



Socio-Scientific Issues-Based E-Module using Liveworksheets to Enhance Students' Scientific Literacy on Acid-Base Topics

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Abstract: According to PISA data, the level of scientific literacy in Indonesia is relatively low, highlighting the need for innovative learning media tailored to the needs of Generation Z students. This study aims to develop an e-module based on socio-scientific issues using the Liveworksheets platform to enhance students' scientific literacy on acid-base topics. The research employed a Research and Development (R&D) method with the ADDIE model, encompassing analysis, design, and development phases. Product validation was conducted by material experts, media experts, and reviewers, while a limited trial was carried out with students. Validation results revealed that the e-module achieved an excellent category from material experts, media experts, and reviewers, with an average ideality percentage of 95%. Student trials also yielded positive responses with excellent content, language, and user-friendliness ratings. The developed e-module incorporates relevant socio-scientific issues, supports technology-based learning, and is designed to accommodate visual, auditory, and kinesthetic learning styles. Therefore, this e-module is an innovative and effective alternative learning medium to improve students' scientific literacy on acid-base topics. In addition, this e-module has the potential to nurture scientifically literate citizens who can contribute to solving socio-scientific issues in society.

Keywords: e-module; scientific literacy; socio-scientific issues

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INTRODUCTION

Generation (Gen) Z is the digital generation nurtured by technology (Hastini et al., 2020). Based on existing technological developments, Gen Z has flexibility, intelligence, tolerance, and multitasking (Purnomo et al., 2016; Rastati, 2018). Gen Z students love challenges and discussions and use technology as the primary source of information in their search for information (Saputra, 2020). The use of technology in the learning process for Generation Z is considered more effective in achieving learning goals (Pujiono, 2021; Zazin & Zaim, 2019). Cyberteaching-based learning or virtual teaching can be an alternative option for adjusting the learning behavior of the digital generation (Dalu & Rohman, 2019). Cyberteaching is an internet learning process (Saraswati et al., 2019). This learning provides easy access to Internet-based learning media such as e-books, e-modules, e-learning, e-journals, e-dictionaries, e-labs, and other Internet facilities (Budiarto et al., 2022; Yakub, 2014). The internet facilities provided do not have access restrictions to support a flexible learning process (Nurmala et al., 2021; Somantri et al., 2017). Based on the ease of access obtained, cyber-based teaching can shift the learning paradigm to student-centered because students will be more active in learning (Amalia et al., 2020; Khikmiyah, 2021). In addition, cyberteaching can also make the learning atmosphere more accommodating, effective, engaging, and fun so that the quality of student learning outcomes will increase (Firmadani, 2020). However, providing learning media supporting cyberteaching has still experienced various obstacles (Alwi, 2017).

One media that can support cyberteaching is e-modules (Winatha et al., 2018). E-modules can be interpreted as teaching materials that are designed in a structured manner based on the curriculum, arranged in a specific unit of time, and packaged using electronic devices such as computers or androids (Larasati et al., 2020; Lestari & Parmiti, 2020). E-modules are interactive because they can display text, images, animations, and videos through electronic devices (Laili et al., 2019). The design of the e-module is also equipped with practice questions that can be a means for students to learn independently (Dari & Nasih, 2019). In addition, the e-module presents the material in complete use of everyday language so that students feel that they are interacting directly with the teacher through the e-module (Susanti, 2021; Wulandari et al., 2021). E-modules are also flexible and can be accessed and studied through electronic media at any time, according to the needs of students (Padwa & Erdi, 2021). Based on its advantages, using e-modules in learning can increase student motivation and activeness because it is more interesting and can improve learning outcomes (Pramana et al., 2020; Ricu & Najuah, 2020). However, the current e-modules are still not good at providing learning evaluation,

so they require means that can overcome these problems (Ramadhani & Fitri, 2020). One of the means that can be used as an option is Liveworksheets. It is a web-based platform that provides an alternative to worksheets that students can access and work on online (Rhosityda et al., 2021). The platform provides various questions such as multiple choice, short answers, true and false, and matchmaking (Prabowo, 2021). Liveworksheets can also contain videos, images, and audio, so they can be an option for providing interactive worksheets (Widiyani & Pramudiani, 2021). In addition, teachers can also create their worksheets by uploading previously created ones (Susilawati et al., 2022). Teachers can also use questions created by other users by copying the question link and sharing it with students (Hazlita, 2021). The advantage of using this platform is that it can save manufacturing time and is environmentally friendly because it can save paper (Mispa et al., 2022). An attractive display will also increase students' learning motivation (Ariyanti & Yunus, 2021; Nirmayani, 2022). Seeing the various positive benefits of this platform, Liveworksheets can be used to implement technology in the world of education to support digital-based learning (Cholifah & Novita, 2022).

Implementing technology in learning is crucial in the curriculum that is currently set, namely the emancipated curriculum (Cholilah et al., 2023). The characteristics of the emancipated curriculum emphasize the profile of Pancasila students and aspects of 21st-century skills that must be mastered to face the challenges of the times, such as literacy, critical thinking, collaboration, innovation, adaptive, leadership, and cultured skills (Suhaimi et al., 2023). One of the literacy skills that students must master is scientific literacy (Huryah et al., 2017). Scientific literacy is a person's ability to apply their knowledge to identify questions, construct new knowledge, provide scientific explanations, draw conclusions based on scientific evidence, and the ability to develop a reflective mindset so that they can participate in overcoming issues and ideas related to science (OECD, 2016). Scientific literacy is closely related to how a person can understand the environment and the problems faced by modern society related to science and technology and social society (Kemendikbud, 2017). Scientific literacy is the primary goal of science education, which includes developing basic knowledge and critical thinking skills, applying what is learned, and understanding the nature of science (Sutrisna, 2021). Scientific literacy is a strong foundation for facing the changing times (Wibowo, 2021). However, the scientific literacy ability of students in Indonesia is very concerning. Based on data released by the Programme for International Student Assessment (PISA), Indonesian students' scientific literacy skills are still low compared to the average international score (Rohmaya, 2022).

One of the learning strategies that has the potential to be applied to overcome the problem of low scientific literacy is contextual learning, such as based on socio-scientific issues (SSI) (Mudawamah, 2020). SSI has excellent potential when presented as the foundation of science education because socio-science-based learning uses societal issues or problems as a source of learning (Minin & Fauziah, 2022). Learning based on socio-scientific issues can bridge between real problems in daily life and scientific knowledge in the learning process. The problems raised are issues that are related to science and technology, as well as social issues related to science (Putra, 2022). The solutions must consider moral, political, social, and economic aspects (Prastyo & Hartono, 2020). SSI is important to be taught in science education because it has various advantages, including being relevant to students' lives, learning is more meaningful and engaging, there is active involvement of students in dialogue and discussion, training students in evaluating scientific data and information, practicing moral sensitivity, caring, empathy, and practicing argumentation (Zeidler et al., 2019).

One of the chemistry materials widely related to daily life is acid-base solution matter. Acid-base solution material is one of the appropriate materials to be taught in the context of socio-scientific issues (Nurmilawati et al., 2021). The topics of acid-base solution material include the development of acid-base theory, indicators of acid-base solutions, pH concepts, acid-base equilibrium (K_a/K_b) settings, pH calculations, and the application of pH concepts to the environment (Fatihah & Ruhiat, 2023). The acid-base solution material emphasizes the discussion of concepts not only limited to clearly observed concepts (macroscopic) but also invisible concepts (microscopic) and symbolic concepts (Darwis et al., 2020). Acid-base solution materials are closely related to daily life, such as environmental pollution, food or beverage products, diseases, cleaning products, industry, and the like (Munandar et al., 2020). In addition, acid-base material meets the content selection criteria for the PISA International Scientific literacy evaluation because this material has long-term relevance and measures knowledge and process competence (Islami et al., 2016). Seeing the importance of acid-base material, special attention is needed so that students can apply the theories obtained in the classroom to real life (Hidayah et al., 2020). Preliminary research activities through face-to-face interviews with teachers and high school students in Yogyakarta stated that learning media in e-modules has not been implemented. The use of learning media is still in the form of print media, such as modules and student worksheets. This is based on several reasons, such as the lack of teacher skills in developing technology-based learning media and teachers still finding it difficult to integrate technology, curriculum, and assessment. This shortcoming can be a topic that must be discussed more deeply because the role of technology in the Independent Curriculum is crucial to improving the quality of education. In addition to paying attention to this in the independent curriculum, choosing learning media that support differentiated learning is very important. Therefore, e-modules that include students' visual, auditory

and kinesthetic learning needs can be considered alternative options. Research on the development of e-modules has been carried out, including the development of acid-base e-modules based on socio-scientific issues assisted by professional flip pdfs (Firanti & Erna, 2024), socio-scientific issues-based and science-literate-oriented acid-base module feasibility tests (Agnia et al., 2021), development of interactive chemistry e-module based on scientific approach using Liveworksheets on reaction rate materials (Aruan & Amdayani, 2023). However, among these studies, there has been no research on developing e-modules containing socio-scientific issues using liveworksheets to improve students' scientific literacy on acid-base material. This research develops a socio-scientific issue (SSI)-based e-module as an innovative solution to enhance students' scientific literacy. Its novelty lies in the systematic integration of SSI within the module's content and activities, presented interactively with the addition of Liveworksheets. This research contributes by providing an alternative learning resource that is relevant, contextual, and effective in developing students' scientific literacy skills, including critical thinking, moral reasoning, and an understanding of the social implications of science.

METHODS

Research and development (R&D) was applied to develop e-modules containing socio-scientific issues using Liveworksheets of acid-base solution materials to improve student literacy. R & D in the educational context refers to the systematic process used to develop and test new educational products (Gall et al., 2007). This study adopts the ADDIE research model developed by Reiser and Mollanda. ADDIE Model includes analysis, design, development, implementation, and evaluation (Molenda, 2003; Branch, 2009). The analysis stage includes collecting information to understand existing needs and problems. The analysis stage includes an analysis of needs, learning materials, and the environment through interviews, literature studies, and document studies. The design phase involves designing solutions based on the information. The design stages include initial data collection, product design, e-module layout design, technology selection, and e-module specifications. The development stage includes the creation of products based on the design. At the development stage, e-modules are made and evaluated by one material expert, one media expert, and five reviewers, and testing is limited to 10 students. At the implementation stage although not always carried out in every research, the implementation stage is when the product is introduced to end users. The final stage, namely evaluation, includes collecting user feedback and making revisions if necessary.

This research aims to achieve a series of action-oriented goals, including designing and developing e-modules, identifying the characteristics of SSI e-modules through the validation process, and analyzing the impact of e-modules on scientific literacy abilities through evaluating students' perceptions of e-modules. These objectives are designed to produce empirical findings that can provide new insights into the impact of the developed SSI e-modules in improving students' scientific literacy and provide a basis for practical recommendations for the development of more effective e-modules. The dataset included observations and interview data collected during the analysis and development phase, involving one material expert, one media expert, and five reviewers/chemistry teachers who evaluated the quality of the developed products. Additionally, ten students completed response sheets as participants providing feedback on the product. The instruments utilized in this research comprised product validation sheets and product quality assessment sheets employing the Likert scale (see Table 1) and student response sheets based on the Guttman scale (see Table 2).

Table 1. Blueprint of expert validation and reviewer assessment towards e-module

Expert	Indicator Aspect Assessment	Number of Instrument Items
Material Expert	Content	4
	Language	4
	E-module features	5
	Scientific literacy	4
Media Expert	Presentation	3
	Graphics	3
	Liveworksheets Software	2
Reviewer	Content	4
	Language	4
	E-module features	5
	Scientific literacy	4
	Presentation	3
	Graphics	3
	Liveworksheets Software	2
	Use	3

Table 2. Blueprint of student response towards e-module

Indicator Aspect Assessment	Number of Instrument Items
Material	2
Language	2
Presentation	2
User friendly	2
Scientific literacy	6

Qualitative data, including observation, interviews, and developing the e-module, were analyzed descriptively, while data from experts and reviewers were analyzed statistically and descriptively. The quantitative data were then categorized using the ideal criteria in Table 3.

Table 3. Ideal Assessment Criteria

Score Range (i) Quantitative	Qualitative Category
$X_i + 1,8 \text{ SBi} < X$	Excellent
$X_i + 0,6 \text{ SBi} < X \leq X_i + 1,8 \text{ SBi}$	Good
$X_i - 0,6 \text{ SBi} < X \leq X_i + 0,6 \text{ SBi}$	Satisfactory
$X_i - 1,8 \text{ SBi} < X \leq X_i - 0,6 \text{ SBi}$	Poor
$X \leq X_i - 1,8 \text{ SBi}$	Very poor

This criterion is used because it uses a formula that provides structured and transparent assessment criteria. Using defined score ranges, researchers can easily classify results such as Excellent, Good, Enough, Less, and Very Less based on the obtained empirical values. Converting numbers into categories makes the research results easier for various parties to understand.

RESULT AND DISCUSSION

Needs analysis aims to identify products by the goals based on the problems educators face in the learning process and discover the need for developing a product to solve the problems. This analysis was carried out through literature studies and interviews. Interviews were conducted with chemistry teachers and students at a high school in Yogyakarta. Based on the interviews, teachers said schools need learning media to support differentiated learning. Learning media is said to be able to support differentiated learning if it contains at least LKPD, discussion forums, and practicum activities. The learning media that can contain these important components is e-modules. One of the advantages of using e-modules is integrating various media with digital formats in a file (Karnando et al., 2022). E-modules can adapt the needs of students to diverse levels of knowledge through content variety, interactivity, and access flexibility (Kristiyaningsih & Febrianti, 2024; Manggala et al., 2024). Research that has been conducted shows that e-modules can facilitate the diversity of students' learning styles and needs (Sanjaya et al., 2023).

The material analysis showed that students struggled with acid-base material, especially distinguishing weak acids and bases. This fact supports issue-based learning as a solution to providing more meaningful acid-base learning (Aini et al., 2024). Students will find it easier to understand concepts by applying daily life phenomena. Regarding scientific literacy in learning, it has not been applied optimally due to time constraints. Therefore, the e-module developed uses a socio-scientific issues approach to improve scientific literacy. Similar research that has been carried out has obtained the result that the learning process with a socio-scientific issues approach can build scientific literacy by helping students analyze and investigate social problems related to science (Khasanah & Setiawan, 2022). Other studies showed that the approach to socio-scientific issues could improve students' scientific literacy skills regarding knowledge and competence, critical thinking skills, scientific argumentation skills, and mastery of science concepts (Nurhalimah et al., 2024).

Furthermore, learning materials are analyzed to determine learning materials adjusted to the applicable curriculum in schools and student needs. This stage is carried out with a document study to see the learning outcomes in phase F in acid-base material: "Students can use the concept of acid and base in daily life." The third analysis stage is environmental analysis, which identifies the learning environment and delivery strategies in learning. This stage was conducted by interviewing a chemistry teacher at a high school in Yogyakarta. The narrative of the interviews is in the form of methods used in the learning process and the atmosphere of the teaching and learning environment created by applying these learning methods. The results obtained by the teacher said that the method often used in chemistry learning is discovery learning; in the learning process, this method is effective because it can condition students well. Based on the explanation, the teacher stated that flexible learning media is needed with various learning models in practice. E-modules are learning media adapted for various learning models, including discovery learning (Dari & Sudatha, 2022).

The design stage describes the concept of a strategy that was carried out to solve the previously analyzed problem. A product prototype was produced at this stage, which goes through three stages. First, the e-module components containing objectives, guidelines, activity sheets, worksheets, assessments, and keys must be determined. The second stage was the creation of the layout, applying several platforms, such as Canva, Liveworksheets, and Heyzine Flipbook Maker. Canva was selected as it can create e-modules with attractive designs (Putri & Erita, 2023), has many features, such as animations and templates, the availability of applications or websites, excellent image upload quality, and ease of editing process (Tanjung & Faiza, 2019). Research indicates that e-modules developed with Canva received excellent categories in every aspect (Taufan et al., 2023). The second platform used was Liveworksheets. The advantage of this platform is that it can provide interactive worksheets with various questions and ease the assessment process (Fauzi et al., 2021). Liveworksheets is a platform that supports differentiated learning because it provides many design and shape options with formats that can be adjusted to needs (Shalahuddin & Hayuhantika, 2022). The final result of the developed e-module is transformed into a flipbook format with the help of a web-based program called Heyzine Flipbook, which can convert PDF files into books, brochures, catalogs, magazines, and digital brochures (Ashari & Puspasari, 2024). This platform was chosen because Heyzine Flipbook Marker has interesting features that can be used, such as adding links, images, videos, audio, and the web. Hence, the e-module with the Heyzine Flipbook application contains more information from various sources. Heyzine also provides easy access both through smartphones and PCs (Saraswati et al., 2021). The outline of the e-module developed is presented in Figure 1.

DAFTAR ISI	
Kata Pengantar	i
Daftar Isi	ii
Glosarium	iii
Profil Pelajar Pancasila	iv
Komponen Inti	v
Tujuan Pembelajaran	vi
Petunjuk Penggunaan	vii
Peta Konsep	viii
Komponen Socio-Scientific Issues	ix
Fun Fact	x
Uraian Materi	xi
• Pengertian asam basa	1
• Teori asam basa	2
• Keseimbangan ion dalam larutan	20
• pH larutan asam basa	33
• Indikator asam basa	41
• Titrasi asam basa	50
Evaluasi	61
Daftar Pustaka	64

Figure 1. E-Module Design

The development stage contains the realization of the product design at the previous stage and product validation. The product specifications developed contain social science issues in each material. The content of socio-scientific issues presented in the e-module is divided into three parts: scientific background, evaluation of information, and decision-making. The scientific background section contains social science issues related to daily life nationally and internationally. In contrast to existing SSI e-modules that often use examples from other countries or global issues, this study develops SSI-focused e-modules that are relevant to the local context and student experience. This increases the relevance of learning and allows students to relate science concepts to their daily lives. This section represents the first aspect of scientific literacy, namely the context that contains local/national and global issues, both current and past, that require an understanding of science and technology. In addition, this section also contains the second aspect of scientific literacy, namely knowledge. Knowledge consists of the ability to understand facts, concepts, and explanations of theories that form the basis of science and technology knowledge. The use of social science issues makes learning more relevant and meaningful because students can see firsthand how scientific concepts can be used to overcome the problems they face. This supports the improvement of students' scientific literacy because it is closely related to a person's understanding of scientific concepts and facts (Nurhayati & Handayani, 2020).

The second part of the socio-scientific issues content in this e-module is the evaluation of information. This section is a follow-up question to the issue that has been presented. Evaluation of information represents

the third aspect of scientific literacy, namely competence. Competency consists of the ability to explain phenomena scientifically, evaluate and design scientific questions, and interpret data and facts/evidence scientifically. The questions asked require students to look for supporting scientific data and confirm the facts presented. This activity requires students to think critically, have the ability to analyze information and evaluate various points of view, including advanced skills from scientific literacy.

Decision-making represents the fourth aspect of scientific literacy, namely attitude. This aspect contains attitudes that show interest in science and technology, assessment of appropriate scientific and investigative approaches, and perception and awareness of environmental issues or problems. In this section, students will be given reflection questions about what information is obtained after completing the questions presented. In addition, students will be allowed to convey the benefits of the activities that have been carried out. This will make students interested in science. The three experts also carried out a validation and assessment process at this stage. The validation results are in Table 4.

Table 4. Result of Material Expert Product Assessment

Validator	Assessment Aspects	Σ Score	Σ Ideal Maximum Score	% Ideal	Qualitative Category
Material Expert	Content	18	20	90%	Excellent
	Language	20	20	100%	Excellent
	Features	23	25	92%	Excellent
	Scientific Literacy	20	20	100%	Excellent

The quality of e-modules containing socio-scientific issues in acid-alkaline materials received an excellent category with a total ideality percentage of 95.29%. The language aspect uses fixed patterns to make it easier for students to understand the information in the e-module (Winatha et al., 2018). Scientific literacy obtained an excellent category with indicators of increasing conceptual understanding and interest in science (Rahmayanti & Andayani, 2023). However, in terms of content and characteristics, the development of the material and the adaptive nature of the e-module needs to be refined.

Table 5. Result of the Media's Product Evaluation

Validator	Assessment Aspects	Σ Score	Σ Ideal Maximum Score	% Ideal	Qualitative Category
Media Expert	Presentation	14	15	93.33%	Excellent
	Graphics	14	15	93.33%	Excellent
	Liveworksheets software	10	10	100%	Excellent

Based on the assessment of media experts, the e-module obtained 95% percent of the total ideality. Liveworksheets in e-modules make it easier for students to interact with the material directly, making learning more interesting and interactive.

Table 6. Reviewer Product Assessment Results

Validator	Assessment Aspects	Σ Score	Σ Ideal Maximum Score	% Ideal	Qualitative Category
Reviewer	Content	19.2	20	96%	Excellent
	Language	19.6	20	98%	Excellent
	Features	24.6	25	98.4%	Excellent
	Scientific literacy	19.2	20	96%	Excellent
	Presentation	14.8	15	98.66%	Excellent
	Graphics	14.4	15	96%	Excellent
	Liveworksheets software	9.8	10	98%	Excellent
	Usage	14.4	15	94,66%	Excellent

The percentage of total assessment from reviewers was 97.16%. This indicates that the e-module developed supports integration with various learning models to provide convenience for teachers in its implementation (Rohmatulloh et al., 2022). Experts and reviewers gave a positive response to the learning media developed. The results of testing this product align with the research (Rohmaya, 2022), which shows that learning in the context of SSI can train students to study science-related social issues and increase their scientific literacy.

Table 7. Student Response Results

Product Rating	Assessment Aspects	Σ Score	Σ Ideal Maximum Score	% Ideal Total	Category
Student Response	Material	2	2	92,85%	Excellent
	Language	2	2		
	Presentation	2	2		
	User Friendly	2	2		
	Scientific literacy	5	6		

The results of the student response test obtained an ideality percentage of 92.85%, which indicated excellent results. This research offers a new approach to developing SSI e-modules by combining three key elements, namely systematic and contextual integration of SSI, interactive features and interesting technologies, and differentiation-centered learning design. This combination aims to maximize the impact of e-modules on various aspects of students' scientific literacy, including concept understanding, critical thinking skills, and moral reasoning. At this stage, the dissemination of e-modules is also carried out so that they can be used according to the needs of students. The research is the initial stage of product development, so the implementation stage is not carried out due to time limitations. Moreover, the purpose of the research is to focus on product development. However, in this study, product evaluation is always carried out. The development process requires several tests by a team of experts, individual research subjects, and a limited scale to improve the final product so that further research can be implemented or used on a teaching scale.

CONCLUSION

The product developed in this study is an e-module loaded with socio-scientific issues using liveworksheets on acid-base material. The results of validation and assessment from material experts, media experts, and reviewers resulted in excellent categories in every aspect. The test was limited to the students' responses, obtaining an excellent category for each question asked. Based on student assessments and responses, states that students have an interest in social science issues, a new understanding of social science issues, and concern for social science issues around us. The product developed can be a choice of learning media that supports the improvement of scientific literacy by integrating social scientific problems students face in daily life. This research focuses on product development, so it has limitations in the implementation stage. It is recommended that a wider implementation be carried out to continuously evaluate the product's effectiveness.

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