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Development of E-Module Discovery Learning Integrated Science Literacy by Kvisoft Flipbook Maker on Chemical Equilibrium

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Abstract: *Chemical equilibrium is an abstract concept illustrated by concrete examples requiring understanding of macro, submicroscopic, and symbolic levels and their interconnections. Observations at SMAN 2 Sidikalang show that learning still relies on textbooks, especially for chemical equilibrium, which limits student engagement and creativity due to minimal technology use. This research aims to obtain the development of an e-module Discovery Learning integrated science literacy by Kvisoft Flipbook Maker on chemical equilibrium to improve student learning outcomes and obtain positive responses from students. This research uses the type of Research and Development (R&D) using a 4D development model. The e-module developed was validated by material experts and media experts, consisting of 2 chemistry lecturers and 1 chemistry teacher. The results of this study are 1) The E-module was deemed highly valid, with average scores of 93.43% from material experts and 95.51% from media experts; 2) Students' response to the e-module was very positive with an average score percentage of 90.84%; 3) The increase in chemistry learning outcomes of students who are taught using e-modules is categorized as high marked by an N-Gain value of 0.84.*

Keywords: *e-module; discovery learning; science literacy; chemical equilibrium; student learning outcome*

INTRODUCTION

Education is one of the things that everyone must do to improve their standard and quality of life. Education can also be interpreted as a stage of student development to achieve maturity in their lives. Through education, an individual will be able to improve their behavior and knowledge for the better (Priliyanti, et al., 2021). Along with the development and change of the times, there are changes in human behavior, and changes from time to time.

Chemistry is one of the subjects that is part of the natural sciences, which contains facts, theories, principles, and laws of the scientific work process. Chemistry is one of the important subjects that needs to be taught to students because it can improve their thinking skills and stimulate a creative mindset. It's just that in reality, there are still many students who have difficulties when studying chemistry (Agustina et al., 2021).

The most prominent problem of the learning process is that it does not encourage students to be actively involved in thinking and developing knowledge. This is due to learning that is more dominated by teachers (Prasetyo & Abduh, 2021).

One of the chemistry topics studied in grade XI is chemical equilibrium, an abstract concept illustrated through concrete examples that require understanding of macroscopic, submicroscopic, and symbolic phenomena, as well as their interconnections. (Zuraini et al., 2017). Most students have difficulty understanding chemical equilibrium material. One of the causes of these difficulties is that the teaching materials used do not accommodate multiple chemical representations, resulting in incomplete learning integration. Based on the results of previous research conducted by Nurwiatin (2022) in the results of his analysis, it was found that high school/MA chemistry textbooks, especially on chemical equilibrium material, only develop two types of representations, namely macroscopic and symbolic, without connecting the three macro, submicro and symbolic representations.

Based on the results of observations at SMAN 2 Sidikalang, it was found that in the learning process, teachers still rely on student package books as teaching materials, especially on chemical balance materials. The teaching materials used are considered inadequate to provide a deep and specific understanding to students. This leads to a lack of student involvement and creativity, due to the lack of use of technology, and only dominated by teachers in learning. Students' lack of understanding of teaching materials can be seen from the learning outcomes, where only about 50% of students get optimal scores. Therefore, alternative teaching materials are needed that can overcome this problem, one of which is by creating an e-module (Fadhilah & Nainggolan, 2024).

Electronic modules (e-modules) are technology-based teaching materials designed to help students understand the subject matter more interactively. These e-modules include various elements such as text, images, audio, and video, which are presented attractively for students to understand. As teaching materials that can be accessed through electronic devices such as computers, smartphones, or notebooks, e-modules offer convenience and flexibility in the learning process. The use of e-modules has been proven to be more effective in supporting teaching and learning activities (Rahamawati et al., 2022). E-modules are able to make it easier for teachers to explain the subject matter to students (Hamid et al., 2021). In addition, the use of E-modules can help students with difficulties in learning (Wulansari et al., 2018). In the current era of technology, e-modules are an alternative to train students to learn better, which provides students with breadth in accessing teaching materials. In addition, e-modules will be very effective if combined with the learning model Discovery Learning (Suharyat et al., 2023).

The development of e-modules based on Discovery Learning helps students understand the material more easily and improves their study concentration. According to Yunsyahana et al., (2022), Discovery Learning is a learning model that encourages students to actively search, study, and analyze information independently, so that learning results are easier to remember.

Several studies have shown an increase in learning activity by using the Discovery Learning learning model. Among them, by Istikomah et al., (2018) in a study conducted in the first cycle, the success of students was 86% and in the second cycle increased to 95% with the Discovery Learning learning model. The Discovery Learning model can also run optimally if integrated with science literacy. With the science literacy approach in the e-module, students can be more active in finding existing concepts or information.

An aid application that teachers can use to produce electronic modules is Kvisoft Flipbook Maker. This software converts PDF documents into e-books. Kvisoft Flipbook Maker is equipped with a file editing feature

that allows the addition of hyperlinks, audio, video, images, and other multimedia objects into e-books, making them more interactive and similar to original printed books. Students' problem-solving skills can be improved through ebooks created with this app, which are complemented by videos and flash e-books (Roldy et al., 2021).

LITERATURE REVIEW

A. Development of Teaching Materials

According to Novili et al., (2013), teaching materials are a collection of learning resources or tools that encompass content, methods, scope, and assessment techniques, systematically and appealingly designed to achieve specific learning objectives, namely the achievement of competencies and subcompetencies and all their complexities. This shows that the creation of teaching materials requires many book references to be used as references, which can then be developed with a more interesting approach, but still focus on the goals to be achieved.

The selection and use of good teaching materials is one of the key elements in the quality of education. Teaching materials that support independent learning activities for students contribute greatly to improving and honing high-level thinking skills (Panggabean et al., 2022). There are various types of teaching materials, both printed and non-printed. Printed teaching materials include books, handouts, modules, brochures, and student worksheets. Meanwhile, non-print teaching materials include audio teaching materials such as cassettes, radio, vinyl records, and audio CDs. In addition, there are also interactive multimedia teaching materials such as CAI, interactive learning multimedia CDs, and web-based teaching materials such as e-modules.

B. E-Module

According to Isnaini et al., (2022) explain that e-modules are self-taught materials that are designed in a structured manner to be used in learning activities, intending to achieve learning goals. The e-module is displayed in electronic form with a self-guided use guide, covers all the material in an integrated manner, without relying on other learning resources, and is easy to use due to its practical, lightweight, and not limited by space or time. Its use aims to make it easier for students to solve their problems in their own way through an effective and efficient display of electronic media, which includes images, audio, or a combination of both. According to Lasri (2023), a well-designed learning module possesses several key features, including being self-instructive, self-contained, independent, adaptable, and easy to use.

E-modules have advantages as teaching materials compared to packaged books or printed modules, especially in terms of two-way communication that supports distance education, interactivity, and a clear structure. E-Modules can increase student motivation to learn, as each assignment and lesson is presented with clear boundaries and according to the student's ability.

C. Discovery Learning Module

According to Iwantoro et al., (2022) the Discovery Learning learning model is an approach that aims to develop an active learning way for students through discovery and independent investigation. The results obtained from this method will be easier to remember and last a long time in the student's memory. Discovery Learning provides an opportunity for learners to be actively involved in building on the knowledge they have acquired.

The Discovery Learning learning model, which focuses on active discovery and exploration by students, emerged as one of the effective methods to support the implementation of the Independent Curriculum (Salam & Kasmawati, 2023). The syntax or steps in Discovery Learning, according to Khasinah (2021) consists of 6 steps, namely Stimulation, Problem statement, Data collection, Data Processing, Verification, and Generalization.

D. Science Literacy

Scientific literacy is formed from two terms: literacy and science. Literally, literacy

refers to the ability to read and write or the elimination of illiteracy, while science originates from the word "science," meaning knowledge. According to the Program for International Student Assessment (PISA), scientific literacy is described as the capacity to apply scientific knowledge, identify relevant questions, and make evidence-based conclusions to comprehend the natural world and the changes brought about by human activities (Sutrisna, 2021).

Based on the above definition, science literacy can be interpreted as the ability to use scientific knowledge in identifying questions, obtaining new information, explaining scientific phenomena, and drawing conclusions based on scientific evidence.

E. Chemical Equilibrium

The material of chemical equilibrium is an important part of the study of physical chemistry, which discusses the stable state achieved by a reversible chemical reaction in a closed system. In a reversible chemical reaction, the reaction can take place in two directions, namely from the reagent to the product (forward reaction) and from the product back to the reagent (back reaction). When the two directions of the reaction proceed at the same rate, the system is said to have reached a state of chemical equilibrium. At this point, the concentration of the substances involved in the reaction does not change over time, although at the particle level, the reaction remains continuous in both directions. Therefore, chemical equilibrium is dynamic, not static.

In chemical equilibrium, there is a law of equilibrium expressed in the form of an equilibrium constant, known as Kc (for reactions in the solution or gas phase with a unit of molar concentration) or Kp (for a reaction in a gaseous phase with a partial unit of pressure). The equilibrium constant is the ratio of the product of the concentration of the product that is raised by its reaction coefficient, divided by the result of the multiplication of the concentration of the reagent, which is also multiplied by the reaction coefficient, all under equilibrium conditions. The value of the equilibrium constant depends solely on temperature and is not affected by changes in the initial concentration of the substance, volume, or pressure of the system.

In addition, an understanding of the Le Chatelier principle is essential in the study of chemical equilibrium. This principle states that if a system at equilibrium experiences a disturbance (change in concentration, pressure, volume, or temperature), the system will respond by adjusting the direction of the reaction in order to reduce the influence of the disturbance and return the system to a new state of equilibrium. This mechanism exhibits the adaptive nature of the equilibrium system that naturally seeks to maintain its stability. For example, the addition of reactants will cause the system to shift in the direction of a forward reaction to reduce the excess of the reactant, and vice versa (Ramli et al., 2022).

F. Kvisoft Flipbook Maker

The Kvisoft Flipbook Maker application is one of the tools that supports the creation of learning media that can facilitate the teaching and learning process. The app not only relies on text but also allows the addition of motion animations, videos, and audio, which makes the learning medium more interactive and engaging, thus avoiding boredom in learning. One of the results that can be obtained from using the Kvisoft Flipbook Maker application is an electronic module or e-module. Students' problem-solving skills can be improved through e-modules created with this application, which are complemented by flash videos and e-books (Maharcika et al., 2021). E-modules created with this application can be accessed offline and do not require large costs because they are presented in the form of digital files.

METHODS

This research was carried out at SMA Negeri 2 Sidikalang, which is located at Jalan Air Bersih No. 64, Sidikalang, Dairi Regency, North Sumatra. The implementation time of

this research will be carried out from February 2025 to March 2025.

The population in this study is all students (8 classes) XI of SMA Negeri 2 Sidikalang for the 2024/2025 school year. The sample used in this study was taken in one class by purposive sampling, namely classes XI–3 (Phase F) of SMA Negeri 2 Sidikalang.

This research uses the type of research and development, or Research and Development (R&D). The development process uses a 4D development model consisting of Define, Design, Develop, and Disseminate. The 4D model is more compact because the test stage is not layered, and there is no need for mass production in this development, as well as the testing and revision stages of the developed product, so that it meets the criteria of a good and tested product.

The results of data analysis in this study are the results of the validation of e-module products by material experts & media experts, the improvement of student learning outcomes, and the results of student responses to the development of e-modules.

The analysis of data from the validation of e-module products by material experts and media experts was analyzed using non-test instruments in the form of questionnaires referring to the BSNP feasibility questionnaire using the Likert scale with a scale of 4, 3, 2, and 1, which is composed of strongly agree, agree, disagree, and strongly disagree. The questionnaire was given to two chemistry lecturers and 1 chemistry teacher who had at least 10 years of teaching experience as material expert validators and media expert validators.

The analysis of improving student learning outcomes was analyzed using test instruments in the form of pretest and posttest, namely multiple-choice questions to determine the improvement of student learning outcomes before and after learning with the developed e-module.

The analysis of student response assessment was analyzed using a student response questionnaire given after learning using the developed e-module. The questionnaire uses the Likert scale with a scale of 4, 3, 2, and 1, which is composed of strongly agree, agree, disagree, and strongly disagree. The questionnaire was given to 35 students in grades XI–3 of SMA Negeri 2 Sidikalang

RESULT AND DISCUSSION

This research produced a product in the form of a chemical equilibrium e-module based on Discovery Learning that is integrated with science literacy, using the help of Kvisoft Flipbook Maker in developing it. This research is based on the lack of teaching media and teaching materials, especially in chemical equilibrium materials, which causes learning to be less effective and less interesting. The main purpose of this research is to produce media and teaching materials in the form of valid e-modules so that they are suitable for use in the teaching and learning process. With the creation of e-modules that are suitable for use, it is hoped that these teaching materials will be able to improve student learning outcomes and provide a good response for students.

This research uses the type of research and development or Research and Development (R&D). The development process uses a 4D development model consisting of Define, Design, Develop, and Disseminate. The following is a discussion from the research stage.

A. Define

The definition stage carried out by the researcher is intended to identify and formulate the needs and problems faced by teachers and students in the teaching and learning process.

From the results of the identification carried out by the researcher, students have difficulties in learning chemical equilibrium material. This can be seen from the low achievement of learning outcomes. Students are less interested in chemical equilibrium materials because the learning model used is the lecture model, and the teaching materials

used only rely on printed books from schools that are considered less attractive to students.

The next stage is for researchers to analyze students to find out what is needed by students. Through the results of the analysis carried out, students experienced difficulties learning chemistry, especially in the chemical equilibrium material. The causative factor is that the teaching materials used are incomplete and less interesting. The method used by teachers is a lecture method that makes students feel bored. Students need interactive and engaging digital-based teaching media and materials that can increase interest in learning. Students also need teaching materials that they can explore independently through literacy, learn at their own pace, and be accessible anytime and anywhere.

From the results of observations, the research is directed to produce a chemical equilibrium e-module based on Discovery Learning integrated science literacy. This module is expected to be feasible to use to improve student learning outcomes and provide a good response for students

B. Design

At this stage, the researcher makes an initial product or product design. The planned e-modules are made in accordance with previous observations. The development of this e-module has followed the standards set by BSNP. The initial design of this e-module is compiled based on the Discovery Learning learning model, which is combined with science literacy in each subchapter. The structure of the e-module starts from the e-module cover, foreword, table of contents, list of images, and video list to make it easier for users to navigate. Furthermore, there are instructions for use for teachers and students, a brief description of the module, a Learning Objectives Flow, and an infographic describing the integration of Discovery Learning and science literacy in this module. Also included are concept maps, perceptions as an introduction to students' initial understanding, and learning activities that include material on the concept of chemical equilibrium, equilibrium settings, and equilibrium shifts, all of which are designed according to the Discovery Learning syntax and science literacy approach. In addition, this e-module is also equipped with a summary of the material, an interactive competency test that can be accessed via a link or QR code scan, a glossary containing important terms, a periodic table of elements, a bibliography, and an author profile.

C. Develop

At this stage, the researcher validates the material and media from the initial design that has been made.

The material and media validation sheet instruments were given to 3 validators of material and media experts, consisting of 2 lecturers of Chemistry at the State University of Medan and 1 teacher at SMA Negeri 2 Sidikalang. The percentage results obtained from the 3 material and media validators will be presented and can be seen in the table below.

Table 1. Percentage of Material Expert Validator Assessment Results

No.	Valuation	Average Percentage
1.	Self-Instructional Aspects	92.86%
2.	Self-Contained *Aspects*	91.67%
3.	Stand Alone *Aspect*	97.22%
4.	Adaptive Aspects	100%
5.	User Friendly *Aspect*	85.42%
Average percentage score (*P*)		93.43%
Validity Criteria		Highly Valid

Table 2. Percentage of Media Expert Validator Assessment Results

No.	Valuation	Average Percentage
1.	Format Aspect	98.81%
2.	Organizational Aspects	96.21%
3.	Attraction Aspect	93.33%
4.	Aspects of Letter Form and Size	92.59%
5.	Aspect of Empty space	98.33%
6.	Consistency Aspect	93.75%
Average percentage score (*P*)		95.51%
Validity Criteria		Highly Valid

Based on the table of the percentage of assessment results of material and media expert validators from the development of e-modules based on Discovery Learning integrated science literacy assisted by Kvisoft Flipbook Maker on chemical equilibrium materials, the average percentage of score (*P*), material validity was 93.43% and the average percentage of score (*P*) media validity of 95.51%, so that the e-module based on Discovery Learning integrated science literacy assisted by Kvisoft Flipbook Maker on chemical equilibrium material is declared very valid and very feasible to use.

D. Disseminate

The e-module that has gone through the validation process is used by the researcher as a teaching material for teaching in learning activities in grades XI-3 of SMA Negeri 2 Sidikalang. The application of e-modules that have been validated by material and media experts aims to improve student learning outcomes and obtain positive responses from students.

After the e-module is taught to students, pretest and posttest test instruments are given in the form of multiple-choice questions that have been validated by lecturers and students in previous relevant research to determine the success of the e-module developed, judging from the improvement of student learning outcomes. Pretests are given before learning to measure students' initial knowledge. Meanwhile, posttests are given after learning to find out the learning outcomes of students after learning using the e-modules that have been developed. The pretest and posttest were given to 35 students in grades X–3 of SMA Negeri 2 Sidikalang. There are 20 multiple-choice pretest and posttest questions with five answer options (a, b, c, d, e). The improvement in student learning outcomes can be seen from the N-Gain value, with the formula :

$$g = \frac{s_{post} - s_{pre}}{s_{maks} - s_{pre}}$$

Data on improving student learning outcomes from pretest and posttest instruments will be presented and can be seen in the table below.

Table 3. Data on Improving Student Learning Outcomes

No.	Instruments	Average Score	N-Gain	Category
1.	*Pretest*	28.57	0.84	Tall
2.	*Posttest*	88.43		

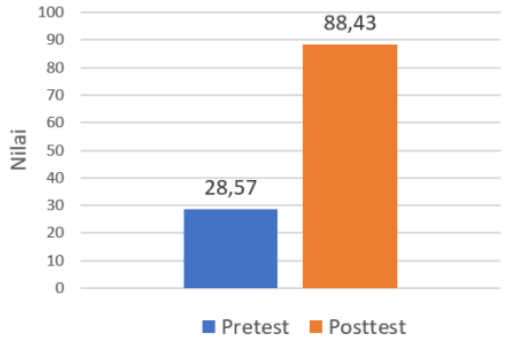

Figure 1. Student Learning Outcome Improvement Data Graph

Based on data on improving student learning outcomes before e-modules were implemented in the learning process, the average student learning outcomes were relatively low, which was 28.57. However, after learning was carried out using the e-modules that had been developed, the average student score increased to 88.43. Based on the analysis of pretest and posttest data, a Normalized Gain (N-gain) value of 0.84 was obtained, which shows an increase in student learning outcomes in the high category.

The final stage after the e-module has been developed is declared valid, and the e-module has been taught to students, namely, providing a student response questionnaire that has previously been validated by the validator to find out how students respond to the e-module based on Discovery Learning integrated with science literacy assisted by Kvisoft Flipbook Maker on chemical equilibrium material. This questionnaire was given to 35 students in grades XI–3 of SMA Negeri 2 Sidikalang. The following is a table of data on the percentage of student responses

Table 4. Student Response Percentage

No.	Assessment Aspects	Percentage Assessment
1.	Presentation of Materials	91.43%
2.	Media/display	91.76%
3.	Learning with e-modules	89.71%
4.	Benefit	90.45%
Average percentage score (*P*)		90.84%
Student Response Criteria		Very Positive

Based on the results of the data obtained from the student response questionnaire, an average score percentage (*P*) was obtained of 90.84%. This shows that students' responses to the development of e-modules based on Discovery Learning integrated with science literacy assisted by Kvisoft Flipbook Maker on chemical equilibrium materials are very positive.

CONCLUSION

The Discovery Learning-based e-module integrated with science literacy assisted by Kvisoft Flipbook Maker on chemical equilibrium material, was declared very valid, with the average percentage of the score of the assessment results of the material expert validator being 93.43% and the average percentage of the score of the assessment results of the media expert validator of 95.51%. The students' response to this study was very positive, with an average percentage of student response scores of 90.84%. The increase in chemistry learning outcomes of students who were taught using this research media was categorized as high, marked by an N-Gain value of 0.84.

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