



Visual Representation of Biology Books on Circulatory System Material

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Abstract

Background: Representation is a tool to improve students' communication, interpreting, and problem-solving skills. Visual representation (RV) can provide information about understanding the object/phenomenon observed about the concept under study. This study aimed to determine the relationship between visual representations and material content and between visual representations and the reality of images contained in the Circulation System material. **Methods:** This study used a content analysis method with a qualitative data analysis technique. **Results:** The analysis results show a relationship compared to the category of significant associations between the circulation system's material and the relationship of symbolic visual representations. **Conclusions:** In the analysis that has been carried out on the visual representation of SMA/MA biology books in the city of Stabat for the circulation system material, it can be concluded that the Visual Representation relationship contained in SMA/MA biology books was found to be more dominant for the category of no relationship compared to the category of a significant relationship in circulation system material presented. In addition, when analyzed concerning the reality of the image, the visual representation displays the relationship of symbolic visual representations in the analyzed biology textbooks. In addition to choosing a textbook, the teacher should pay attention not only to the content of the learning material but also to look at the components in the book, one of which is the picture in the textbook. This will later be useful to support students' understanding of the concepts being taught.

Keywords: Biology Textbook; Circulation System; Visual Representation

Introduction

Textbooks are sources or teaching materials that contain learning materials, methods, limitations, and assessment methods (Hertati 2020). A textbook can serve as a bridge between the intended curriculum, or the curriculum implemented in learning and is often used as a teaching basis (Zhuang et al., 2021) which limits the content taught and influences the teaching strategies used (Alajmi 2012). In addition, textbooks are essential teaching material for students to use to build scientific knowledge (Cheung & Winterbottom 2021). Furthermore, textbooks are tools and teaching materials that can be used in learning activities to achieve good learning objectives. Teachers can use books as a resource to inform students about the subject matter (Mulyani, 2014).

Textbooks influence the teaching-learning process since it is not only a source of instrumental knowledge but also a significant impact on the students' abilities (García-Cabeza & Sánchez-Bello, 2013). Then Ramnarain and Chanetsa (2016) stated that textbooks offer convenience and convenience for teachers to plan lessons, and worksheets



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are readily available on demand. Therefore, textbooks are essential in ensuring that curriculum objectives are met (Pratiwi et al., 2012). Textbooks are guidelines that must be owned in primary, secondary, or tertiary education with learning materials. Textbooks are essential because they contain descriptions of systematically arranged material selected based on goals, learner orientation, and student development to improve mastery of science and technology and increase sensitivity and aesthetic ability (Rahmawati, 2016).

Lee (2010) explains that textbooks are one of the most graphically filled printed materials used to communicate and share scientific ideas. Graphic media presents a concept, idea, or fact by offering numbers, phrases of words and symbols, or other images (Sibirian, 2016). Thus, using this graphic material will attract attention, explain facts, and clarify concepts to improve further the assimilation of information for students to understand learning (Colburn 2010).

Nim (2009) found that a medium is needed to concretize abstract material, so students' cognition of the material becomes correct in studying biology. The proper media selection can focus students' attention, reduce verbal expression, and increase student motivation in subsequent learning. Furthermore, science education justifies that developing visual representations is an important science process skill for the scientific method, especially in making hypotheses, designing experiments, analyzing and presenting data, and communicating results (Canlas 2021).

Representation is a tool that can be used to improve communication, interpreting, and problem-solving skills for students. Representation makes it easier for students to understand the problems that occur (Sabirin 2014). Representations in biology learning, especially in biology textbooks, can be displayed in pictures, diagrams, and others (Mulyani, 2014). The use of visualization in learning plays an important role in providing positive feedback to build vital concepts so that learning objectives can be achieved (Utami & Subiantoro, 2021).

Brandstetter (2017) explains that a visual representation is a two-dimensional pictorial message generated by a graphic designer to communicate information about particular content. Therefore, Mulyani (2014) said that the selection of images displayed in biology textbooks must be precise, clear, and related to the subject matter so that there is no wrong interpretation. Incorrect visualization in biology textbooks can create misconceptions and affect student learning achievement. Empirical studies show that visual representation can help students actively and longer understand scientific concepts than learning texts (Brandstetter, 2017).

The visual representation displayed in the textbook has a meaning and value related to the material's content (Millah 2018). Biological matter is a science branch requiring extensive visualization (Asenova & Reiss, 2011; Tsui & Treagust, 2013; Anderson et al., 2013; Roth & Pozzer-Ardenghi., 2013) to help elaborate explanations around material ideas and mechanisms related to physiological procedures. In addition, Tsui & Treagust (2013) state that biological matter can be classified according to its abstraction level, starting from the symbolic level to the macro level. A visual representation can provide information about understanding the observed object or phenomenon concerning the concept under study starting from the macroscopic or symbolic level, which is relevant for biological materials that require clear visualization (Ladisa and Rahmat 2020; Mulyani 2017).

Therefore, biology textbooks need to be accommodated to display proper visual representations. Visual representations in biology textbooks serve as tools for student conceptual change and are essential in presenting abstract and concrete information (Parthasarathy & Premalatha, 2022). A visual representation can help reduce the ambiguity of textual explanatory narratives in textbooks. In addition, complex scientific phenomena will be more straightforward for students to understand if they are presented in the form of illustrations.

Thus, visual representation has a fundamental position in deciphering the subject matter and will impact the formation of student understanding and learning outcomes

(Elfada et al., 2015). However, many biology textbooks still explain ideas, data, or concepts simply (Elfada et al., 2015). As a result, the information that should be communicated to the reader becomes less than ideal and can even be misinterpreted (Asenova & Reiss, 2011). This can cause students to fail to understand the concept of biology, which can affect their learning outcomes (Mulyani, 2014). Student learning outcomes are greatly influenced by the books or materials they read (Mulyani, 2014). Thus, visual representations in textbooks for biological materials will foster students' interest and ambition in learning. The material displayed in a combination of text, photos, or images will make it easier for readers to understand the material being read (Mulyani, 2014).

Based on the background above and some of the research carried out in advance, there has not been much discussion about the visual representation of biology books, especially for the Circulation System material. The selection of the Circulation System material is based on research that has been carried out by Fajriana (2017), which states that misconceptions often occur in the Circulation System material. This research provides an opportunity to conduct a recent study using the circulation system material. This is very important to do because it will have an impact on students' understanding of the material concept of the Circulation System and the effect that will occur if visual representations are not carried out on this material, causing misconceptions in students (Fajriana, 2017)

Thus, this research is crucial to be carried out because visual representation in textbooks has many benefits and functions that are useful for achieving goals in learning (Hertati, 2020); in addition, according to Fotakopoulou & Spiliotopoulou (2008), visual representations in textbooks have five functions, namely as decorated, illustration, example giving, explanation and complement (Eltasari & Susilo, 2021). Through this research, it is hoped that textbooks can be used to support learning activities by looking at the quality of their visual representations by the concept of the material being taught and the reality of the images of the material discussed. In addition, the results of this study are helpful for teachers to provide explicit guidelines for images in high school biology textbooks on the Circulation System material by raising the formulation of the problem as follows 1) How does the distribution of visual representation categories of different biology textbooks differ?, 2) How does visual representation relate to the material content of the Circulation System?, 3) How does visual representation relate to image reality in circulation system material? Therefore, this study aims to determine the relationship between visual representation and material content and the relationship between visual representation and image reality contained in circulation system material.

Methods

This research uses a method, namely content analysis. The content analysis focuses on the characteristics of the material. This means that research methods are applied to written or visual materials to identify specific parts of the material. The analyzed material can be textbooks, newspapers, web pages, speeches, television programs, advertisements, musical compositions, or documents (Ary, 2010).

The research instrument used is a checklist table that has been validated by validators who are experts in the field of biology. This analysis will outline the visual representations contained in biology textbooks for circulatory system materials. There are five indicators of visual representation used in this study, namely: 1) visual representation with the nature of images, 2) visual representations with image functions, 3) visual representations with image types, 4) visual representations of the conformity of images to the content of the material, and 5) visual representations with the reality of images (Hertati, 2020).

The sample books used were as many as three biology textbooks. Namely: (1) biology textbooks of Erlangga publishers, (2) biology textbooks of Grafindo publishers, and (3) biology textbooks of Triad publishers, which are the most widely used biology textbooks in the Stabat city area. The identity of the biology textbook can be seen in Table 1, then, because this book takes the Circulation System material. The characteristics in each chapter of the book are presented in Table 2.

Table 1. Book Identity

Authors	Publisher	Title	Page	Curriculum
Imaningtyas, dan Yossa Istiadi	Erlangga	Biology Student Book	304	Improved 2013 curriculum
Yusa, dan MBS Maniam	Grafindo	Book of Active and Creative Students Learning Biology	276	2013 Curriculum (2016 revised edition)
Henny Riandari	Tiga Serangkai	Biological Sciences	266	Improved 2013 curriculum

Table 2. Circulatory System Characteristics in Biology Textbook

Karateristik Buku				
Publisher	Page	Figure	Title	
Erlangga	23	15	<ul style="list-style-type: none"> • Sistem Peredaran Darah Pada Manusia • Maknisme Pembekuan Darah • Golongan Darah • Uji Golongan Darah • Transfuse Darah • Organ Peredaran Darah • Mekanisme Peredaran Darah • Sistem Limfa • Darah • Organ Pada Sistem Peredaran Darah 	
Grafindo	15	20	<ul style="list-style-type: none"> • Proses Peredaran Darah • Golongan Darah • Teknologi Kesehatan Jantung • Darah • Alat-Alat Peredaran Darah 	
Tiga Serangkai	15	13	<ul style="list-style-type: none"> • Mekanisme Peredaran Darah • Kelainan/Penyakit Pada Sistem Peredaran Darah • Sistem Peredaran Darah Getah Bening 	

The analysis carried out by this study used data analysis techniques. This study was carried out qualitatively and quantitatively. Qualitative data analysis techniques are through coding based on visual representation indicators. Meanwhile, quantitative analysis is done by calculating the frequency of occurrence of visual representation categories/indicators in the three analyzed books.

The ways that are carried out in analyzing data are as follows:

1. Determining the biology textbook to be explored and determining the material to be interpreted according to the existing problems.
2. Make book initials, namely books published by Erlangga (Book A), books published by Grafindo (Book B), Books published by Triumvirate (Book C)

3. Analyze by identifying and calculating the number of images in the circulation system material chapter and grouping them according to the indicators made.
4. Calculating the percentage of analysis quantitatively using the Margono (2010) formula as follows:

$$P = \frac{n}{N} \times 100\%$$

Information

P: percentage

n: number of images obtained

N: total number of book images

5. Determining suitability categories based on categories adapted from John Wilkison (1999).

Table 3. Compliant Category

Percentage	Category
<40%	Non-Compliant
40%-75%	Compliant
>75%	Highly Compliant

Result

The availability of images in each book is different, and not all the pictures in the book follow the indicators that have been made. The data from the percentage calculation in the three SMA/MA biology textbooks for the Circulation System material are presented in tables and diagrams.

Description of Aspects of Visual Representation with the Nature of the Image

The results of the study for the nature of visual representation images in sample books A, B, and C as a whole have their proportions, which for the highest results are the nature of descriptive pictures, while for the nature of images that are processed are less. This can be seen in the following diagram.

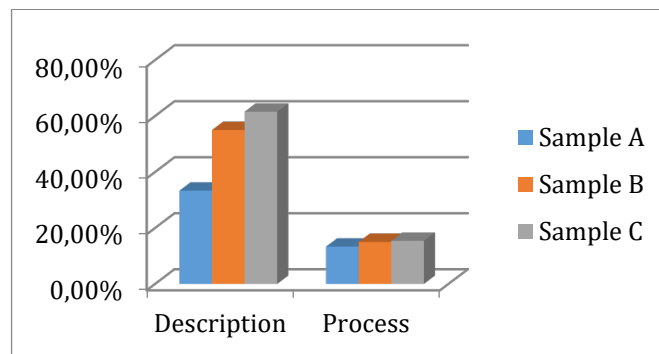


Figure 2. Comparison diagram of the description and process characteristics of sample books A, B, and C

Description of Aspects of Visual Representation with Image Functions

Based on the results obtained from the three samples of books A, B and C for the category of image functions in the SMA / MA biology book for circulation system material, it shows results that vary between the three books. As an illustration, the category of image function is in a higher position than the image function as Decorative, Exemplifying, Explanatory, and Complementary. The data results from these three books can be seen in the following diagram.

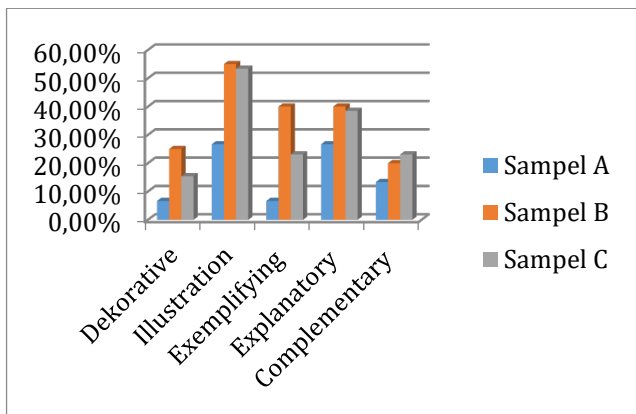


Figure 3. Comparison diagram of function drawing of sample books A, B, and C

Description of Aspects of Visual Representation with Image Types

Based on the analysis results obtained from the three samples of books A, B, and C, there are types of images in the form of models that dominate compared to image types in the form of concept maps, photos, schemes, and tables. The research data from these three book samples can be seen in the following diagram.

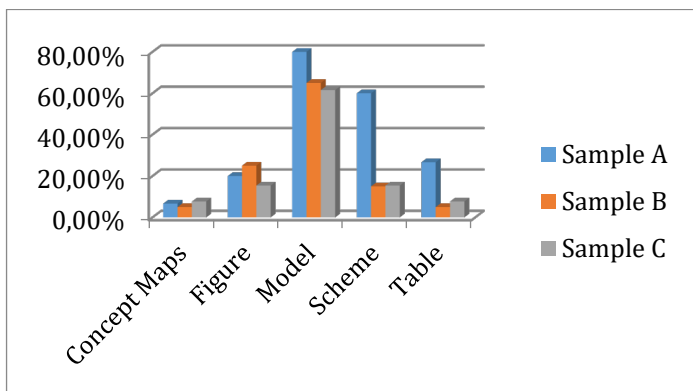


Figure 4. Comparison diagram of sample book types A, B, and C

Description of Aspects of Visual Representation of The Conformity of the Image to the Content of the Material

The study's results on the suitability of images with material content are similar to the three book samples. Namely, in the category, there is a high proportion of relationships. The meaningful type occupies the second position, and the third for the category, no relationship is not found. The research results on the three samples of books A, B, and C can be seen in the diagram below.

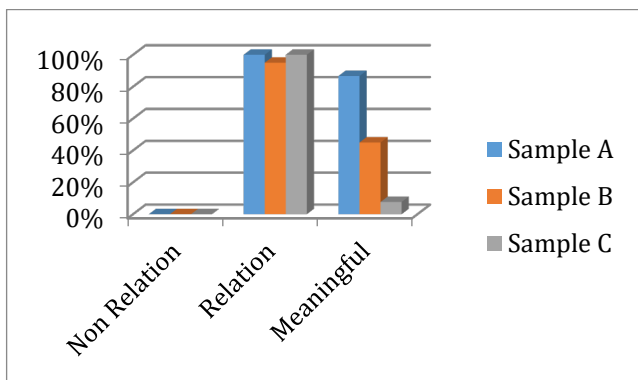


Figure 5. Diagram of comparison images with the content of sample books a, b and c

Description of Aspects of Visual Representation with Image Reality

The relationship between the visual representation of high school/ma biology books on circulatory system materials with image reality is classified into two categories, namely realistic and metaphorical. Based on the results of the analysis carried out on the sample of books A, B, and C, the category of metaphorical images dominate more than the category of realistic pictures. The data results of the three books can be seen in the following diagram.

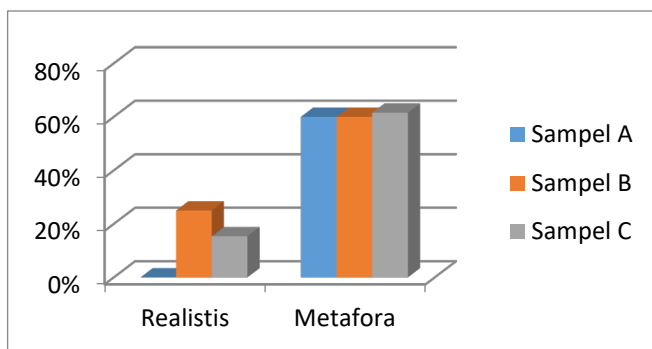


Figure 6. Reality comparison diagram of sample book pictures a, b and c

Discussion

The Relationship of Visual Representation with the Nature of the Image

The relationship of Visual Representation with the nature of the images found from the samples of books A, B, and C displays different values in each piece of the book, but when viewed as a whole from the results of the data that has been analyzed the dominating proportion is that the nature of the image is a description and the last is the nature of the idea which is a process. A decrypted visual representation is an image that explains a material as a reinforcement of concepts. This explanatory image strengthens the teaching and learning process and provides an allure to the material ideas communicated. This interest is the most important factor in learning success, motivating students to focus on performance. Visually, an object presented excitingly will make the person who sees it try to understand the thing (Mulyani, 2017). Book B shows a display of organs in the human circulatory system, namely the heart, in the image of the chambers and heart valves by providing precise and colorful visuals, see Figure 7. Whereas books A and C for organs in the human circulatory system only describe parts of the heart without a clear visual description.

Visual representation is the primary function of representation as a source of perception that tests, describes, and confirms (Prain & Tytler, 2013). A graphic example of the nature of the image for the process aspect can be seen in Figure 8. The picture in book A describes the mechanisms for the circulatory system through the circulatory diagram. This is also related to the material discussed. It is, therefore, essential for a textbook, especially a biology textbook, to get images of a process nature because students need clear images without having to use a lot of words or sentences (Postigo & López-Manjón, 2019)

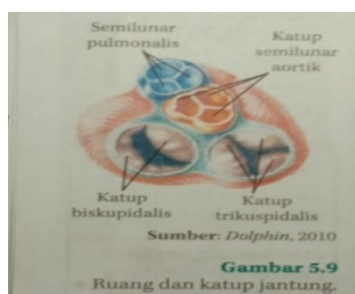


Figure 7. Sample B

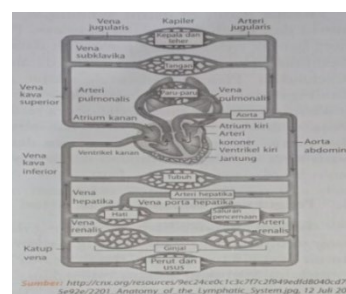


Figure 8. Sample A

The Relationship of Visual Representation With Image Functions

The visual representations that we can find in the three biology books that have been analyzed are grouped based on their functions, namely as decoration (decorative), illustration (illustration), giving examples (exemplifying), explaining (explanatory), and complementary (complementary). In the results that have been obtained, the image function that is illustration has the highest value, followed by the image function as explanatory, exemplifying, complementary, and the image function as decorative.

Visual representations that have the function of illustrating the ideas listed in the reading can influence the establishment of concept perception. In Figure 9, the illustration given for the blood material is clear because book A provides a clear visual of the blood component and what is contained in each component. Meanwhile, in books B and C, the illustration of images from blood material is not clear enough. It only describes the blood component. Therefore, textbooks with sufficient accuracy or accuracy of concepts will show good visual representation and can be classified in the group of illustrations because they are supported by prominent reading concepts (Elfada et al., 2015).

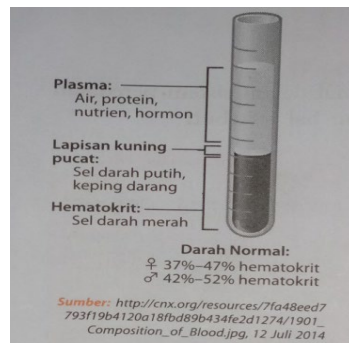


Figure 9. Illustration-Sample A

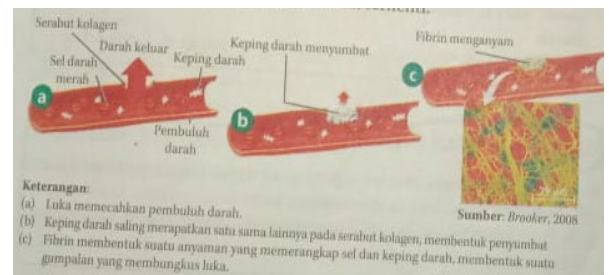


Figure 10. Explanatory-Sample B

The role of visual representation in biology textbooks for circulation system materials is an explanation that provides a concrete example of the circulation system (Mulyani, 2017). In addition, the explanatory function can provide information regarding the concept of material that is explained entirely (Elfada et al., 2015). This can be seen in Figure 10, which is an image of the blood clotting mechanism by providing clear visuals and captions on each image also add understanding to students. Books A and C themselves, in describing the mechanism of blood clotting it uses only schemes.

Visual representations that have the function of being complementary apparently have a representation that is not significant enough to exist. The presence of such visual representations exists only to help complete the interpretation of the material described (Mulyani, 2017). Figure 11 in book C for blood type material allows students to see the difference in blood type; because of the three books, only book C provides a complementary picture after explaining the material.

The Relationship of Visual Representation with Image Type

The types of images found in the high school / MA biology book class XI on the circulation system material are images in the form of concept maps, photos, models, schemes, and tables. Visual representations in the form of pictures the form of models dominate or have the highest value on almost every page in the explanation of the circulation system. Notice Figure 12.

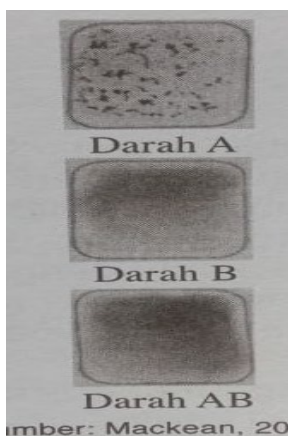


Figure 11. Complementary-Sample C

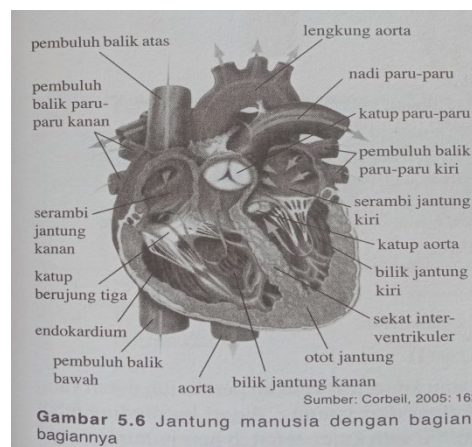


Figure 12. Model – Sample C



Figure 13. Figure – Sample Book B

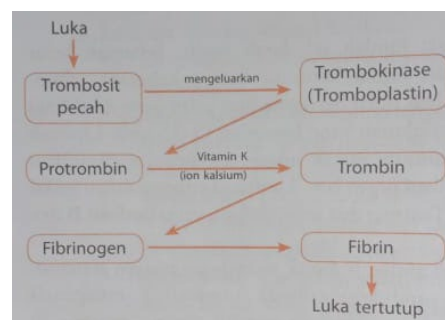


Figure 14. Scheme-Sample Book A

The visual representation above is a model that depicts the human heart with its parts. Sample book A is also appropriate in describing the heart organs and their parts. Then for the sample, book B has a clear colored image so that the difference can be known as a whole if observed.

The second type of image that has the second highest proportion of values is the photo. The photographs found in the samples of books A, B, and C show that in the real visual application, it should be the first choice to explain the characteristics and examples of an image in the material of the circulation system. Images have great validity compared to simply presenting a word or sentence in conveying information (Postigo & López-Manjón, 2019). It can be seen in Figure 13 that book B displays quite a lot of photo types when compared to books A and C. where during the learning process, visual representations in the form of images will significantly improve the student's memory (Asenova & Reiss 2011), allowing it to be stored in long-term memory and interpreted (Roth & Pozzer Ardenghi, 2013). In addition, Wolff's (2013) explains that the types of visual representations presented in textbooks should be adapted to the material concept.

The third type often appears a scheme, which describes the process or stage. Schematics that combine writing and images as a whole will have a significant effect compared to using only text alone. In biology books, general schemes are also used to describe the physiological ways that occur in the body of organisms (Mulyani, 2017). In Figure 14, book A shows a schematic of the blood clotting process in the human body if it suffers a wound.

The table describes the differences between the objects or processes that occur. Tables have a fairly significant role, where many aspects are explained related to quite complex concepts. The material displayed in the form of a table generally contains explicit, concise, and concise material. Then the image type takes the form of a concept map shown at the beginning and serves as a valuable tool for showing essential concepts throughout the chapter. The concepts represented on the concept map are generally connected with connecting words and become a concept map. The three samples of biology books A, B, and C that use concept maps as a starting point can provide a deep understanding of the material described in each chapter. In addition, the learning process that uses concept maps has

benefits where. Ausubel said that through a network of concept maps depicted in concept maps, learning becomes meaningful because the knowledge described becomes a structure, and students become easier to understand and understand the concepts (Khasanah, 2019).

The Relationship of Visual Representation of the Conformity of the Image with the Content of the Material.

Any textbook on visual representation must be qualified. That is, it must be consistent with the one described. The visualization displayed will be more meaningful when there is a meaningful relationship with the material so that the decipherment of the idea becomes more apparent. The importance of visualization is crucial for students since the relationship between visual expression and material is based on the findings of the three books examined (Mulyani, 2017). Sample book C had the lowest meaningful proportion compared to books A and B, which was 7.69%. From the results of the research that has been carried out, it is found that visual representations have an inappropriate image. This can be seen in Figure 15. The various leukocytes whose images are not quite right to explain how the neutrophils, lymphocytes, and monocytes form. Figure 16 is a visual representation that references the book's assessment of sample C. This view has the right image to be used as a visual for various leukocytes.

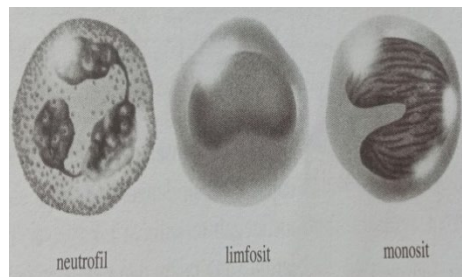


Figure 15. Improper Image-Sample Book C

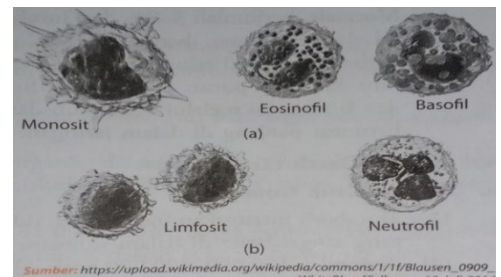


Figure 16. Images that serve as a reference for assessment- Sample Book A



Figure 17. There is a Relationship and Meaning – Book Sample A

Textbooks serve both as a tool and a learning resource for students and must be built on the importance and interrelationship of all the components it contains. In general, most of the visual representations of the textbooks of that studied biology indicate an essential relationship with the material described. The meaningful relationship between the visuals displayed and the content of the material has a significant influence on the learning mechanism of students. In line with the statement of Ardenghi (2013), students are consistent in seeking a link between the writing and the images presented. Meaningful learning occurs when students can relate the concepts taught to daily life.

The Relationship of Visual Representation with The Reality Of Images

When viewed with the reality of the image, the visual representation displays the result of a high metaphorical relationship. This linkage shows that the visual representations expressed in the SMA/MA biology book on the circulation system material are unrealistic (real). Figure 18, where the image shows a metaphorical visual.

While realistic pictures can arouse the understanding of beginner biology students rather than abstract conventions that require special knowledge (Wiley et al., 2017), realistic visual representations that match the real thing can be processed. Based on the theory of dual coding, it is explained that the information received can be in the form of verbal or non-verbal. Linguistic information can enter human memory through special coding in vision, hearing, pronunciation, and others (Clark & Paivio, 1991). The representation of linguistic communication can be sentenced in textbooks, schools, educators, and others. Instead, verbal information can take the form of unique visuals, such as flower graphs, flower formulas, and so on.

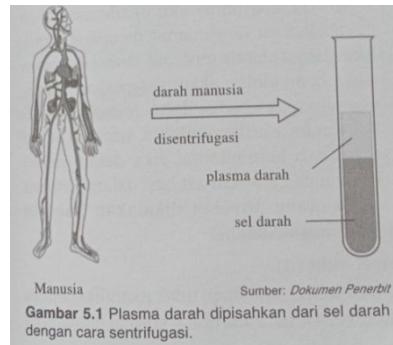


Figure 18. Metafora – Sample C

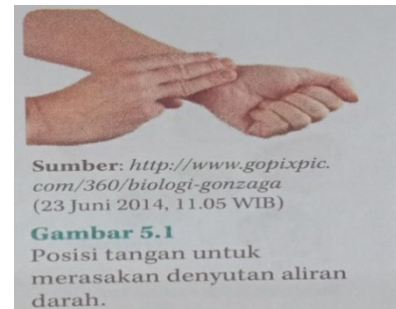


Figure 19. Realistic – Sample B

Conclusions

Based on the analysis that has been carried out on the visual representation of SMA / MA biology books in the Stabat city area for circulation system material, it can be concluded that the most distribution is in the suitability of the material with the material content, namely in the relationship with the percentage in the Erlangga book 100%, Grafindo book 95%, and the Triumvirate book 100%. Then for the Visual Representation relationship contained in the SMA/MA biology book, it was found to be more dominant for the category of there is a relationship compared to the category of meaningful relationships in the circulatory system material presented. In addition, when analyzed about the reality of images, visual representations display metaphorical visual representation relationships in analyzed biology textbooks. In addition to choosing a textbook, teachers should pay attention not only to the content of the learning material but also to look at the components in the book, one of which is the image in the textbook. This will be useful to support students' understanding of the concepts taught. Then suggestions can be conveyed to publishers and textbook authors to be able to modify or continuously develop so that the images in the textbook are more realistic. Then, for further research, we can create the material not only in one chapter but can be even more comprehensive. Besides that, the scope of the area can also be expanded into one area and can cover the entire territory of Indonesia.

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Declaration statement

The authors reported no potential conflict of interest

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