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Developing an E-Module on Economics Based on ESD to Enhance High School Students' Critical Thinking

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Abstract: This study developed an economics e-module aligned with Education for Sustainable Development (ESD) to respond to the urgent need for innovative learning resources that foster students' critical thinking in facing sustainability challenges. The e-module was designed using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), created with Canva, and presented in flipbook format via Heyzine. Findings confirmed a significant advancement in students' critical thinking skills, with a Paired Sample t-Test result of Sig. (2-tailed) < 0.001 and an Independent Sample t-Test result of 0.040. The experimental class attained higher mean N-Gain score (0.64, moderate) contrasted to the control class (0.53). Students also rated the e-module very positively (90%, excellent). These results reveal that the ESD-based economics e-module is practical, effective, and contributes to the enhancement of high school students' critical thinking abilities.

Keywords: e-module, Education for Sustainable Development (ESD), critical thinking, economics education, high school

Abstrak: Penelitian ini mengembangkan e-modul Ekonomi berbasis Education for Sustainable Development (ESD) sebagai respon terhadap kebutuhan mendesak akan sumber belajar inovatif yang mampu menumbuhkan keterampilan berpikir kritis peserta didik dalam menghadapi tantangan keberlanjutan. E-modul dirancang berdasarkan model ADDIE (Analysis, Design, Development, Implementation, Evaluation), dirancang menggunakan Canva, dan disajikan dalam format flipbook melalui Heyzine. Hasil penelitian menunjukkan adanya peningkatan signifikan keterampilan berpikir kritis peserta didik, dengan hasil uji Paired Sample t-Test Sig. (2-tailed) < 0,001 dan Independent Sample t-Test sebesar 0,040. Skor maea N-Gain kelas eksperimen (0,64, kategori sedang) lebih tinggi dibandingkan kelas kontrol (0,53). Persepsi peserta didik juga sangat positif dengan penilaian 90% (kategori sangat baik). Hal ini membuktikan bahwa e-modul

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Ekonomi berbasis ESD bersifat praktis, efektif, dan berkontribusi pada pengembangan kemampuan berpikir kritis peserta didik SMA.

Kata Kunci: modul elektronik, *Education for Sustainable Development* (ESD) , keterampilan berpikir kritis, pendidikan ekonomi, sekolah menengah atas (SMA)

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INTRODUCTION

Education is a strategic instrument in preparing young generations to face global challenges in the 21st century. One essential competency that must be developed is critical thinking, which involves logical reasoning, problem solving, and decision making. Previous studies emphasize that critical thinking not marely supports expertise mastery and also shapes students' social, moral, and cognitive development (Sakti et al., 2023; Indriani & Sakti 2022), Within the framework of Education for Sustainable Development (ESD), critical thinking is recognized as a key competence to achieve the Sustainable Development Goals (SDGs) (UNESCO, 2017).

Within the framework of ESD, critical thinking is recognized as one of the essential competencies to reach the SDGs (UNESCO, 2020). ESD aims to embed sustainability values in education, preparing learners to address environmental, economic, and social challenges in a holistic manner Luthfiyah et al., (2025). A systematic review further confirms that critical thinking is a fundamental competence in ESD implementation, highlighting its significance in fostering sustainability-oriented education (Felix et al., 2025).

However, in practice, the critical thinking skills of Indonesian student remain at a concerning level. Results from the Programme for International Student Assessment (PISA), released by the OECD in 2018 and 2022, indicate that Indonesian students still score low in reading, mathematics, and science literacy all of which are key criteria for assessing critical thinking. This reveals a Disparity between the expected improvement of critical thinking competencies in schools and the actual classroom implementation (Ketut et al., 2023; Ismawati et al., 2023). Furthermore, as pointed out by Arsana et al., (2024), this condition can be attributed to the lack of real world case studies, time constraints, and limited conceptual understanding fostered by conventional teaching methods.

This issue is particularly evident to of economics education at the senior high school level. Economic subjects offer great potential to foster students' economic reasoning in understanding the relationships between individual, household, government, and environmental decisions. However, in reality, economics learning in many schools tends to be theoretical and disconnected from students' daily lives. Based on initial observations at SMA Negeri 1 Karangbinangun, economics lessons are rarely contextualized or linked to local issues or sustainable economic challenges. As a result, learning becomes less meaningful and fails to optimally stimulate students' competence in critical thinking (Rahman et al., 2022; Purnomo et al., 2023).

SMA Negeri 1 Karangbinangun is located in a rural area of Lamongan Regency, where the local economy relies heavily on rice farming and aquaculture. This local potential could serve as a relevant and engaging context for economics learning. Unfortunately, the teaching materials used are still generic and lack integration with local economic contexts or actual sustainability issues. This reflects a Disparity

between the ideal condition which demands meaningful, contextualized learning and the reality of instructional practices (Munir & Santoso, 2022; Mat et al., 2024)

To address this, a more transformative learning framework is needed one that aligns both with local realities and global demands. ESD provides such a framework. It aims to equip students with knowledge, values, and skills that empower them to take conscious efforts to confirm future sustainability (UNESCO, 2020). In economics education, ESD helps students analyze the effect of economic behavior on the environment and society Kamalia et al., (2025), while simultaneously fostering critical thinking as a means to rational decision making and sustainable development (Olsson, 2022).

To address this, a more transformative framework is needed. ESD, supported by technology-based innovations such as electronic modules (e-modules), offers an opportunity to provide flexible, interactive, and student-centered learning. Prior studies show that e-modules can improve motivation, conceptual understanding, and higher-order thinking skills (Herawati & Muhtadi, 2018; Hasanah et al., 2023; Lastri, 2023). Recent evidence from international journals further confirms the potential of ESD based e-modules. For instance, (Rasyid et al., 2024) demonstrated that an e-module designed with ESD principles using the Flipcreator platform was valid and effective in enhancing students' environmental awareness. However, few studies have explicitly integrated ESD with e-modules in economics education, especially within local contexts such as Karangbinangun (Najwa & Suhartini, 2023). Therefore, this investigation seeks to develop an ESD-based economics e-module to enhance students' critical thinking while connecting global sustainability principles with local economic realities.

RESEARCH METHODS

This study employed a research and development (R&D) approach, aiming to produce an innovative and effective learning product based ESD. The The applied development model was ADDIE (Analysis, Design, Development, Implementation, and Evaluation) (Branch, 2009). It was chosen to provides a systematic and structured framework that aligns well with the needs of product development in education. Compared to other instructional design models, ADDIE offers a flexible and iterative cycle, allowing continuous feedback and revision at each stage to confirm the feasibility, practicality, and effectiveness of the product. Moreover, its widespread use in educational research and product development (Lah et al., 2024; (Draper-Rodi et al., 2018) demonstrates its relevance and credibility, making it particularly suitable for developing an e-module that integrates critical thinking skills and ESD principles.

Analysis

At this stage, problems in Grade X economics learning at SMA Negeri 1 Karangbinangun were identified through classroom observations and teacher interviews. The findings revealed low critical thinking skills, lack of contextual and sustainable materials, and limited use of digital media. Student analysis showed that learners (15–17 years) preferred digital and real-life–based content. The curriculum analysis referred to the Merdeka Curriculum Phase E, with materials mapped to ESD themes and Facione's (2015) critical thinking framework.

Design

The e-module structure was drafted in Canva and converted into a flipbook using Heyzine. Content included objectives, concept maps, core materials, reflection prompts, activities, summaries, and assessments. Instruments consisted of expert validation sheets, student response questionnaires, and

pre/post critical thinking tests Derived from Facione's indicators (interpretation, analysis, evaluation, inference, and explanation).

Development

The draft was validated by experts in economics, language, and design, then revised accordingly. The final version was interactive, visually appealing, and compatible with digital devices.

Implementation

The e-module was tested using a quasi-experimental design with two classes: the experimental group (X-1) using the e-module and the control group (X-2) with conventional instruction, both applying PBL. Pretest and posttest were given to measure improvement.

Evaluation

Effectiveness and practicality were assessed through expert validation scores, student responses, and test results. Analysis of the data was conducted using descriptive statistics, paired and independent t-tests, and N-Gain scores. The e-module was considered effective if N-Gain > 0.3 (Hake, 1998).

The data analysis consisted of three main steps. First, the validation sheets from material, language, and graphic experts were analyzed using descriptive quantitative techniques with a Likert scale to determine the feasibility of the e-module. Second, students' responses obtained through questionnaires were studied descriptively to evaluate the practicality of the product. Third, the effectiveness of the e-module was assessed using pretest and posttest results. Statistical analysis included prerequisite tests (normality and homogeneity), followed by paired sample t-tests and independent sample t-tests to identify significant contrasts within and across categories. In addition, N-Gain assessment was utilized for measure the enhancement of learners critical thinking skills.

RESULTS AND DISCUSSION

This outcomes of each development phase and the product's effectiveness in enhancing students' critical thinking. Data are organized into validation, practicality, effectiveness, and hypothesis testing, supplemented with visual documentation of the developed e-module.

The development of the e-module was conducted using the ADDIE model, a systematic instructional design approach comprising five phases: Analysis, Design, Development, Implementation, and Evaluation. This design was chosen due to its iterative nature and suitability for producing high quality, learner centered educational materials.

Analysis

In this initial phase, the researcher conducted a needs assessment through interviews and observations involving economics teachers and tenth-grade students at SMA Negeri 1 Karangbinangun. The findings revealed a lack of interactive teaching materials and limited integration of sustainability concepts in economics lessons. Additionally, the current resources were not fully aligned with the students' local context, which includes agricultural and aquaculture activities. A curriculum analysis also highlighted the opportunity to integrate ESD principles into the topic of demand and supply.

Design

Based on the needs analysis, the design phase focused on structuring the e-module's learning objectives, content flow, media format, and interactive features. The instructional design followed the

principles of ESD and critical thinking skills development. Visual materials were created using Canva, and the e-module was formatted as a flipbook to facilitate student accessibility across digital devices.

Development

At this development phase, the prototype of the product was developed. The content covered economic concepts contextualized through sustainability issues relevant to the students' environment. The draft was validated by a panel of experts, including specialists in material content, educational media, and language. Feedback from these experts guided the revision process to confirm content accuracy, linguistic clarity, and engaging multimedia integration.

Figure 1. Cover Page of the Developed E-Module

The cover features a symbolic integration of economics and sustainability, with an image of the Earth and gears representing the link between the environment and economic systems. The color scheme and icons reinforce the ESD theme, aligning with the goals of sustainable education.

Figure 2. Sample Page Display from the E-Module

The figure shows an internal content page of the ESD based e-module on economic concepts. The structure begins with a chapter title and engaging visual illustration to introduce the topic. On the following page, the learning content is organized into sections with concise explanations, key terms, and real life examples related to sustainability. The page also includes reflection prompts and interactive student activities to encourage critical thinking and contextual application. This design helps promote meaningful learning by combining conceptual understanding with values based inquiry.

Implementation

The validated e-module was then implemented in a quasi-experimental setting involving two groups: an experimental and a control class, each consisting of 34 students. The experimental group utilized the constructed e-module over several education process sessions, while the control group received conventional instruction. Observations and field notes were recorded during this phase to capture student engagement and instructional effectiveness.

Evaluation

Finally, evaluation was conducted both formatively and summatively. Formative evaluation occurred throughout each ADDIE phase, while summative evaluation was based on students' pretest and posttest performance on critical thinking assessments, along with their responses to usability questionnaires. The results provided insights into the overall impact and areas for further improvement of the e-module.

Feasibility of the E-Module Based on Expert Validation

Validation was conducted by three expert reviewers: a content/material expert, a media design expert, and a language expert. The evaluation used a structured questionnaire with Likert scale items covering aspects of accuracy, relevance, visual quality, language clarity, and alignment with ESD principles. The outcome of the expert assessments are summarized in the following table:

Table 1. Expert Validation Results of the E-Module

No	Expert Type	Mean Score	Category
1	Content Expert	88,15%	Highly Feasible
2	Media Expert	96,6%	Highly Feasible
3	Language Expert	100%	Highly Feasible

Expert validation indicated the e-module was highly feasible in terms of content, media design, and language, with scores above 88%. These results confirm that the product meets standards of validity and relevance for ESD-based economics instruction.

These findings align with the standards proposed by Sugiyono (2019), who stated that a high quality instructional product should meet the criteria of validity (content accuracy), practicality (ease of use), and effectiveness (learning outcomes). Moreover, the inclusion of ESD elements, such as environmental awareness and critical reflection, confirms that the module conform tos the goals of transformative education(UNESCO, 2017).

Taken together, the validation outcomes provide strong evidence demonstrating that the e-module can be effectively employed in classroom settings and can serve as an effective medium to promote critical thinking and sustainability oriented learning.

Practicality of the E-Module Based on Student Response

The practicality of the e-module was evaluated through a learner assessment survey administered after the implementation phase. A total of 34 students in the experimental class at SMA Negeri 1 Karangbinangun participated in the trial. The questionnaire measured students' perceptions across several indicators, including attractiveness, ease of use, interactivity, content clarity, and overall learning experience.

The outcome of the practicality test are 4,48 *the mean scores and assessment categories such as "Very Practical.* The data show that students generally rated the e-module as **"very practical"**, with particularly high scores in the aspects of interactivity and visual appeal. Students appreciated the contextual examples, especially those involving local agricultural and aquaculture themes, which helped them better relate to economic concepts.

Figure 3. E-Module Flipbook Display on Student Device

The use of a digital flipbook format was found to enhance accessibility and encourage independent learning. This aligns Supporting the prior work of Najuah et al., (2020), which emphasized that digital modules with multimedia integration can support diverse learning styles and improve students' learning motivation. In conclusion, the practicality findings suggest that the developed e-module is not only functional and user friendly but also aligns well with students' learning preferences and technological readiness. It holds potential to be widely implemented in similar educational contexts.

Effectiveness of the E-Module in Enhancing Students' Critical Thinking Skills

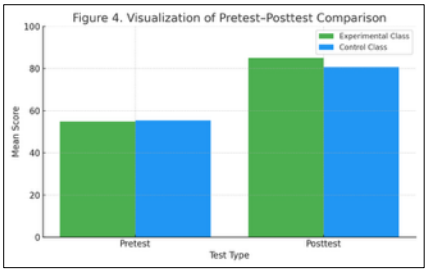
To evaluate the effectiveness of the e-module in enhancing students' critical thinking skills, pretest and posttest data were analyzed. The results are presented in the following tables:

Table 3. Comparison of Pretest and Posttest Scores

N	Group	Total Score	Mean
34	Pretest (Experimental)	1,865	54.85
34	Posttest (Experimental)	2,890	85.00
34	Pretest (Control)	1,880	55.29
34	Posttest (Control)	2,740	80.59

Both groups showed learning gains, but the experimental class improved more (54.85 → 85.00) than the control (55.29 → 80.59), indicating the ESD-based e-module had a stronger Contribution on students' critical thinking. The comparison of pretest and posttest results can also be illustrated in the following figure.

Figure 4. Visualization of Pretest–Posttest Comparison



The figure illustrates the mean score improvements in both experimental and control groups. The experimental class showed a greater increase in posttest scores n contrast to the control class, this

suggests the positive Contribution of using the ESD based e-module in enhancing students' critical thinking skills.

Furthermore, to measure the improvement in critical thinking skills, an N-Gain analysis was conducted to Table 4.

Table 4. N-Gain Analysis of Critical Thinking Skills

Group	N	Mean N-Gain	Interpretation
Experimental Class	34	0.64	Moderate
Control Class	34	0.53	Moderate

The results showed that the experimental class achieved a higher N-Gain score (0.64, moderate) compared to the control class (0.53, moderate), indicating that the e-module contributed more effectively to students' learning progress. to determine the significance of the e-module's effect, paired sample t-tests and independent sample t-tests were conducted. Results of the paired sample t-test are presented below.

Table 5. Paired Sample T-Test Results (Experimental Class)

Paired Sample Test

		Paired differences					significance	
	Mean	St. Deviatio	Std. Error Mean	t	df	One-Sided P	Two-Sided P
Pair	Pretest Eskperimen-Posttest Eskperimen	81.294	9.049	1.097	74.083	67	<.001	<.001

The results of the paired sample t-test showed a significant difference between pretest and posttest scores in the experimental group ($p < 0.05$), suggesting that the e-module had a measurable Contribution on enhancing students' critical thinking. Results of the independent sample t-test are presented below.

Table 6. Independent Sample T-Test Results Between Classes

			Significance	Mean Difference	Std. Error Difference
	t	df	Two-Sided P		

Hasil	Equal varinces assumed	2.092	66	.040	4.412	2.109
	Equal varinces not assumed	2.092	65.603	.040	4.412	2.109

Furthermore, the independent sample t-test confirmed that the improvement in the experimental group was statistically higher than that in the control group. These findings are consistent with previous research Indriani & Sakti, (2022), which emphasized that critical thinking can be effectively fostered through problem based, reflective learning strategies both of which are embedded in the structure and content of the developed e-module.

The development process using the ADDIE model provided a systematic and iterative approach to confirm product quality. Each phase from needs analysis to expert validation and classroom implementation yielded valuable insights and feedback. Utaminingsih & Ellianawati, (2024) and Rasyid et al., (2024) found that instructional media developed with the ADDIE model, particularly flipbook based e-modules with sustainability themes, resulted in valid and pedagogically sound learning tools. The feasibility assessment through expert validation confirmed that the module meets high standards in content, media design, and language use. These results resonate with the findings of Novianti et al. (2023), who validated an ESD based e-module and emphasized its suitability for fostering critical competencies in learners.

Furthermore, the integration of ESD elements such as environmental reflection, local case analysis, and community centered contexts is in line with UNESCO, (2017) vision of transformative education for sustainable futures and has been echoed by Kohl & Hopkins, (2022), who showed that ESD based education improves student engagement with global and local challenges. In terms of practicality, student responses indicated high levels of satisfaction, particularly in areas of visual appeal, usability, and interactivity. This supports Najuah et al., (2020) assertion that digital modules enriched with multimedia and contextual materials can increase students' motivation and learning engagement. Similar results were reported by Fitriana et al., (2024), who concluded that e-modules integrated with PBL enhance usability and self directed learning among students. Hasanah et al., (2023) also demonstrated that interactive e-modules, especially in flipbook format, help boost learner enthusiasm and comprehension in economic topics.

Most notably, the e-module contributed significantly to the improvement of students' critical thinking capacity. The experimental group, which used the module, showed significantly higher posttest scores and N-Gain values compared to the control group. This supports the work of Facione (2015), who emphasized that critical thinking involves more than content mastery it requires structured reflection, evaluation of arguments, and decision making, all of which were embedded in the learning activities of the module. The findings are consistent with Sulhan et al., (2023), who reported that e-modules rooted in problem based learning promote significant improvements in higher order thinking. Pitorini et al., (2024) further validated the effectiveness of combining PBL and Socratic dialogue in digital modules to foster reasoning and metacognitive growth.

The use of real world problems such as sustainability issues in agriculture and aquaculture in the students' environment served as a stimulus for students to think critically and analytically. This contextual approach aligns with the findings of Indriani & Sakti (2022), who emphasized that materials linked to students' lived experiences trigger deeper cognitive engagement. Moreover, Damayanti & Surjanti, (2022) highlighted that embedding ESD within economics learning on demand and supply not only improved student performance but also sustainability awareness. Surjanti et al., (2019) also emphasized the value of environmental-based economics modules in nurturing both ecological consciousness and critical thinking. Taken together, the findings of this study suggest that well designed, locally contextualized, and ESD integrated digital modules can serve as a key facilitator in building students' higher order thinking skills. This implies a strong potential for broader adoption of similar modules in economics education and possibly across other disciplines.

CONCLUSION AND RECOMMENDATION

The evidence from this research indicate which incorporates Education for Sustainable Development (ESD) into e-module development through the ADDIE model is both feasible and and proven to advance students' critical thinking in economics learning. The structured process of analysis, design, development, implementation, and evaluation produced a well-designed learning tool responsive to student needs and local contexts. Expert validation confirmed high standards in content accuracy, media design, and language use, while students' responses highlighted visual appeal, usability, and contextual relevance. The inclusion of sustainability issues grounded in local economic conditions further increased engagement and encouraged deeper reflection.

Most importantly, the e-module significantly strengthened students' critical thinking skills, as indicated by the substantial progress observed in pretest and posttest assessments. These results reinforce prior research emphasizing that contextual, problem-based, and value-driven learning tools can foster higher-order thinking, particularly when aligned with ESD principles.

Based on these outcomes, educators are encouraged to adopt and adapt ESD-based e-modules across economics topics, while curriculum developers should embed sustainability values into instructional materials to support future-oriented learning. Further studies are recommended to examine scalability, long-term impacts, and applications across broader educational contexts and disciplines.

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