by combining collected data and prior knowledge. Items not found in all textbooks are, item 15 (begin with question) and item 17 (questions quide procedures). The absence of item 15 (begin with question) will result in the absence of item 17 (questions quide procedures). The imbalance of each item and the absence of several items in a textbook hinder a comprehensive understanding of scientific inquiry. The hope is that 8 aspects of understanding scientific inquiry (the third dimension of ITAI) must be present in balance in one science textbook (Yang et al., 2019). This is important because an adequate understanding of scientific inquiry is a crucial first step for students to conduct inquiry properly.

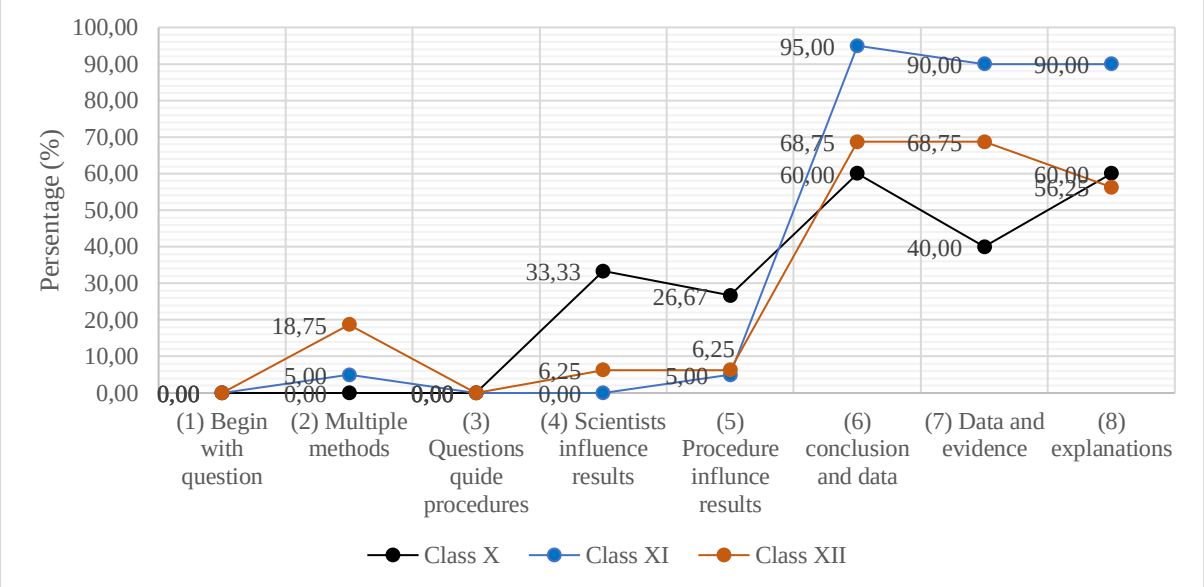



**Figure 3**. Results of analysis on the three dimensions of ITAI

Item 16 (no single set of methods) was found to be a low percentage, the most in class XII textbooks compared to class XI, and not in class X textbooks. Inquiry is much more complex compared to the linear

Question-Procedure-Result-Interpretation-Action approach, and through the process itself (Bevins & Price, 2016; Yang et al., 2019). Item 18 (scientists influence results) was found with a relatively small percentage, most in class X textbooks followed by class XII textbooks and not found in class XI textbooks at all. The low item 18 indicates most inquiry-based tasks tend to lead all students to a uniform conclusion.

## 4. CONCLUSION

Inquiry-based assignments in biology textbooks still do not provide ample opportunities for students to hone their inquiry process skills. This deficiency becomes evident through the imbalance of inquiry process skills featured in a single textbook, with process skills such as observing, interpreting data, and drawing conclusions being more dominant. Furthermore, various other essential process skills are rarely encountered in all textbooks, such as asking questions, operational definitions, controlling variables, predicting, formulating hypotheses, creating models, and effectively communicating. Consequently, inquiry-based assignments in biology textbooks are still unable to cultivate students' scientific comprehension of the inquiry process. This limitation is evident in the numerous inquiry-based assignments that do not commence with questions and instead tend to offer activity guidance resembling cooking recipes, which can lead students to reach uniform conclusions. This situation restricts students' capacity to creatively employ diverse methods in their inquiries. In response to these challenges, the book's author has taken immediate action to revise and enhance inquiry tasks that align with the ITAI criteria.

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