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ANALYSIS OF THE STRUCTURE AND CONTENT OF THE MERDEKA CURRICULUM ON GREEN CHEMISTRY MATERIALS

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Abstract: This research aims to describe the compatibility between the structure and content of Merdeka's curriculum on green chemistry based on the revised Bloom's Taxonomy, Dave and Dyers' Taxonomy, and chemistry textbooks. This research is descriptive with a qualitative approach with a content structure analysis research design derived from the Model of Educational Reconstruction (MER). The data collection technique was carried out based on a literature study, while the data analysis technique was carried out based on the Milles and Huberman data analysis technique. The instruments used standard content analysis tables and structural analysis tables. The standard content analysis table was prepared according to the revised Bloom's and Dave and Dyers' taxonomy. The content structure analysis table measures the breadth of the material, guided by the senior high school textbook from the Ministry of Education and Culture, and the depth of the material is guided by the Handbook of Green Chemistry and Technology by James Clark & Duncan Macquarrie. The research results obtained (1) Elements of chemical understanding were following the revised Bloom taxonomy, (2) Elements of process skills only dominated abstract skills, (3) Elements of the Pancasila student profile contained abstract skills and the realm of attitude. Whereas in content analysis, (1) the breadth of material on the learning outcomes of green chemistry is by high school books from the Ministry of Education and Culture, (2) the depth of material contained in high school chemistry textbooks published by the Ministry of Education and Culture has not explained in more detail less in presenting the questions, and some material was not suitable to be placed for phase E high school based on the Merdeka's curriculum.

Keywords: *Content Structure Analysis, Green Chemistry Material, Merdeka Curriculum.*

INTRODUCTION

Merdeka's curriculum is a refinement of the 2013 curriculum in realizing Indonesia's superior human resources through educational transformation [1]. This curriculum was raised to create independence for students or teachers in education, both in terms of content and administration [2]. The mechanism for implementing the independent curriculum according to the Decree of the Minister of Education, Culture, Research and Technology of the Republic of Indonesia Number 56 of 2022, concerning "The Guidelines for Implementing Curriculum in the Context of Recovery of Learning" regarding planning for preparing teaching modules, states that the government provides learning goal that will be implemented to students. Furthermore, educational units and teachers can develop this learning goal into learning objectives, and learning objectives flow in teaching modules according to student needs.

The implementation of Merdeka's curriculum is also complemented by establishing Graduate Competency Standards as stipulated in The Ministry of Education and Culture Regulation 5 of 2022 concerning Graduate Competency Standards at the early childhood education level, basic education level, and secondary education level. In addition, standards are also set in planning, implementing, and evaluating activities during learning in the form of content, process, and assessment standards. Setting content, process, and even assessment standards in implementing the independent curriculum is indispensable in creating effective and efficient learning. Another goal is to fully develop students' attitudes, knowledge, and skills. In addition, learning resources are also needed to create effective and efficient learning; one of these is through textbooks. Textbooks are a learning resource that helps teachers and students [3].

Textbooks are learning tools compiled directly by experts, both material substance experts, books, learning, and even from education practitioners who are adapted to the demands of the curriculum [4]. Textbooks consist of main textbooks and supplementary textbooks. The government provides the main textbooks to the Ministry of Education and Culture. In contrast, complementary textbooks are published by the private sector and are used as additional learning references by teachers and students [5]. Therefore, the use of textbooks must be clear regarding the materials, concepts, and information available [6].

The quality of the main textbooks is one of the determining factors for the success of teachers and students in the use of textbooks [7]. Several aspects that must be considered in the main textbooks used include alignment of content, material with the curriculum, arrangement of material presented, and level of mastery of the material [8]. The main textbooks that are scattered are always adapted to the

applicable curriculum. However, discrepancies are often found in presenting material with the applicable curriculum competency standards [9]. In response to this, of course, the National Education Standards Agency has criteria for assessing whether or not a textbook is appropriate to be used in learning activities. Several aspects that must be met include presentation feasibility, language eligibility, content eligibility, and graphic eligibility, which consists of an initial section, a content section, and an ending section[10].

Based on the results of interviews with several high school chemistry teachers at driving schools in the city of Padang, it was found that learning activities already used the main textbooks sourced from the Ministry of Education and Culture, according to Merdeka. However, the material presented in the main textbooks still needs to be more general and complete, so most teachers take additional material from supplementary textbooks and the Internet. Especially for green chemistry material, the material presented is still fairly general, and several sub-material placements need to be in the order in which they should be taught to the students.

Based on this problem, it is necessary to analyze the structure and content of the independent curriculum in Phase E chemistry subjects, especially green chemistry material. Stages in structural analysis, namely analyzing the compatibility of the learning goal formulation in the independent curriculum based on students' cognitive level guided by the revised Bloom taxonomy, process skills, and Pancasila student profiles according to abstract skills and affective domains. At the same time, the stages in the content analysis are by analyzing the breadth and depth of the material, in the form of material coverage and material sequences, that are guided by chemistry by the main textbooks, which are limited by high school textbooks from the Ministry of Education and Culture. Therefore, it is necessary to conduct an analysis that aims to further analyze the suitability of chemical material green in the (*Kemendikbudristek)* chemistry class books in phase E with an independent curriculum both in structure and content based on Bloom's taxonomy and Dave and Dyers.

RESEARCH METHODS

This research includes descriptive research with a qualitative approach. Descriptive research describes a phenomenon that is real, actual, and happening at this time based on the facts, characteristics, and relationships that occur [11]. A qualitative approach is defined as research that produces data in a written or spoken form, and the object can be observed holistically [12]. The research design was to analyze the structure and content, which is carried out according to the first stage of MER (Model of Educational Reconstruction). The purpose of designing MER is to become a research framework for developing science education and to serve as a guide in planning science education practice activities in schools [13]. The MER component consists of 3 stages, namely: (1) content structure analysis, (2) teaching and learning research, (3) lesson development and evaluation [14].

In its implementation, the research phase was only carried out on the content structure analysis activities according to the first stage in the MER model. The activities carried out in the structure analysis stage discuss the suitability between the analysis of levels of knowledge, skills, and attitudes according to the taxonomy of Bloom, Dave, and Dyers. Furthermore, contents analysis activities were carried out, which discussed the suitability of the material in the main textbooks, which were limited to the science textbooks from the Ministry of Education and Culture. The data collection technique used a literature study, while the data analysis technique used the theory of Miles and Huberman. Miles and Huberman's analysis stages are data reduction, data presentation, and conclusion [15]. The research instrument used consisted of content standard analysis tables and analysis tables for levels of knowledge, attitudes, and skills in green chemistry material. Sources of data come from teacher books and student books entitled natural sciences, published by the Ministry of Education and Culture, the Handbook of Green Chemistry and Technology by James Clark & Duncan Macquarrie, as well as learning goals according to the Decree of the Agency for Research, development, and bookkeeping number 28 of 2021.

RESULTS AND DISCUSSION

Analysis of levels of knowledge, attitudes, and skills (structural analysis) in green chemistry material

This analysis still used the learning goal published by the Ministry of Education and Culture by producing three elements: knowledge level, process skill, and Pancasila student profile. The results of the analysis are presented in Table 1

Table 1. Knowledge level analysis

Learning goal	Knowledge Level
Applying chemical concepts in environmental management includes explaining the phenomenon of global warming.	apply (C3) explain (C2)
1. Observing	choose (C1)

Able to choose the right tools to make measurements and observations. Pay attention to relevant details of objects	
2. Questioning and predicting Identify questions and problems that can be investigated scientifically. Students connect existing knowledge with new knowledge to make predictions	predict (C2) identify (C1)
3. Plan and conduct an investigation Students plan scientific investigations and carry out operational steps using correct references to answer questions. Students measure or compare the dependent variable using appropriate tools and pay attention to scientific principles	do (C3) compare (C2)
4. Processing and analyzing data and information Interpret the information obtained honestly and responsibly. Analyze using appropriate tools and methods, assess the relevance of the information found by including references, and conclude the results of the investigation	process (C3) analyze (C4) interpret (C2) evaluate (C5) conclude (C5)
5. Evaluate and reflect Students are brave and polite in evaluating conclusions through comparisons with existing theories. Demonstrate the advantages and disadvantages of the inquiry process and its effect on the data. Point out problems in the methodology and propose suggestions for improvement for the next investigation process.	evaluate (C5)
6. Communicate results It is communicating the results of the investigation as a whole, including considerations of safety, environment, and ethics supported by arguments, language, and scientific conventions that are appropriate to the context of the investigation. Demonstrate a pattern of systematic thinking according to the specified format.	show (C1)

Table 2. Skill level analysis

Learning goal	Concrete skills	Abstract skills
Applying chemical concepts in environmental management includes explaining the phenomenon of global warming.		
1. Observing Able to choose the right tools to make measurements and observations. Pay attention to relevant details of objects	Choose (P2)	Observe (KA1)
2. Questioning and predicting Identify questions and problems that can be investigated scientifically. Students connect existing knowledge with new knowledge to make predictions.		ask (KA2)
3. Plan and conduct an investigation Students plan scientific investigations and carry out operational steps using correct references to answer questions. Students measure or compare the dependent variable using appropriate tools and pay attention to scientific principles	do (P2)	try (KA3)
4. Processing and analyzing data and information Interpret the information obtained honestly and responsibly. Analyze using appropriate tools and methods, assess the relevance of the information found by including references, and conclude the investigation results.		reasoning (KA4)
5. Evaluate and reflect Students are brave and polite in evaluating conclusions through comparisons with existing theories. Demonstrate the advantages and disadvantages of the inquiry process and its effect on the data. Point out problems in the methodology and propose suggestions for improvement for the next investigation process.	show (P3)	reasoning (KA4)
6. Communicate results It is communicating the results of the investigation as a whole, including considerations of safety, environment, and ethics supported by arguments, language, and scientific conventions that are appropriate to the context of the investigation. Demonstrate a		Serve (KA5)

pattern of systematic thinking according to the specified format.	
7. Critical reasoning	Reasoning (KA4)
8. creative	Create (KA6)

Table 3. Attitude level analysis

Learning goal	Attitude
Applying chemical concepts in environmental management includes explaining the phenomenon of global warming	apply (C3) explain (C2)
1. Observing Able to choose the right tools to make measurements and observations. Pay attention to relevant details of objects	chosen (A2) notice (A3)
2. Questioning and predicting Identify questions and problems that can be investigated scientifically. Students connect existing knowledge with new knowledge to make predictions	connect (A4)
3. Have Faith, fear the Almighty God, and have a noble character	practice (A5)
4. Berkebinekaan Global	Practice (A5)
5. Worked together	Practice (A5)
6. Independent	Practice (A5)

Based on the analysis conducted on the Chemistry learning goal formulation in the independent curriculum, it appears that the analysis of the knowledge dimension refers to the revised Bloom taxonomy from Anderson and Krathwohl, the skills domain (which includes abstract and concrete skills), and the affective/attitude domain based on Krathwohl and Bloom. Structural analysis on learning goal green chemistry analyzes three levels: the level of knowledge, skill level, and attitude level. Activities that appear at the knowledge level are choosing, showing, explaining, interpreting, comparing, predicting, applying, processing, analyzing, assessing, evaluating, and concluding. Activities carried out at the level of knowledge are measured based on the revised Bloom's taxonomy adapted to the learning goal from the Ministry of Education and Culture.

The analysis results obtained from the elements of process skills include six elements; observing, questioning, and predicting; planning and conducting investigations; processing and analyzing data and information; evaluating and reflecting; and communicating results. The first process skill element is observing. Observing activities are abstract skills number 1 (KA1)) where students are given the opportunity to pay attention and observe an object that is given/directed in a relevant manner [16]. Furthermore, the second element of process skills is questioning and predicting, which is an abstract skill number 2 (KA2)). In activities carried out in the form, students are allowed to ask questions about the type, quality, and number of questions given to students [16]. In this process skill, students will identify problems that arise to be scientifically identified, so they can relate the knowledge obtained with new knowledge to make predictions. The context of abstract skill 2 (Keterampilan Abstrak 2 (KA2)) is by the questioning indicator.

The third process of skill analysis is planning and conducting investigations. The activity carried out by the students is to develop plans for scientific investigations by the stages obtained from several correct sources to answer questions. In addition, the students measure or compare the dependent variable with appropriate instruments using scientific principles. Therefore, the third process abstract skill element is classified as abstract skill (KA3). The fourth process skill is processing and analyzing data and information. This skill belongs to abstract skills because students can develop interpretations and arguments and draw conclusions from this information [16]. In the fourth element of process skills, students can use appropriate tools and methods and assess the appropriateness of the information obtained.

The results of the fifth skill analysis are evaluating and reflecting. Elements of this skill are included in abstract skills because students are asked to carry out assessments and reflections by providing comparisons based on existing theory to see whether or not there is a theoretical relationship from several non-contradictory sources [16]. The sixth process skill is communicating results. In this skill, students discuss the results of investigations with considerations and arguments regarding inappropriate language in the context of the investigation. The fifth process skill belongs to abstract skills 5 (KA5)) because students interpret findings (through observing activities to reasoning) in the form of writing, graphics, electronic media,

and others [16]. Communication skills do not only focus on oral activities but also can be applied in written form [17].

The results of the analysis of the profile of Pancasila students consist of Faith, piety to the almighty God, noble character; global diversity; working together; independence; critical reasoning; and creativity. Based on the results of the analysis, it was found that the element of Faith; fear of the one and only God; noble character; global diversity; working together; and independence are included in the affective domain category (A5) practice. Activities carried out in the first to fourth precepts are included in the form of practice activities. Practice or characterization is a form of integration of all value systems that are the personality and behavior patterns of a person [18].

Analysis of the fifth element, namely critical reasoning, is classified as an abstract skill (KA4). In this skill, students get information and ideas, analyze and evaluate reasoning, reflect on thoughts and thought processes, and make decisions. The sixth element of the Pancasila student profile is creativity; this element is classified as an abstract skill KA6) because students must produce an idea, design, or decision [16]. In addition, creative elements are carried out as activities that produce something according to their ideas.

Content standard analysis

The results of the analysis of content standards come from an analysis conducted on learning goals and an analysis of the subject matter contained in science books published by the Ministry of Education and Culture and university textbooks. The results of the content standard analysis are listed in Table 1. Based on the standard content analysis results, the green chemistry material included in the learning goal applies chemical concepts in environmental management, including explaining the phenomenon of global warming. The depth of material contained in teacher books and student books from books published by the Ministry of Education and Culture starts with the understanding and importance of green chemistry, which is a prerequisite material for students to know the principles of green chemistry in environmental conservation efforts, chemical processes in everyday life related to things that not by the principles of green chemistry, as well as creating activities that support the principles of green chemistry. The subject matter of chemical processes in everyday life learns about elemental matter, atoms, molecules, chemical equations, and chemical processes. Whereas in the material for creating activities that support the principles of green chemistry, it discusses the United Nations' 2030 sustainable development agenda and biodiesel B-30 as renewable energy. Green chemistry is studied in Phase E for class X SMA/MA, which applies Merdeka's curriculum [10]. The results of the analysis conducted on several university textbooks, Handbook of Green Chemistry and Technology by James Clark & Duncan Macquarrie green chemistry contain the principles of green chemistry as well as green chemistry and sustainable development. The green chemistry material in high school textbooks is applicable, so it does not explain in detail as described in university textbooks.

Content analysis (depth and breadth analysis of material) on green chemistry

The content analysis aims to provide input on the sequence and suitability of the material presented in textbooks from the Ministry of Education and Culture, especially green chemistry material. The depth of a material is related to the level of detail of the concepts that must be mastered by students based on the amount of material contained in the subject matter [19]. The research method used in clarifying this material is analytical by analyzing content and text [20].

Based on the content analysis carried out, the depth and breadth of the material in the learning goal, which studies green chemistry, is by the material in university chemistry textbooks, namely the Handbook of Green Chemistry and Technology by James Clark & Duncan Macquarrie. However, if we look again, there is a slight difference, namely that the green chemistry material in the independent curriculum is not in the learning goal itself but is in the learning goal on global warming. The green chemistry material displayed in the Ministry of Education and Culture textbooks is in a separate chapter. Explanation of green chemistry material in a university textbook entitled Handbook of Green Chemistry and Technology by James Clark & Duncan Macquarie has 23 chapters of material. However, the discussion regarding green chemistry, which is by the material taught at the high school level in the independent curriculum, is only in chapters 1 to 5. The chapter description describes past, present, and future chemistry, the twelve principles of green chemistry and sustainable living, chemistry and the environment, green chemistry and sustainable development, and life cycle assessment: a tool for further identification of a product and process**.**

The Handbook of Green Chemistry and Technology in the first chapter explains that the conditions of human life on Earth require chemicals and their life in the past, present, and future. The chapter talks about the increasing human population and the need for products made from chemical substances, but the production process does not apply the precautionary principle. In addition, some activities are very wasteful, from the disposal and processing of industrial waste from chemicals, so chemists have started to think

about the principle of sustainable life. Therefore, an idea emerged from the United States Environmental Protection Agency (1998) regarding the presented solution, namely the application of green chemistry. The description in chapter 2 describes the twelve principles of green chemistry. The discussion of the twelve principles of green chemistry is explained in detail, starting from the type, the phenomena that arise, the reactions that occur, and even the complete description of the material in one discussion chapter.

Chapter 3 of the book contains materials on chemistry and the environment. The discussion presented was about atmospheric chemistry and terrestrial environmental chemistry. Atmospheric chemistry discusses the structure of the atmosphere, the occurrence of pollution in the troposphere and stratosphere, and even pollution of the built environment. Terrestrial environmental chemistry discusses fresh water and pollution that occurs in fresh water, soil pollution, and pollution in the sea. Furthermore, chapter 4 of the Handbook of Green Chemistry and Technology by James Clark & Duncan Macquarrie discusses the main subject, namely green chemistry and sustainable development. The discussion in Chapter 4 is more detailed and structured on the concept of sustainability, green chemistry, and sustainability parameters, as well as sustainability scenarios. The discussion that appears on green chemistry and sustainability parameters is the procedure for using chemicals according to sustainability principles and the sustainable use of energy and water. The discussion in Chapter 5 describes the life cycle assessment: water for identifying more sustainable products and processes. This cycle contains an LCA method with the principle of extraction from raw materials to the final disposal of a product. And it has also explained the three components of sustainable development: the presence of society, environment, and economy.

The scope of green chemistry material in high school books published by the Ministry of Education and Culture has five learning objectives, namely to describe the meaning and importance of green chemistry, analyze the principles of green chemistry in everyday life, identify chemical processes in everyday life related to things that are not by the principles of green chemistry; and creating activities that support the principles of green chemistry. The problem raised at the beginning of the material was that a chemical factory explosion occurred in Cilegon City. The chronology of the explosion has been explained, even equipped with an illustration. The problems raised direct students to think about what will happen to the Earth and living things if an explosion occurs so that the next narrative directs students to be able to find out about efforts to protect the environment for the global community by getting to know more about green chemistry.

The first and second learning objectives about the understanding and importance of green chemistry depart from four examples of chemical processes (photosynthesis; incomplete combustion; rusting of iron; the baking of bread). The chemical process displayed is equipped with chemical reaction equations and explanations as well. The examples given help students think that not all chemical processes are scary because they are dangerous and should be avoided. Rather, many of the simple activities in everyday life are chemical processes. Then on the third learning objective, the principles of green chemistry in supporting efforts to preserve the environment, namely discussing the 12 principles of green chemistry. The discussion that is raised is only 12 points from the principles of green chemistry, along with one explanatory paragraph, without examples or chemical phenomena that occur. While in activities, students are asked to find the relationship between the principles of green chemistry and facts and solutions in supporting environmental conservation efforts.

The fourth goal is chemical processes in everyday life related to things that do not follow the principles of green chemistry. The first activity that was instructed to students in this learning outcome was that they were asked to pay attention to the periodic system of elements. Students are asked to understand the meaning of elements, the relationship between elements and atoms and molecules, then pay attention to writing chemical equations. So that from some of the material explanations, students are given activities to discuss with their groups balancing chemical reaction equations. After achieving these activities, students are directed to activities to identify chemical processes in everyday life that do not follow the principles of green chemistry and their solutions.

An example is burning plastic waste in the open air. The fifth learning objective is to create activities that support green chemistry principles. Students are introduced to the 17 sustainable development agendas proclaimed by the United Nations. However, the point emphasized is principle number 7 regarding using renewable energy sources. The cases given to students are about accelerating the application of Biosolar 30 (B30) in everyday life. Student activities are directed to seek information from various sources about biodiesel B30 from various sources; then, it is analyzed with the group to display it.

Based on the results of this analysis, the green chemistry material in the Kemdikbudristek textbooks is by university textbooks. Still, for the level of depth, the material needs to be more detailed and systematic. Several material

subchapters need to be revised to be taught first when referring to the existing arrangements in the Kemendikbudristek textbook according to the learning goal in phase E of the independent curriculum. The third learning outcome is to analyze the principles of green chemistry in everyday life [21-22]. Departing from the explanations presented in the student book, the material presented is limited to an introduction to the 12 principles of green chemistry with a little explanation. No description is explained in more depth regarding the principles of green chemistry, so the indicators for analyzing the learning objectives are not achieved at all. The explanation of the 12 principles of green chemistry should first explain some of the reactions that exist in chemistry because if you refer to the Handbook of Green Chemistry and Technology by James Clark & Duncan Macquarrie that several types of reactions are explained, such as alkylation reactions, acylation reactions, Friedel-crafts reaction, and other reactions. In addition, the discussion of the 12 principles of green chemistry also explains reagents, catalysts, and synthesis. This discussion will be found in the material after green chemistry is taught by the arrangement in the student textbook issued by the Ministry of Education and Culture. So it can be concluded that the green chemistry material taught in the independent curriculum is unsuitable for phase E study but can only be learned in phase F.

Analysis of the relationship between a learning goal **and the order of matter in green chemistry**

The final results from the learning goal analysis to the analysis of the depth and breadth of the material produce an analysis of the learning goal relationship and the order of the material, which is the result of the content structure analysis in this study. Based on the results of learning goal analysis and the sequence of green chemistry materials, it can be seen that there is a concordance between the material based on university textbooks limited by teacher and student textbooks issued by the Ministry of Education and Culture by the demands of the material that must be achieved according to the learning goal formulation. Analysis of the learning goal is in accordance with the structure of elements of understanding chemistry, elements of process skills, and student profiles of Pancasila. Of course, it has been carried out based on standard scientific principles, including the revised bloom taxonomy, skills, and affective domain.

Several things must be considered based on the structural analysis of green chemical materials. It can be seen in the first and second learning outcomes, which explained several chemical processes and chemical reaction equations. Students should be introduced in advance to elements, atoms, and molecules, as in the fourth learning outcome. So that when looking at chemical reaction equations, students are clear of the reactions shown. In addition, it is necessary to pay attention again to the depth of the material displayed. The third learning objective also requires a little attention; the expected indicator is to analyze the principles of green chemistry in everyday life. However, the explanation in the Kemendikbudristek textbook only explains a little. It means that the indicators to be achieved in the learning objectives are not optimally achieved.

CONCLUSION

Structural analysis of green chemistry material against the learning goal formulation of the independent curriculum with Bloom's taxonomy, there is compatibility between the learning goal formulations of elements of understanding chemistry. Elements of process skills and Pancasila student profiles also have conformity based on Dave and Dyers' taxonomy, namely abstract skills and affective domains. The content analysis found compatibility between the sequence of material in the Handbook of Green Chemistry and Technology by James Clark & Duncan Macquarrie and the textbook issued by the Ministry of Education and Culture, referring to the learning goal of applying chemical concepts in environmental management, including explaining the global warming phenomenon issued by the Ministry of Education and Culture based on the Decree of the Head of Balitbangbuk No. 28 of 2021. However, the material's depth level has not yet been explained in detail and detail. Several materials are not suitable for being taught in phase E. Still, only for phase F. This is because the supporting material and the prerequisite material have not been delivered in the previous material. It can be concluded that the material is coherent but has not been conveyed clearly to students. Furthermore, there is a match between the learning goal and the content structure. Still, it needs to be evaluated again in the analysis of the learning goal formulation regarding the suitability of the material and the structure of the learning goal formulation.

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