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Development of Environmental Sustainability Modules with A Love-Based Curriculum and A Deep Learning Approach

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Abstract: This study aims to develop a Natural Science learning module based on the Love-Based Curriculum (KBC) with a Deep Learning approach on Environmental Sustainability material for Grade VII Junior High School/Islamic Junior High School students. The study employed Research and Development (R&D) using the 4D model, comprising define, design, develop, and disseminate stages. Subjects included science teachers and Grade VII students in a limited trial. Data were collected through needs analysis questionnaires, expert validation sheets, and teacher and student response questionnaires. The results showed that the module met valid criteria based on material and media expert assessments and readability tests, with a very feasible category. The module was practical and effective, demonstrated by positive responses and improved conceptual understanding and ecological awareness. Integrating *Panca Cinta* values through Deep Learning promotes meaningful, reflective, and contextual learning while fostering environmental concern. Thus, the module is suitable as alternative teaching material for environmental sustainability learning.

Keywords: Deep Learning; Environmental Sustainability; Junior High School/Islamic Junior High School; Learning Module; Love-Based Curriculum.

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Introduction

In recent years, science education in Indonesia has focused not only on cognitive achievement but also on strengthening students' character and ecological awareness (Sufyadi et al., 2021). Science learning is considered strategic because it directly relates to environmental phenomena and students' daily lives. Each subject matter has varying levels of difficulty (Fauziyah et al., 2020). Environmental sustainability is a crucial topic in science learning because it plays a role in fostering a caring and responsible attitude towards the environment from an early age(Zulfiani et al., 2025). Numerous studies have shown that contextual science learning can improve students' conceptual understanding and ecological awareness (Utami & Fadhilah, 2022). Therefore, science learning needs to be systematically designed to ensure it does not stop at conceptual understanding alone.

In the context of religious education, the Ministry of Religious Affairs introduced the Love-Based Curriculum (KBC) as a new paradigm that emphasizes the internalization of values of love for God, fellow human beings, science, the environment, and the nation (Sandy, 2025). This curriculum is expected to be able to address the challenges of the value crisis and environmental degradation through learning oriented towards building student character (Nurwati, 2025). implementation of the KBC requires learning tools that are able to integrate cognitive, affective, and reflective dimensions in a balanced manner (Syafrian, 2025). In science subjects, the integration of KBC values is highly relevant because the characteristics of the material are close to students' real lives. However, the success of the KBC implementation is highly dependent on the readiness of the teaching materials used by teachers in the classroom. Teaching materials are classified based on their production method, characteristics, and form (Rohmaniah et al., 2020). The process of acquiring knowledge is effective and efficient if there are supporting, high-quality learning resources available (Maulidatul et al., 2019).

Along with the strengthening of the Love-Based Curriculum, the Deep Learning approach has developed as a learning approach that emphasizes in-depth understanding, the interconnectedness of concepts, and critical reflection on learning experiences (Kemendikdasmen, 2025). This approach encourages students to not only understand concepts but also to be able to apply knowledge in real-world contexts (Fitriani & Santiani, 2025). In science learning, Deep Learning is considered effective for developing critical thinking skills and ecological awareness through the analysis of environmental problems (Lestari, 2023). In science learning, Deep Learning is considered effective for developing critical thinking skills and ecological awareness through the analysis of environmental problems.

Learning modules are seen as an effective medium for implementing the Deep Learning approach and curriculum values in a structured manner (Nisa, 2025). Modules allow for the systematic presentation of learning objectives, materials, activities, reflections, and assessments tailored to student characteristics. In the learning module,

there must be a learning model so that learning can run as expected (Mardiani et al., 2020). Previous research has shown that the use of science modules can increase student learning independence and active engagement in learning (Rahayu, 2025). Furthermore, modules facilitate teacher learning management, becoming a strategic solution for improving the quality of science learning.

However, the implementation of the Love-Based Curriculum in science learning in junior high schools (SMP/MTs) still faces various obstacles. One major obstacle is the limited availability of science teaching modules specifically designed based on the Panca Cinta values and deep learning (Syafrian, 2025). Science learning is still dominated by textbooks that do not fully accommodate the integration of ecological values and reflection in students (Kemendikdasmen, 2025). As a result, learning about environmental sustainability tends to be conceptual and does not optimally shape environmental attitudes and behaviors. This situation indicates a gap between curriculum demands and classroom learning practices.

Furthermore, empirical studies show that most research on science module development still focuses on improving cognitive learning outcomes, while the integration of religious curriculum values and the Deep Learning approach has not been widely studied simultaneously (Zulfiani et al., 2025). The use of the 4D development model (Define, Design, Develop, Disseminate) in the context of developing KBC-based science modules is also relatively limited. While the 4D model is considered effective in producing valid, practical, and ready-to-use learning products in educational settings (Rahayu, 2025). this gap indicates the need for more specific and targeted development research.

Based on these conditions, this study aims to develop a science learning module based on the Love-Based Curriculum with a Deep Learning approach on environmental sustainability material for seventh-grade junior high school/Islamic junior high school students using the 4D development model. This study aims to describe the module development process through the Define, Design, Develop, Disseminate stages. In addition, this study aims to assess the feasibility of the module based on validation by material experts and validation by media experts.

The validity of the module is evaluated through an expert sheet that covers aspects of content suitability, presentation, graphic components, and language (Arif & Hala, 2026). This study also examines the practicality and potential effectiveness of the module in supporting value-based science learning. Thus, the developed module is expected to support the optimal implementation of the Love-Based Curriculum in junior high schools/Islamic junior high schools. In addition, the modules developed are designed to meet the standards of suitability of teaching materials, so that they can provide a more meaningful learning experience and encourage the formation of students' character in accordance with the principles of Islamic and humanitarian values (Aulianingsih et al., 2021). With clear content integrity and value integration, this module is expected to be an

effective learning tool in implementing the Love-Based Curriculum vision in Islamic junior high school environments (Koesnadi & Astuti, 2024).

Methods

This study employed a Research and Development (R&D) method, aiming to produce a science learning module based on the Love-Based Curriculum (KBC) with a Deep Learning approach to environmental sustainability. The development model used was the 4D model, consisting of four stages: Define, Design, Develop, and Disseminate. This study was not designed as a pure experiment, but rather focused on the development and evaluation of the quality of the learning product. Limited trials were conducted to obtain data on the module's feasibility and readability. The primary focus of the research was to produce a valid and practical learning product for use in science learning. Therefore, the 4D model was chosen because it provides a systematic development framework and aligns with the characteristics of research into the development of teaching materials based on expert and user feedback.

The study was conducted in the even semester of the 2024/2025 academic year at a MTs (Islamic Junior High School) that has implemented the Love-Based Curriculum. The study population included all seventh-grade students and science teachers at the school. The study sample consisted of one seventh-grade class selected using purposive sampling, considering curriculum suitability and teacher readiness to use the module. The research subjects also involved one material expert and one media expert as validators. Science teachers were involved as respondents in the readability test, along with seventh-grade students. This selection of subjects ensured that the module testing was conducted in an authentic learning context.

The define stage aims to identify initial needs in developing a science learning module. This stage includes a curriculum analysis, an analysis of environmental sustainability materials, and an analysis of the characteristics of seventh-grade MTs students. Teacher and student needs analysis was conducted through questionnaires distributed to science teachers and students. The teacher questionnaire addressed aspects of the availability of teaching materials, the suitability of the materials to the curriculum, learning difficulties, and the need for a learning module that integrates the Love-Based Curriculum values. The student questionnaire covered science learning experiences, level of material understanding, readability of the teaching materials, and interest in the learning module. The questionnaire data was analyzed descriptively to identify user preferences.

The design stage focused on designing the learning module based on the results of the needs analysis from the previous stage. This stage developed learning objectives, material mapping, and designed learning activities based on the Deep Learning approach. The module structure was systematically designed to be easily understood by seventh-grade MTs students. Furthermore, exercises and learning assessments were designed to

support the achievement of learning objectives. Module appearance aspects such as layout, font type, and illustrations were designed with readability and visual appeal in mind. The results of the design stage are in the form of an initial draft of the learning module.

The development phase aims to produce a valid and usable learning module. This stage involves module development based on the established design, followed by validation by subject matter and media experts. Subject matter expert validation focuses on content suitability, conceptual accuracy, and curriculum alignment. Media expert validation assesses the module's graphics, layout, visual readability, and attractiveness. Input and suggestions from the validators are used as the basis for revising and refining the module. After revision, the module is piloted through a readability test by science teachers and seventh-grade students of Islamic Junior High Schools (MTs).

Data collection was conducted using subject matter expert validation sheets, media expert validation sheets, and teacher and student readability questionnaires. All instruments are structured using a Likert scale and include a comment section for qualitative data collection.

Table 1.
Assessment Criteria.

Scale	Category
4	Excellent
3	Good
2	Fair
1	Poor

Furthermore, the quantitative data obtained were analyzed descriptively by calculating the mean score and the percentage of the module's feasibility. The mean score was used to determine the overall tendency of the assessment of the developed module and was calculated using the following formula:

$$\bar{X} = \frac{\sum X}{N}$$

Description: $\bar{X}$ is the average score, $\sum X$ is the total score obtained, and N is the number of assessment items. Next, the module eligibility percentage is calculated using the formula:

$$P = \frac{\sum X}{\sum X_{maks}} \times 100\%$$

Note: P is the percentage of eligibility, $\sum X$ is the number of scores obtained, and $\sum X_{maks}$ is the maximum possible score obtained. The results of the eligibility percentage are then interpreted based on the module eligibility criteria. Qualitative data in the form of suggestions and comments from experts, teachers and students are analyzed descriptively as a basis for improving and perfecting learning modes.

Table 2.
Eligibility criteria.

Percentage	Category
81% - 100%	Very Eligible
63% - 80%	Eligible
44% - 62%	Quite Eligible
25% - 43%	Not Eligible

A learning module is deemed suitable for use if validation results by material experts and media experts indicate a suitable or very suitable category, and student responses through readability tests indicate that the module is easy to understand and can be used as a learning resource. This eligibility criteria aligns with research by Ulgari et al., (2024) which states that learning products resulting from the development of the 4D model are deemed suitable if they receive positive assessments from experts and positive responses from end users.

Results & Discussion

The development of a Love-Based Curriculum-based science learning module using a Deep Learning approach began with a preliminary needs analysis involving students and teachers. The analysis revealed that 89% of teachers taught environmental sustainability without linking it to the value of compassion, as stated in the Love-Based Curriculum principles. However, only 33% of teachers had ever implemented a Deep Learning approach, such as reflection or in-depth analysis. Meanwhile, 85% of students had studied environmental sustainability, but 65% of them were still limited to using textbooks and teacher explanations without real-world practice, and 25% experienced difficulty understanding the material. These findings indicate that science learning is still dominated by a conceptual approach that focuses on cognitive aspects and has not optimally integrated the affective dimension and contextual learning experiences. This condition aligns with Sandy (2025) view, which emphasizes that the implementation of the Love-Based Curriculum requires learning tools that explicitly integrate the values of compassion and reflection into the learning process, supported by a Deep Learning approach that can help students build deeper conceptual understanding through the connection between learning materials and everyday life (Lestari, 2023).

Learning obstacles faced by teachers include 78% low student awareness of the environment, 56% less interesting teaching materials, and 44% limited time for learning activities in the field, meanwhile, students expect more contextual learning, with 45% of students wanting tree planting practices, 30% waste projects, and 25% students wanting direct observation. This need for contextual learning indicates that the rest requires learning experiences that are not only cognitive, but also applicable and reflective, as the characteristics of Deep Learning (Kemendikdasmen, 2025). The high need for innovation in

teaching materials is reflected in 99% of teachers and 90% of students agreeing on the development of the KBC-Deep Learning module on environmental sustainability material to form a caring character for the environment. This shows a collective awareness that science learning needs to be directed at forming a caring character for the environment through the integration of the values of compassion, reflection, and real involvement of students in everyday life. As emphasized by Sandy (2025), the implementation of the Love-Based Curriculum requires learning tools that can balance the cognitive, affective, and action dimensions.

Based on this analysis, the module was designed to include structured learning objectives, environmental sustainability material mapping, Deep Learning-based activities, reflections on the Panca Cinta values, and learning evaluation instruments. The module was systematically structured to facilitate student independent learning while assisting teachers in managing the learning process. The Deep Learning approach is realized through exploration of environmental issues, reflective discussions, contextual problem-solving exercises, and strengthening the connection of concepts to everyday life. This reinforcement design aligns with Fitriani & Santiani (2025), who stated that Deep Learning can encourage deeper conceptual understanding and develop students' thinking skills.

The designed modules are then validated by material experts and media experts, then tested for readability by teachers and students.

Table 3.

Recapitulation of Validation Results and Readability Tests.

Assessment Type	Total Score	Maximum Score	Percentage	Category
Media Expert Validation	42	44	95,45%	Very Worthy
Material Expert Validation	69	76	90,79%	Very Worthy
Readability Test	1142	1380	82,75%	Very Worthy

Based on Table 3, media expert validation achieved a percentage of 95.45%, material expert validation achieved 90.79%, and readability testing achieved 82.75%. All of these results are in the very appropriate category, indicating that the module has met the eligibility criteria in terms of media display, material substance, and ease of use by students. This high percentage indicates that the module is not only theoretically valid according to experts but also practical and easy to understand in learning implementation. This finding aligns with Utami & Fadhilah (2022) who emphasized that display quality, material suitability, and clarity of presentation influence increased student understanding and learning engagement.

Table 4.
Media Expert Validation Results.

Item	Assessment Indicators	Score
1	Module size complies with ISO standards	4
2	Module cover illustrations depict the content/material and object characteristics	3
3	Does not use too many font combinations	4
4	Module color design is contrasting, attractive, and supports the learning process	4
5	Professional font size proportions for titles, subtitles, and supporting text	4
6	Module material aligns with learning objectives	3
7	Module font variations are not excessive	4
8	Images align with the text message (material)	4
9	Spacing between lines in normal text	4
10	Spacing between letters is normal	4
11	Module appearance is attractive	4
	Total score	**42**
	Maximum score (11 x 4)	**44**
	Percentage	**95,45%**
	Category	**Very worthy**

Based on Table 4, the media expert validation achieved a 95.45% rating, categorized as very appropriate. High scores were obtained for module size, letter legibility, color matching, image clarity, and attractiveness of the display. These results indicate that the module meets the graphic and visual requirements, supporting reading comfort and student engagement in learning. This finding aligns with Fitriani & Santiani (2025), who stated that the quality of the visual display of teaching materials plays a crucial role in increasing student learning motivation and conceptual understanding.

In addition to the quantitative assessment, the media validator also commented that the module was generally good, but still needed revision and refinement. This feedback indicates that although the graphic and visual aspects met the very appropriate category, a refinement process was still necessary to optimize and maintain the final product's quality. In developing teaching materials, the revision stage based on expert input is crucial for ensuring the quality, readability, and effectiveness of learning media (Sugiyono, 2019). The revisions were not only technical in nature but also aimed to strengthen the alignment of content design and learning objectives.

Table 5.
Results of Validation by Material Experts.

Item	Assessment Indicators	Score
1	Material alignment with identified student readiness	4
2	Material alignment with learning outcomes	3
3	Material alignment with learning indicators	3
4	Material depth with learning indicators	4
5	Material alignment with images used	3
6	Material difficulty level appropriate to student ability	4
7	Material is easy to understand and clear	4
8	Material is accountable	4

Item	Assessment Indicators	Score
9	The module's role in imparting environmental knowledge	4
10	Material alignment with student level and age	3
11	Material alignment with developments in science and technology	4
12	The material's role in preserving and fostering environmental awareness	3
13	Language is easy to understand, simple, and on-target	4
14	Language is free from double meanings or ambiguity	4
15	Conservation material is engaging	3
16	Module connects knowledge to daily life	4
17	Image alignment with material	4
18	Layout and color alignment of material	4
19	Images are relevant to students' daily lives	3
	Total score	**69**
	Maximum score (19 x 4)	**76**
	Percentage	**90,79%**
	Category	**Very worthy**

Based on Table 5, the validation by material experts achieved a percentage of 90.79%, categorized as very appropriate. The highest scores were seen in the aspects of the material's suitability to student readiness, depth of material, clarity of language, integration of images with the material, and relevance of the learning context to everyday life. This indicates that the environmental sustainability material has been systematically and contextually structured in accordance with learning outcomes and developments in science and technology. This finding supports the opinion of Nisa, (2025) that structured learning modules can improve student understanding while supporting the implementation of a values-based curriculum.

Based on comments and suggestions from material experts, although the module received a very appropriate category, several improvements are still needed to optimize its academic quality and consistency. This is particularly true in the writing of unfamiliar terms, such as Deep Learning, which should be italicized according to scientific principles, the use of equal font size and consistent writing style, and the emphasis on the uniqueness of the developed model to clearly differentiate it from other modules. Suggestions regarding the addition of references from journals and relevant sources also demonstrate the importance of strengthening the theoretical foundation to enhance the module's academic credibility. Furthermore, the alignment of the material with the learning elements and outcomes emphasizes that validation focuses not only on content but also on systematics, curriculum accuracy, and the technical quality of the presentation. The validation process by material and media experts is a crucial stage in the research and development of teaching materials to ensure the module's feasibility, consistency, and suitability before implementation with students.

After revisions based on input from validators, the module was tested through a readability test involving 16 teacher and student respondents. The readability test results showed a readability percentage of 82.75%, categorized as very appropriate. This indicates that the module is easy to understand in terms of language, clarity of instructions, and

presentation of material. Positive student responses indicate that the module can increase learning interest and facilitate understanding of environmental sustainability concepts. These findings align with Utami & Fadhilah (2022), who stated that contextual science learning contributes to improved conceptual understanding and ecological awareness in students.

Figure 1.
Bar Chart of Module Eligibility Percentage.

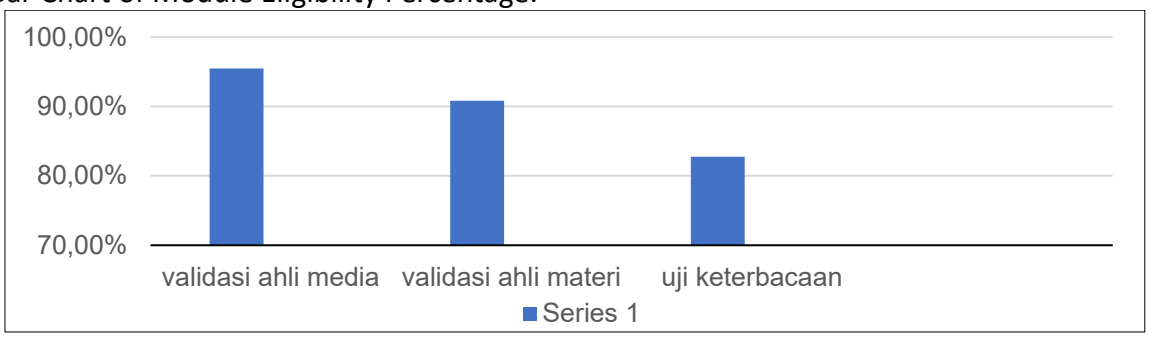

Figure 1 shows that all assessment components are in the very appropriate category, with the highest percentages in media expert validation, followed by material expert validation and readability testing. This indicates that the module is not only appropriate in terms of appearance and content, but also easy to use for teachers and students.

Overall, the validation results from media experts, material experts, and the readability testing indicate that the module is in the very appropriate category. The integration of Love-Based Curriculum values with the Deep Learning approach in this module has the potential to encourage more meaningful, reflective, and contextual learning, particularly in fostering students' environmental stewardship. This reinforces Sandy (2025) view that implementing a Love-Based Curriculum requires learning tools that can integrate cognitive, affective, and reflective dimensions in a balanced manner. Therefore, the developed module is deemed suitable for use as supporting teaching materials for environmental sustainability learning in junior high schools (SMP/MTS) and as part of the transitional efforts to implement the Love-Based Curriculum.

Conclusion & Recommendation

Based on the results of research and development, the science learning module based on the Love-Based Curriculum with the Deep Learning approach on environmental sustainability material was declared very feasible to use, with a validation percentage of 95.45% from media experts, 90.79% from material experts, and 82.75% from readability tests. The findings of the needs analysis indicate a gap in learning, where 89% of teachers have not integrated the value of compassion and only 33% apply deep learning, while 65% of students still learn theoretically without contextual practice. The developed module is

able to answer these needs through the integration of the Panca Cinta values, reflective activities, and contextual problem solving that support the formation of environmentally conscious characters. However, this research is still limited to a feasibility test and has not tested its effectiveness experimentally on improving learning outcomes and residual ecological attitudes. Therefore, further research is recommended to test the effectiveness of the module on a wider scale and develop a digital format to increase the accessibility and sustainability of the implementation of value-based learning.

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