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Development of a Green Chemistry-Based E-Module on Inorganic Waste Reduction and Management Oriented toward Environmental Literacy

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ABSTRACT

Environmental literacy is important for helping students understand environmental problems and take appropriate actions to address them. In chemistry learning, inorganic waste management can be connected with green chemistry principles through contextual teaching materials. This study aimed to develop a green chemistry-based e-module on inorganic waste reduction and management oriented toward environmental literacy and to determine its validity and feasibility. This study used Design-Based Research (DBR) with three stages: analysis and exploration, design and construction, and evaluation and reflection. The e-module was developed as an Android application that integrates four dimensions of environmental literacy: knowledge, cognitive skills, attitudes, and actions. The validation was conducted by three lecturers, while the feasibility test involved 15 fourth-semester students of the Chemistry Education Study Program. The validation scores were 0.89 for the material aspect, 0.89 for the display aspect, and 0.93 for the language aspect, with an overall score of 0.91. The feasibility test results were 92% for the material aspect, 94% for the display aspect, and 91% for the language aspect, with an average of 92.33%. These results show that the developed e-module obtained high validation scores and was considered very feasible by the students. Further testing is needed to determine its effectiveness in improving students' environmental literacy.

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E-module; environmental literacy; green chemistry; inorganic waste; waste management

Environmental literacy is an important competency for understanding environmental problems and responding to them appropriately. Environmental literacy includes knowledge, cognitive skills, attitudes, and actions related to environmental responsibility (Hariyadi et al., 2021). These aspects are related to each other because environmental knowledge needs to be supported by the ability to analyze problems, show concern for the environment, and take appropriate action. Therefore, environmental literacy is important in dealing with environmental problems such as pollution, ecosystem degradation, and waste management (Prastiwi et al., 2020).

Environmental literacy is also important for teacher-education students because they are future educators who may later teach environmental concepts in schools. Irawati et al. (2024) reported that environmental literacy among teacher-education students includes knowledge, competence, attitudes, and environmentally responsible behavior. In chemistry learning, environmental issues can be connected with scientific concepts through topics such as green chemistry and waste management. This allows students to understand chemistry not only as scientific knowledge but also in relation to environmental problems found in daily life.

Inorganic waste is one of the environmental problems that can be used as a context in chemistry learning. Plastic and other inorganic materials are difficult to degrade and require proper management. Poor waste management can cause environmental pollution and increase the amount of waste accumulated in the environment (Suasono et al., 2023). Therefore, the topic of waste reduction and management can be introduced not only as an environmental issue but also as a context for applying chemistry concepts and green chemistry principles.

Green chemistry provides principles that can be used to reduce the environmental impact of chemical substances and processes. In waste management, these principles can be applied through activities such as reducing, reusing, and recycling waste, selecting safer materials, and developing more environmentally responsible practices. Integrating green chemistry into learning can help students understand environmental problems and consider possible solutions.

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However, environmental learning is still often focused on the delivery of information and provides limited contextual activities that connect knowledge with attitudes and actions (Ahmadi, 2022). Environmental literacy is also important for teacher-education students because they are future educators who may later teach environmental concepts in

Digital teaching materials can be used as an alternative to present environmental topics in a more varied form. E-modules can combine text, illustrations, videos, and evaluation activities in one learning medium and can be accessed independently by students. Several studies have developed e-modules and other digital learning materials for science and environmental learning. Sureni et al. (2023) developed a Flip PDF-based e-module to support science literacy, while Khusna and Dewi (2024) developed a Flip Builder-based module related to environmental understanding and disaster response. Widiantie et al. (2023) also used inorganic waste in hydroponic activities to support environmental literacy.

Several studies have also developed digital chemistry learning materials related to environmental issues and green chemistry. Ramdhaniah et al. (2021) developed a green chemistry-oriented e-module on alternative fuels, while Subarkah et al. (2021) developed an e-module on addictive substances integrated with Islamic values. Agustin et al. (2024) developed an electronic magazine oriented toward environmental literacy for plastic waste management. These studies show that digital learning materials can be used to integrate chemistry with environmental issues. However, the previous studies used different learning products, topics, and instructional orientations. Therefore, there is still a need for an e-module that combines inorganic waste reduction and management, green chemistry principles, and environmental literacy in one learning product.

In this study, the e-module combines inorganic waste reduction and management, green chemistry principles, and four dimensions of environmental literacy: knowledge, cognitive skills, attitudes, and actions. The material includes identification and impacts of inorganic waste, reduction and management strategies, recycling technologies and innovations, and environmental policies and actions. Contextual examples of inorganic waste management, including ecobrick activities, are also included to relate the material to environmental problems in Indonesia.

Based on the problems described above, this study aimed to develop a green chemistry-based e-module on inorganic waste reduction and management oriented toward environmental literacy and to determine its validity and feasibility.

Methods

This study used Design-Based Research (DBR) consisting of three main stages: analysis and exploration, design and construction, and evaluation and reflection (Masngudah & Aznam, 2025). The study was conducted from December 2025 to August 2026 and involved fourth-semester students of the Chemistry Education Study Program, Faculty of Tarbiyah and Teacher Training, UIN Sunan Gunung Djati Bandung. The product developed in this study was an Android-based e-module on inorganic waste reduction and management that integrated green chemistry principles with four dimensions of environmental literacy: knowledge, cognitive skills, attitudes, and actions. The prototype was revised after expert validation before being tested for feasibility by students.

The analysis and exploration stage was conducted to identify the content and learning needs for developing the e-module. This stage included a review of relevant literature, analysis of inorganic waste reduction and management concepts, preparation of a concept map, and identification of the environmental literacy dimensions to be included in the learning material. The suitability of the material with the digital media format was also considered at this stage (Wardhana & Purtadi, 2024). The results of this stage were used as the basis for designing the e-module before entering the design and construction stage (Fitriyanti et al., 2024).

The design and construction stage began with the preparation of a flowchart to describe the sequence and navigation of the e-module. A storyboard was then developed as a visual guide for each section of the e-module. The material was organized into five main topics: identification of inorganic waste, impacts of inorganic waste, reduction and management strategies, recycling technologies and innovations, and environmental policies and actions. The material was designed to connect green chemistry principles with the four dimensions of environmental literacy. Microsoft Word was used to prepare the content and storyboard, Adobe Illustrator and Canva were used for visual design, and Unity was used to develop the e-module as an Android application. The flowchart and storyboard were used as guides for organizing the structure and appearance of the e-module before the product was developed (Octarya & Fadhillah, 2023).

Problem Based Learning (PBL) was used to organize the learning activities in the e-module. Contextual problems related to inorganic waste were presented to encourage students to identify environmental problems and consider possible solutions. The evaluation section was divided into two levels. The first level consisted of 10 questions related to knowledge and cognitive skills, while the second level consisted of 10 questions related to attitudes and actions. The score was displayed automatically after students completed each evaluation.

The evaluation and reflection stage consisted of expert validation, product revision, and a student feasibility test. Expert validation involved three lecturers, consisting of two material experts and one media expert. All validators assessed the material, display, and language aspects using a five-point Likert scale ranging from 1 (very poor) to 5 (very good). The validators also provided comments and suggestions for improving the e-module. These comments and suggestions were used as the basis for revising the product before the student feasibility test (Masngudah & Aznam, 2025).

The validation score for each item was calculated by dividing the total score obtained from the three validators by the maximum score of 15. The validation score for each aspect was calculated from the total score of all items in that aspect and then rounded to two decimal places. The scores ranged from 0 to 1 and were reported as validation scores.

After expert validation, the e-module was revised based on the comments and suggestions from the validators. Revisions were made to the content, presentation, visual design, and language where needed. The revised e-module was then used in the student feasibility test.

The feasibility test involved 15 fourth-semester Chemistry Education students. The students evaluated the e-module using a five-point questionnaire covering three aspects: material, display, and language. The material aspect included the clarity of the content and the suitability of contextual environmental examples. The display aspect included text readability, color, layout, and ease of using the application, while the language aspect included clarity, accuracy, and ease of understanding. The feasibility percentage was calculated by dividing the obtained score by the maximum score and multiplying it by 100. Quantitative data from expert validation and student responses were analyzed descriptively, while the validators' comments were used as the basis for product revision.

Results and Discussion

Characteristics of the E-Module

The result of this study was an Android-based e-module on inorganic waste reduction and management oriented toward environmental literacy. The e-module integrates inorganic waste material and green chemistry principles with four dimensions of environmental literacy: knowledge, cognitive skills, attitudes, and actions.

At the analysis and exploration stage, the material was organized based on concept analysis and the learning objectives. A concept map was prepared to show the relationship between the main topics and the dimensions of environmental literacy. The material was then divided into five main topics: identification of inorganic waste, impacts of inorganic waste, reduction and management strategies, recycling technologies and innovations, and environmental policies and actions.

At the design and construction stage, a flowchart and storyboard were prepared as guides for developing the e-module (figure 1). The flowchart showed the sequence and navigation of the application, while the storyboard described the content and layout of each section. The storyboard was used to provide a clearer picture of the e-module design before the product was developed (Sanusi et al., 2015).



Figure 1. Initial design of the e-module

The final e-module has a main menu that directs students to the available learning sections and features (figure 2). The navigation was designed to help students access the material and evaluation activities independently.

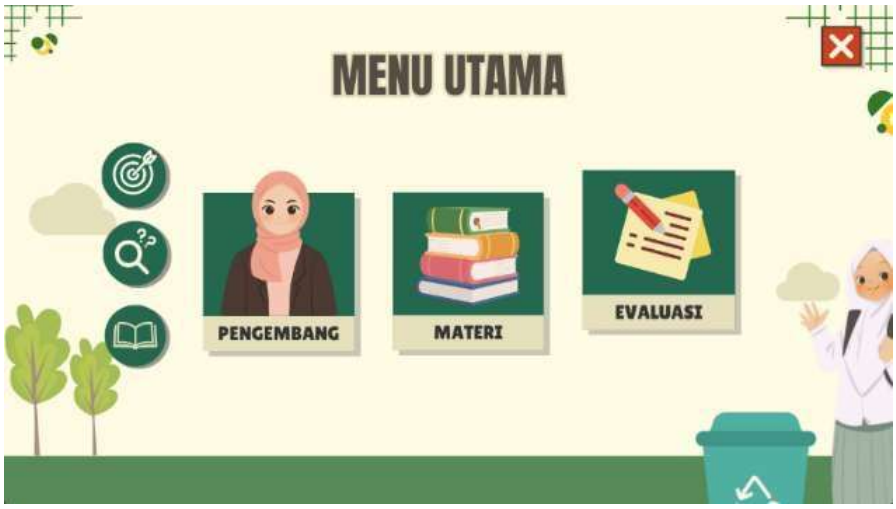


Figure 2. Main menu of the e-module

The content menu presents five main topics in the e-module (figure 3). Each topic combines inorganic waste issues with green chemistry principles and environmental literacy activities. Contextual examples, illustrations, and supporting videos are also included to help students relate the material to environmental problems in daily life.

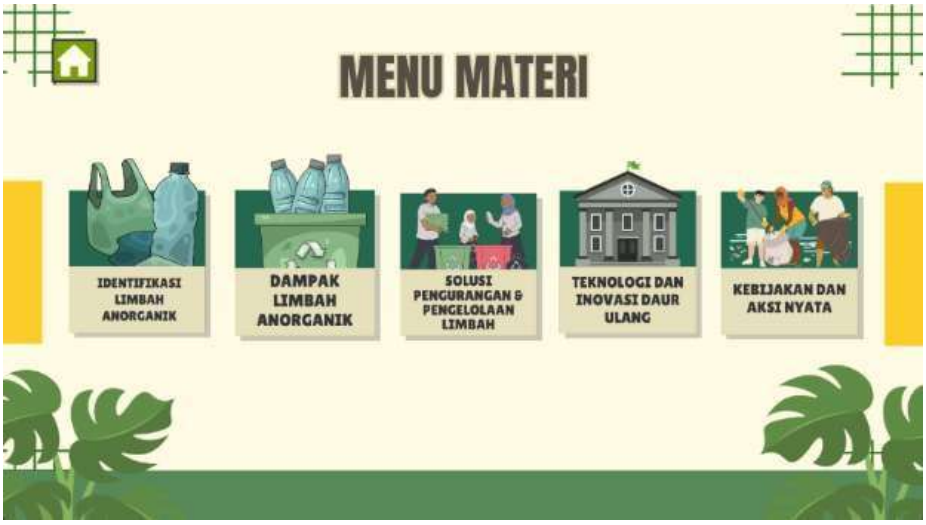


Figure 3. Content menu of the e-module

The learning activities in the e-module were organized using Problem Based Learning (PBL). Environmental problems related to inorganic waste were used as learning contexts to encourage students to analyze the problems and consider possible solutions. The use of PBL in science learning can help connect learning materials with contextual problems that require students to analyze information and propose solutions (Suryati et al., 2021).

The four dimensions of environmental literacy were integrated into the material and evaluation activities. Knowledge was presented through information about inorganic waste and green chemistry, while cognitive skills were developed through questions that required students to analyze environmental problems. Attitudes were related to students' responses toward environmental protection, while actions were represented through activities and choices related to waste reduction and management. These dimensions are consistent with the environmental literacy components discussed in previous studies (Siddiq et al., 2020; Anandari et al., 2023; Hariyadi et al., 2021).

The evaluation section was divided into two levels. The first level consisted of 10 questions related to knowledge and cognitive skills, while the second level consisted of 10 questions related to attitudes and actions. After completing the questions, students could see their scores automatically in the application.



Figure 4. Evaluation question levels in the e-module

Overall, the developed e-module combines inorganic waste reduction and management, green chemistry principles, and four dimensions of environmental literacy in one Android-based learning product. The e-module also includes contextual examples of waste management, such as ecobrick activities, together with visual materials and evaluation activities. These features were designed to help students understand inorganic waste problems from scientific and environmental perspectives (As'ari et al., 2022).

Expert Validation Results

Expert validation was conducted to assess the material, display, and language aspects of the developed e-module. Three lecturers participated as validators, consisting of two material experts and one media expert. All validators assessed the three aspects using the same validation instrument. They also provided comments and suggestions that were used to revise the e-module before the student feasibility test. The material aspect included the clarity of learning objectives, suitability of the material with the objectives, sequence of material presentation, integration of environmental literacy, and suitability of illustrations, images, and videos. The validation results for the material aspect are presented in Table 1.

Table 1. Validation results for the material aspect

Assessment item	V1	V2	V3	Validation score
Clarity of learning objectives	5	4	4	0.87
Suitability of material content with the objectives	5	4	5	0.93
Suitability of the sequence of material presentation	5	4	5	0.93
Suitability of the material with environmental literacy	4	5	4	0.87
Suitability of illustrations, images, and videos	4	5	4	0.87
Average				0.89

The material aspect obtained an average validation score of 0.89. The highest scores were obtained for the suitability of the material with the learning objectives and the sequence of material presentation. The other items, including the integration of environmental literacy and the suitability of illustrations, images, and videos, also received high scores. These results show that the material was considered suitable for the developed e-module and was consistent with the four dimensions of environmental literacy: knowledge, cognitive skills, attitudes, and actions (Siddiq et al., 2020; Anandari et al., 2023; Hariyadi et al., 2021).

The display aspect included the clarity of instructions, text readability, color and design, font type and size, and ease of accessing and using the features. The validation results for the display aspect are presented in Table 2. The display aspect obtained an average validation score of 0.89. The highest scores were obtained for the clarity of instructions and the suitability of color and design. The e-module used green, yellow, and blue as the main colors and was supported by illustrations, infographics, and simple navigation. These elements were used to provide a clear and organized presentation of the learning material. The importance of visual design in digital learning media has also been reported in previous studies (Purnamasari et al., 2018).

Table 2. Validation results for the display aspect

Assessment item	V1	V2	V3	Validation score
Clarity of media-use instructions	5	5	4	0.93
Readability of text	4	5	4	0.87
Suitability of color and design	5	5	4	0.93
Suitability of font type and size	4	5	4	0.87
Ease of accessing and using the features	4	5	4	0.87
Average				0.89

The language aspect included spelling and punctuation, sentence structure, ease of understanding, consistency of scientific terms, and the absence of ambiguous sentences. The validation results for the language aspect are presented in Table 3. The language aspect obtained the highest average validation score of 0.93. The item related to ease of understanding obtained the highest score of 1.00, while the other items obtained scores ranging from 0.87 to 0.93. These results show that the language used in the e-module was considered clear and easy to understand by the validators. Clear and communicative language is important in teaching materials because it helps students understand the learning content more easily (Sureni et al., 2023).

Table 3. Validation results for the language aspect

Assessment item	V1	V2	V3	Validation score
Accuracy of spelling, terms, and punctuation	4	5	5	0.93
Accuracy of sentence and phrase structure	4	5	5	0.93
Ease of understanding the language	5	5	5	1.00
Consistency of scientific and foreign terms	4	5	5	0.93
Absence of ambiguous sentences	4	5	4	0.87
Average				0.93

The overall expert validation results are presented in Table 4. The material and display aspects obtained validation scores of 0.89, while the language aspect obtained the highest score of 0.93. The overall validation score was 0.91. These results show that the e-module received high scores from the validators for the three aspects assessed. The comments and suggestions from the validators were also used to revise the e-module before the student feasibility test.

Table 4. Summary of expert validation results

Aspect	Validation score
Material	0.89
Display	0.89
Language	0.93
Overall average	0.91

Student Feasibility Results

After the revision based on expert validation, the e-module was tested on 15 fourth-semester Chemistry Education students. The feasibility test was conducted to obtain student responses to the material, display, and language aspects of the e-module. The results of the feasibility test are presented in Table 5. The average feasibility score was 92.33%, which was included in the very feasible category. The display aspect obtained the highest score of 94%, followed by the material aspect at 92% and the language aspect at 91%. These results show that the students gave positive responses to the material, display, and language of the developed e-module.

Table 45 Student feasibility test results

Aspect	Feasibility Percentage (%)	Category
Material	92	Very Feasible
Display	94	Very Feasible
Language	91	Very Feasible
Average	92.33	Very Feasible

The material aspect obtained a feasibility score of 92%. This aspect included the clarity of the material, suitability of contextual examples, and relevance of the content to inorganic waste reduction and management. The results show that the students considered the material clear and suitable for use in learning. The use of contextual environmental issues in learning materials is also supported by previous studies that relate scientific concepts to environmental situations (Agustin et al., 2024).

The display aspect obtained the highest feasibility score of 94%. This aspect included text readability, color selection, layout, illustrations, and ease of using the application. The results show that the students gave positive responses to the visual appearance and use of the e-module. This result is similar to the study by Ismanida et al. (2022), which also reported a high score for the graphical aspect of a Problem Based Learning e-module. Visual design is important in digital learning materials because it helps present the material in a clear and organized way.

The language aspect obtained a feasibility score of 91%. This aspect included clarity, sentence structure, accuracy of terms, and ease of understanding. The results show that the students considered the language used in the e-module clear and easy to understand. Clear and communicative language is important in digital teaching materials because it helps students understand the learning content more easily (Masy & Lestarani, 2022; Alwasi et al., 2023).

Overall, the student responses show that the developed e-module was considered feasible in terms of material, display, and language. However, these results only represent students' responses to the product and do not show that the e-module improves environmental literacy. The feasibility test involved only 15 students from one study program, so the results should be considered as an initial evaluation of the product. Further testing using learning outcome measures or a pretest-posttest design is needed to determine the effectiveness of the e-module.

This study has several limitations. The e-module focuses only on inorganic waste reduction and management, while environmental issues also include organic waste, hazardous waste, water pollution, air pollution, and climate-related problems (Marliani, 2014). In addition, the e-module was developed only for Android devices, which limits its use on other operating systems. Further development can include broader environmental topics and make the e-module accessible on different platforms.

Conclusions

A green chemistry-based e-module on inorganic waste reduction and management oriented toward environmental literacy was developed using Design-Based Research through three stages: analysis and exploration, design and construction, and evaluation and reflection. The e-module was developed as an Android application containing five main topics: identification of inorganic waste, impacts of inorganic waste, reduction and management strategies, recycling technologies and innovations, and environmental policies and actions. The content integrates four dimensions of environmental literacy: knowledge, cognitive skills, attitudes, and actions.

The validation scores were 0.89 for the material aspect, 0.89 for the display aspect, and 0.93 for the language aspect, with an overall score of 0.91. The feasibility test involving 15 fourth -semester Chemistry Education students obtained scores of 92% for material, 94% for display, and 91% for language, with an average of 92.33%. These results show that the developed e-module obtained high validation scores and was considered very feasible by the students.

Further research is needed to determine the effectiveness of the e-module in improving students' environmental literacy using learning outcome measures or a pretest -posttest design.

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Conflici of Interest

The authors declare no conflict of interest.

References

Agustin, R., Subarkah, C. Z., & Sukmawardani, Y. (2024). Pengembangan majalah elektronik berorientasi literasi lingkungan pada penanggulangan limbah plastik. *INKUIRI: Jurnal Pendidikan IPA, 13*(3), 320–332. https://doi.org/10.20961/inkuiri.v13i3.83950

Ahmadi, Z. S. (2022). Review article: Peningkatan literasi lingkungan siswa di sekolah. *Educatoria: Jurnal Ilmiah Ilmu Pendidikan, 2*(3), 175–180. https://doi.org/10.36312/ejiip.v2i3.105

Alwasi, F. T., Nurohmah, W., & Prihantini. (2023). Analisis penggunaan infografis mengenai masalah pelestarian sumber daya alam sebagai upaya meningkatkan literasi lingkungan pada siswa sekolah dasar. *Semantik: Jurnal Riset Ilmu Pendidikan, Bahasa dan Budaya, 2*(1), 69–82. https://doi.org/10.61132/semantik.v2i1.190

Anandari, R., Suama, I. W., & Amiruddin, A. (2023). Hubungan literasi dan sikap dengan sensitivitas lingkungan masyarakat. *Jurnal Educatio FKIP UNMA, 9*(1), 242–250. https://doi.org/10.31949/educatio.v9i1.4488

As'ari, E., Syiakhoni, Y., Nafisah, A., & Irhamudin, I. (2022). Pemberdayaan ekonomi kreatif ibu PKK dalam pembuatan meja dan kursi dengan pemanfaatan limbah plastik. *Wisanggeni: Jurnal Pengabdian Masyarakat, 2*(1), 31–43. https://doi.org/10.25217/wisanggeni.v2i1.2246

Fitriyanti, Y., Hidayat, S., Apriliya, S., & Abidin, Y. (2024). Pengembangan media pembelajaran berbasis augmented reality pada tokoh pahlawan Indonesia untuk kelas tinggi SD. *Jurnal Penelitian Pendidikan, 24*(3), 368–379. https://doi.org/10.17509/jpp.v24i3.77776

Hariyadi, E., Maryani, E., & Kastolani, W. (2021). Analisis literasi lingkungan pada mahasiswa pendidikan geografi. *Gulawentah: Jurnal Studi Sosial, 6*(1), 1–16. https://doi.org/10.25273/gulawentah.v6i1.6685

Irawati, H., Aprilia, N., & Saifuddin, M. F. (2024). Literasi lingkungan mahasiswa keguruan. *Didaktika Biologi: Jurnal Penelitian Pendidikan Biologi, 7*(2), 91–97. https://doi.org/10.32502/dikbio.v7i2.5801

Ismanida, D. P., Enawaty, E., Lestari, I., Erlina, E., & Ulfah, M. (2022). Pengembangan e-modul laju reaksi menggunakan model problem based learning. *Edukatif: Jurnal Ilmu Pendidikan, 4*(6), 8263–8280. https://doi.org/10.31004/edukatif.v4i6.3903

Khusna, N. I., & Dewi, S. (2024). Efektivitas e-modul berbantuan FlipBuilder pada empathy project based learning tema peduli lingkungan dan tanggap bencana berbasis nilai agama. *Dinamika Sosial: Jurnal Pendidikan Ilmu Pengetahuan Sosial, 3*(1), 13–29. https://doi.org/10.18860/dsjpips.v3i1.6929

Marliani, N. (2014). Pemanfaatan limbah rumah tangga (sampah anorganik) sebagai bentuk implementasi dari pendidikan lingkungan hidup. *Formatif: Jurnal Ilmiah Pendidikan MIPA, 4*(2), 124–132. https://doi.org/10.30998/formatif.v4i2.146

Masngudah, B., & Aznam, N. (2025). Desain e-modul berbasis kontekstual terintegrasi nilai-nilai keislaman pada materi laju reaksi. *Jurnal Riset Pendidikan Kimia (JRPK), 15*(2), 129–139. https://doi.org/10.21009/JRPK.152.04

Masy, M., & Lestarani, D. (2022). Pengembangan e-modul pembelajaran kimia menggunakan software Flipbook HTML5 pada materi termokimia terintegrasi etnosains kelas XI SMA/MA. *Jurnal Beta Kimia, 2*(2), 49–56. https://doi.org/10.35508/jbk.v2i2.9372

Octarya, Z., & Fadhillah, F. (2023). Desain dan uji coba media pembelajaran interaktif menggunakan Articulate Storyline 3 pada materi larutan elektrolit dan non elektrolit. *Konfigurasi: Jurnal Pendidikan Kimia dan Terapan, 7*(1), 31–42. https://doi.org/10.24014/konfigurasi.v7i1.21556

Prastiwi, L., Sigit, D. V., & Ristanto, R. H. (2020). Hubungan antara literasi ekologi dengan kemampuan memecahkan masalah lingkungan di sekolah Adiwiyata Kota Tangerang. *Jurnal Pendidikan Matematika dan IPA, 11*(1), 47–61. https://doi.org/10.26418/jpmipa.v11i1.31593

Purnamasari, H., Siswoyo, S., & Serevina, V. (2018). Pengembangan media pembelajaran e-komik pada materi dinamika rotasi. *Prosiding Seminar Nasional Fisika (E-Journal), 7*, SNF2018-PE-29–35. https://doi.org/10.21009/03.SNF2018.01.PE.05

Ramdhaniah, H., Sari, S., & Farida, I. (2021). Application of green chemistry oriented alternative fuel e-module. *Gunung Djati Conference Series, 2*, 83–96. https://doi.org/10.15575/gdcs.v2i.39

Sanusi, S., Suprapto, E., & Apriandi, D. (2015). Pengembangan multimedia interaktif sebagai media pembelajaran pada pokok bahasan dimensi tiga di sekolah menengah atas (SMA). *JIPM (Jurnal Ilmiah Pendidikan Matematika), 3*(2), 398–416. https://doi.org/10.25273/jipm.v3i2.510

Siddiq, M. N., Supriatno, B., & Saefudin, S. (2020). Pengaruh penerapan problem based learning terhadap literasi lingkungan siswa SMP pada materi pencemaran lingkungan. *Assimilation: Indonesian Journal of Biology Education, 3*(1), 18–24. https://doi.org/10.17509/aijbe.v3i1.23369

Suasono, E., Linardi, A., Yudinata, M. V., Hasibuan, F. J., Yunizar, D., & Yohana, S. (2023). The effectiveness of plastic waste management based on the legal system in Indonesia. *Dialogia Iuridica, 15*(1), 38–58. https://doi.org/10.28932/di.v15i1.6596

Subarkah, C. Z., Alhak, A. A., Sari, S., Ruswandi, U., & Rochman, C. (2021). Developing e-module on the topic of integrated addictive substances with Islamic values. *JTK (Jurnal Tadris Kimiya), 6*(1), 16–25. https://doi.org/10.15575/jtk.v6i1.9802

Sureni, S., Leksono, S. M., & Biru, L. T. (2023). Pengembangan modul elektronik (e-modul) berbasis Flip PDF Profesional pada tema pencemaran lingkungan untuk meningkatkan literasi sains siswa SMP kelas VII. *Jurnal Pendidikan MIPA, 13*(2), 350–357. https://doi.org/10.37630/jpm.v13i2.944

Suryati, S., Hendrawani, H., & Walidatun, N. (2021). Pengaruh modul PBL berorientasi green chemistry pada materi hidrolisis garam terhadap literasi sains siswa. *Lensa: Jurnal Kependidikan Fisika, 9*(1), 86–100. https://doi.org/10.33394/j-lkf.v9i1.4343

Wardhana, W., & Purtadi, S. (2024). Pengembangan infografis keselamatan kerja di laboratorium sebagai media pembelajaran kimia tingkat SMA untuk mendukung literasi informasi kimia. *Jurnal Riset Pembelajaran Kimia, 9*(1), 27–34. https://doi.org/10.21831/jrpk.v9i1.19029

Widiantie, R., Handayani, H., Prianto, A., & Tedi, T. (2023). Utilization of anorganic waste as a hidroponic media to increase environmental literacy of the Kasturi Village community: Pemanfaatan limbah anorganik sebagai media hidroponik untuk meningkatkan literasi lingkungan masyarakat Desa Kasturi. *Mattawang: Jurnal Pengabdian Masyarakat, 4*(3), 295–299. https://doi.org/10.35877/454RI.mattawang2024