Vol 10(2) (2021): 184-193
DOI: http://dx.doi.org/10.24235/sc.educatia.v10i2.9163

SCIENTIAE EDUCATIA: JURNAL PENDIDIKAN SAINS

http://www.syekhnurjati.ac.id/jurnal/index.php/sceducatia

Analysis of Pedagogical Content of Biology Text Books on Structures and Functions of Animal Tissues for Class XI

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article info

Article history:
Received: 20 October 2021
Received in revised form: 08 November 2021
Accepted: 16 December 2021
Available online: 31 December 2021

Keywords:
Animal tissues
Biology textbooks
Pedagogical content
Readability
Visual representations

abstract

Textbooks will not be separated from the applied curriculum. There are four aspects analyzed in the pedagogical content analysis of the textbook research: the accuracy of concepts, the accuracy of curriculum objectives, the readability of texts, and the visual representation. This study aimed to compare the pedagogical content of biology textbooks on structures and functions of animal tissues from different curricula (the 2006 Education Unit Level Curriculum, the 2013 Curriculum, and the 2016 Revised Edition of the 2013 Curriculum) for class XI. This research employed a descriptive qualitative method and a content analysis technique. The research sample was the biology textbooks for class XI compiled by Sri Pujiyanto and published by Platinum. The research instrument was a content analysis protocol by codification (data coding). The results showed that the accuracy aspects in the sample books with the 2006 Education Unit Level Curriculum, the 2013 Curriculum, and the 2016 Revised Edition of the 2013 Curriculum were more dominant and categorized as adequate. The books with the 2013 Curriculum and the 2016 Revised Edition had better accuracy than those with the 2006 Education Unit Level Curriculum book. The text readability aspect of the three sample books was not suitable for class XI students. The books with the 2013 Curriculum and the 2016 Revised Edition of 2013 Curriculum had better visual representation than the book with the Education Unit Level Curriculum. The three sample books showed that the relationship with the material content was more dominant in the meaningful category, the relationship with reality was more dominant in the real category, and the visual representation function was more dominant in the explanatory category.

1. Introduction

The government of Indonesia has developed education by improving individual quality. One of the efforts is developing a curriculum. The curriculum is a plan used to guide teaching and learning activities (Sukmadinata, 2009). The dynamics of curriculum changes are expected to implement efficient and effective learning. Changes in the old curriculum to the latest curriculum impact various educational components. One component of learning that also changes is teaching materials. Ministry of Education (2006) defines teaching materials as systematically

arranged materials that allow students to learn and adapt to the existing curriculum. Teaching materials will facilitate teachers to convey materials to their students; thus, they will understand the learned materials more comprehensively. One form of teaching material is a textbook.

Textbooks are inseparable from the applied curriculum. If the old curriculum is replaced, the content or material in the textbooks must be adapted to the new curriculum. However, it is still found that the content or material in the textbooks is not following the applicable curriculum. The content of the textbooks more comprehensively describes the educational curriculum.

Chandra (2014) explains that in general,' there are several approaches to analyze and evaluate the quality of a university's curriculum. Several studies have developed various approaches to the higher education curriculum evaluation model, such as the grounded research method (Ibrahim, 1980) and the discrepancy model (Ali, 1986). One approach that has not been widely used is the pedagogical content analysis approach.

Shulman (1986) suggests that a must-have teacher content and pedagogical knowledge must be integrated with learning to create new knowledge and produce learning easily understood by students; this system is called pedagogical content knowledge (PCK). The PCK refers to a thinking concept that provides an understanding to teach science because only understanding the content of science material (knowing science) is not enough, but it must be accompanied by strategies to teach. The PCK includes ideas about teachers' success in learning specific understanding of academic and pedagogical content. Knowledge of pedagogical content includes knowledge of concepts, principles, topics in a discipline, and techniques of teaching a subject (Shulman, 1986).

The explanation above indicates that teachers function as a learning resource and must master the knowledge of pedagogical content because prospective teachers and teachers must organize structures of content knowledge and integrate this ability with knowledge of pedagogical content (Rosnita, 2011). The pedagogical analysis content in textbooks referred to a study of analyzing textbooks used by students to determine the extent to which the content or material of the textbook agreed with pedagogical principles developed by Magnusson et al. (2002). These principles were as follows; 1) Orientation to teaching science serves as a concept of accuracy and acts as a conceptual map, teachers' beliefs in teaching the concept to students, 2) Curriculum knowledge serves as the accuracy of curriculum objectives and consists of teacher knowledge in the curriculum used, 3) Students understand knowledge as text readability, and teachers understand students' conditions, such as difficulty and learning styles, 4) Knowledge of instructional strategies, such as strategies and approaches, serves as visual representations, and 5) Knowledge of assessment.

This model shows that subject knowledge, pedagogical knowledge, and knowledge of context significantly affect the formation of pedagogical content knowledge in several aspects: text readability, concept accuracy, visual representation, and curriculum objectives. However, knowledge of assessment was not carried out in the pedagogical content analysis of this textbook because this research only focused on content or material.

The subjects of the structures and functions of animal tissues are included in basic competencies 3.4 and core competence 4.4. The structures and functions of animal tissue are abstract materials difficultly understood by students and frequently emerging misconceptions because many terms are not always used in life. Muntiani (2015) analyzed students' misconceptions about the structure and function of animal tissues in biology. The results of the study found that 25% of students in a public school in Yogyakarta experienced misconceptions. Misconceptions can be caused by several factors, one of which is textbooks. Since textbooks are abstract, adequate internal pedagogical principles are needed to explain this material.

Platinum is one of the book publishers in Indonesia whose textbook publication always follows curriculum changes. However, there has been no research exploring the pedagogical content in biology textbooks published by Platinum, their applicable curriculum, and their appropriateness. The content or material presented agrees with the pedagogical principles described above.

Based on the description above, it is necessary to analyze the pedagogical content of the circulating textbooks because, to date, there has been no research examining the pedagogical content of textbooks used by students. Therefore, the researchers were interested in conducting a comparative analysis of the pedagogical content of biology textbooks for class XI; these textbooks used discussed structures and functions of animal tissues and applied three different curricula.

2. Method

The study was conducted from April 28 to June 23, 2021. Moreover, it employed a descriptive qualitative method. Meanwhile, the data analysis technique was the content analysis to analyze the content of discourse. The research instrument used was a content analysis protocol using codification (data coding). The content analysis protocol is a coding sheet equipped with a guide to filling out the coding sheet. Sample books A, B, and C, were analyzed by considering the variables studied. The research results were calculated using the percentage proportion formula for each variable. Then, the pedagogical content components of the three textbooks using three different curricula were compared.

The subjects of this study were textbooks for class XI using three different curricula, compiled by Sri Pujiyanto and published by Platinum. The three textbooks are as follows, 1) Book sample A was a biology book for class XI using the 2006 Education Unit Level Curriculum curriculum. The book was compiled by Sri Pujiyanto and published by Platinum, 2) Book sample B was a biology book for class XI using the 2013 curriculum. The book was compiled by Sri Pujiyanto and published by Platinum, and 3) Book sample C is a biology book for class XI using the 2016 revised edition of the 2013 curriculum. The book was compiled by Sri Pujiyanto and published by Platinum.

3. Result and Discussion

This pedagogical content analysis research analyzed four aspects: the accuracy of the concept, the accuracy of the curriculum objectives, the level of text readability, and visual representation.

Accuracy of the concept

The accuracy of the concept was analyzed by identifying the accuracy of the concepts of the books using three main or sourcebooks: Campbell Biology 12th edition (Reece et al., 2020), Biology 12th Edition (Raven et al., 2019), and Biology 11th Edition (Solomon and Martin, 2018). The accuracy of the concepts of biology textbooks for class XI was analyzed because all concepts had identical definitions. The authors of book samples B and C exemplified several concepts, paraphrased the language used, and changed the writing format into a point-to-point form or sub-chapters in several concepts. These changes did not change the definition of the concepts in the three sample books. The results of analyzing the concept accuracy are summarized in Figure 1.

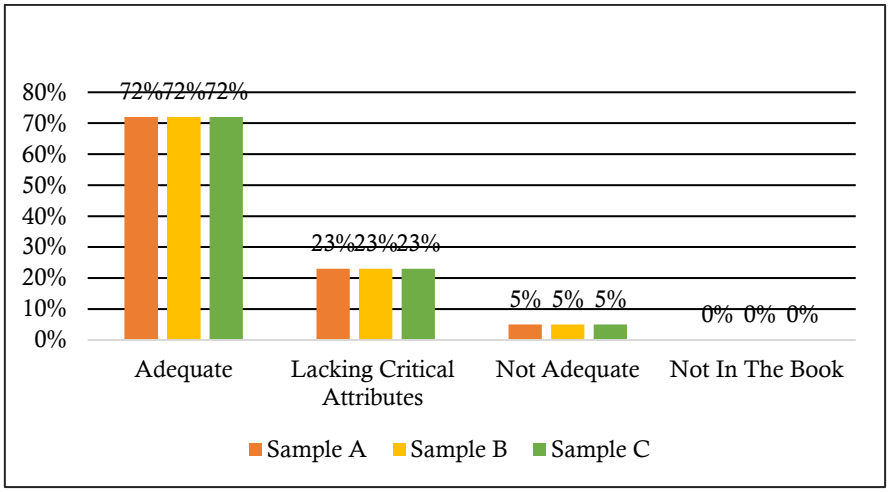

Figure 1. Graphic analysis of concept accuracy of the book samples A, B, and C

Figure 1 shows that the biology textbooks for class XI in the 2006 Education Unit Level Curriculum, the 2013 Curriculum, and the 2016 revised edition of the 2013 curriculum had the largest proportion of the accuracy concepts by 72%, the concept of lacking critical attributes was 23%, and the concept was not adequate at 5%. Meanwhile, the concept not in the book had a percentage of 0%.

The research results showed that the three books had adequate concept accuracy. This result indicated that the potential for misunderstandings (misconceptions) in students' understanding was relatively small. The accuracy of the concepts of biology textbooks for class XI was analyzed once because all concepts had a similar definition.

The adequate category constituted the definition of the concept in the investigated book and had all critical attributes as the research reference. The category of lacking critical attributes was intended to define the concept in the investigated book, which only had some critical attributes as the research reference. However, the concept label was printed on a book. The inadequate concept category was a concept defined in the investigated book that did not have any critical attributes that became the research reference. However, the concept label is printed on the book. The concept category that was not in the book was intended to label concepts not listed in the book. Therefore, there was no definition.

The accuracy concept was related to teaching orientation, referring to the teacher's knowledge and beliefs about the intent and purpose of teaching material at a certain level. The teacher's orientation was expressed as a concept map to determine learning objectives, implement curriculum materials, and evaluate student learning.

Concerning the education system in Indonesia, teaching orientation was identical to student competencies, such as core competencies and essential competencies in the curriculum. Students' understanding of the material included students' needs for certain material concepts and potential learning difficulties that they experienced and misunderstood (misconceptions) and probably occurred when learning the concepts of specific topics discussed (Magnusson et al., 2002).

Accuracy of curriculum objectives

The accuracy of curriculum objectives of the textbooks was reviewed by considering several aspects, listed in Minister of Education and Culture Regulation No 22 of 2016 (Ministry of Education, 2016), concerning the standard processes to formulate learning objectives. These objectives included the accuracy of active verbs to formulate learning objectives, the level of balance of the realm to formulate learning objectives, and the accuracy of the material to

formulate learning objectives. The results of analyzing the accuracy of books using curriculum objectives are summarized in Table 1.

Table 1. Assessment of accuracy of books using curriculum objectives

Aspects	Scores			Average
	Education unit level curriculum textbook	The 2013 curriculum textbook	Revised edition textbook of the 2013 curriculum	
Accuracy of Operational Verbs	1	2	2	1.7
Balance of Realms in the Formulation of Lesson Objectives	1	1	1	1
Accuracy of the Material to Formulate Learning Objectives	3	3	3	3

Table 1 shows that the average of the three books was 1.7. The aspect of balance domain to formulate the objectives had an average of 1. Meanwhile, the aspect of the material accuracy to formulate learning objectives had an average of 3. The learning objectives in the textbook must use the right operational verbs in which the selection of operational verbs must be measurable in cognitive, affective, and psychomotor domains and consider the highest level to formulate learning objectives. Nurzain (2015) explains that learning objectives should be formulated using the operational verbs and includes generic competencies and material accuracy; thus, they are easily measured.

The aspect of the balance of realms follows minister of education and culture regulation No. 103 of 2014 (Ministry of Education, 2014) concerning the preparation to formulate learning objectives, including balance levels in the formulation of learning objectives. Moreover, this aspect must include three domains: cognitive, affective, and psychomotor domains. Meanwhile, the aspect of the accuracy of the material to formulate learning objectives agrees with Muhimmatin et al. (2015), stating that this aspect is pivotal, and determining the material must agree with the material to formulate learning objectives or essential competencies.

Curriculum knowledge shows the teacher's understanding of the goals and objectives of student learning and the scope and sequence of scientific concepts to teach. Teacher curriculum knowledge consisted of two categories: (a) applicable curriculum objectives and learning objectives for each topic and (b) specific curricular programs, resources, and materials (Magnusson et al., 2002).

Text readability levels

The text readability was analyzed using the Raygor formula. Raygor charts assessed readability based on sentence and word length. Readability discusses difficulty levels or ease of reading a text for readers at a certain level (Fatin, 2017).

The readability level of a reading book was revealed by analyzing one-by-one texts. The readability of the sample book was analyzed by taking 100 words in discourse. The analysis results of each sample were then accumulated to find the average and converted into a Raygor graph; thus, the readability level of the analyzed discourse was revealed. These results are presented in Table 2.

Table 2. The analysis results of the readability level

No.	Samples		Total of each level text readability		Total number of text codes	Description
			Appropriate	Not appropriate		
1	The 2006 Education Unit Level Curriculum	Total	5	13	18	Not suitable for class XI
		Percentage	28%	72%		
2	The 2013 Curriculum	Total	5	14	19	Not suitable for class XI
		Percentage	26%	74%		
3	The 2016 Revised Edition of the 2013 Curriculum	Total	6	14	20	Not suitable for class XI
		Percentage	30%	70%		

Table 2 denotes that 28% of 18 biology textbooks using the 2006 Education Unit Level Curriculum were readable and suitable for class XI. Meanwhile, 72% were not suitable for class IX students. Furthermore, of 19 biology textbooks using the 2013 Curriculum, 26% of them were suitable for class XI while 74% were not suitable for class XI students. Meanwhile, of 20 sample textbooks using the revised 2013 curriculum, 30% were appropriate for class XI students while 70% were not suitable for class XI students. Therefore, the text readability of the three sample books was still not suitable for class XI students.

Ginanjar (2020) revealed that one of the factors causing the readability discrepancy of a text in textbooks was too long sentences for grade 11 students. Raygor's graphic calculations considered this determination. The higher the readability rating was, the more difficult readers would understand the text. To overcome this, the number of words was necessarily reduced, and difficult words had to be replaced with easy words without reducing the meaning of the text. There are several aspects necessarily considered and related to the textbook readability. One of them is discourse. In general, a good discourse for reading assessment materials is a discourse with a moderate difficulty level or one following with students' ability levels (Rahma, 2016).

This research is necessarily followed up by conducting additional research on whether the Raygor chart was suitable for Indonesian texts or necessarily modified. Not all words had more than six letters and were classified as difficult words. Moreover, not all words, shorter, fewer than, or exactly six words, were easy words. We could not ignore the semantic meaning and contextual discourse. This was certainly a consideration for using Raygor charts and other charts to measure the readability level.

Magnusson et al. (2002) developed the principles of knowledge of pedagogical content, one of which was student understanding. Teachers' understanding of their students' condition consisted of several aspects: difficulties and learning styles. These aspects were related to the text readability of the textbooks used by students because the text readability will certainly affect students' understanding of the concept of the studied material.

Visual representation

Visual representation was analyzed based on visual representation aspects in three sample books using a different curriculum. These aspects were the relationship between visual representations and material content, the relationship between visual representation and reality, and the relationship between visual representation and functions. The analysis results of the relationship between visual representation and material content of animal tissue structures and functions. These results are presented in Figure 2.

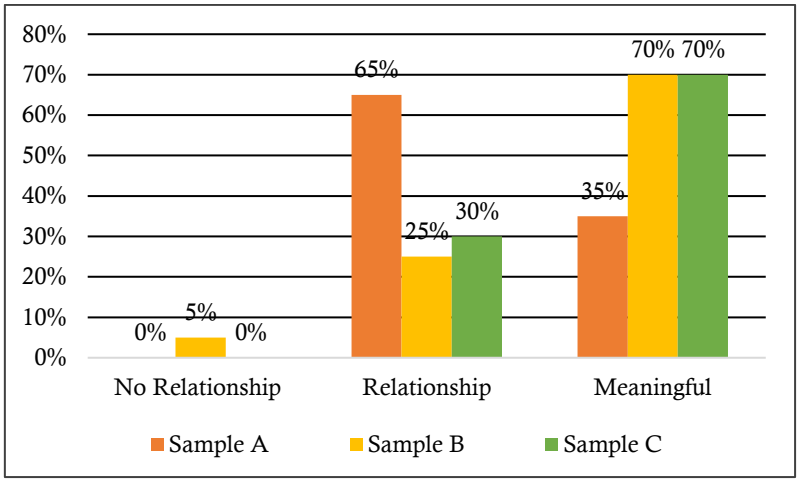

Figure 2. The comparison of the relationship between visual representation and material contents

Figure 2 shows that comparing the relationship between visual representation and material contained in book samples B (the 2013 Curriculum) and C (the 2016 revised edition of the 2013 curriculum) had a more dominant proportion of meaningful categories with a percentage of 70%. Meanwhile, book sample A (the 2006 Education unit level curriculum) had a meaningful category proportion of only 35%. Book sample A had the category of the relationship of 65% and the category of no relationship of 5%. Book sample B had the category of the relationship of the 25% and the category of no relationship of 5%.

Meanwhile, book sample C had the category of the relationship of 30% and the category of no relationship of 0%. These results concluded that the meaningful category was dominant. Thus, book samples B and C had a meaningful visual representation relationship with more dominant material content than sample book A. These research results agree with Tarigan and Djago (2009), proposing several guidelines to assess good textbooks, one of which is stimulating students' interests in reading these textbooks that students must understand. Students can be stimulated by presenting an attractive visualization and having continuity with the explained material; thus, the visualization had a meaningful function.

The relationship between visual representation and reality is divided into two types (Fotakopoulou & Spiliotopoulou, 2008). The first is realistic, indicating that the images in the textbook serve to convey or express aspects of reality. Meanwhile, the image in question refers to an image pointing to the actual object. The second is a metaphor, meaning that the image presented is a form of symbolizing the meaning in the material through the presented images. The analysis results are presented in Figure 3.

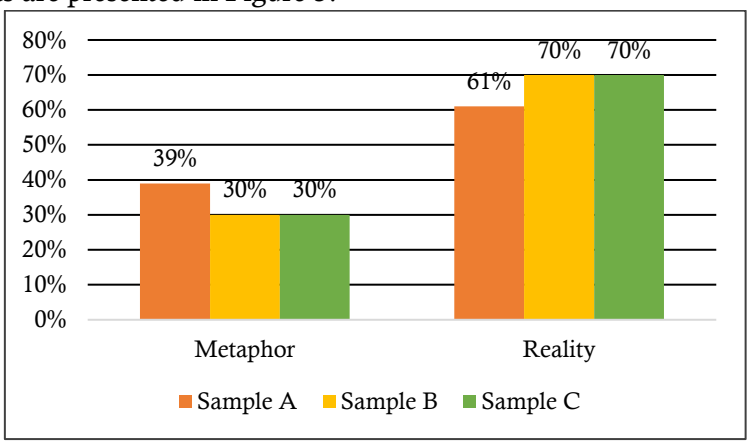

Figure 3. The relationship between visual representations and reality

Figure 3 signifies that the three books' relationship between visual representations and reality was in the reality category. Book sample A (the 2006 Education Unit Level Curriculum) had a percentage of 61%, sample book B (the 2013 Curriculum) had a percentage of 70%, and sample book C (the 2016 revised edition of the 2013 curriculum) had a percentage of 70%. Meanwhile, the metaphor category of book sample A was 39%, book sample B was 30%, and book sample C was 30%.

These results indicate that book samples B and C had a more dominant reality category while book samples A had a more metaphorical visualization category. More dominant reality categories illustrated that the abstract structures of animal tissues and topics about these structures must be presented in reality. Thus, readers could more comprehensively understand parts of animal tissues and original pictures of animal tissue structures. Such strategies will clarify each part.

The results of this study agreed with Vinisha and Ramadas (2013), stating that visual representation facilitates students to understand abstract concepts more easily. A visualization that is close to reality will facilitate students to understand the textbooks' messages easily. The realistic visual representation must agree with the information processing system; thus, it can be stored in the long-term memory system (Mulyani, 2014).

The relationship between visual representations was analyzed based on functions and employed indicators developed by Fotakopoulou and Spiliotopoulou (2008). These indicators are as follows: 1) A decorative indicator that does not play a role in learning but makes the page more attractive or creates an aesthetic sense, 2) An illustrative indicator is a description of the information in the text without adding meaning or information in the textual reference. Illustration more usefully provides meaning to avoid misconceptions than definition, 3) Exemplifying indicator refers to completed or various cases related to entities or language concepts of the material, 4) Explanatory refers to adding information not related to explanatory information, and 5) Complementary constitutes providing excluded information and explicitly explaining complements and implied information of the presented material. The comparison data of the relationship between visual representation and function are presented in Figure 4.

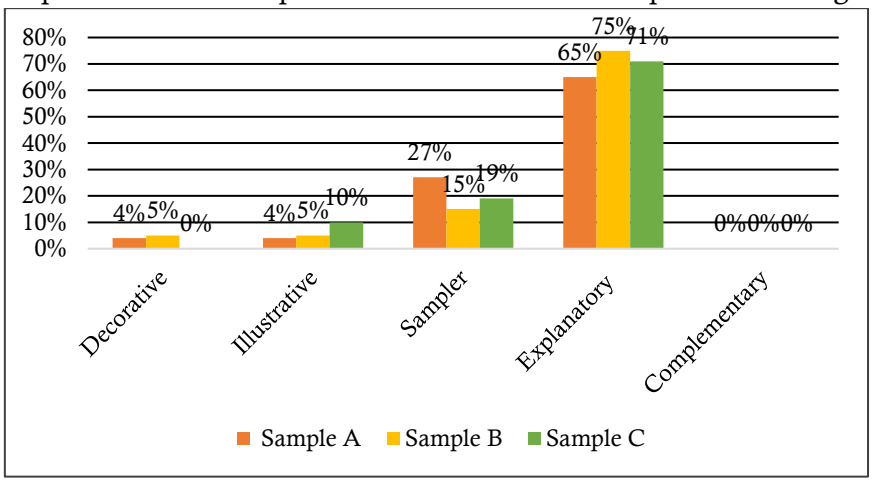

Figure 4. The relationship between visual representation and functions

Figure 4 shows the relationship between visual representation and functions. Book sample A (the 2006 Education Unit Level Curriculum) had the decorative category of 4%, the illustrative category of 4%, a sample giving category of 27%, the explanatory category of 65%, and the complementary category of 0%. Meanwhile, book sample B (the 2013 Curriculum) had the decorative category w of 5%, the illustrative category of 5%, the sample giving category of 15%, the explanatory category of 75%, and the supplementary category of 0%.

Meanwhile, book sample C (the 2016 revised edition of the 2013 curriculum) had a decorative category with a percentage of 0%, an illustrative category of 10%, the sample giving category of 19%, the explanatory category of 71%, and the complementary category of 0%. The relationship between visual representation and function of the three sample books had a higher percentage in the explanatory category.

Magnusson et al. (1999) support this visual representation analysis, which states that knowledge of instructional strategies is related to knowledge of learning and general strategies commonly used in learning; for example, learning strategies through learning cycles and specific strategies in learning specific topics. Moreover, the strategies explain techniques to represent a concept in a certain way, such as model diagrams, pictures, tables, and graphs, and involve students in conducting investigations, experiments, demonstrations, and simulations, solving problems, or delivering examples.

The visual representation analysis of structures and functions of animal tissues in three high school biology textbooks revealed no significant differences between the three books. Ainsworth (2008) explains that learning can be supported by combining several visual representations that have vital roles.

The pedagogic aspect that must appear in every textbook aims to possibly display a visual representation to choose an appropriate representation to explain a particular material or concept. The visual representation in the textbook is related to the pedagogical aspects. Meanwhile, the accuracy of the visual representation selection is related to students' cognitive development (Mulyani, 2014).

4. Conclusion

This study compared the pedagogical content of structures and functions of animal tissues in biology textbooks using different curricula for class XI students. The study revealed that the concept of accuracy in book samples A (the 2006 Education Unit Level Curriculum), B (the 2013 Curriculum), and C (the 2016 Revised Edition of the 2013 Curriculum) was more dominant and in the adequate category. Moreover, book samples B and C had better accuracy of curriculum objectives than book samples A. However, the three books did not have readable texts suitable for class XI students. Book samples B and C had better visual representation than book samples A. Meanwhile, the relationship between the three books and material content was more dominant in the meaningful category. Their relationship with reality was more dominant in reality (objective), and the visual representation function is more dominant in the explanatory category.

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