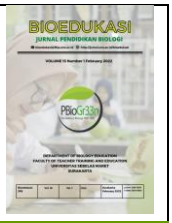
UNIVERSITAS SEBELAS MARET
BIOEDUKASI: JURNAL PENDIDIKAN BIOLOGI
https://jurnal.uns.ac.id/bioedukasi
1693-265X (Print) | 2549-0605 (Online)



Developing the Case Method Module on Environmental Management to Improve Students' 21st-Century Skills

Diah Anugrah Dipuja [a, 1, *], Resma Wahyuni [b, 2], Ayu Maysaroh [c, 3]

Biology Education, Faculty of Teacher Training and Education, Riau University, Pekanbaru-Indonesia
[1] diahanugrah@lecture.unri.ac.id; [2] resmawahyuni@lecturer.unri.ac.id; [3] ayumaysaroh1705@gmail.com
* Corresponding author: resmawahyuni@lecturer.unri.ac.id

Submission : 17/11/2023
Revision : 14/11/2024
Accepted : 11/02/2025

ABSTRACT

The limited variety of learning methods and teaching materials used in environmental management material affects students' 21st-century skills. Current learning is still conventional and ignores the development of 21st-century skills, which include critical thinking, creativity, communication, and collaboration. This research aims to produce a case method-based environmental management module to improve students' 21st-century abilities that is valid, practical, and effective. The research was conducted in June-October 2023 at Riau University. The research sample included students from the marine science study program who took Environmental Science courses. This type of research is development using the ADDIE model. The research instruments used validation sheets, observation sheets, and response questionnaires. The average validation result for the module is 3.64, with a very valid category. The results of the response questionnaire in the limited trial obtained an average score of 3.82 in the very valid category, while the results of the practicality questionnaire received a score of 85% in the practical category. The observation results obtained a score of 85 for the competence category. Based on the research results, it can be concluded that the environmental management-based case method improves students' 21st-century abilities, it is very valid, practical, and effective to use in learning

Keywords: module, case method, environmental management, 21st-century skills

Introduction

21st-century skills in learning are widely discussed and debated (Alt & Raichel, 2020; Wahono et al., 2021). Today's life is very competitive and requires increasing competencies adapted to the 21st century, such as critical thinking, collaboration, communication, and creativity (Celume & Maoulida, 2022). Current learning also focuses on developing 21st-century skills for both pupils and students (OECD, 2018). Excellent universities should provide opportunities for students to develop abilities and skills, especially 21st-century skills, through lectures (Andayani et al. 2021). This is certainly the biggest challenge for lecturers as lecture facilitators, so they always carry out learning reconstruction that refers to the 7th Key Performance Indicator (IKU), one of which is using the case-solving learning method (case method). Thus, lecturers have become an important element in supporting the quality of education and developing quality learning.

Environmental management is one of the materials used in Environmental Science and Disaster Mitigation courses. Environmental management is an integrated effort to preserve environmental functions, including policies to structure, utilize, develop, maintain, restore, monitor, and control the environment (Suwondo et al., 2019). Law Number 32 of 2009 states that environmental management functions to preserve and prevent environmental pollution and damage. The environmental management steps include planning, utilization, control, maintenance, supervision, and law enforcement. The results of observations on Environmental Science and Disaster Mitigation learning found that learning was still conventional and did not pay attention to the need to develop students' skills, especially 21st-century skills. Learning was not varied, and only discussed material without any deeper introduction to environmental problems that require further environmental management.

Learning that is not varied means that students' skills cannot be honed properly; students only get learning theory without any practice, which creates gaps. According to (Koro, 2023) a higher education environment will produce human resources that can adapt, resolve, and provide solutions to the problems encountered. However, in reality, learning in class has not been able to facilitate students' problem-solving skills. Apart from problem solving, critical thinking, communication, creativity, and collaboration skills cannot be developed if learning still uses conventional methods, such as the lecture method. According to Taufiqurrahman 2023 21st-century skills are necessary, so learning must accommodate the development of these skills well.

Student skills can be trained through learning using various methods, such as the base case method. The case method is an alternative to teaching and learning activities that involve case studies on problems related to lecture materials (Fauzi et al., 2022). This case can originate from the internal or external environment. By applying this case method, participation-based learning and problem-solving discussions can stimulate and improve critical thinking skills, active communication, collaboration, and creativity (Asep et al. 2023).

According to Nadir et al. (2022), learning modules can be integrated into case method learning activities or problems that are close to students' lives so that students can learn through problems or cases that exist in their surroundings. Learning modules are teaching materials that are short, organized, and designed so that students can formulate procedures, analyze results, and draw learning conclusions independently. Meanwhile, in determining topics, questions, and supporting materials, lecturers act only as facilitators (Pratama et al., 2022). The advantage of learning using modules is that they can provide feedback so that, in the learning process, there is interaction that occurs, thus facilitating the process of evaluating and reflecting on learning. An analysis of the needs for developing teaching materials showed that students and lecturers needed a module-based learning case method, especially for environmental management materials. The environmental management module has also never been developed, so learning is still based on theoretical textbooks and is not case-based, which is closely related to the surrounding environment; thus, the development of the environmental management module is based on the indispensable case method.

This research aims to develop an environmental management-based case method to improve students' 21st-century skills. The results of the development of teaching modules can be used by lecturers in classroom learning to improve 21st-century skills, namely critical thinking skills, active communication, collaboration, and student creativity.

Methods

This research was conducted from June to October 2023 at Riau University. The type of research is Research and Development (R&D) using the Analyze, Design, Development, Implementation, and Evaluation (ADDIE) model, and research was carried out at this stage of development, namely, limited trials. The research instruments used were questionnaires and observation sheets. The questionnaire was used to obtain data for the analysis of module requirements, validation, and practicality. Observation sheets were used to obtain data on students' 4Cs improvement. Product validation is carried out by two validators, which include module format and graphics, language, presentation techniques, and syntax case methods, to improve the 4Cs. The trial was carried out with 30 students of the marine science study program who were taking Environmental Science courses. The data obtained were based on Likert scale calculations. The rating categories are given by the validators in Table 1 (Sary et al., 2023).

Table 1. Rating category by validator

Score	Categories
4	Very valid
3	Valid
2	Not valid
1	Invalid

The validation results were calculated using the following average score formula:

$$\text{Average Score} = \frac{score\ item}{score\ all\ item}$$

The interpretation of module validation is shown in Table 2.

Table 2. Validity criteria

Score	Categories
3,6 < P < 4,0	Very valid
2,6 < P < 3,5	Valid
1,6 < P < 2,5	Not valid
1 < P < 1,5	Invalid

The practicality of the module was assessed using a practicality questionnaire. The practicality questionnaire is aimed at practitioners assessing products in terms of use, time efficiency, and benefits. The practicality questionnaire assessment is presented in Table 3 (Husna et al., 2022).

Table 3. Interpretation of the practicality questionnaire

Score	Categories
0-20%	Impractical
21-40%	Less Practical
41-60%	Quite Practical
61-80%	Practical

Increased critical thinking, creativity, communication, and collaboration skills. Students are measured using observation sheets. The observation sheet assessment intervals are presented in Table 4 (Purnawirawan, 2019).

Table 4. Assessment of the observation sheet

Interval Value	Rank	Categories
86-100	A	Very Competence
81-85	B	Competence
76-80	C	Less Competence
<75	D	Not Competence

Results and Discussion

This research aims to produce a module-based environmental management case method to improve students' 21st-century skills that are valid, practical, and effective using the ADDIE development model (Analyze, Design, Development, Implementation, and Evaluation).

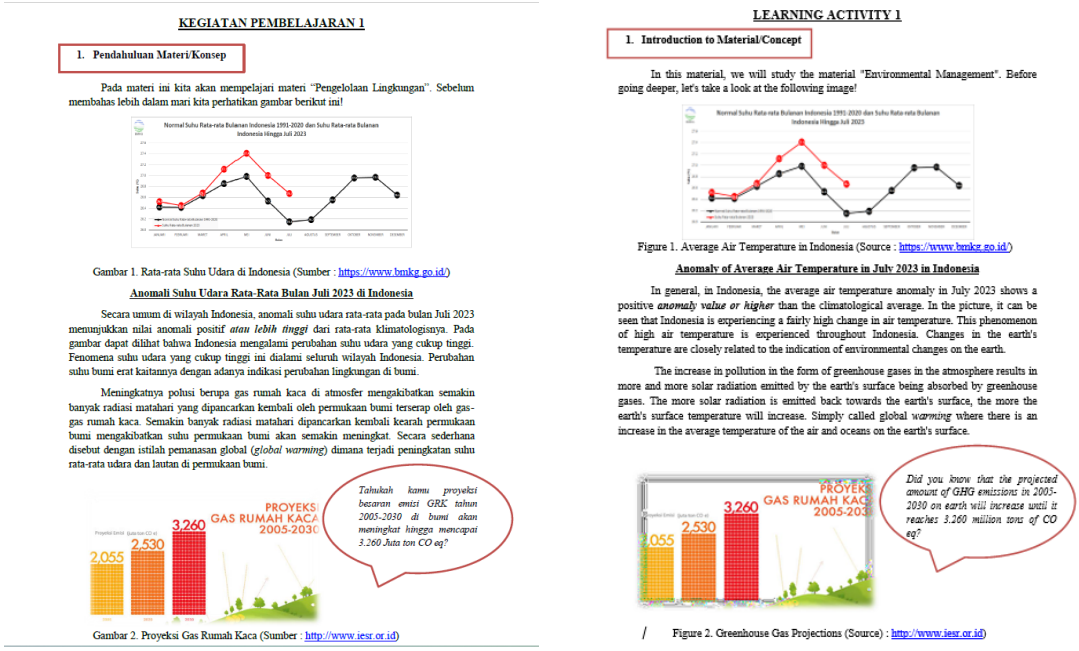
Development of Environmental Management Module

In developing a good learning module, various things must be considered, such as being interesting, useful for students, correct and on target, well/coherently structured, and words and images relevant to the subject matter. The first stage of development is an analysis of the curriculum and materials to be used. The development of the environmental management module refers to the semester learning plan (RPS) (Haerullah et al., 2022) of the Environmental Science and Disaster Mitigation course. Next, we look for relevant materials and cases from various sources to develop the learning module content.

Figure 1. Module cover (left: Indonesian and right: English version)

The module was developed using the case method syntax, namely, the learning steps of deepening the material/concepts, presenting cases, forming groups, solving cases, presenting

and debating cases, and evaluating cases (Asep et al., 2023; Mahdi et al., 2020; Wu et al., 2019). Each case-solving activity actively involves students in critical thinking, collaboration, creativity, and effective communication by observing problems, providing conclusions, and reflecting on the results of investigations and posters (Hossain et al., 2018).



KEGIATAN PEMBELAJARAN 1

1. Pendahuluan Materi/Konsep

Pada materi ini kita akan mempelajari materi "Pengelolaan Lingkungan". Sebelum membahas lebih dalam mari kita perhatikan gambar berikut ini!

Gambar 1. Rata-rata Suhu Udara di Indonesia (Sumber : https://www.bmkg.go.id/)

Anomali Suhu Udara Rata-Rata Bulan Juli 2023 di Indonesia

Secara umum di wilayah Indonesia, anomali suhu udara rata-rata pada bulan Juli 2023 menunjukkan nilai anomali positif *atau lebih tinggi* dari rata-rata klimatologisnya. Pada gambar dapat dilihat bahwa Indonesia mengalami perubahan suhu udara yang cukup tinggi. Fenomena suhu udara yang cukup tinggi ini dialami seluruh wilayah Indonesia. Perubahan suhu bumi erat kaitannya dengan adanya indikasi perubahan lingkungan di bumi.

Meningkatnya polusi berupa gas rumah kaca di atmosfer mengakibatkan semakin banyak radiasi matahari yang dipancarkan kembali oleh permukaan bumi terserap oleh gas-gas rumah kaca. Semakin banyak radiasi matahari dipancarkan kembali kearah permukaan bumi mengakibatkan suhu permukaan bumi akan semakin meningkat. Secara sederhana disebut dengan istilah pemanasan global (*global warming*) dimana terjadi peningkatan suhu rata-rata udara dan lautan di permukaan bumi.

Gambar 2. Proyeksi Gas Rumah Kaca (Sumber : http://www.iesr.or.id)

LEARNING ACTIVITY 1

1. Introduction to Material/Concept

In this material, we will study the material "Environmental Management". Before going deeper, let's take a look at the following image!

Figure 1. Average Air Temperature in Indonesia (Source : https://www.bmkg.go.id/)

Anomaly of Average Air Temperature in July 2023 in Indonesia

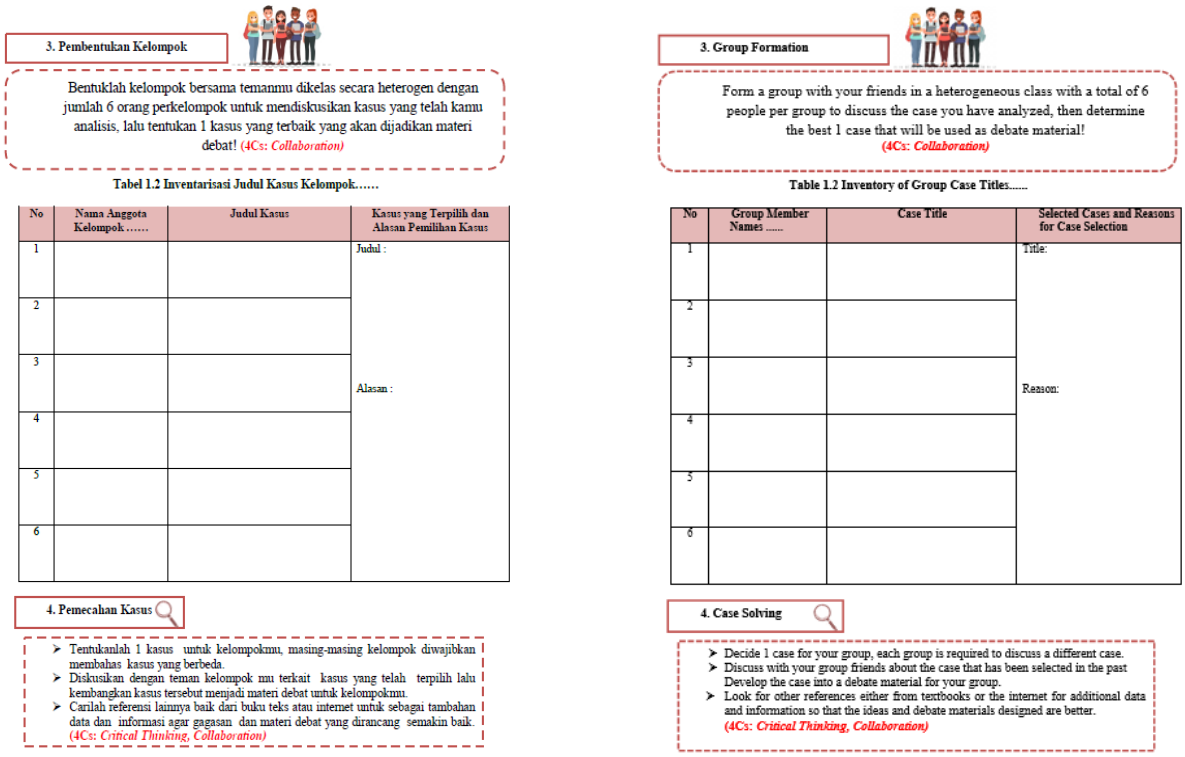
In general, in Indonesia, the average air temperature anomaly in July 2023 shows a positive ***anomaly value or higher*** than the climatological average. In the picture, it can be seen that Indonesia is experiencing a fairly high change in air temperature. This phenomenon of high air temperature is experienced throughout Indonesia. Changes in the earth's temperature are closely related to the indication of environmental changes on the earth.

The increase in pollution in the form of greenhouse gases in the atmosphere results in more and more solar radiation emitted by the earth's surface being absorbed by greenhouse gases. The more solar radiation is emitted back towards the earth's surface, the more the earth's surface temperature will increase. Simply called global *warming* where there is an increase in the average temperature of the air and oceans on the earth's surface.

Figure 2. Greenhouse Gas Projections (Source) : http://www.iesr.or.id)

Figure 2. Presenting case (left: Indonesian and right: English version)

The design of the environmental management module is illustrated in Figure 1. This teaching module is also equipped with assessment instruments and rubrics to achieve learning objectives. After determining the series of assessment processes that will be undertaken, the assessment rubric of critical thinking, creativity, collaboration, and effective communication will be used.



3. Pembentukan Kelompok

Bentuklah kelompok bersama temanmu dikelas secara heterogen dengan jumlah 6 orang perkelompok untuk mendiskusikan kasus yang telah kamu analisis, lalu tentukan 1 kasus yang terbaik yang akan dijadikan materi debat! (4Cs: *Collaboration*)

Tabel 1.2 Inventarisasi Judul Kasus Kelompok.....

No	Nama Anggota Kelompok	Judul Kasus	Kasus yang Terpilih dan Alasan Pemilihan Kasus
1			Judul :
2			
3			Alasan :
4			
5			
6			

4. Pemecahan Kasus

- Tentukanlah 1 kasus untuk kelompokmu, masing-masing kelompok diwajibkan membahas kasus yang berbeda.
- Diskusikan dengan teman kelompok mu terkait kasus yang telah terpilih lalu kembangkan kasus tersebut menjadi materi debat untuk kelompokmu.
- Carilah referensi lainnya baik dari buku teks atau internet untuk sebagai tambahan data dan informasi agar gagasan dan materi debat yang dirancang semakin baik.

(4Cs: *Critical Thinking, Collaboration*)

3. Group Formation

Form a group with your friends in a heterogeneous class with a total of 6 people per group to discuss the case you have analyzed, then determine the best 1 case that will be used as debate material!

(4Cs: *Collaboration*)

Table 1.2 Inventory of Group Case Titles.....

No	Group Member Names	Case Title	Selected Cases and Reasons for Case Selection
1			Title:
2			
3			Reason:
4			
5			
6			

4. Case Solving

- Decide 1 case for your group, each group is required to discuss a different case.
- Discuss with your group friends about the case that has been selected in the past
- Develop the case into a debate material for your group.
- Look for other references either from textbooks or the internet for additional data and information so that the ideas and debate materials designed are better.

(4Cs: *Critical Thinking, Collaboration*)

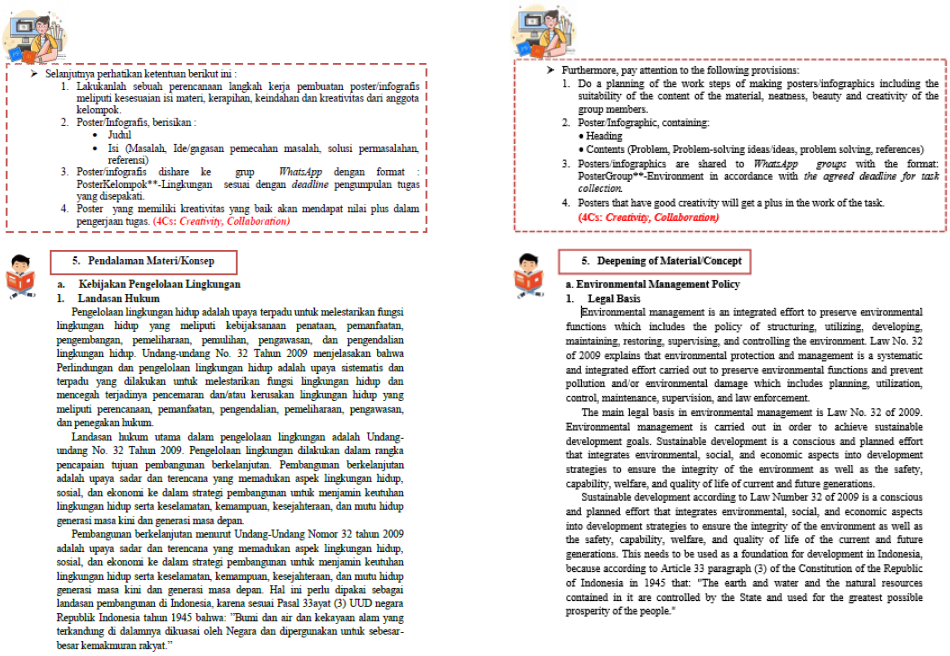


Figure 3. Syntax case method to improve the 21st Century Skills in the module (left: Indonesian and right: English version)

A. Environmental Management Module Validation Results by Expert Validators

Based on the results of the data analysis, validation results were obtained for module development on module format and graphics, language, presentation techniques, and syntax case methods to improve the 4Cs presented in Table 5.

Table 5. validation value of all aspects

Aspect	Average	Categories
Module Format and Graphics	3.64	Very Valid
Content	3.73	Very Valid
Languange	3.55	Valid
Average	**3.64**	**Very Valid**

Based on Table 4, it can be seen that the average score of the module from aspects of module format and graphics, language aspects, and content aspects is 3.64, with a very valid category. Meanwhile, the aspect that received the lowest score was the language assessment aspect, with a score of 3.55 in the valid category. The average validation result was 3.64 with a very valid category. The content aspect includes presentation techniques and the learning steps of the case method. The results of the case method validation by experts are presented in Figure 4.

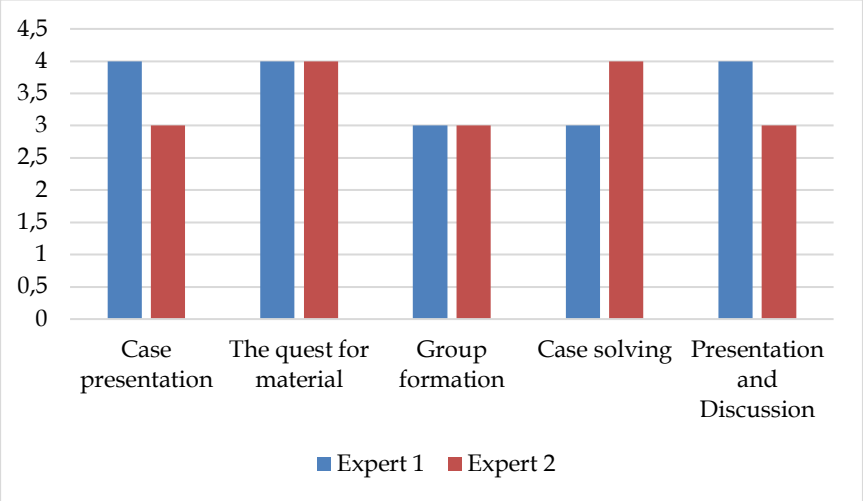


Figure 4. Validation of the case method module by the expert

According to (Permatasari et al., 2019) the presentation of concepts in the module must be presented sequentially according to the learning objectives, so that it makes it easier for students to understand the concepts presented. The environmental management module is presented sequentially, starting from the cover, glossary, concept map, identity, and sub-module achievements, and learning activities 1 and 2, which contain case methods and 21st-century skills, as well as evaluation through tests and reflection. Improvements to the module development were also made following input from experts, and the module cover design was revised by adding more specific images. In addition, there were revisions to the concept map design, structuring the design of the module content, adding pictures or illustrations to support understanding of the concept, tidying up existing pictures, and adding assessment rubrics to guide student work. The results of this validation indicate that the developed environmental management module is suitable for learning (Anggis, 2023).

The content of the material was accompanied by indicators of critical thinking skills, collaboration, creativity, and effective communication. This module provides a case of air change owing to increased pollution. The next case will be analyzed by students by associating various scientific references to develop critical thinking skills. The case-solving process involves discussions with small and large group teams, so that collaboration and communication skills arise. Team discussions involve cooperation between individuals in a team, sharing ideas, and effective communication within a group. This is in line with the opinion of Wahyuni (2020) that communication is an important aspect that supports the effectiveness of improving collaboration skills. At the end of the topic, the students were asked to compile a project in the form of an infographic poster that discussed the importance of environmental management for a sustainable Earth. The preparation of this poster certainly requires student creativity in pouring ideas, developing designs, and implementing designs in a poster project. In addition to the syntax of the module that leads students to 4C skills, this module is prepared using simple and communicative language so that students can easily understand it.

Trial of Using a Based Environmental Management Module Case Method

The trial use of the module's environmental management-based case method was conducted in two meetings. Thirty students were tested using the module based on the environmental management case method. The results of the student response questionnaires are presented in Table 6. The development of an environmental management module based on the case method obtained an average score of 3.82 in the very valid category.

Table 6. Student response questionnaire

Aspect	Average	Categories
Module Format and Graphics	3.76	Very Valid
Content	3.85	Very Valid
Languange	3.86	Very Valid
Average	**3.82**	**Very Valid**

The results of the module practicality questionnaire included ease of use, time efficiency, and benefits (Yerimadesi et al., 2018). The practical results are listed in Table 7.

Table 7. Practicality of the environmental management module

Aspect	Average	Categories
Easy of use	84%	Practical
Time efficiency	83%	Practical
Benefits	87%	Practical
Average	**85%**	Practical

The module had a practical category (84%) in terms of ease of use. This is because the modules are arranged using communicative language and are easy for the students to understand. The syntax of 4C activities also uses a clear, concise, and structured language. These data show that the module is easy to use by students and lecturers. This is in accordance with the practicality of ease of use (Shazlin et al., 2023). With regard to learning time efficiency, the module has a practical category (83%); in accordance with Mutiya Oktariani (2023), learning using modules can make learning time more efficient. The use of modules can increase the efficiency of learning time because the modules provide activity steps that can be carried out by students independently. This will make it easier for lecturers to teach environmental science and disaster-mitigation materials. In terms of benefits, the module was in the practical category (87%). The module-based case method has the benefit of increasing problem-solving abilities, because it is case- or problem-based.

According to (Ni'mah, 2023)Problem-solving through specific cases is a process that can combine several critical thinking activities, such as identifying problems, exploring alternative solutions, implementing the chosen alternative or solution, and producing a result called a conclusion. This is in line with research (Pandia & Sitepu, 2022; Sofia et al., 2023; Sujanem et al., 2022) using a base module case method to improve critical thinking skills. The use of the module-based case method can also improve communication and collaboration skills, as well as student creativity. During open discussion and debate activities, students train their communication skills in line with research (Nashihah, 2020). that discussions and debates can improve oral and written communication skills. Students are also trained in collaboration and creativity skills in learning activities, namely, when selecting the main case and making case posters. This is in line with research (Nashihah, 2020) showing that collaboration and creativity skills can be trained by making posters, one of which is a poster on the latest environmental issues.

The results of student observations using the environmental management module are based on case methods to improve critical thinking, communication, creativity, and collaboration skills is 86. Each respondent who used the environmental management module for each indicator fulfilled three of the five assessment criteria for each observation indicator. The results are presented in Table 8.

The results of the 30 students regarding critical thinking, collaboration, communication, and creative aspects can be seen in the following diagram.

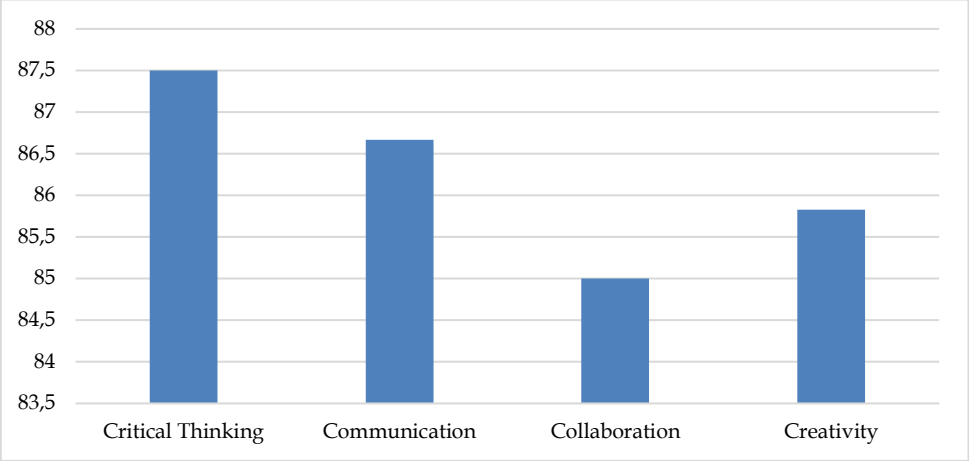


Figure 5. Students 21 21st-century skills after using the module

The aspect of critical thinking observation is selecting problems that are appropriate for factual learning, being able to provide simple explanations, being able to report observational results systematically, being able to evaluate, and being able to consider solutions to problems. For the critical thinking aspect, the result was 85, which is the very competent category. In terms of communication, students improve their communication skills through debate and discussion by conveying opinions in good, structured, and logical language. The results of the observations on communication indicators were 83 categories of very competent. The aspects of collaboration include cooperation, respect for opinions, motivation for a common goal, and the ability to coordinate group members. The result was a score of 85, indicating high competence. Creativity includes high curiosity, being open to new perspectives, putting forward new ideas, being able to create novelty, and applying creative ideas. The result of the observations on the creativity indicator was 87 in the very competent category. Thus, it can be concluded that the environmental management module-based case method can improve 21st-century skills, namely critical thinking, communication, collaboration, and creativity.

Conclusion

Based on the results of this research, it can be concluded that the development of environmental management modules is based on a case method with a very valid category (3.64). The results of the response questionnaire in the limited trial obtained an average score of 3.82 in the very valid category, while the results of the practicality questionnaire received a score of 85% in the practical category. The observation results obtained a score of 85 for the competence category. Based on the research results, it can be concluded that the environmental management module is a case-based method to improve students' 21st-century abilities; it is valid, practical, and effective for use in learning.

Acknowledgment

The research team would like to thank the Faculty of Teacher Training and Education (FKIP) at the University of Riau for funding this activity through FKIP PNBP funding, the validator lecturer, Dr. Darmawati, M.Si, and Dr. Fitra Suzanti, who reviewed and provided input from the tools that researchers have developed.

References

Alt, D. and Raichel, N. (2020). Enhancing perceived digital literacy skills and creative self-concept through gamified learning environments: insights from a longitudinal study. *International Journal of Educational Research*, *101*(January), 101561. https://doi.org/10.1016/j.ijer.2020.101561

Andayani, E., Mustikowati, R. I., Setiyowati, S. W., & Firdaus, R. M. (2021). Case Method: Mengoptimalkan Critical Thinking, Creativity Communication Skills, and Collaboratively Mahasiswa Sesuai MBKM di Era Abad 21. *Jurnal Penelitian Dan Pendidikan IPS (JPPI)*, *16*(1), 52–60. https://ejournal.unikama.ac.id/index.php/JPPI/article/view/6973/3460

Anggis, E. V. (2023). Learning Plan Evaluation of Quality Assurance Biology Education. *Bioedukasi: Jurnal Pendidikan Biologi*, *16*(1), 1. https://doi.org/10.20961/bioedukasi-uns.v16i1.66800

Asep, A., Helmi, D., Ansiska, P., & Sohilait, D. (2023). Aktivitas Pembelajaran Berbasis Metode Case Method Dalam Pembelajaran Geografi Mata Kuliah Antropologi. *Jurnal Ilmiah Profesi Pendidikan*, *8*(1b), 515–522. https://doi.org/10.29303/jipp.v8i1b.1216

Celume, M. P. & Maoulida, H. (2022). Developing 21st Century Competencies among Youth through an Online Learning Program: BE a Global Citizen. *Education Sciences*, *12*(3). https://doi.org/10.3390/educsci12030148

Fauzi, A., Ermiana, I., Rosyidah, A. N. K., & Sobri, M. (2022). Implementasi Case Method (Pembelajaran Berbasis Pemecahan Kasus) Ditinjau Dari Kemampuan Kolaboratif Mahasiswa. *Jurnal Eduscience*, *9*(3), 809–817. https://doi.org/10.36987/jes.v9i3.3446

Haerullah, A., Hasan, S., Sahil, S., & Ermin. (2022). Pengembangan Bahan Ajar Kemampuan Dasar Mengajar Berorientasi Case Methode untuk Meningkatkan Keterampilan Abad 21 Mahasiswa. *Jurnal Ilmiah Wahana Pendidikan*, *8*(18), 551–559.

Hossain, Z., Bumbacher, E., Brauneis, A., Diaz, M., Saltarelli, A., Blikstein, P., & Riedel-Kruse, I. H. (2018). Design Guidelines and Empirical Case Study for Scaling Authentic Inquiry-based Science Learning via Open Online Courses and Interactive Biology Cloud Labs. *International Journal of Artificial Intelligence in Education*, *28*(4), 478–507. https://doi.org/10.1007/s40593-017-0150-3

Husna, H., Fajar, N., Marneli, D., & Haviz, M. (2022). Pengembangan Modul IPA Terintegrasi Al-Qur'an Berbasis Problem Based Learning (PBL) Dengan Strategi Scaffolding di MTsS Koto Tinggi-Pandai Sikek. *Edusainstika: Jurnal Pembelajaran MIPA*, *2*(1), 50. https://doi.org/10.31958/je.v2i1.4432

Koro, M. (2023). Pembelajaran Berbasis Case Method untuk Meningkatkan Kemampuan Pemecahan Masalah Mahasiswa PGSD. *Fondatia*, *7*(1), 251–259. https://doi.org/10.36088/fondatia.v7i1.3185

Mahdi, O. R., Nassar, I. A., & Almuslamani, H. A. I. (2020). The role of using case studies method in improving students' critical thinking skills in higher education. *International Journal of Higher Education*, *9*(2), 297–308. https://doi.org/10.5430/ijhe.v9n2p297

Mutiya Oktariani. (2023). Analisis Kebutuhan Mahasiswa Terhadap Bahan Ajar Sebagai Acuan Untuk Mengembangkan E-Module Pembelajaran Koperasi. *Jurnal Riset Rumpun Ilmu Pendidikan*, *2*(1), 196–202. https://doi.org/10.55606/jurripen.v2i1.1046

Nadir, M., Arthur, R., & Daryati, D. (2022). Literature Review: the Role of E-Modules in Improving Vocational Students' Scientific Literacy Skills. *Jurnal PenSil*, *11*(3), 197–205. https://doi.org/10.21009/jpensil.v11i3.28673

Nashihah, U. H. (2020). Membangun Kemampuan Komunikasi Matematis Siswa dengan Pendekatan Saintifik : Sebuah Perspektif. *Jurnal Pendidikan Matematika (Kudus)*, *3*(2), 185. https://doi.org/10.21043/jmtk.v3i2.8578

Ni'mah, N. (2023). Analisis Berpikir Kritis Mahasiswa Pendidikan Guru Sekolah Dasar Bergaya Kognitif Impulsif Dalam Memecahkan Masalah Matematika Critical Thinking Analysis Of Elementary School Teacher Education Students With Impulsive Cognitive Style In Solving Mathematica. *Maret 2023*, *18*(1), 28–42.

OECD. (2018). Preparing our youth for an inclusive and sustainable world. The OECD PISA Global Competence Framework. In *OECD Publishing*. https://eric.ed.gov/?id=ED581688

Pandia, W., & Sitepu, I. (2022). Modul Pembelajaran Berbasis Masalah Kontekstual untuk Meningkatkan Keterampilan Berpikir Kritis Matematika. *JIIP - Jurnal Ilmiah Ilmu Pendidikan*, *5*(6), 1942–1944. https://doi.org/10.54371/jiip.v5i6.655

Permatasari, I., Ramdani, A., & Syukur, A. (2019). Pengembangan Bahan Ajar IPA Berbasis Inkuiri Terintegrasi Sets (Science, Environment, Technology And Society) pada Materi Sistem Reproduksi Manusia. *Jurnal Pijar Mipa*, *14*(2), 74–78. https://doi.org/10.29303/jpm.v14i2.1256

Pratama, R., Alamsyah, M., & Noer, S. (2022). Analisis Kebutuhan Guru Terhadap Pengembangan Modul dalam Meningkatkan Kemampuan Berpikir Kritis Peserta Didik. *EduBiologia: Biological Science and Education Journal*, *2*(1), 7. https://doi.org/10.30998/edubiologia.v2i1.9769

Purnawirawan, O. (2019). *Pengembangan Instrumen Penilaian 4C (Creativity, Critical Thinking, Communication, Dan Collaboration) Sistem Pembelajaran Abad Dua Satu dalam Pengajaran Bidang Produktif Sekolah Menengah Kejuruan*. Universitas Negeri Semarang.

Sary, A. L., Isnawati, I., & Asri, M. T. (2023). Validity of teaching modules based on local wisdom of macroscopic fungi and PjBL-oriented to improve scientific attitudes and science literacy. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *9*(3), 256–270. https://doi.org/10.22219/jpbi.v9i3.28884

Shazlin, Hamdani, & Salimi, A. (2023). Praktikalitas d an Efektifitas " Subhan Si Pematdas " Bahan Ajar Berbasis Etnomatematika Pada Kelas Rendah di SDN 07 Sadayan Kecamatan Tangaran Kabupaten Sambas. *INNOVATIVE: Journal Of Social Science Research Volume*, *3*(4), 3054–3065.

Sofia, N., Ritonga, M., Arita, S., Syahrul, S., Shalihah, M. A., Dewi, I. P., & Sofya, R. (2023). Peningkatan Keterampilan Berpikir Kritis Melalui Pengembangan E-Modul Perpajakan Berbasis Case Method. *Jurnal Ecogen*, *6*(1), 54. https://doi.org/10.24036/jmpe.v6i1.14185

Sujanem, R., Nyoman, I., Suwindra, P., & Suswandi, I. (2022). Efektivitas E-Modul Fisika Berbasis Masalah Berbantuan Simulasi PHET Dalam Ujicoba Terbatas Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa SMA. *Jurnal Pendidikan Fisika Undiksha*, *12*(2), 181–191.

Suwondo, Rudi, H., & Sri, W. (2019). *Pendidikan Lingkungan Berbasis Potensi Lokal* (1st editio). UR Press.

Taufiqurrahman, M. (2023). Pembelajaran Abad 21 Berbasis Kompetensi 4C di Perguruan Tinggi. *PROGRESSA: Journal of Islamic Religious Instruction*, *7*(1), 78–90. https://doi.org/10.32616/pgr.v7.1.441.78-90

Wahono, B., Narulita, E., Chang, C. Y., Darmawan, E., & Irwanto, I. (2021). The Role of Students' Worldview on Decision-Making: An Indonesian Case Study by a Socio-Scientific Issue-Based Instruction Through Integrated STEM Education. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(11), 1–15. https://doi.org/10.29333/ejmste/11246

Wahyuni, R., & Anhar, A. (2020). Readiness of High School Biology Teachers in West Sumatera in The Face of Learning in the Era of 4.0 Industrial Revolution in Aspects of Collaborative Skills. *International Journal of Progressive Sciences and …*, 207–213. http://www.ijpsat.es/index.php/ijpsat/article/view/1932

Wu, I. C., Lo, C. O., & Tsai, K. F. (2019). Learning Experiences of Highly Able Learners With ASD: Using a Success Case Method. *Journal for the Education of the Gifted*, *42*(3), 216–242. https://doi.org/10.1177/0162353219855681

Yerimadesi, Y., Bayharti, B., & Oktavirayanti, R. (2018). Validitas dan Praktikalitas Modul Reaksi Redoks dan Sel Elektrokimia Berbasis Guided Discovery Learning untuk SMA. *Jurnal Eksakta Pendidikan (Jep)*, *2*(1), 17. https://doi.org/10.24036/jep/vol2-iss1/143