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Development of Merdeka Curriculum Teaching Modules for PjBL-Based Green Chemistry Learning

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Abstract: The world of Indonesian education, which is already experiencing a learning crisis, has been increasingly affected by the COVID-19 pandemic. The government, through the Indonesian Ministry of Education and Culture, developed a merdeka curriculum to solve this problem. However, in its implementation, many educators are still unable to compile teaching modules for the Merdeka curriculum. In fact, the learning process of the merdeka curriculum without teaching modules experiences material irregularities. This study aims to develop a "Merdeka Curriculum Teaching Module for PjBL-based Green Chemistry Learning". The research design used is R&D with the ADDIE model. Literature study and questionnaire data collection techniques. The data analysis technique uses Aiken's V 0.73 validation instrument on teaching module material and media validated by 10 validators. Teaching modules that were declared valid were tested on 43 students in class X SMAN. The results showed that the teaching module was proven valid with a material aspect validity value of 0.96 and a media aspect of 0.95 and obtained student response results with a value of 0.84% (including very good criteria). It can be concluded that the teaching module developed is valid and feasible for use as a school teaching tool.

Keywords: Green Chemistry, Merdeka Curriculum, Teaching Module, PjBL

Abstrak: Dunia pendidikan Indonesia yang sudah mengalami krisis pembelajaran semakin terdampak pandemi Covid-19. Pemerintah melalui Kemendikbud RI mengembangkan kurikulum merdeka untuk menyelesaikan permasalahan ini. Namun, dalam pengimplementasiannya masih banyak pendidik yang belum mampu menyusun modul ajar kurikulum merdeka. Kenyataannya proses pembelajaran kurikulum merdeka tanpa modul ajar mengalami ketidakteraturan materi. Penelitian ini bertujuan untuk mengembangkan "Modul Ajar Kurikulum Merdeka Untuk Pembelajaran Kimia Hijau Berbasis PjBL". Desain penelitian yang digunakan ialah R&D dengan model ADDIE. Teknik pengumpulan data studi literatur dan angket. Teknik analisis data menggunakan instrumen validasi Aiken's V 0,73 terhadap materi dan media modul ajar yang divalidasi oleh 10 validator. Modul ajar yang dinyatakan valid diujicobakan kepada 43 siswa kelas X SMAN. Hasil penelitian menunjukkan bahwa modul ajar terbukti valid dengan nilai validitas aspek materi sebesar 0,96 dan aspek media sebesar 0,95 dan diperoleh hasil respons siswa dengan nilai sebesar 0,84% (termasuk kriteria sangat baik). Dapat disimpulkan bahwa modul ajar yang dikembangkan valid dan layak digunakan sebagai perangkat ajar sekolah.

Kata kunci: Kimia Hijau, Kurikulum Merdeka, Modul Ajar, PjBL

INTRODUCTION

Based on the results of national and international studies, Indonesia has long experienced a learning crisis. In addition, there is an educational gap between certain regions and groups in Indonesia. This is exacerbated by the emergence of the COVID-19 pandemic. Systematic solutions are needed to overcome these problems, and one of the efforts made by the government through the Ministry of Education and Culture is to develop a merdeka curriculum (Kemdikbud, 2022).

The merdeka curriculum is a curriculum that contains a variety of intracurricular learning, where in the merdeka curriculum, the content is more focused and in-depth so that students obtain a better understanding and are ready to face the challenges of the times. There are core characteristics of the merdeka curriculum in an effort to address the learning crisis, namely, the learning process is generally project-based to train soft skills and strengthen the character of the Pancasila learner profile, the content is essential and in depth, and educators are free to create teaching tools and learning content tailored to local content and student abilities (Direktorat Sekolah Dasar, 2022).

In the implementation of the merdeka curriculum, there are obstacles experienced by educators, as educators have not been able to develop teaching tools based on the merdeka curriculum, namely, the merdeka curriculum teaching modules. In fact, the Merdeka curriculum teaching module is an important instrument in the learning process for completing learning outcomes. If the learning process in the Merdeka curriculum does not use teaching modules or the preparation of teaching modules is not good, it will result in unsystematic material. Thus, it is difficult for students to understand the material, and the learning process is boring because it happens in only one direction (Maulinda, 2022).

The reason why educators have not been able to develop merdeka curriculum teaching modules is that they have not been able to reduce learning outcomes into learning objectives and reduce learning objectives into criteria for achieving learning objectives (Rindayati et al., 2022). This is further strengthened by the results of research conducted by Indarwati (2021), who stated that educators' understanding of the principles and work steps for developing subthemes from the themes determined by the Ministry of

Education and Culture is still lacking; thus, educators have difficulty developing teaching modules. Therefore, educators have difficulty developing learning elements in the Merdeka curriculum.

Based on the Decree of the Head of the Education Standards, Curriculum and Assessment Agency of the Ministry of Education, Culture, Research and Technology Number 033/H/KR/2022 Regarding the Learning Outcomes of Senior High Schools in the Merdeka Curriculum (2022), in class X, the chemistry subject in phase E has a learning outcome "Applying Chemical Concepts in Environmental Management Including Explaining the Phenomenon of Global Warming". One of the essential concepts that needs to be learned to achieve these learning outcomes is green chemistry.

Green chemistry material is new material in the Merdeka curriculum, so there have not been many Merdeka curriculum teaching module developments on green chemistry material (Zai & Ulianas, 2023). According to Agusti (2018), some students still experience misconceptions, where they believe that chemical reactions are dangerous. Whereas not all chemical reactions are dangerous, chemical reactions, such as photosynthesis reactions, do not harm the environment and are beneficial to humans. Learning green chemistry materials can be one solution to overcome these misconceptions through changing the learning process of hazardous chemistry to be more environmentally friendly and sustainable (Karpudewan, 2020).

The learning process of green chemistry materials can be integrated with local contexts and projects. Learning that integrates local wisdom is called ethnoscience (Ningtyas & Setiawan, 2023). The ethnoscience method is in line with the character of the merdeka curriculum, namely, strengthening the profile of Pancasila students, in developing learning through the ethnoscience approach, it is necessary to identify the local context in the area, after which the local context of the area is integrated into the learning material (Fahrozy et al., 2022). The local context of the surrounding community can be connected to green chemistry materials (Suryanti et al., 2021). The relationship between local content and science can help educators explain science concepts more easily (Alfiana & Fathoni, 2022). According to Mandler (2012), obtaining green chemistry material can increase students' interest in and motivation to solve environmental problems; thus, teaching tools integrated with the *project-based learning model* are needed to facilitate student performance.

Examples of problems that can be solved with the principles of green chemistry are commonly found in everyday life, so this material is closely related to the local context (Maulidiningsih & Kusumaningrum, 2023).

One of the environmental problems, as well as local contexts, that can be solved by the application of green chemistry principles is agricultural waste in the form of rice straw and rice husks. The burning of rice straw and rice husk waste can cause environmental problems in the form of carbon gas emissions and can cause health problems for the surrounding community because, owing to the formation of suspension particles in the air, rice straw and rice husk waste can be processed into a product to overcome these problems (Nguyen-Van-Hung et al., 2019).

Based on these problems, research is needed to develop teaching tools in the form of a merdeka curriculum teaching module that uses the *project-based learning* (PjBL) learning model in a local context, namely, the utilization of agricultural waste in the form of rice straw and rice husks for learning green chemistry material in phase E of class X, namely, applying chemical concepts in environmental management, including explaining the phenomenon of global warming. This statement is in accordance with the results of field findings where educators agree that if a "Development of Merdeka Curriculum Teaching Modules for PjBL-Based Green Chemistry Learning" is developed.

METHOD

This study used a research and development (R&D) research design with the ADDIE model (analysis, design, development, implementation, evaluation). The analysis stage consists of analyzing literature studies, analyzing the needs of educators through the distribution of questionnaire instruments and analyzing the merdeka curriculum. The design stage consists of project design, prototype design and the development of key curriculum teaching modules. The development stage consists of validating the teaching module developed by involving 10 material and media expert validators via validation instruments adapted from the BNSP. The data were analyzed via Aiken's V test with the following formula:

$$V = \frac{\sum s}{n(c-1)}$$

Description:

V = rater agreement index
s = r-Io
r = the score given by the validator
Io = lowest validity assessment score
c = highest validity assessment score
n = number of validators

The scoring scale used is a Likert scale of 1–4 with an error rate of 5% (0.05); if the calculated V value is ≥ 0.73 or Vcount ≥ Vtable, then the item is declared valid (Lewis R. Aikens, 1985).

The implementation stage was carried out by conducting a limited test on 43 class X students in one of the State Senior High Schools in Serang Regency, which has implemented the merdeka curriculum. Data collection uses a student response questionnaire instrument with an alternative Likert scoring scale, as shown in Table 1, which is then analyzed using the following formula:

$$P = \frac{\sum X}{SMI} x\ 100\%$$

Description:

P = percentage sought

∑X = sum of scores

SMI = ideal maximum score

Table 1. Likert Scale Scoring Alternative

Positive Statement	Negative Statement	Score
Strongly disagree	Strongly agree	1
Disagree	Agree	2
Agree	Disagree	3
Strongly agree	Strongly disagree	4

Source: Riduwan (2019)

The formula is also used to analyze the results of observations in the form of project implementation and observations of the Pancasila student profile. To make it easier to interpret the data, the assessment criteria in Table 2 are used, namely:

Table 2. Assessment Categories

Percentage (%)	Criteria
0-20	Very less
21-40	Less
41-60	Simply
61-80	Good
81-100	Very good

Source: Riduwan (2019)

The evaluation stage consists of evaluating all stages of ADDIE that have been carried out in accordance with the image in Figure 1 to make the developed teaching module truly suitable for use as a teaching tool in schools.

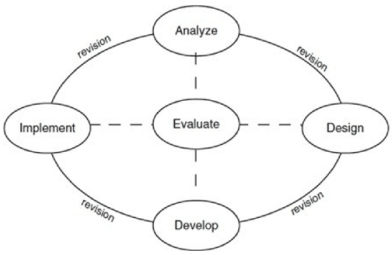

Figure 1. Stages of the ADDIE Model

Source: Branch (2009)

RESULTS AND DISCUSSION

Analysis Stage

In the analysis stage, an analysis of the needs of educators, an analysis of literature studies and a curriculum analysis were carried out on the availability of the use of the Merdeka curriculum teaching modules in schools, especially with respect to green chemistry materials and the application of green chemistry principles; the availability of teaching tools for green chemistry learning; problems of students and educators in green chemistry materials; and environmental problems

that can be overcome by the principles of green chemistry. This activity produces the results of the analysis of the needs of educators, including green chemistry learning in phase E, which can be accompanied by the local context and project activities. The learning model that is often used in class by educators is project-based learning (PjBL). These results are in line with research conducted by Maulidiningsih (2023), which states that green chemistry material is closely related to local wisdom and that examples are often encountered in everyday life. One of the efforts to achieve the objectives of green chemistry material is to use contextual learning models such as the PjBL learning model (Ratnawati & Praptomo, 2023).

The results of the literature review revealed that green chemistry materials are still relatively new in the merdeka curriculum; thus, owing to the lack of availability of teaching modules for green chemistry materials in schools (Ratnawati & Praptomo, 2023), the learning system for green chemistry materials is still teacher-centered, which results in students playing a less active role in learning activities. There is prerequisite material that has not been studied. The teaching materials used are less interesting, and the level of students' understanding of green chemistry materials cannot be categorized as good because students' experience of conceptual errors or misconceptions in green chemistry materials and the application of green chemistry principles (Suci & Zainul, 2023), namely, students assume that chemical reactions are dangerous even though not all chemical reactions are dangerous (Agusti et al., 2018). One of the reasons for this problem is that educators have not been able to compile the merdeka curriculum teaching module properly in the learning process in the new curriculum, which results in unsystematic material; thus, students find it difficult to understand concepts, and learning seems less interesting or one-way learning occurs (Maulinda, 2022). Another problem that requires the application of green chemistry principles is the effort to overcome environmental problems, especially agricultural waste in the form of rice straw and rice husks, due to their burning, which causes greenhouse gas emissions (Rhofita & Chana AW, 2019). The utilization of PjBL in this teaching module is considered superior for learning green chemistry in the local context, namely, students can be actively involved in learning, and the knowledge gained by students will form by itself through projects carried out by students by connecting indigenous science and

scientific science and training critical thinking skills in solving problems and responsibility (Muliadi et al., 2022).

Analysis was also carried out on the Merdeka curriculum to formulate learning objectives and criteria for achieving the learning objectives used in phase E learning outcomes, especially green chemistry materials. The Merdeka curriculum is a new curriculum implemented after the Covid-19 pandemic and functions to overcome the occurrence of *learning loss* due to distance learning or learning lag caused by Covid-19 (Farhana, 2022). Based on the Decree of the Head of the Education Standards, Curriculum and Assessment Agency of the Ministry of Education, Culture, Research and Technology Number 033/H/KR/2022 concerning Learning Outcomes at the Secondary Education Level in the Merdeka Curriculum (2022b), in phase E of the grade X secondary school chemistry subject contains learning outcomes, namely, "Applying Chemical Concept In Environmental Management Including Explaining the Phenomenon of Global Warming". Thus, the concept that will be studied to achieve this goal is green and sustainable chemistry.

Design Stage

At the design stage, a series of activities were carried out to prepare the storyboard of the Merdeka curriculum teaching module to be developed. The Merdeka curriculum teaching module to be developed is a print-based teaching module, but in the process of preparing the teaching module, a prototype is first made using other media. The media used to design teaching modules are canva as a medium for making image and illustration designs. Then, the Microsoft Word 2021 program is used as a word processing medium, automatically correcting spelling and grammatical errors and preparing the material in the teaching module, and there are other interesting features, such as barcode scans and learning videos sourced from YouTube. The format in the preparation of the merdeka curriculum teaching module is the typeface used: Marykate, Mothern, Cochin and Tabarra Semi Serif, with font sizes of 24 (subtitles), 15 (subactivities), and 15 (text) and a media size of 210×297 mm. This stage produces a PjBL-based Merdeka curriculum teaching module designed for green chemistry learning in phase E, which contains each component in accordance with the Merdeka curriculum learning and assessment guidelines, and the content contained leads to the context of local wisdom, the environment and the utilization of local potential in the form of farmers' habits of disposing of or burning

rice straw waste and rice husks in their area, which are linked to green chemistry learning topics in phase E. The green chemistry material presented in the Merdeka curriculum teaching module is the result of collection from various reading references and relevant sources and is adjusted to the material that defines the level of understanding of representations that are continuous with the TP and KKTP in the Merdeka curriculum learning phase. Then, the learning activities contained in the Merdeka curriculum teaching module are systematically arranged using the project-based learning model, which consists of three projects in each activity, including making paper, biobattery paste and adsorbents, where this project is able to make students actively involved in learning, students' ability to connect scientific knowledge with original science and train critical thinking skills in solving problems and responsibility (Muliadi et al., 2022). The final result of this stage is the storyboard design of the PjBL-based Merdeka curriculum teaching module, which is used as a print-based Merdeka curriculum teaching module and is used in the next stage.

Development Stage

The next stage is the development of the PjBL-based Merdeka curriculum teaching module, which includes the preparation and validity testing of the teaching module that has been prepared through material and media validation by experts. The storyboard design of the Merdeka curriculum teaching module formulated in the previous stage is realized in the form of a complete, intact, and PjBL-based Merdeka curriculum teaching module that covers all aspects of learning.

The Merdeka curriculum teaching modules that have been developed are then validated by 10 validators, both media experts and material experts, consisting of 4 lecturers and 6 chemistry teachers involved in practitioner education. The results of the material and media validation on the PjBL-based Merdeka curriculum teaching module are then processed and calculated for validity using the Aiken's V validity formula (1985) with 4 scale options and an error rate of 5% (Vcount ≥ Vtable, Vtable = 0.73), which is considered valid if a validity value or Vcount of more than 0.73 is obtained. The validity scores for each aspect of the Merdeka curriculum teaching module on the validation instrument that has been adapted by the BNSP can be seen in Table 3.

Table 3. Aspect validity of the PjBL-based Merdeka curriculum teaching module

No.	Aspects	Validity	Criteria

No.	Aspects	Validity	Criteria
1	Content Feasibility	0,96	Valid
2	Presentation	0,95	Valid
3	Language	0,94	Valid
4	Graphics	0,96	Valid

With respect to content feasibility, what was validated by expert validators was the suitability of the material with learning objectives and criteria for achieving learning objectives, the accuracy of the material, the currency of the material and encouraging curiosity. This aspect received a validity score of 0.96 with the criterion "Valid". Based on these results, the content of the material presented in the merdeka curriculum teaching module is in accordance with the learning objectives (TP) and criteria for achieving learning objectives (KKTP) set out in the Decree of the Head of the Education Standards, Curriculum and Assessment Agency of the Ministry of Education, Culture, Research and Technology Number 033/H/KR/2022 concerning Learning Outcomes at the Secondary Education Level in the Merdeka Curriculum (2022b). The material contained in the teaching module is also accurate because it is equipped with examples of relevant cases or phenomena that occur in everyday life and are closely related to the topic of green chemistry to increase students' understanding of green chemistry material. In addition, the content of the material contained in the Merdeka curriculum teaching module in the form of projects and reading materials is good enough to encourage students' curiosity about phenomena in everyday life related to the concept of green chemistry in environmental and sustainable management.

Next, with respect to the presentation aspect, the expert validators validated the presentation techniques, presentation support and learning presentation. This aspect obtained a validity score of 0.95 with the criterion "Valid". This shows that the components in the Merdeka curriculum teaching module have referred to the components of teaching materials set out in the BNSP. components of teaching materials stipulated in the BNSP. The PjBL-based Merdeka curriculum teaching module developed in this study presents a learning design for one learning objective and complete and systematic components, referring to the Education Learning and Assessment Guidelines set by the Ministry of Education and Culture (Anggraena et al., 2022). The Merdeka curriculum teaching module is equipped with a QR code scan and link to make it easier for students to access the learning video in the link and uses images that are in accordance with the discussion of green chemistry material to assist in the learning process

with the aim of forming meaningful learning for students (Magdalena et al., 2021).

The next aspect is the language feasibility aspect, where several indicators are validated by expert validators, including straightforwardness, communicativeness, conformity with language rules and the use of terms, symbols and icons, and a validity score of 0.94 is obtained with the criterion "Valid". The assessment of this aspect aims to evaluate the readability and effectiveness of the use and writing of sentences on the material so that the proposed curriculum teaching module is easily understood by students and the presentation of messages and information in the teaching module can be conveyed properly to students. The validity results indicate that the writing and use of the language of the Merdeka curriculum teaching modules developed are feasible and good enough to follow the rules of good and correct Indonesian language and are related to each other in each main idea in the paragraph. The clarity and accuracy of writing and the use of good language in the teaching module can enable students to understand the content of the material and the implied messages presented in this teaching module (Aisyah et al., 2021).

The last aspect is grammatical feasibility, which consists of several indicators, namely, the size of the teaching module and the appearance of the teaching module. The validity of each indicator in terms of grammatical feasibility was 0.96 and was included in the "Valid" criteria. These results indicate that the aspects of the feasibility of the graphics contained in the teaching module of the Merdeka curriculum are good enough and suitable for use in the learning process.

All aspects of material and media in the PjBL-based Merdeka curriculum teaching module obtained an average validity of the material aspect of 0.96 and an average media aspect of 0.95, including the criterion "Valid". These results revealed improvements in the Merdeka curriculum teaching modules, which were developed in accordance with the input and suggestions provided by the validators to produce better teaching tools. The input and suggestions obtained from this validation were used by researchers as a reference for improving the specific curriculum teaching modules developed so that they were considered valid and suitable for use. Improvements were made to several components of the Merdeka curriculum teaching module, such as writing indices on chemical formulas and Latin names, the appropriateness of using

time allocations in learning activities, adding video material presented in the form of barcode link scans, readability and word selection. clarity of images and consistency of the display format of the Merdeka curriculum teaching module.

In addition, empirical validation was carried out on the questions that had been made to determine the validity of the questions tested using the Pearson product moment validity test, and the significance level used was 5% and df = 43–2 = 41, with a rcount value of 0.3008. Of all the questions tested, 14 multiple-choice questions and 17 essay questions were declared valid because the r count value was greater than the r table value. Next, the validity of the questionnaire, which was declared valid using Cronbach's alpha analysis, was tested. The instrument is declared reliable if the Cronbach's alpha value is > 0.6 (Sujarweni, 2014). The Cronbach's alpha value of the multiple-choice questions was 0.788, and that of the essay questions was 0.856. Because the Cronbach's alpha value of the two types of questions was > 0.6, the scale was deemed reliable. After making improvements and testing the questions that have been made, the Merdeka curriculum teaching module can be implemented for students through limited trials.

Implementation Stage

The implementation stage of the merdeka curriculum teaching module was carried out in a limited test on 43 class X students at one of the senior high schools in the Serang Regency. The implementation stage through limited testing in this study aims to determine the student's response to the Merdeka curriculum teaching module developed. Through the response questionnaire sheet, the students assessed the use of the Merdeka curriculum teaching module for 3 weeks.

Based on the data from the students' questionnaire responses to the developed Merdeka curriculum teaching modules, the average percentage value was 84%, with very good criteria. The results of the students' responses are in accordance with the formula for calculating the percentage of responses that have been determined from (Riduwan., 2019), where the percentage range value of 81–100 is very good. The following table shows the results of the learner response questionnaire:

Table 4. Results of the Student Response Questionnaire for Each Aspect

No.	Aspects	Percentage	Criteria
1	Project	83%	Very good
2	Local Wisdom	84%	Very good
3	Material	85%	Very good
4	Aesthetics	84%	Very good
	Average	84%	Very good

The table above shows that several aspects are assessed by the students; then, the data obtained are processed, and the percentage of feasibility is calculated. The first aspect is the project with a percentage of 83% with the criterion "very good". This shows that the project presented in the Merdeka curriculum teaching module has been carried out well. Thus, the project contained in the PjBL-based Merdeka curriculum teaching module can be used as a solution to environmental problems, especially as a result of the burning of agricultural waste in the form of rice straw waste and rice husks, which can be performed easily at school.

With respect to local wisdom, a percentage of 84% was obtained with the criterion "very good". This shows that this Merdeka curriculum teaching module can help students understand the concept of green chemistry because this teaching module is contextual and contains examples of environmental problems that are relevant to real life, especially the problem of carbon gas emissions due to burning rice straw waste and rice husks commonly carried out by farmers. The application of green chemistry concepts and the application of green chemistry principles in schools with the implementation of a project- or project-based learning-based learning model can be used in an effort to overcome these problems. This is supported by Muliadi's statement (2022) that the utilization of PjBL learning in this teaching module is considered superior for learning green chemistry in the context of local wisdom, namely, that students can be actively involved in learning, that the knowledge gained by students will form by themselves through projects carried out by students by connecting *indigenous* science and scientific science, and that critical thinking skills in solving problems and responsibility be trained.

Furthermore, 85% of the material aspects met the criterion of "very good". This indicates that the green chemistry material presented in the Merdeka curriculum teaching module is related to the project carried out, which is useful for overcoming environmental problems due to the burning of rice straw and rice husks caused by carbon gas emissions and is closely related to the handling of green chemical materials. This statement is also in accordance with the results of the needs analysis of educators, where educators argue that green chemistry materials can be accompanied by local contexts and project activities. This is reinforced by Eiliks and Rauch (2012), who reported that green and sustainable chemistry learning

can be accompanied by local contexts or events that occur in everyday life.

The last aspect is the aesthetic aspect, which obtained a percentage of 84% with the criterion of "very good". These results indicate that the Merdeka curriculum teaching module that has been developed can be said to be aesthetic because it contains images of case phenomena in accordance with the discussion of green chemistry material so that it helps students understand green chemistry material. The use of images can help in the learning process with the aim of forming meaningful learning for students (Magdalena et al., 2021).

Overall, the average percentage of student responses to the PjBL-based Merdeka curriculum teaching module on the topic of green chemistry phase E was 84%, with the criterion "very good". On the basis of these results, the developed Merdeka curriculum teaching module is suitable for students and educators at school.

The implementation of the PjBL-based Merdeka curriculum teaching module development in the utilization of rice straw and rice husk waste for green chemistry learning in phase E can also be seen in terms of direct observation through the project implementation stage and observation of the Pancasila student profile of the learning activity process in the classroom. Learning activities using PjBL learning syntax are carried out three times at a time allocation of 90 minutes, where at each meeting, an assessment is carried out, including observations of project implementation, observations of the Pancasila student profile, and LKPD 1 to LKPD 3 assessments in the form of project assessments and reflections on both educators and students. Project activities are carried out in groups where each group receives a different project title, namely, a papermaking project, a battery paste-making project and an adsorbent-making project. From these learning activities, good results were obtained in terms of project implementation, with a score of 76%, the results of the observation of the Pancasila student profile, with good criteria of 73%, and the results of the learning test assessment, 93%, indicate that students have been declared complete in learning green chemistry.

The indicator used to measure the implementation of the project is the project implementation observation sheet using the PjBL learning model, where students carry out projects in groups. Indicators show that students have the ability to design, conduct and complete projects, appropriate product results and observations, analyze and evaluate projects

carried out and the involvement of students in the project; however, in the implementation of the project, some students do not clean the tools before or after the project and have not properly used tools such as pipette drops. According to the results obtained by 73%, the indicators used to measure the profile of Pancasila students are through direct observation sheets where students show attitudes or behaviors that are in accordance with the expected profile of Pancasila students. However, some students lack critical thinking attitudes, resulting in students being unable to formulate the core of the problem and choosing logical arguments. A total of 93% of the indicators used to measure the completeness of students' ability to learn green chemistry through learning test instruments, assignments and individual and group assessments contained in the developed teaching modules show that 40 students achieved completeness in achieving learning objectives and that 3 students did not achieve completeness; thus, remedial is needed.

Based on the results of the validation, students' responses to the teaching module of the Merdeka curriculum on the topic of green chemistry, the results of project implementation and the results of the learning test assessment are related and aligned. The Merdeka curriculum teaching module obtains valid criteria for materials and media; this learning tool is valid and good for use in chemistry learning. This is supported by the results of the students' responses and project implementation, which obtained very good and good ratings in line with the validation, indicating that the teaching module of the Merdeka curriculum using the project-based learning model can attract students' interest and motivation. These results are reinforced by the learning completeness of students achieved in group assessments in the form of presentations and project reports and individual assessments in the form of LKPD 1, LKPD 2 and projects, as much as 93% complete green chemistry learning.

Evaluation Stage

At this stage, a series of comprehensive evaluation activities are carried out on the results of each stage of the development of the PjBL-based Merdeka curriculum teaching module from needs analysis to implementation to identify existing shortcomings and improve the products produced to be of higher quality and in accordance with the needs of educators and students at school. The results of this stage include evaluation at the analysis stage, such as adding some literature analysis related to the need for

teaching modules for the Merdeka curriculum on the topic of green chemistry and the utilization of agricultural waste in the form of rice straw and rice husks to solve one of the environmental problems through projects. The evaluation of the Merdeka curriculum teaching module design stage includes making improvements to project procedures based on the level of the student and applying green chemistry principles to each project design; making improvements to storyboards by adding point tables of content, page numbers, and profiles of authors and supervisors; and, in the teaching module of the Merdeka curriculum, making improvements in terms of writing in the form of font type and size and adding the name of the supervisor as the compiler of the teaching module as directed by the supervisor. Next, at the development stage of the Merdeka curriculum teaching module, several aspects are evaluated, namely, making improvements to the teaching module in accordance with the input and suggestions from the validators. Furthermore, the improvements made after the implementation stage of the Merdeka curriculum teaching module are to improve the tools and materials as well as the amount in the LKPD sheet according to the student's suggestions and input.

CONCLUSION

The PjBL-based Merdeka curriculum teaching module for green chemistry learning in phase E produced in this study was developed using each stage of the ADDIE model. The teaching module has three components, where each component contains several points in accordance with the learning and assessment guidelines, namely, the general information component (module identity, initial competencies, Pancasila learner profile, facilities and infrastructure, target learners, learning models and modes), main components (learning objectives, assessment, meaningful understanding, triggering questions, learning activity steps, reflection, written tests, Pancasila learner profile assessment, performance assessment: group presentations, project assessments and project reports, reading materials and LKPD) and attachments (enrichment and remedial, glossary, bibliography and author profile). Based on the results of the data processing validation of the material aspects and media aspects of the PjBL-based Merdeka curriculum teaching module using the Aikens'V formula, the average value of the material aspect is 0.96, and the media aspect is 0.95, with valid criteria where the calculated V value is greater than 0.73. These results indicate that the Merdeka

curriculum teaching module that has been prepared is declared "Valid".

The students' response to the PjBL-based Merdeka curriculum teaching module in phase E, which was developed as a whole based on the average percentage of aspects, was 84%, with "very good" criteria for the use of modules in green chemistry learning. In addition, direct observations of the implementation are needed. Learning progressed well, as evidenced by the average percentage of project implementation, which reached 76%, and the percentage of observations of the Pancasila student profile, which reached 73%.

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