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The Skill Profile of Pre-Service Science Teachers In Writing STREM-Based (Science-Technology-Religion-Engineering-Mathematics) Science Teaching Materials

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Abstract

This study aims to identify the profile of STREM-based science writing skills in pre-service science teachers. The study was done using a descriptive method through a study of STREM-based science teaching materials documentation written by the pre-service science teachers. The target population is the seventh-semester students. Fifty people who are enrolled in the elective course of Integrated Science Learning were selected through Purposive Sampling. Performance assessment of the STREM-based science teaching materials was done using an analytical rubric with a score of 1-4 on the aspect of pedagogic, content, and context. Determination of inter-rater reliability was taken from 25 random samples of teaching materials and correlated their scores using Pearson's correlation. The inter-rater reliability score obtained is 0.938 in all aspects of teaching materials; 0.690 in the pedagogic aspect; 0.976 in the aspect of content; and 0.921 in the context aspect. The score of the teaching materials is then converted in the form of a percentage and interpreted based on certain criteria. The average score of pre-service science teachers' writing skills was 53.3% in the "good" criteria. The writing quality of teaching materials has not yet met the expected criteria from the pedagogic, content, and context aspects. Thus, it is important to develop appropriate learning strategies to improve the writing skills of STREM-based science teaching materials for pre-service science teachers.

Keywords: Writing Skills, STREM, Teaching Materials, Preservice Science Teacher

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INTRODUCTION

Writing teaching materials is an essential skill of a teacher because it is one of the main tasks of a teacher during their teaching assignments (Peraturan Menteri Pendidikan Nasional, 2007). In the Permediknas, it is stated that every teacher is required to meet academic quality and competency standards. The teacher competency standards consist of four main competencies, including pedagogic, personality, social, and professional competencies. Professional competencies that must be met by a teacher include developing learning materials that are guided through creativity (Peraturan Menteri Pendidikan Nasional, 2007). Therefore, a professional teacher is required to be creative to be able to write teaching materials that are innovative, varied, interesting, contextual, and are based on the students' necessities. Teaching materials are all materials (both information, tools,

and texts) that are systematically arranged, displaying competencies that will be learned by students and used in the learning process with the aim of planning and reviewing learning implementation. Interesting, effective, and efficient learning certainly requires innovative teaching materials (Prastowo, 2012)

Science is the study of nature to understand and form the foundation of organized knowledge that has the power to predict and be applicable in society (Chiappetta & Koballa, 2010). To broaden students' view and increase awareness that science is not merely about memorizing concepts or understanding mathematical formulas, it is necessary to discuss the relationship between the concepts studied and the context in the real world in the science teaching materials, namely phenomena that occur and are experienced by students (Fensham, 2009). Science teaching materials that discuss the relation between concepts and real-world contexts are in line with the main feature of the PISA project by OECD, which is assessing scientific literacy in 15-year-old students (OECD, 2006), that are junior high school students. Furthermore, the current learning approach strongly supports the achievement of 21st-century competencies in Science, Technology, Engineering, Mathematics (STEM)-based learning. To train students' 21st-century skills, which include problem-solving skills, the learning process must have the characteristic that relates science concepts to problems encountered in the real world using the STEM approach (Yanuar, 2018). In STEM learning, educators must be able to integrate knowledge, skills, and values of science with technology, engineering, and mathematics to be able to solve a problem related to learning in the context of everyday life. (Setiawan et al, 2020).

Science learning is a means for students to be STEM literate. STEM literacy can be defined as; First, the knowledge, attitudes, and skills to identify questions and problems in real-world situations, explain natural phenomena, design, and draw evidence-based conclusions about STEM-related issues. Second, the understanding of characteristics of STEM disciplines as a form of human-initiated knowledge, inquiry, and design. Third, the awareness of the STEM disciplines that make up the material, intellectual, and cultural environment. Fourth, the desire to examine issues related to STEM (energy limitations, climate change, disaster mitigation, competency development) as constructive, caring, and reflective citizens by using the ideas of science, technology, engineering, and mathematics (Bybee, 2010; Ceylan & Ozdilek, 2014). It can be concluded that the learning process involving the four components in STEM can train students' problem-solving skills related to real-life contexts.

In schools, especially in Islamic schools, science learning should not be separated from the contents of tauhid and should become a means of teaching akhlak (morals) that can lead students to increase their faith in Allah. Lessons on the benefits of technology and natural phenomena should also be followed by an encouragement to be grateful because said phenomena are Allah's blessings given to humans (Zarman, 2020). In the education sector of Indonesia, religious attitudes are a prominent aspect that is reflected in the first Core Competencies (Kompetensi Inti / KI). The 2013 curriculum places spiritual (religious) attitudes at the first order of core competencies. In science subjects at the junior high school level, Basic Competency 1.1 is "to admire the order and complexity of God's creation on the physical and chemical aspects, the life in ecosystems, and the role of humans in the environment, as well as actualizing it in the practice of their religious teachings" (Kementerian Pendidikan dan Kebudayaan, 2013). The integration of religious values into the learning curriculum contributes to producing good human beings who can apply knowledge and skills following Islam (Jamilah, Najib, Dzulkhairi, Ariff, & Ismail, 2014). This becomes a strong foundation for the realization of science learning based on faith values. Furthermore, science learning in itself can also contain religious values (Yudianto,

2005; Widodo, 2021). Science learning is needed to produce scientists who are faithful, devoted, and able to build the nation's morals through a religious approach (Tafsir, 2005 dalam Yudianto, 2005; Poedjiadi, 2005). By incorporating aspects of religious attitudes into STEM, the STREM concept that includes Science, Technology, Religion, Engineering, and Mathematics is proposed (Agustina dkk, 2018b).

In the process of writing teaching materials, teachers should not just convey information. A teacher also needs to note the characteristics of students as the main users of the information. When developing teaching materials, the teachers need to master several aspects that include: 1) student characteristics, 2) the depth and the breadth of the teaching materials developed, 3) the ability to choose the reference for writing teaching materials, 4) the ability to present teaching materials, and 5) the ability to relate the concepts to real-world events (Departemen Pendidikan Nasional, 2008). The adequacy of material coverage also needs to be considered. Adequate coverage of teaching materials will help the achievement of the basic competencies that have been determined. The scope of teaching materials also needs to be determined to find out whether the material to be taught is too much, too little, or enough so that there is a correlation to the basic competencies. The order of presentation is also useful for determining the order of the learning process. The right order, if some of the teaching materials have a prerequisite relationship, will make it easier for students to learn. Students will understand a certain concept easier if the explanation starts from something easy, concrete, and is real in their environment (Prastowo, 2012).

In developing or writing teaching materials, in addition to considering aspects of material content such as the accuracy of concept description and visualization, the teacher must also consider the pedagogical aspects, namely considering the characteristics of students as the readers. Pedagogic knowledge that is used to convey certain material so that it is easily understood by students is called Pedagogical Content Knowledge (PCK) (Shulman, 1986). In addition, there needs to be a discussion about the relationship between the concept of science and the context of technology and engineering. Mastery of science followed by mastery of technology provides various advantages for a country. It has been proven that politically, economically, and militarily strong countries are countries that excel in science and technology (Zarman, 2020). To support STREM-based learning, teachers, especially in Islamic educational institutions, need to add the aspects of spiritual (religious) attitudes in the teaching materials they develop. Education-based on religious values is important to be realized to prevent moral problems such as gang fights, sexual crimes, and consumptive behavior (Yaacob, 2013).

The skill of developing teaching materials, as mandated by the Minister of National Education, has been taught in courses at many Educational Personnel Education Institutions (Lembaga Pendidikan Tenaga Kependidikan / LPTK) as an effort to prepare pre-service teachers to become teachers who meet the required competencies. However, based on several studies related to writing skills of teaching materials that have been carried out, it showed that the ability of preservice teacher in compiling teaching materials was still lacking (Sukawati, Ismayani, & Permana, 2019), even many teachers still lack knowledge in writing teaching materials (Rafiudin, et al, 2021). Other researchers stated that low competence in writing teaching materials for teachers due to low theoretical knowledge of teaching materials and low interest in writing teaching materials (Asniati & Syamsuri, 2021) and the teaching materials made by the teacher were good, but there were several components that were not completely covered the scope of teaching materials based on state curriculum standards (Handayani, S., Halidjah, S., & Ghasya, 2021) and

This study presents the results of observations of STREM based science teaching materials documents for junior high school students made by pre-service teachers. This

study aimed at investigating pre-service science teachers' writing skill of STREM based teaching material to show the need of training writing skill of teaching material strategies. Research question that presents in this study is, how is the profile of the skill level of pre-service science teachers in writing STREM-based science teaching materials at an LPTK in Bandung.

METHODS

This study uses a descriptive method, which is to explore the facts on the field and present them according to the actual conditions. This descriptive method is used to describe pre-service teachers' skills in writing STREM-based science teaching materials. The target population in this study is the seventh-semester students of the Biology Education study program who will carry out the Field-School Professional Program (Program Profesi Lapangan-Sekolah Dekat Rumah / PPL-SDR) in the 2021/2022 academic year. The pre-service teachers carry out PPL-SDR while participating in online lectures for the seventh semester. Purposive sampling in this study was conducted on 50 pre-service teachers in an LPTK located in Bandung who contracted the Integrated Science Learning course consist of 7 men and 18 women. Data collection on STREM-based science teaching materials written by the pre-service teachers in this study is done by using documentation techniques (Creswell, 2012).

Before giving the task of writing STREM-based science teaching materials, the researcher in this case is the author explains the meaning of STREM, why a teacher must be skilled in developing STREM-based science teaching materials and what components should appear in STREM-based science teaching materials to the participants. The pre-service teachers are given 2 weeks to write science teaching materials that must include the STREM aspects. A sample of 50 people was divided into 8 groups. The groups are divided according to the teaching topics/materials which consist of 1) Classification of Living Things, 2) Life Organizational Systems, 3) Structure and Functions of Human Skeleton, Joints, and Muscles, 4) Structure and Functions of Plant Tissues, 5) Diseases and Efforts to Maintain the Respiratory System, 6) Cell Division and the Human Reproductive System, 7) Genetic material and the inheritance of living things through breeding, and 8) Physical and chemical properties of soil, soil organisms, and the importance of soil for the sustainability of life (Kementerian Pendidikan dan Kebudayaan, 2017). The topic set by the researcher are science topics for grades 7 and 8. Topic selection is based on consideration of the relevance of the topic to STREM. In a group of three to four people, the pre-service teachers write teaching materials with the same topic/material and they are allowed to discuss with friends in their group. STREM-based teaching materials are assumed to be used as a learning tool for one class meeting on a certain basic competency.

The analysis of the teaching materials was carried out using a rubric for writing teaching materials which were adapted from a textbook assessment instrument published by BSNP (BSNP, 2014) and further developed by the researchers. The details of the rubric for each component are developed to analyze each component in teaching materials by following normative standards by referring to the reference sources (eg. McNeill & Krajcik 2008). The rubric component for writing teaching materials includes pedagogic, content, and context aspects as presented in Table 4. The pedagogic aspect consists of two sub-components, namely: a) the correlation between the description of the teaching material with the Basic Competence (KD) & Competency Achievement Indicators (IPK), and b) the coherence of the description of the teaching material. The content aspect consists of four sub-components, namely: a) accuracy of the description of the science (biology) material,

b) quantity of visual representations, c) accuracy of visual representations, and d) completeness of visual representations. The context aspect consists of two components, namely: a) relating the concept of science with the context of technology, religion, engineering, and mathematics, and b) the use of sentences in explaining the context of technology, religion, and engineering.

The assessment of STREM-based teaching materials is carried out by two researcher in this case is the authors. Scoring is done using an analytical rubric with a score of 1-4 (Zainul, 2001). Table 1 presents an example of an assessment rubric on the STREM aspect. To determine the inter-rater reliability twenty-five samples of teaching materials were taken randomly from fifty STREM-based teaching materials written by pre service science teacher who involved in this research. When two or more investigators are collecting data, interrater reliability is determined by calculating the percentage of agreement between their scores. In this research, inter-rater reliability were correlated using Pearson's correlation.

Table 1. Examples of Rubrics and Scoring of the Writing Skills for Science Teaching Materials on Technology, Religion, and Engineering Aspects

Indicators	Score	Description
The accuracy of Technology/Religion/Engineering context	1	There is no discussion of the context of Technology/Religion/Engineering in the description of the material
	2	The topic of the context of Technology/Religion/Engineering is not relevant to the science concept in question
	3	The topic of the context of Technology / Religion / Engineering is relevant to the science concept even though it does not come from the immediate environment of the students Unfamiliar to students' environment
	4	The topic of the context of Technology / Religion / Engineering is relevant to the concept of Biology Familiar in the nearest enviroment of the students Familiar with student life
The description of Technology/Religion/Engineering context	1	Cannot be assessed because there is no Technology/Religion/Engineering context
	2	Sentences are difficult to understand, less effective Using a lot of terms that students are not familiar with Lack of attention to students' prior knowledge
	3	Sentences can be understood although less effective. Uses more terms familiar to students. There are efforts to pay attention to students' prior knowledge and student learning needs.
	4	Sentences are easy to understand, effective and use more terms that are already known to students. Very attentive to student learning needs so that students understand the context of science/technology.

The maximum total score to determine the level of quality of the teaching materials written by the pre-service teachers is set at 100. This score reflects the level of skill of the

pre-service teachers in writing teaching materials. The score obtained is then converted in percentage form and then the data is interpreted based on the percentage criteria for the quality of teaching materials adapted from Sinaga Suhandi,A & Liliasari (2014) as presented in Table 2.

Table 2. Quality Criteria for Teaching Materials

Interval (%)	Criteria
81 – 100	Excellent
61 – 80	Very Good
41 – 60	Good
21 – 40	Fair
0 – 20	Poor

RESULTS & DISCUSSION

The analysis of teaching materials was carried out using a rubric for writing teaching materials which was adapted from the textbook assessment instrument published by BNSP (BNSP, 2006) and further developed by the researchers. Inter-rater reliability using Pearson's correlation coefficients obtained results of 0.938 for all aspects of teaching materials; 0.690 for the pedagogic aspect; 0.976 for the content aspect; and 0.921 for the context aspect.

The average score of the pre-service teachers' skills in writing STREM-based science teaching materials is 53.3 which is in the "good" criteria. The distribution of writing skill scores for all participants is shown in Figure 1.

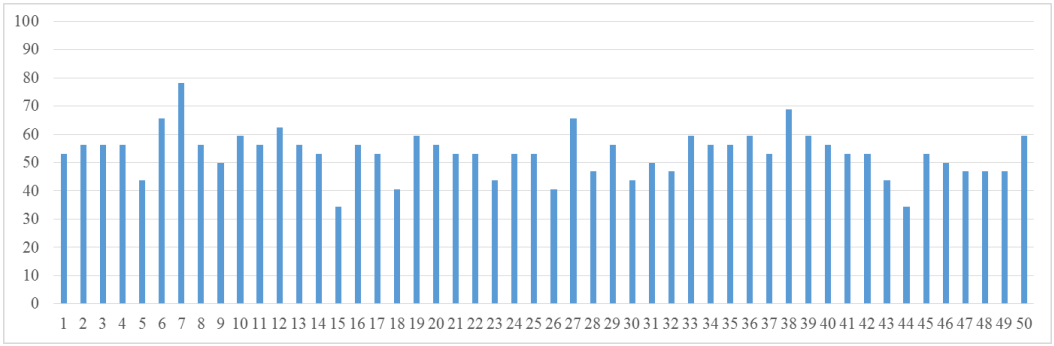


Figure 1. Distribution of Teaching Materials Writing Skills Score

The classification is done based on the quality criteria of teaching materials from all the data obtained, as shown in Table 3.

Table 3. Classification of Teaching Material Quality Criteria

Interval (%)	Criteria	Participants
81 – 100	Excellent	0 (0%)
61 – 80	Very Good	3 (6%)
41 – 60	Good	44 (88%)
21 – 40	Fair	3 (6%)
0 – 20	Poor	0

Based on the quality criteria of teaching materials, it appears that the majority of the quality of teaching materials are in the "good" criteria. This means that as many as 88% of pre-service teachers have the skills to write teaching materials in the "good" category with scores achieved at intervals of 41-60%.

The average score of teaching materials writing skills based on pedagogic aspects, content, and context is shown in Table 4.

a. Teaching Materials Writing Skills based on Pedagogic Aspects

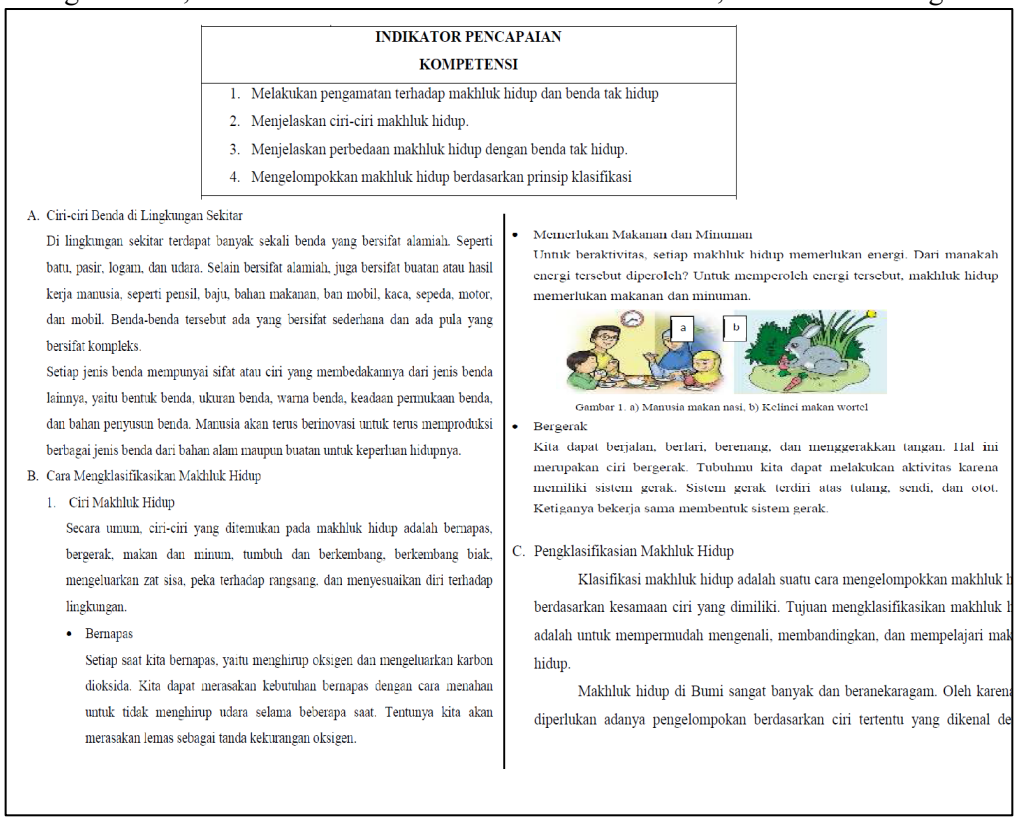
Teaching materials are a means of communication between writers (teachers) and their audiences (students). The quality of the description of the teaching materials is determined by whether or not the depth of the material described is adequate, both in the text mode and in its visualization.

Table 4. Average Score of Teaching Material Writing Skills Based on Pedagogic Aspects, Content, and Context

No	Scoring Aspect	Average Score
I	**Pedagogic**	**61,75**
1	The correlation between the description of teaching materials with Basic Competencies (KD) & Competency Achievement Indicators (IPK)	66
2	The coherence of the description of the teaching material	57,5
II	**Content & Visual Representation**	**58,5**
1	The accuracy of the description of the science (biology) material	62,5
2	The quantity of visual representations	61
3	The accuracy of visual representations	52
4	The completeness of visual representations	58,5
III	**STREM Context**	**34,5**
1	The accuracy of STREM context	35
2	The description of STREM context	34

Using a rubric for writing teaching materials which were adapted from a textbook assessment instrument and further developed by the researchers, the results of the analysis in the pedagogic aspect, in the sub-aspect of the correlation between the description of teaching materials with KD and IPK, only 2% of fifty pre-service teachers as a participant have been able to describe all the material properly. The majority of the pre-service teachers have not yet reached the level of skill in describing the material specified in the KD and IPK. In describing the material, the majority of the pre-service teachers only cover a little or part of the material determined by the KD and IPK, and as a result, there is still a lot of material that is not explained / left behind. This condition show that the learning of pedagogic knowledge given to pre-service teachers who are assumed to have mastered the field of study, is less able to create competent teachers to deliver subject matter to students effectively. Teaching science to students effectively can be done if the teacher is able to integrate content knowledge into knowledge about the curriculum (Erwin et al, 2019). Evens et al's (2018) research on pre-service teachers found that presenting them with pedagogical knowledge domains and content knowledge was not sufficient to develop

PCK. One example of the discorrelation between the IPK and the description of the teaching material, or material that is not described / left behind, can be seen in Figure 2.



INDIKATOR PENCAPAIAN KOMPETENSI

1. Melakukan pengamatan terhadap makhluk hidup dan benda tak hidup
2. Menjelaskan ciri-ciri makhluk hidup.
3. Menjelaskan perbedaan makhluk hidup dengan benda tak hidup.
4. Mengelompokkan makhluk hidup berdasarkan prinsip klasifikasi

A. Ciri-ciri Benda di Lingkungan Sekitar

Di lingkungan sekitar terdapat banyak sekali benda yang bersifat alamiah. Seperti batu, pasir, logam, dan udara. Selain bersifat alamiah, juga bersifat buatan atau hasil kerja manusia, seperti pensil, baju, bahan makanan, ban mobil, kaca, sepeda, motor, dan mobil. Benda-benda tersebut ada yang bersifat sederhana dan ada pula yang bersifat kompleks.

Setiap jenis benda mempunyai sifat atau ciri yang membedakannya dari jenis benda lainnya, yaitu bentuk benda, ukuran benda, warna benda, keadaan permukaan benda, dan bahan penyusun benda. Manusia akan terus berinovasi untuk terus memproduksi berbagai jenis benda dari bahan alam maupun buatan untuk keperluan hidupnya.

B. Cara Mengklasifikasikan Makhluk Hidup

1. Ciri Makhluk Hidup

Secara umum, ciri-ciri yang ditemukan pada makhluk hidup adalah bernapas, bergerak, makan dan minum, tumbuh dan berkembang, berkembang biak, mengeluarkan zat sisa, peka terhadap rangsang, dan menyesuaikan diri terhadap lingkungan.

- Bernapas

Setiap saat kita bernapas, yaitu menghirup oksigen dan mengeluarkan karbon dioksida. Kita dapat merasakan kebutuhan bernapas dengan cara menahan untuk tidak menghirup udara selama beberapa saat. Tentunya kita akan merasakan lemas sebagai tanda kekurangan oksigen.

- Memerlukan Makanan dan Minuman

Untuk beraktivitas, setiap makhluk hidup memerlukan energi. Dari manakah energi tersebut diperoleh? Untuk memperoleh energi tersebut, makhluk hidup memerlukan makanan dan minuman.

Gambar 1. a) Manusia makan nasi, b) Kelinci makan wortel

- Bergerak

Kita dapat berjalan, berlari, berenang, dan menggerakkan tangan. Hal ini merupakan ciri bergerak. Tubuhmu kita dapat melakukan aktivitas karena memiliki sistem gerak. Sistem gerak terdiri atas tulang, sendi, dan otot. Ketiganya bekerja sama membentuk sistem gerak.

C. Pengklasifikasian Makhluk Hidup

Klasifikasi makhluk hidup adalah suatu cara mengelompokkan makhluk h berdasarkan kesamaan ciri yang dimiliki. Tujuan mengklasifikasikan makhluk h adalah untuk mempermudah mengenali, membandingkan, dan mempelajari mak hidup.

Makhluk hidup di Bumi sangat banyak dan beranekaragam. Oleh karena diperlukan adanya pengelompokan berdasarkan ciri tertentu yang dikenal de

Figure 2. Examples of Teaching Materials on the Correlation Aspect of Material Description with IPK

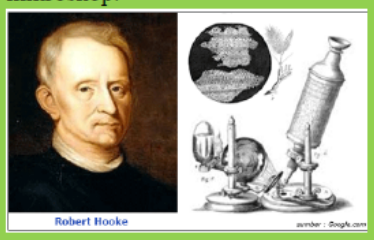
The skills that need to be improved in the pedagogic aspect are in terms of paying attention to the coherence of the description of the teaching material. This sub-aspect relates to skills in measuring students' learning abilities and prior knowledge. This component is very important in writing teaching materials because it is closely related to the purpose of writing teaching materials. Coherency is the order of description of the material starting from factual knowledge to conceptual (Anderson & Krathwohl, 2010). The coherency of presenting the teaching materials content should begin with knowledge that is familiar to or has been studied by students and continued by explaining concepts that are unfamiliar and will be studied. Consistent presentation will make it easier for students to learn, and also lead students to get used to thinking coherently. However, these skills have not been mastered by the pre-service teachers. In making material descriptions, as many as 66% of fifty pre-service teachers do not start from factual knowledge to conceptual knowledge, and do not show a coherent and relevant link to connect easy/concrete concepts with complex/abstract concepts. The writer (teacher) who does not consider students' learning abilities and students' prior knowledge, by Gunstone, McKittrick, and Mulhall (2005), is referred to as a condition that only focuses on the author's own understanding. Figure 3 shows an example of teaching materials written by a pre-service teacher.

SISTEM ORGANISASI KEHIDUPAN

A. SEL

Sel merupakan unit (satuan, zarah) terkecil dari makhluk hidup yang dapat melaksanakan kehidupan. Sel disebut sebagai unit terkecil karena sudah tidak dapat dibagi-bagi lagi menjadi bagian yang lebih kecil yang berdiri sendiri. Secara strukturan, tubuh makhluk hidup tersusun atas sel-sel sehingga sel disebut satuan strukturan makhluk hidup. Secara fungsional, tubuh makhluk hidup dapat melangsungkan kehidupan jika sel-selnya berfungsi. Oleh karena itu tiap-tiap sel yang membentuk organisme dan sel disebut sebagai satuan fungsional makhluk hidup.

Sel pertama kali ditemukan oleh Robert Hooke pada tahun 1665. Ia melihat pada sayatan sel gabus (sel mati). Lihat Gambar 6.2 ukuran sel sangat kecil sehingga baru terlihat dengan bantuan mikroskop.



Gambar 6.2 Penemuan Robert Hooke

Figure 3. Examples of Teaching Materials on Coherency Aspects of Material Description

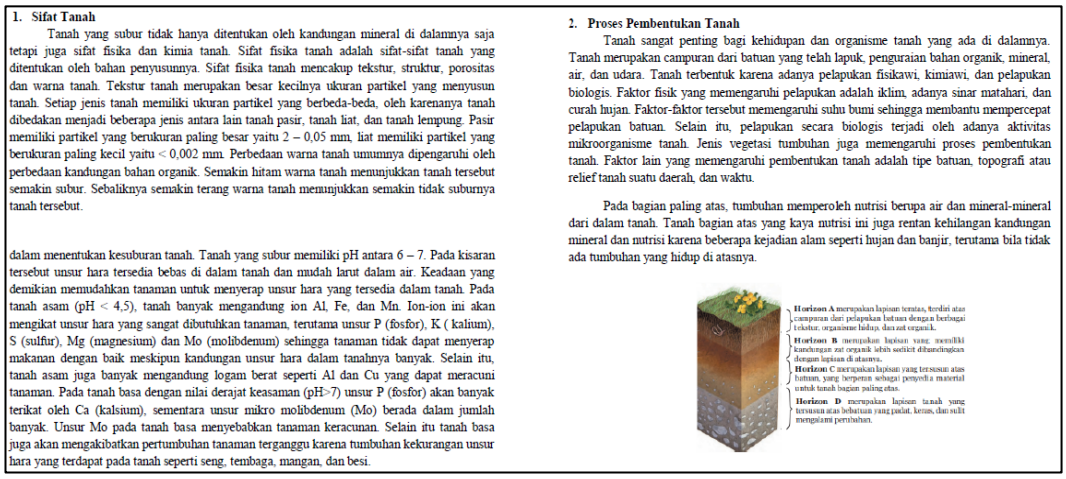
In Figure 3, it appears that the explanation of cells (which is an abstract concept) does not begin with an explanation related to informations familiar to students. Explanation of cells can begin with the fact that if we look at a piece of cork through a microscope, we will see a lot of empty spaces in the shape of a box that looks like a honeycomb, and Hooke named these parts as "cells".

b. Teaching Materials Writing Skills based on Content Aspects

Using a rubric for writing teaching materials which developed by the researchers, the results of the analysis in the sub-aspects of the accuracy of the description of the science (Biology) material, 34% of fifty pre-service teachers as a participant have adequate skills. The accuracy of the description seems to have been in accordance with the learning needs of students at the junior high school level and based on the results of reading appropriate reference sources. Although there are still a few errors in the description of the material, it only requires minor improvements that do not cause misconceptions. However, there are still 66% of the pre-service teachers who still have a few errors in the description of the material and do not cause misconceptions, but it appears that the description of the material is based on the results of reading inappropriate reference sources. The description of the material does not seem to suit the target audience and the learning needs of students at the junior high school level. Figure 4 shows an example of teaching materials written by a pre-service teacher on the topic of Soil.

It appears that the description of the material shown in figure 4 regarding Soil is not appropriate if it is read by junior high school students due to the many unfamiliar scientific terms. The description of the material seems to be based on reference sources or textbooks for a pre-service teacher. In order to suit the varying intellectual conditions of students and to maintain the clarity and accuracy of subject matter as desired by experts,

the material should be transformed and manipulated first so that it meets the criteria of being easily teachable and easily accessible (Siregar, 1998).



1. Sifat Tanah

Tanah yang subur tidak hanya ditentukan oleh kandungan mineral di dalamnya saja tetapi juga sifat fisika dan kimia tanah. Sifat fisika tanah adalah sifat-sifat tanah yang ditentukan oleh bahan penyusunnya. Sifat fisika tanah mencakup tekstur, struktur, porositas dan warna tanah. Tekstur tanah merupakan besar kecilnya ukuran partikel yang menyusun tanah. Setiap jenis tanah memiliki ukuran partikel yang berbeda-beda, oleh karenanya tanah dibedakan menjadi beberapa jenis antara lain tanah pasir, tanah liat, dan tanah lempung. Pasir memiliki partikel yang berukuran paling besar yaitu 2 – 0,05 mm, liat memiliki partikel yang berukuran paling kecil yaitu < 0,002 mm. Perbedaan warna tanah umumnya dipengaruhi oleh perbedaan kandungan bahan organik. Semakin hitam warna tanah menunjukkan tanah tersebut semakin subur. Sebaliknya semakin terang warna tanah menunjukkan semakin tidak suburnya tanah tersebut.

dalam menentukan kesuburan tanah. Tanah yang subur memiliki pH antara 6 – 7. Pada kisaran tersebut unsur hara tersedia bebas di dalam tanah dan mudah larut dalam air. Keadaan yang demikian memudahkan tanaman untuk menyerap unsur hara yang tersedia dalam tanah. Pada tanah asam (pH < 4,5), tanah banyak mengandung ion Al, Fe, dan Mn. Ion-ion ini akan mengikat unsur hara yang sangat dibutuhkan tanaman, terutama unsur P (fosfor), K (kalium), S (sulfur), Mg (magnesium) dan Mo (molibdenum) sehingga tanaman tidak dapat menyerap makanan dengan baik meskipun kandungan unsur hara dalam tanahnya banyak. Selain itu, tanah asam juga banyak mengandung logam berat seperti Al dan Cu yang dapat meracuni tanaman. Pada tanah basa dengan nilai derajat keasaman (pH>7) unsur P (fosfor) akan banyak terikat oleh Ca (kalsium), sementara unsur mikro molibdenum (Mo) berada dalam jumlah banyak. Unsur Mo pada tanah basa menyebabkan tanaman keracunan. Selain itu tanah basa juga akan mengakibatkan pertumbuhan tanaman terganggu karena tumbuhan kekurangan unsur hara yang terdapat pada tanah seperti seng, tembaga, mangan, dan besi.

2. Proses Pembentukan Tanah

Tanah sangat penting bagi kehidupan dan organisme tanah yang ada di dalamnya. Tanah merupakan campuran dari batuan yang telah lapuk, penguraian bahan organik, mineral, air, dan udara. Tanah terbentuk karena adanya pelapukan fisikawi, kimiawi, dan pelapukan biologis. Faktor fisik yang memengaruhi pelapukan adalah iklim, adanya sinar matahari, dan curah hujan. Faktor-faktor tersebut memengaruhi suhu bumi sehingga membantu mempercepat pelapukan batuan. Selain itu, pelapukan secara biologis terjadi oleh adanya aktivitas mikroorganisme tanah. Jenis vegetasi tumbuhan juga memengaruhi proses pembentukan tanah. Faktor lain yang memengaruhi pembentukan tanah adalah tipe batuan, topografi atau relief tanah suatu daerah, dan waktu.

Pada bagian paling atas, tumbuhan memperoleh nutrisi berupa air dan mineral-mineral dari dalam tanah. Tanah bagian atas yang kaya nutrisi ini juga rentan kehilangan kandungan mineral dan nutrisi karena beberapa kejadian alam seperti hujan dan banjir, terutama bila tidak ada tumbuhan yang hidup di atasnya.

Figure 4. Example of Learning Material on the Topic of Soil

On the other hand, there are still many pre-service teachers (66%) who present material descriptions that are inaccurate, in which the material descriptions are too shallow and concise. Figure 5 shows an example of teaching materials on the characteristics of living things written by a pre-service teacher. It appears that the description of the material on the characteristics of living things is not appropriate if it is intended for students at the junior high school level. The description of the material is more appropriate if it is intended for elementary school students.

1. Ciri-ciri Makhluk Hidup

a. Bernapas

Ketika saat sedang bernapas, kita menghirup udara yang mengandung oksigen dan mengeluarkan udara yang mengandung karbondioksida.

b. Memerlukan makan dan minum

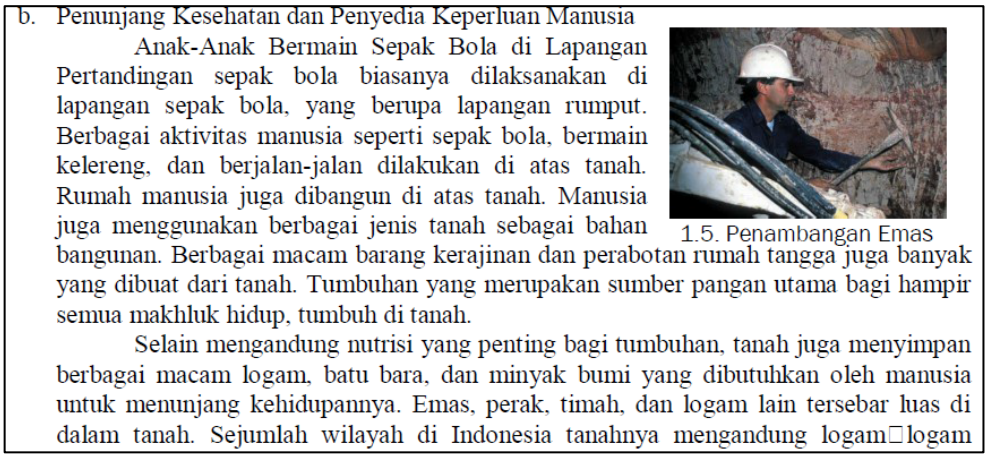
Untuk dapat beraktivitas, kita membutuhkan energi. tubuh dapat menghasilkan energi dari makanan dan minuman yang telah kita konsumsi

a) Kambing makan rumput; b) Manusia makan nasi

Figure 5. Example of Learning Material on the Topic of Characteristics of Living Things

In the sub-aspect of visual representation, namely the quantity and accuracy of visual representations, it was found that 54% of the pre-service teachers were skilled enough in presenting visual representations. The majority of the visual representations used

are images. The visual representation is mostly accurate, although it requires only minor improvements for accuracy. Analysis of teaching materials shows that in presenting visual representations in the form of images, 30% of the pre-service teachers still need a lot of improvement in accuracy, with problems such as: 1) pictures are still difficult to read, 2) pictures are still in English instead of Indonesian, 3) tables are not equipped with titles, and 4) not all modes of visual representation are referenced in the body of writing. There are still images that do not function as a support in the explanation of the concept, so that the image appears to be just an accessory. Multimode representation is concerned with understanding concepts that are still superficial and deep conceptual understanding only really materializes when one is able to generate connections within and between different representations (Ainsworth, 2006). Figure 6 is an example of a visual representation that does not support the explanation of the concept.


b. Penunjang Kesehatan dan Penyedia Keperluan Manusia

Anak-Anak Bermain Sepak Bola di Lapangan Pertandingan sepak bola biasanya dilaksanakan di lapangan sepak bola, yang berupa lapangan rumput. Berbagai aktivitas manusia seperti sepak bola, bermain kelereng, dan berjalan-jalan dilakukan di atas tanah. Rumah manusia juga dibangun di atas tanah. Manusia juga menggunakan berbagai jenis tanah sebagai bahan bangunan. Berbagai macam barang kerajinan dan perabotan rumah tangga juga banyak yang dibuat dari tanah. Tumbuhan yang merupakan sumber pangan utama bagi hampir semua makhluk hidup, tumbuh di tanah.

1.5. Penambangan Emas

Selain mengandung nutrisi yang penting bagi tumbuhan, tanah juga menyimpan berbagai macam logam, batu bara, dan minyak bumi yang dibutuhkan oleh manusia untuk menunjang kehidupannya. Emas, perak, timah, dan logam lain tersebar luas di dalam tanah. Sejumlah wilayah di Indonesia tanahnya mengandung logam□logam

Figure 6. Visual Representation That Doesn't Support Concept Explanation

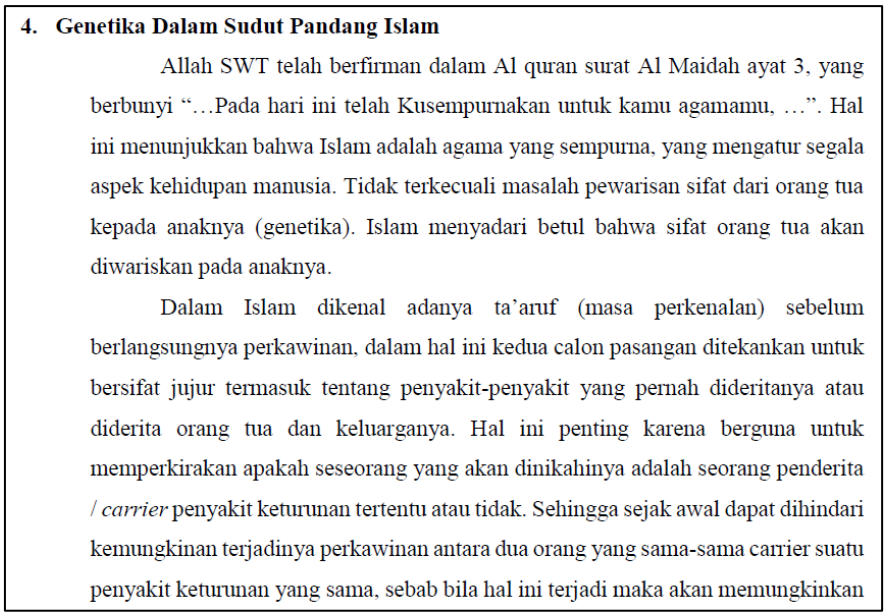
Around 12% of the pre-service teachers only use text without using any visual representations. This situation is in line with the statement of DiSessa (2004) and Eilam (2012) which state that the development of visual representations is very challenging, because visual representation uses symbolic language and conventions that have special characteristics.

c. *Teaching Materials Writing Skills based on Context Aspects*

In the context aspect of teaching material, two components are covered: a) relating the concept of science with the context of technology, religion, engineering, and mathematics, and b) the use of sentences in explaining the context of technology, religion, and engineering. To broaden students' view and increase their awareness that science lessons are not just about memorizing concepts or understanding mathematical formulas, teaching materials should discuss the relationship between the concepts being studied and phenomena that occur and are experienced by students. Therefore, the discussion of the material needs to include a contextual discussion. From the results of the analysis of teaching materials using a rubric which developed by the researchers, it appears that only 2% of fifty pre-service teachers relate the concept of science to the context of technology/engineering in the description of the teaching material. Most of the pre-service teachers do not relate the concept of science with the context of technology/engineering. This condition is in line with the opinion of Fensham (2009), that relating real-world

contexts involving science and technology is not an easy task for science teachers. Their academic background (as a teacher) is more likely to be in the field of scientific concepts than in its field of application, and most of the pre-service teachers have no hands-on experience, either through scientific research or investigating real-world problems. They may also feel inexperienced and insecure about their non-scientific abilities.

As an effort to develop student's spiritual attitude (the first order of core competence), namely increasing faith in God, it is necessary to incorporate the value of faith in teaching materials by relating science concepts with religious aspects. In this aspect, 68% of the pre-service teachers do not relate the concept of science with the context of religion in the body of written texts. Based on a rubric which developed by the researchers, there are only 8% of fifty pre-service teachers who relate the science concept to the context of religion (Qur'anic verses) with good relevance. Around 24% of the pre-service teachers who are already able to relate the concept of science to aspects of religion, even though they are less relevant in choosing the right verses of the Qur'an. Contextualization of religion into the science concept can be done with the following models: 1) providing an introduction containing Islamic advice, 2) relating natural phenomena with the existence of God, 3) revealing the wisdom of nature's creation that fosters gratitude, 4) inserting relevant verses from the Qur'an or hadith, 5) correcting science concepts that are contrary to Islamic teachings, 6) incorporating information about Muslim scientists and their contribution in science, and 7) relating science material with the application of Islamic teachings (Zarman, 2020). Figure 7 provides an example of the religious aspects on the topic of genetic material and inheritance. In this teaching material, the contextualization model carried out by the pre-service teacher is to relate science material with the application of Islamic teachings.



4. Genetika Dalam Sudut Pandang Islam

Allah SWT telah berfirman dalam Al quran surat Al Maidah ayat 3, yang berbunyi "…Pada hari ini telah Kusempurnakan untuk kamu agamamu, …". Hal ini menunjukkan bahwa Islam adalah agama yang sempurna, yang mengatur segala aspek kehidupan manusia. Tidak terkecuali masalah pewarisan sifat dari orang tua kepada anaknya (genetika). Islam menyadari betul bahwa sifat orang tua akan diwariskan pada anaknya.

Dalam Islam dikenal adanya ta'aruf (masa perkenalan) sebelum berlangsungnya perkawinan, dalam hal ini kedua calon pasangan ditekankan untuk bersifat jujur termasuk tentang penyakit-penyakit yang pernah dideritanya atau diderita orang tua dan keluarganya. Hal ini penting karena berguna untuk memperkirakan apakah seseorang yang akan dinikahinya adalah seorang penderita / *carrier* penyakit keturunan tertentu atau tidak. Sehingga sejak awal dapat dihindari kemungkinan terjadinya perkawinan antara dua orang yang sama-sama carrier suatu penyakit keturunan yang sama, sebab bila hal ini terjadi maka akan memungkinkan

Figure 7. Relating Science Material with the Application of Islamic Teachings

CONCLUSION

The pre-service teachers involved in this research are seventh semester students who have received several assignments to write teaching materials in previous years, so it

is assumed that students already have skills in writing teaching materials. However, from the results of our study it appears that writing quality of teaching materials produced by the pre-service teachers has not met the expected criteria from the pedagogic, content, and context aspects. In the pedagogic aspect, the material description only covers a little or part of what is determined by the KD and IPK, and there is still a lot of material that is left unexplained. In addition, the teaching materials do not start the description from factual knowledge to conceptual knowledge and do not show a coherent and relevant link to connect easy/concrete concepts with complex/abstract concepts. In terms of content, the description of the material (text) does not seem to suit the target audience and the learning needs of students at the junior high school level. As well as the lack of a complete and synchronous reflection as a single unit in explaining the concept of Science (Biology). The material descriptions have been equipped with visual representations in the form of images, although most of them still need a little improvement for accuracy. Almost all of the pre-service teachers (98%) do not relate the science concepts discussed to the context of science/technology. Around 24% of the pre-service teachers have been able to relate the concept of science to aspects of religion, even though the topic is less relevant in determining the verses of the Qur'an. During writing teaching material process the pre-service teachers must maintain a focus on factors such as organization, form and features, purposes and goals, audience needs and perspectives, and evaluation of the communication between author and reader. This activity is a highly complex and demanding process. To manage the cognitive load brought on by these processes, writers frequently use strategies. It is the responsibility of the lecturer to teach strategies in writing to their students in develop teaching material writing skills well during their studies. The strategy is provided by lecturers of the respective discipline are recommended: (1) Promote students' development of positive attitudes about writing and themselves as writers, (2) Assist students in developing knowledge about STREM based writing teaching material and strategies involved in the writing process, including planning, writing, revising, and editing, (3) Support students in the ongoing development of the abilities needed to monitor and manage their own writing.

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