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Development of Socio-Scientific Issue-Based E-Modules on Addictive Substances to Enhance Students' Chemical Literacy

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Abstract

Chemical literacy is an essential competency that includes understanding chemical concepts, critical thinking skills, and scientific-based decision-making in dealing with relevant social issues. Based on this urgency, this study aims to develop an e-module based on Socioscientific Issues (SSI) on addictive substances as an effort to develop chemical literacy. This study uses the R&D method with the ADDIE (Analyze, Design, Development, Implement, and Evaluation) model up to the Development stage to develop an e-module based on sociosatific issues. The research sample includes two material experts, one media expert, and 15 Chemistry Education students of UIN Sunan Gunung Djati Bandung as respondents for the acceptability test. Data were collected using validation sheets and questionnaires, then analyzed descriptively to determine the validity and feasibility of the e-module. The validation results of two material experts and one media expert showed an average score of the material aspect of 0.90, language 0.89, and appearance 0.87 (very valid). The student feasibility test showed a score of the material aspect of 92.22%, language 89.33%, and appearance 88.22% (very feasible). This e-module is feasible to be used as an innovative and contextual learning media and the basis for further development of the implementation and evaluation stages. This study presents a novelty in the form of an interactive e-module based on socio-scientific issues (SSI) for addictive substances material in Android format (.apk). This e-module is relevant for digital learning and is designed to improve students' chemical literacy by linking chemical concepts to real problems and training critical thinking and science-based decision making.

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INTRODUCTION

The 21st century is marked by the rapid development of science and technology, particularly in the field of information and communication technology, which has had a global impact. This advancement has made a significant contribution to improving quality of life, especially in the areas of education, health, communication, and nanotechnology (Astiti et al., 2016). However, alongside these benefits, various challenges have also emerged, such as global warming, energy crises, and environmental degradation. These conditions demand the presence of human resources who possess the ability to understand scientific concepts and the interconnection between science, technology, and society (Rahayu, 2017). Individuals who are able to integrate this knowledge to solve real-world problems are considered part of a society with chemical literacy (Pratiwi et al., 2019).

Chemical literacy is part of scientific literacy that emphasizes an individual's ability to understand chemical concepts and apply them critically, creatively, and responsibly in solving

everyday problems (Irwansyah et al., 2017). In the PISA framework, scientific literacy, including chemical literacy, is measured through aspects of context, content, process, and attitude (Tiara & Sulistina, 2021). Unfortunately, the scientific literacy of Indonesian students based on PISA 2000–2015 data is relatively low (average score 403, ranked 74 out of 79 countries) . This gap indicates the need for learning innovation to improve chemical literacy, especially so that students are better able to teach chemical concepts with socioscientific issues (Socioscientific Issues/SSI) in everyday life (Laksono, 2018).

One potential solution is the development of interactive e-module-based learning media that contains the SSI context, so that learning becomes more relevant and meaningful. However, based on the latest literature review, the development of SSI-based e-modules in chemistry learning is still relatively limited, both in terms of number and variety of topics. Most new studies emphasize the development of inquiry-based or STEM-based e-modules in general, while the development of specific e-modules to improve students' chemical literacy through SSI integration has not been widely reported. Therefore, the development of SSI-based e-modules is needed to support chemistry learning and at the same time bridge the integration in students' chemical literacy (Novitasari et al., 2022).

Socioscientific Issues (SSI)-based learning can be implemented by integrating elements of social issues into learning resources. The abuse of addictive substances is one significant social problem that has the potential to lead to behaviors that deviate from societal norms (Faridah & Atakari, 2018). According to the World Drug Report 2021, more than 300 million people worldwide use illegal drugs classified as addictive substances. In Indonesia, the prevalence of drug use among individuals aged 15–24 increased from 1.96% in 2021 to 1.97% in 2023. These addictive substances are categorized into three groups: narcotics, psychotropics, and other addictive substances (Mersi et al., 2021). One contributing factor is the public's limited knowledge of the dangers of addictive substance abuse. Therefore, understanding the risks associated with addictive substances needs to be enhanced through effective learning media, one of which is the use of e-modules (Helsy et al., 2024).

Learning media, especially digital-based e-modules, can effectively support the understanding of chemical concepts and foster chemical literacy (Nisa et al., 2015). E-modules accessible via smartphones have proven effective, with module validation reaching 93% and media effectiveness at 86% (Ricu Sidiq & Najuah, 2020). The use of electronic modules (e-modules) can improve scientific literacy as they are capable of visualizing phenomena to help students explore and develop problem-solving skills, thereby facilitating problem-solving processes. Moreover, e-modules also function as self-directed learning tools that include content, methods, and facilitative approaches systematically designed with direct feedback (Subarkah et al., 2018).

Although scientific literacy is a global educational priority, Indonesian students continue to demonstrate low levels of chemical literacy, particularly in applying concepts to real-life contexts and engaging in critical thinking. Chemistry instruction remains largely decontextualized and lacks integration of digital media that incorporate Socioscientific Issues (SSI). To address this gap, this study develops an interactive SSI-based e-module on addictive substances in Android (.apk) format using Articulate Storyline software. The research explores the module’s design, evaluates its content validity, and assesses its feasibility in supporting students’ chemical literacy.

METHOD

This study uses the Research and Development (R&D) method, which is a method that aims to produce new products while testing their effectiveness. In this study, the development model

used is the ADDIE model, which includes five stages, namely Analysis, Design, Development, Implementation, and Evaluation (Suratnu, 2023). However, in this study the discussion is limited to the Development stage.

Analysis

In the Analysis stage, the researcher conducted an in-depth literature review to determine the learning needs and main concepts that must be included in the e-module. This study includes an analysis of the concept of addictive substances according to curriculum needs, an analysis of chemical literacy based on science literacy indicators in PISA, and the application of the Socioscientific Issues (SSI) approach analysis so that learning is more relevant and contextual. In addition, the researcher also conducted an analysis of the needs of multimedia devices to ensure that the e-module can be developed interactively. The results of this stage are then used to compile instruments and concept maps as guidelines for developing the e-module.

Design

In the Design stage, researchers design the form and structure of the e-module according to learning needs. In this stage, a storyboard is prepared to explain the sequence of presentation of the material and the relationship between frames in the e-module, starting from the opening, concept delivery, to practice questions and evaluation sections. In addition, researchers create a flowchart to map the flow of e-module components to make it more structured and facilitate development in the next stage (Latip, 2022). With this design, it is hoped that the process of making e-modules can take place more systematically and in accordance with learning objectives.

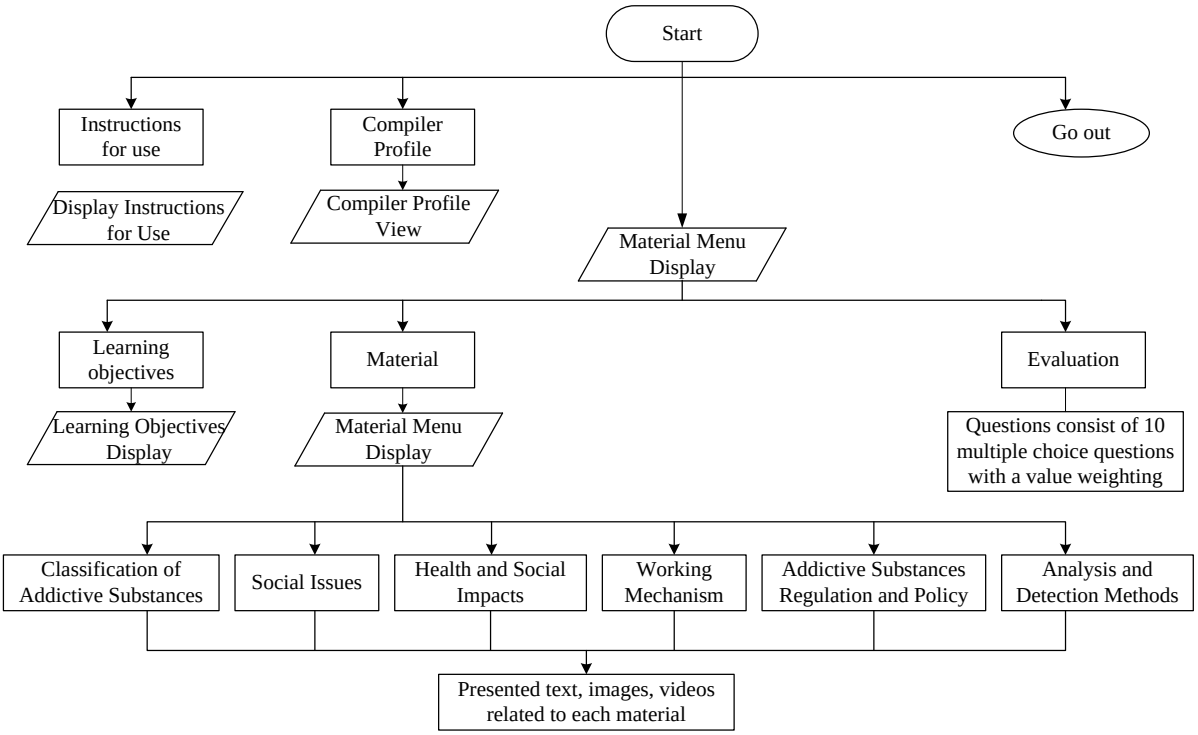

Figure 1. Flowchart

Development

In the Development stage, the researcher realized the design that had been made into an initial e-module product. Using Articulate Storyline 3 software, the e-module was developed in .html format so that it could be accessed interactively and multimedia (Latip, 2022). Furthermore, the .html file was converted into .apk format using Web2APK so that the e-module could be

installed and used directly on Android devices (Astuti et al., 2019). This initial product was then tested for validity through an expert validation process, involving two material expert validators and one media expert validator, to ensure that the content and appearance were appropriate. In addition, a feasibility test was also carried out on Chemistry Education students at UIN Sunan Gunung Djati Bandung to obtain initial input regarding the quality and usefulness of the e-module before proceeding to the implementation and evaluation stages.

RESULTS AND DISCUSSION

The development of the e-module on the topic of addictive substances employs the Design-Based Research (DBR) method combined with the ADDIE approach. This method was chosen because it is effective in designing and developing various learning components, including instructional materials and supporting media (Rosmiati et al., 2022). The ADDIE approach is used as a reference for the research phases because it provides a systematic and structured framework aimed at ensuring the effectiveness of the resulting learning product (Widiana & Rosy, 2021).

The ADDIE development model consists of five main stages: analysis, design, development, implementation, and evaluation (Latip, 2022). However, in this study, the implementation only extends to the development stage. This is aligned with the focus and objective of the research, which is to describe the visual design and analyze the validation results and feasibility of the developed interactive multimedia.

In the ADDIE approach, the first and most crucial stage is the analysis phase, which serves as the foundation for the entire instructional design process. At this stage, the learning needs, learner characteristics, instructional objectives, and the learning environment are identified. This analysis enables instructional designers to develop learning materials and media that are relevant and tailored to the learners' context and needs (Li et al., 2019). Moreover, an accurate analysis supports the creation of more effective teaching strategies that are adaptive to the predetermined learning objectives (Shakeel et al., 2023). Therefore, the analysis phase is considered a vital foundation in the e-module development process, as it directly influences the quality of the final product.

The e-module is developed using Articulate Storyline, a software released in 2014 that allows for the integration of slides, Flash, videos, and engaging animations into a single package (Donnellan, 2021). This application provides attractive and user-friendly templates that engage users and simplify the facilitator’s operation. One of the strengths of Articulate Storyline is its natural "smart brainware" system and effective design process, facilitated through templates that can be distributed both online and offline, making management easier (Yolanda et al., 2022). This application is used to add instructional videos and exercises to the interactive e-module. The addition of quizzes and assessments makes the e-module interactive, as it can provide immediate feedback and scores to users upon completion of the questions (Afdal et al., 2021).

The results of the first stage produced research instruments such as concept analysis and a concept map. Concept analysis is one of the instruments used to examine a subject matter concept in more depth. Through the concept analysis instrument, 43 concept labels related to the topic of addictive substances were identified. These concept labels were then organized into a concept map to illustrate the relationships between the concepts. A concept map is a schematic diagram that shows the interconnection between one concept and another (Nurhidayat, 2022).

The second stage in the ADDIE model is the Design phase, which focuses on systematic planning to achieve the predetermined learning objectives. In this phase, instructional designers develop a learning structure by creating a flowchart and a storyboard, which serve as visual guides for the flow and content of the interactive multimedia to be developed. The flowchart is used to illustrate the relationships between components within the multimedia, while the storyboard details the visual and narrative elements of each part of the learning material. An effective design at this stage ensures that the learning content is structured logically and engagingly, thereby enhancing user engagement and comprehension (Klauder & Fantoni, 2024).

Following the development of the content and the creation of the flowchart, the next step is the development of a storyboard as an initial visual design of the interactive multimedia. The storyboard includes design elements such as media background themes, the selection of font type and size, methods of material presentation, and supporting features such as navigation buttons (Latip, 2022). The storyboard is developed based on the structure and components outlined in the flowchart, ensuring that all icons and navigational elements implemented in the multimedia are consistent and aligned with the previously established design flow (Lestari et al., 2019).

The third stage in the process is the development phase, where the content outlined in the storyboard is realized into a tangible e-module product. This process uses the Articulate Storyline 3 software, which produces output in .html format (Latip, 2022). Subsequently, the .html format is converted into an .apk file using the Web2APK application so that it can be installed and run on Android-based smartphones (Astuti et al., 2019). The initial version of the installed interactive multimedia product is then subjected to a validation test by two subject matter experts and one media expert to ensure the quality and appropriateness of the developed learning media.

The content of the e-module covers various aspects of chemical literacy. The context aspect includes topics such as the dangers of NAPZA (narcotics, psychotropics, and addictive substances), which negatively impact mental and physical health, as well as social life when misused; current issues regarding the misuse of addictive substances at both national and international levels; legal questions related to these issues; and a video showing someone abusing addictive substances. It also addresses individual, family, and environmental factors.

The content aspect of chemical literacy explains how addictive substances work in the body through respiratory, digestive, and circulatory pathways; classification of addictive substances based on their danger level, manufacturing process, and pharmacological knowledge; relevant Indonesian regulations; and causes of substance abuse, including individual, family, and environmental factors.

The process aspect is related to methods of analyzing and detecting addictive substances, including a video demonstrating how to perform a urine test to identify the substances consumed. The attitude aspect focuses on raising awareness of societal issues (Laksono, 2018), aiming to build attitudes that discourage substance abuse. This includes material on the effects of substance abuse and a short narrative emphasizing that addictive substances should only be used in appropriate dosages and must not be misused, complemented by Islamic perspectives and legal viewpoints.

The e-module on addictive substances features a forest and plant background, as shown in the initial display of the e-module (see image below). This screen contains the title of the e-module: "Addictive Substances." On the opening page, there are several clickable buttons, such as "Start," "User Instructions," and "Developer Profile." These buttons lead to the corresponding pages when clicked.

(a) (b) (c)

Figure 2. (a) Initial Display; (b) User Instructions; and (c) Developer Profile

The main menu of this e-module consists of three primary sections: learning objectives, material, and evaluation. The learning objectives menu is presented to inform the expected outcomes after students use the addictive substances e-module, consisting of six indicators that refer to aspects of chemical literacy, including context, content, process, and attitude. The material menu is presented in the form of interactive icons covering the classification of addictive substances, related social issues, health and social impacts, the mechanism of action of addictive substances, regulations and policies, as well as methods of analysis and detection. In addition, there is a preventive message to discourage drug abuse. The evaluation menu begins with an introductory screen and a 'start' button that directs users to a page for selecting a question package. Each package consists of four multiple-choice questions and one multi-select question, with a minimum passing threshold of 75. All icons in the e-module are interactive and guide users to the corresponding pages based on their selections.

Figure 3. Material Menu

The presentation of material in this e-module is designed based on the four components of chemical literacy: content, context, process, and attitude (Permana et al., 2021). For the content aspect, the developer structured the material to strengthen students' conceptual understanding of addictive substances. The material includes the classification of addictive substances, which consists of narcotics, psychotropics, and other addictive substances such as alcohol, nicotine, and caffeine. Each type of substance is systematically explained based on its source, mode of action, and its physiological and psychological effects. The delivery of the material is enriched with narrative texts, visual illustrations, and instructional videos to accommodate macroscopic, microscopic, and symbolic representations of chemical concepts. In addition, the material also explains the mechanism of action of addictive substances in the body through entry routes such as inhalation, digestion, and injection, and their interaction with the central nervous system.

In the context aspect, the e-module presents discussions on current social issues, such as the increasing abuse of narcotics among teenagers and its impact on social, educational, and health aspects. This discussion is linked to national policies, such as Law Number 35 of 2009 on Narcotics, as well as the role of institutions like the National Narcotics Agency (BNN). This contextual presentation aims to help students connect scientific knowledge with social phenomena occurring in their surroundings, making learning more meaningful and applicable (Phangestu et al., 2021).

The process aspect is aimed at developing students' scientific skills through understanding scientific methods in the analysis and detection of addictive substances. The material includes explanations of analytical techniques such as chromatography and spectrophotometry, which are commonly used in laboratory practice. The inclusion of interactive questions, formative exercises, and automatic feedback in the e-module is intended to train critical thinking skills, decision-making, and problem-solving based on scientific data. Thus, students are trained to observe, formulate hypotheses, interpret data, and draw conclusions based on scientific principles.

In the attitude aspect, the material in the e-module is aimed at fostering students' moral and ethical awareness regarding the use of addictive substances. The material presentation includes the negative effects of addictive substances on physical and mental health, as well as social impacts such as criminal behavior and decreased productivity. The e-module also incorporates educational messages and reflective prompts to encourage students to adopt a preventive attitude toward substance abuse. The integration of the attitude aspect in learning aims to cultivate social responsibility and strong scientific character in students as part of a holistic chemical literacy framework.

The next stage is the validation test, which involves two subject matter experts and one media expert. This validation aims to evaluate the feasibility of the multimedia from the experts' perspectives (Latip, 2022). Referring to Sugiyono, (2018), a statement is considered valid if the obtained r_{count} value is greater than 0.3. The validation questionnaire used by the validators applies a rating scale consisting of the categories: Very Good, Good, Fair, Poor, and Very Poor. The evaluated aspects include content substance and material, language substance, as well as multimedia display and software features. The average r_{count} values for each aspect are presented in the following table.

Table 1. Validation Test Results

Aspect	$\mathbf{r_{count}}$	$\mathbf{r_{critical}}$	**Conclusion**	**Interpretation**
Material Aspects	0,90	0,3	Valid	High
Language Aspect	0,89	0,3	Valid	High
Display Aspects	0,87	0,3	Valid	High

The validation results for the content substance aspect showed an r_{count} value of 0.90, which falls into the high category. Several improvements were suggested by the validators regarding this aspect, including increasing the number of quiz packages, adding more questions, and refining the evaluation questions. These suggestions were based on recommendations from the subject matter experts to expand each question set and ensure alignment with the previously established learning objectives. This aligns with Surbakti, (2025), who states that evaluation questions serve to measure the success and level of achievement of learning objectives.

The validation results for the language substance aspect, which is oriented toward chemical literacy, showed an average r_{count} value of 0.89. The validators provided several suggestions for improvement, especially concerning the presentation of chemical processes in the material. Recommended improvements included adding usage instructions for running simulations and inserting experimental procedures before conducting simulations. The detailed feedback from the validators regarding each aspect of chemical literacy can be referred to in the earlier discussion.

The final aspect evaluated through the validation questionnaire was the visual and software interface aspect. This assessment included the visual design of the multimedia, the layout of media in presenting the material, and the ease of use of the application. This is important

because learning media should have integrated features, such as text and image arrangement, consistency and appropriateness in font type, size, and color, as well as harmonious background color combinations (Dewi & Haryanto, 2019). The evaluation results for this aspect showed an average score of 0.87, which is also classified as high. One of the strengths of this e-module's visual appearance is its appealing and well-matched color scheme.

Overall, the e-module on addictive substances was declared valid, although there were several revision notes from the validators regarding specific aspects. After passing the validation phase, this interactive multimedia proceeded to the feasibility testing stage to evaluate the extent to which the media is suitable for use in learning activities. The purpose of this feasibility test is to assess the usefulness and effectiveness of using interactive multimedia based on responses from students (Muzakkir et al., 2022). The feasibility test was carried out by distributing questionnaires to 15 students of the Chemistry Education Study Program who had taken the Addictive and Additive Chemistry course.

The feasibility test questionnaire distributed to the respondents consisted of three aspects: content and material substance, software engineering, and visual appearance. The average percentage results from the feasibility test data can be seen in the following table.

Table 2. Feasibility Test Results

Aspek	**Average Results Percentage**	**Qualification**
Material Aspects	92,22 %	very worthy
Language Aspect	89,33 %	worthy
Display Aspects	88,22 %	worthy

The first aspect, namely the material and content, received a score of 92.22%, which falls into the "highly feasible" category. This indicates that the material presented is well-understood and that the supporting media used to explain the content is appropriate. This is because the interactive multimedia display combines questions with related visualizations, such as video presentations, audio, images, and other illustrations (Syafwan et al., 2019).

The visual appearance aspect in the questionnaire includes the layout of the multimedia and the appropriateness of the supporting media within the interactive module. The result of the feasibility questionnaire for this aspect is 88.22%, which is interpreted as high. The most prominent statement was "the e-module display is attractive," which received a high percentage. This aligns with Marjuni & Harun (2019) statement that a good e-module display should be visually appealing, combining appropriate color schemes, images, and text presentation. However, some respondents provided feedback, such as the videos being too long, with many exceeding a duration of 3 minutes.

In the Development stage, the e-module was developed according to the design using Articulate Storyline 3 software so that it contains interactive and multimodal Socioscientific Issues (SSI)-based content. This initial product was converted into .apk format to make it more practical to access via Android devices (Astuti et al., 2019), then validated by two material experts and one media expert. In addition, a feasibility test was also conducted on Chemistry Education students of UIN Sunan Gunung Djati to see the clarity of the content and their interest in the e-module.

Overall, the validation and feasibility test results show that the e-module scored very well and is suitable for use. The high validation results are due to the e-module being developed according to Mayer (2017) multimedia learning principles, such as the principles of modality, segmentation, and redundancy, which make the material easier to digest and reduce students' cognitive load. In terms of material, the validator assessed that the content was in accordance with the curriculum and was able to improve students' chemical literacy because it was

presented sequentially, contextually, and based on real-life problems (SSI), so that learning became more meaningful. In terms of language, the use of simple and communicative Indonesian makes it easier for students to understand complex chemical concepts, according to the principles of readability and instructional clarity in learning design. In addition, in terms of appearance, the validator agreed that the attractive visualization, use of harmonious colors, interactive icons, and simple navigation were in accordance with the principles of spatial and temporal contiguity in multimedia theory, so that students were more motivated and focused on learning.

Based on the theory of multimedia learning and instructional design, the e-module successfully combines clarity of content, language, and display in an integrated manner (Rasyih et al., 2024). Thus, high validation reflects that this learning media is pedagogically and technically appropriate to support SSI-based chemistry learning, while also having the potential to improve students' chemical literacy in the context of everyday life (Ndruru & Amdayani, 2025).

The development of this SSI-based e-module on addictive substances aims to improve students' chemical literacy by using an approach that is more relevant to real life. Chemical literacy not only involves understanding chemical concepts but also the ability to connect chemical science with social issues and make science-based decisions. In this study, the theoretical gap that formed the basis of the development is the lack of student engagement in understanding the impact of addictive substances from both scientific and social perspectives. Most chemistry learning in classrooms is still theory-oriented without involving contextual aspects related to students' everyday lives (Talanquer, 2015).

The use of the e-module from a cognitive perspective can be linked to the way students think while engaging with learning media. According to constructivist theory, students more easily build their own understanding when learning materials are connected to real-life experiences relevant to their daily lives. In this module, addictive substances are not only studied from a chemical perspective but also from social, health, and environmental viewpoints, allowing students to better grasp how chemical concepts are interconnected with real-world situations.

From the perspective of student responses to learning media, their engagement in science-related social issue-based learning has the potential to enhance both motivation and conceptual understanding. Based on Self-Determination Theory, students are more engaged in learning when they perceive the material as relevant to real life (Ryan & Vansteenkiste, 2023). By presenting content on addictive substances in the context of social issues, students are encouraged to perform critical analysis and reflection on societal consumption habits.

From the affective response side, students using this e-module have shown increased awareness of the dangers of addictive substances and a greater appreciation for the importance of chemistry in making informed decisions related to health and the environment. These findings are consistent with the Affective Domain of Learning theory, which emphasizes that emotionally meaningful learning experiences can enhance understanding and drive behavioral change.

The uniqueness of this study lies in the integration of a Socioscientific Issues (SSI)-based approach, which is still rarely applied in the development of chemistry learning modules. This e-module offers a more interactive learning experience through various case studies, simulations, and reflective discussions that help students connect chemical concepts with social realities (Zeidler et al., 2019). Current conditions indicate that the use of interactive digital media is increasingly recognized as an effective method for enhancing chemical literacy. Furthermore, this approach encourages students to think critically and make evidence-based decisions, which is at the core of chemical literacy in the context of modern society (Ananda et al., 2023).

The high validation results in terms of material, language, and appearance indicate that this Socioscientific Issues (SSI)-based e-module has great potential to be implemented in chemistry education practices. This e-module not only functions as a teaching material, but also as a medium that supports the development of chemical literacy, critical thinking skills, and evidence-based decision-making, in accordance with the demands of the 21st century curriculum. With the SSI approach, the e-module helps teachers link chemistry learning to real issues in society so that it can increase relevance, learning motivation, and student awareness of the importance of science in everyday life. In addition, the use of digital format (.apk) facilitates the distribution and access of learning, especially in the era of technology-based learning. This supports the transformation of chemistry learning practices towards more contextual, independent, and information technology-based learning.

However, the development of this e-module has limitations because it only reaches the stage of expert validation and acceptance test (initial feasibility test) on students. The product has not been widely implemented in real classroom learning scenarios or tested for its effectiveness through experiments on learning outcomes, increasing chemical literacy, or students' critical thinking skills. As a result, although the e-module is considered feasible in terms of substance, language, and appearance, its effectiveness in improving learning outcomes and chemical literacy in real terms has not been confirmed. Therefore, further research is needed that includes the implementation and evaluation stages in real classes to test the impact of the e-module on learning outcomes and to identify challenges in implementation in the field. This further research is important so that the e-module is truly tested as an effective and efficient learning media innovation in chemistry education.

CONCLUSION

The developed e-module presents materials in the form of videos, texts, images, and quizzes. Based on the results of the validation test, the e-module based on socio-scientific issues on the material of addictive substances for the development of chemical literacy was declared valid, with an overall r-count value of 0.88, which is included in the very high category. In addition, the results of the feasibility test on the interactive multimedia aspect showed an overall percentage score of 89.92%, so this e-module is categorized as suitable for use as a learning medium. Substantially, this e-module contributes positively to the development of students' chemical literacy, because the content and learning design presented are able to facilitate the connection between chemical concepts and real problems in society. The novelty of this research which integrates a socio-scientific issue-based approach allows students to practice critical thinking skills, evaluate information evidentially, and make science-based decisions more responsibly. Thus, this e-module not only supports the mastery of scientific concepts and processes, but also strengthens students' abilities in interpreting the role of chemistry in everyday life and forming a caring attitude towards the impact of science and technology. Based on these findings, further development up to the implementation stage in the classroom is recommended to empirically test the effectiveness of using e-modules in improving students' chemical literacy and strengthening the quality of chemistry learning in a sustainable manner.

RECOMMENDATIONS

In light of the findings from this study, it is recommended that future researchers conduct further investigations by involving a larger sample size and a more diverse range of school settings to implement. Additsocio-s as an alternativincrease student, partiin enhancing students’ chemical literacy.

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