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Development of Electrolyte and Nonelectrolyte E-Modules Integrated Demonstration Video and Science Literacy

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Abstract

The type of research used is Educational Design Research with the Plomp development model. The Plomp development model consists of 3 stages, namely; the preliminary research, the prototype phase, and the assessment phase. The research instruments used are; student observation sheets, teacher interview sheets, validity questionnaire sheets, practicality questionnaire sheets, and student learning outcomes tests. The e-module was validated by 5 validators. The results of the e-module validity test were analyzed using the Aiken's V formula, while the practicality test results were analyzed using a Likert scale. The results of the validity of the e-module obtained an average Aiken's V of 0.85 with a valid category and has a CVR value of 1 with a valid category. The results of the practicality of the e-module by teachers and students obtained an average practicality value of 98% and 84% with a very practical practicality category. The results of the e-module effectiveness test obtained an average N-Gain value for the experimental class of 0.63 with a medium category. Based on the research results, it can be concluded that the problem-based learning e-module electrolyte and nonelectrolyte solution integrated demonstration video and scientific literacy that has been developed is valid, practical, and effective.

Keywords: e-module; problem based learning; demosntrations video; science literacy

Abstrak

Jenis penelitian yang digunakan adalah *Educational Design Research* dengan model pengembangan Plomp. Model pengembangan Plomp terdiri dari 3 tahapan, yaitu; tahap investigasi awal, tahap pembuatan prototipe, dan tahap penilaian. Instrumen penelitian yang digunakan yaitu; lembar observasi peserta didik, lembar wawancara guru, lembar angket validitas, lembar angket praktikalitas, dan tes hasil belajar peserta didik. *E-module* divalidasi oleh 5 orang validator. Kemudian pada uji *one to one evaluation*, e-module diujikan kepada tiga orang peserta Uji praktikalitas *e-module* diujicobakan kepada sembilan orang peserta didik (uji *small group*), tiga puluh lima orang peserta didik (*field test*), dan 3 orang guru kimia di SMAN 1 Padang. Hasil uji validitas *e-module* dianalisis dengan formula Aiken's V, sedangkan hasil uji praktikalitas dianalisis dengan skala likert. Hasil validitas e-modul diperoleh rata-rata Aiken's V sebesar 0,85 dengan kategori valid dan memiliki nilai CVR sebesar 1 dengan kategori valid. Hasil praktikalitas e-modul oleh guru dan siswa diperoleh nilai rata-rata kepraktisan sebesar 98% dan 84% dengan kategori kepraktisan sangat praktis. Hasil uji efektivitas e-modul diperoleh nilai rata-rata N-Gain kelas eksperimen sebesar 0,63 dengan kategori sedang. Berdasarkan hasil penelitian, dapat disimpulkan bahwa e-modul larutan elektrolit dan nonelektrolit berbasis *problem based learning* terintegrasi video demonstrasi dan literasi sains yang telah dikembangkan telah valid, praktis, dan efektif.

Kata kunci: e-module; problem based learning; video demontrasi; literasi sains

Introduction

21st century's development shows that almost all equipment used in life has been digitally based. This is following the development of science and technology are very influential on the preparation and strategy and implementation in learning (Satya, 2018).

Classroom learning process must be integrated with today's evolving technologies (Sari et al., 2019). Related to these issues, developments in the world of education require teachers to know how to package learning to be more attractive and the skills needed by learners can be facilitated in the 21st century (Fauziah et al., 2013). 2013 curriculum focuses on modern pedagogy by applying scientific approaches. Problem Based Learning (PBL) is one of the learning models that can be implemented in the 2013 curriculum, by the Minister of Education and Culture Regulation No. 65 of 2003 on Process Standards. The development of e-modules can be combined with learning models that are considered able to support the activities of participants in the program (Alfiantara et al., 2016).

The advantages of problem-based learning e-modules lie in the stages of learning based on problems, namely the orientation of learners to problems, organizing learners to learn, guiding individual and group investigations, developing and presenting works, and analyzing and evaluating problem-solving processes (Sugihartini & Jayanta, 2017). The purpose of learning under the scientific approach is to develop the thinking skills and curiosity of learners so that learners are motivated to observe the phenomena around them (Oktaviani et al., 2020). Learners can be motivated by varying learning resources or learning tools. The development of Information and Communication Technology (ICT) can be used as a way to various learning resources/learning tools (Asmiyunda et al., 2018).

The development of ICT can also be used to increase the learning interest of learners, one of which is through e-modules. E-module is self-taught material that contains information in digital format, e-modules can facilitate its users. E-modules are a result of innovation from ICT-based modules that have advantages compared to print modules, namely the existence of audio, video, images, animation, and quizzes that can provide feedback for learners (Cheva & Zainul, 2019).

COVID-19 pandemic is changing the social order of people's lives into external factors that affect the current learning process (Strielkowski, 2020). In line with the observations that the author has made about the chemical learning process during the current COVID-19 pandemic. Teaching materials used by teachers today are mostly modules and PowerPoint, thus making online learning less attractive to learners and has not been able to improve learners learning outcomes.

Literacy in the context of learning is defined as the ability to access, understand, and use things intelligently through various activities, including reading, seeing, listening, writing, and speaking (Hartati et al., 2020). Science literacy is the ability to use scientific knowledge, identify problems, and draw conclusions based on evidence, to understand and make decisions about nature and changes that occur in nature as a result of humans (Raharjo et al., 2017).

Science literacy is very important to develop because everyone needs information and knowledge to make choices and to solve the problems they face every day, learners are very important to have the ability to learn science literacy to be able to address various science issues that develop in the community. One of the important factors to improve science learning is books (Hartini et al., 2019).

The teaching materials needed are electronic-based teaching materials with integrated learning models of demonstration videos and science literacy that can motivate learners to learn because, during the COVID-19 pandemic, students don't get learning in the laboratory.

Research Method

The type of research used is Educational Design Research. Teaching materials in the form of electrolyte and nonelectrolyte solution e-modules for ten grades of senior high school. In addition, an assessment is also carried out for the level of validity, practicality, and effectiveness of the resulting e-modules.

The development model used in this research is the Plomp & Nieveen (2007) which has three stages namely: (1) preliminary research, (2) prototyping stage, (3) assessment stage.

The data collection instruments used in this study are as follows:

1. Validity of Contents

The method used to analyze the validity of content is Lawshe's CVR (content validity ratio). Lawshe's CVR is a method used to measure the validity of the content. Lawshe proposes that each expert responds to each item with 2 answer options: (1) invalid, (2) less valid, and (3) valid. If more than half of the experts give a valid response to an item, then the item has a higher level of validity (Wahyuni & Yerimadesi, 2021).

The response given by the master broke down first by changing over the response if the answer "legitimate" will be worth 1; if the master replies "less substantial" it will be worth 0 and if the master replies "invalid" it will be worth -1.

$$CVR = \frac{(n - \frac{N}{2})}{\frac{N}{2}}$$

Out of the laugh:

CVR = content validity ratio
n = many experts have answered validly
N = total number of experts

The Lawshe method produces values that range from -1 to 1. Positive values indicate that more than half of experts give valid responses to items. The greater the CVR value of 0, the higher the validity of its contents.

Table 1
CVR critical value

Number of experts	CVR critical value
5	0.736
6	0.672
7	0.622
8	0.582

(Ayre & Scally, 2012)

The average CVR value obtained in each aspect is calculated validity index (CVI) as follows:

$$\text{CVI} = \frac{number\ of\ CVRS\ received}{number\ of\ aspects}$$

CVI is the average CVR value. CVI values illustrate that every aspect has good validity. CVI is calculated based on the number of experts who provide valid assessments. In the final decision, the CVI value should be 1.00 consisting of 5 experts. The minimum CVI score is 0.78 which states aspects in the medium of learning are acceptable.

2. Construct Validity

The method used to analyze the validity of the content is to use Aiken's V. the validator's assessment of each statement is analyzed using Aiken's V formula.

$$v = \sum \frac{S}{n(c-1)}$$

Out of the laugh:

s = r-I0
I0 = low validity assessment number (the lowest scale used is 1)
c = highest validity assessment number (the highest scale used is 5)
r = figures provided by an appraiser
n = number of validators

3. Practicality Analysis Techniques

This practicality test is conducted after it is stated that the instrument has met the eligibility requirements. Practicality tests are used to determine the practicality of the

use of an instrument is practical of use of instrument, so the instrument is practically used.

The practicality test sheet used is two, namely: the practicality test sheet according to the teacher and the practicality test sheet according to the learner. If the number of the appraiser is more than two is the Likert scale.

4. Literature review analysis techniques

Riview analysis of the literature on this study is to measure the effect size of the experimental results data in several scientific articles.

Table 2
Effect Size Value Decision Category

Criteria	Interpretation
< 0,2	Low-level influence
0.2 ≤ x ≤ 0.8	Middle-level influence
> 0,8	High-level influence

(Becker & Park, 2011)

5. Effectiveness Analysis Techniques

Analysis of effectiveness data is obtained from the assessment sheet of learners' learning outcomes. Learning analysis is carried out on data on learners' learning outcomes in the cognitive team.

After obtaining posttest and pretest values, the calculation of the value of normalized gain with the maximum score of N-Gain is 1 and the minimum score of N-Gain is 0.

$$\text{Gain} = \frac{postest - pretest}{100 - pretest}$$

Table 3
Criteria of N-Gain

N-Gain	Criterion
g ≥ 0.7	High
0.3 ≤ g < 0.7	Middle
g < 0.3	Low

(Mulyasari, 2021)

Results and Discussion

In this study, survey data were produced on developing student interest and motivation while studying organic chemistry using the YouTube platform as an alternative during distance learning (PJJ) for five consecutive weeks. In addition to survey data, interview data were also obtained to re-confirm the reasons for doubting or disagreeing with students regarding the statements given.

1. Preliminary Research

In the preliminary research stage, several stages are carried out, namely speed analysis, curriculum analysis, literature studies, and concept analysis. The results of each stage conducted in the preliminary study are described as follows:

a. Needs analysis

Needs analysis is done by collecting information on problems encountered when studying chemistry, especially in electrolyte and nonelectrolyte solution materials in grade X high school. Needs analysis is done through chemistry teacher interviews and spreading questionnaires to learners. The interview was conducted with 3 chemistry teachers from 3 different schools in Padang City, namely from SMAN 1 Padang, SMAN 8 Padang, and SMAN 13 Padang. From the results of interviews with chemistry, teachers obtained information that the school has used the 2013 curriculum revision 2020. The methods commonly used in teaching generally use the methods of lectures, questions and answers, and discussions. Teaching materials used in each school in the form of LKPD, printed books, and power points (PPT). Fill in the teaching

materials used in the form of text, images, and evaluation questions.

Based on the results of observations obtained data that: 1) 0-33 % stated that the material of electrolyte and nonelectrolyte solutions is difficult, 2) 34-64% stated that the matter of electrolyte and nonelectrolyte solution is moderate. 3) 65-100% stated that the electrolyte and nonelectrolyte solution material is not difficult, based on the data it can be concluded that students' knowledge of electrolyte and nonelectrolyte solutions as much as 75.27% has not reached the minimum completion criteria set by the school which is 80. 4) As many as 54.7% of students stated that the teaching materials used by teachers are still printed books, and 51.67 students stated that the teaching materials used by teachers are still modules (still in the form of printed materials). 5) 63% of students like teaching materials that contain videos related to learning materials. Regarding this, a technology-based teaching material is needed that can make students more active and interested in learning so that researchers design a teaching material in the form of e-modules that contain images, videos, and animations that are expected to help students be more active in learning.

b. Curriculum Analysis

Curriculum analysis aims to find out what competencies students should master after studying electrolyte and nonelectrolyte solution materials. The analysis of the learning curriculum conducted is by the current curriculum, namely the 2013 curriculum revision 2020, starting from the analysis of Basic Competence (KD) on electrolyte and nonelectrolyte solution materials in class X semester 2. Basic Competence (KD) for electrolyte and nonelectrolyte solution materials there are 2, namely; KD 3.8. Analyze the properties of the solution based on its electrical delivery power and KD 4.8. Distinguishing the electrical delivery power of various solutions through the design and execution of experiments. KD analyzed on curriculum analysis is KD knowledge (KD 3.8) only because the study is limited to the influence of e-module use on students' cognitive abilities. For KD 4.8., students can listen to the demonstration video of the electrolyte and nonelectrolyte solution delivery experiments that have been provided in the e-module that has been developed. components, namely; cover, foreword, table of contents, drawing list, table list, video list, glossary, introduction (a brief description of material), e-module component, instructions for the use of e-modules (for students and teachers), core competencies, basic competencies and indicators of competency achievement, learning objectives, concept maps, student activity sheets, student worksheets, self-assessment sheets, evaluation questions, layering guidelines, and bibliography.

c. Concept Analysis

Concept analysis aims to identify the main concepts studied in electrolyte and nonelectrolyte solution materials. Arrange and detail it systematically to achieve indicators of competency achievement. Concept analysis is based on indicators that have been formulated in Basic Competencies.

d. Review Literatur

The results obtained based on a review of the literature from several relevant journals in this study regarding the use of problem-based learning models and teaching materials in the form of e-modules can be seen in Table 4.

Based on Table 4, the effect on the problem-based learning model obtained an average effect size value of 7.11 with a high influence on learning outcomes and for the use of e-modules obtained an effect size value of 3.07 with a high influence on learning outcomes.

Table 4
Review Literature Data Processing

No.	Article Title	Data Processing	Category Effect Size (ES)
1	E-module in Blended Learning: Its Impact on Students' Disaster Preparedness and Innovation in Developing Learning Media	ES = $\frac{15.6286-6.4063}{3.27118}$ = 2.82	High
2.	Efektivitas Penggunaan E-Modul Hidrokarbon Berbasis Problem Based Learning untuk Meningkatkan Kemampuan Pemecahan Masalah Peserta Didik	ES = $\frac{38.000}{18.142}$ = 2.094	High
3.	Pengembangan E-Modul Berbasis Project Based Learning Terintegrasi Media Komputasi Hyperchem Pada Materi Bentuk Molekul	ES = $\frac{86.800-74.920}{3.06757}$ = 3.87	High
4.	Improvement of student's learning outcomes and motivation with chemical practicum e-module	ES = $\frac{86.91-80.06}{7.01}$ = 0.98	High
5.	Implementation of E-Module Stoiciometry Based on Kvisoft Flipbook Maker for Increasing Understanding Study Learning	ES = $\frac{89.300-58.800}{11.4723}$ = 2.66	High
	Concepts of Class X Senior High School E-Modul Interaktif Berbasis Proyek Terhadap Hasil Belajar Siswa	ES = $\frac{29.97-7.20}{3.791}$ = 6	High
Average = 3,07			High
7.	The Effect of Mobile Problem-Based Learning Application DicScience PBL on Students' Critical Thinking	ES = $\frac{87.77-82.29}{0.4891}$ = 11.20	High
8.	Penerapan Model PBL Berbantuan E-Modul Berbasis Flipbook dibandingkan Berbantuan Bahan Ajar Cetak Pengaruhnya Terhadap Hasil Belajar Pemrograman Siswa SMK	ES = $\frac{85-32.83}{7.95}$ = 6.56	High
9.	Pengaruh Model Pembelajaran Problem Based Learning (PBL) Terhadap Hasil Belajar Kimia Siswa Kelas X Di SMAN 2 Kota Bima	ES = $\frac{63.65-53.26}{1.82}$ = 5.71	High

2. Prototyping Stage

a. Prototype I

The development of this e-module follows the practical guidelines of the preparation of the ministry's e-module in 2017. The initial design results with each learning activity have components, namely; cover, foreword, table of contents, drawing list, table list, video list, glossary, introduction (a brief description of material), e-module component, instructions for the use of e-modules (for students and teachers), core competencies, basic competencies and indicators of competency achievement, learning objectives, concept maps, student activity sheets, student worksheets, self-assessment sheets, evaluation questions, layering guidelines, and bibliography.

b. Prototype II

After conducting preliminary research, the next step is the prototyping stage. The prototype phase begins with the initial design of the e-module. Products in the form of e-modules developed are assessed by experts (lecturers and teachers) and students to assess the feasibility of e-modules produced with improvements at each stage of the prototype.

The quality of products resulting from development research is assessed based on three aspects, namely validity, practicality, and effectiveness.

1) Validity of E-module

E-module validity data is obtained at the expert assessment stage (expert review) using validated instruments. The e-module design was validated by five validators, consisting of FMIPA UNP, and two chemistry teachers of Senior High School 1 Padang. To test the validity can be used expert opinion (judgment experts) which is a minimum of three people (Sugiyono, 2017).

Validation is content validation and constructs validation that has been done by (Aulia, 2022). The content assessment aspect consists of two aspects, namely aspects of the suitability of the content of the e-module with problem-based learning syntax and the suitability of the content of the e-module to the scientific content of chemistry (Ariyatun & Octavianelis, 2020).

The results of content validation on the electrolyte and nonelectrolyte solution e-module show the value of conformity of content with problem-based learning syntax with a CVI average value of 1 with valid category and for the suitability of e-module content to chemical scientific content also has a CVI average value of 1 with valid category.

Construct validation is validity that is understood as to how far the impact of measurement results can reflect the theoretical construction underlying the development of an instrument or product (Sukma et al., 2022). Based on research that has been done by Aulia (2022) obtained that the average value of Aiken's V is 0.84 with a valid category. This shows that the e-modules of electrolyte and nonelectrolyte solution on problem-based learning integrated demonstration video and science literacy developed have used good, simple, and clear rules of Indonesian so that it is easily understood by e-module users.

Assessment of aspects of presentation components to e-modules of electrolyte and nonelectrolyte based on problem-based learning integrated demonstration video and science literacy that has been carried out by Aulia (2022) obtained the average value of Aiken' V is 0,87 with a valid category. This shows that the presentation of the e-module electrolyte and nonelectrolyte solution based on problem-based learning integrated demonstration video and science literacy developed has been systematically approved based on the components with the guidelines for the preparation of e-module from Kemendikbud (2017).

Assessment of the component aspects of the e-module electrolyte and nonelectrolyte solution based on problem-based learning integrated demonstration video and science literacy relating to the appearance or design of the e-module as a whole such as layouts, symbols, and illustrations presented the proportions should be appropriate and interesting. Based on research that has been done by Aulia (2022), it is obtained that the average value of Aiken's V is 0.85 with a valid category. This indicates that the look or design of the e-module presented is already attractive. On the validity of the graph, the appropriate arrangement of the color and cover of the e-module will have a very valid validation level (Pratama et al., 2021).

2) One to One Evaluation

Based on the analysis of the results of the one to one evaluation test questionnaire on the e-module of electrolyte solution and nonelectrolyte based on problem-based learning integrated video demonstration and science literacy, it was obtained that the cover display on the e-module was interesting because it was accompanied by bright images and colors. The color design and appearance of the e-module are already interesting and make students not easily bored in reading the e-

module. Related to the use of letters on e-modules, the letters used on e-modules are sized and legible. One-to-one results in general that e-module electrolyte and nonelectrolyte solution based on problem-based learning integrated demonstration video and science literacy for grade ten senior high school can lead students in finding and understanding concepts under indicators of achievement of competence and learning goals.

c. Prototype III (Practicality of E-Modules)

Practicality is a measure to know the exposure of the product that is being made by the user. The practicality of a product can be measured by the ease of presentation of a product by the user (Maskar & Dewi, 2020).

Practicality e-module electrolyte and nonelectrolyte solution based on problem-based learning integrated demonstration video and science literacy assessed by chemistry teachers and high school students class X MIPA. E-module are said to be practical if teachers and target users (students) assess that e-module can and are easy to use.

The instruments used are practical questionnaire sheets given to nine students at the small group evaluation stage, 36 students of class XI MIPA, and three chemistry teachers who accompanied the research at the field test stage.

At the small group evaluation stage, the e-module was piloted on nine different students, with the criteria high, medium, and low. Students are required to provide a practical assessment of the e-module, through the practicality questionnaire sheet that has been given. In the field trial phase, the e-module was tested in class XI MIPA at senior high school 1 Padang.

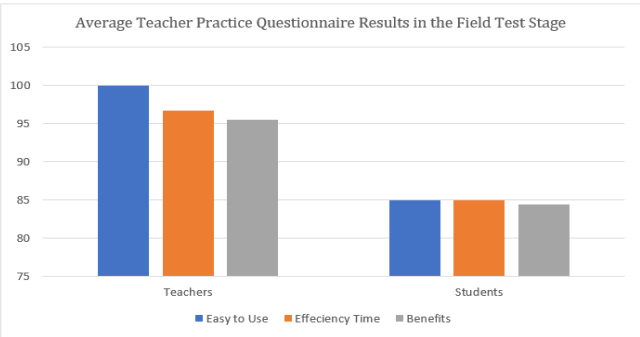
Practical components can be seen from several aspects, namely easy to use by students, products that make students more understanding, the development of products developed (Nurhamidah et al., 2020). At the field test stage reviewed from the aspect of ease to use of e-modules, obtained the percentage of average practicality given by teachers by 100% and the percentage of average practicality given by students by 85% with very practical categories.

This shows that e-module electrolyte and nonelectrolyte solution based on problem-based learning integrated demonstration video and science literacy is easy to use by students and teachers because the instructions for use of e-modules are easy to understand, the material presented is simple and clear, the language used is easy to understand, and this e-module can be stored on mobile phones so that it is easy to carry.

The efficiency aspect of learning time obtained the level of practicality is very practical, namely, the average percentage of practicality provided by teachers is 96.67%, and the average percentage of practicality provided by students is 85%, meaning that using e- modules can make learning time more efficient.

The last aspect assessed is the benefit aspect of e-modules, obtained the level of practicality is very practical namely, the average percentage of practicality provided by teachers is 95.56% and by the students is 83.43 %, meaning that using an e-module can help students learn independently, increase students' learning motivation, can reduce the teacher's workload to explain repetitive material, and make the learning process enjoyable.

Figure 1
Practical Average from Teachers and Students



This is per research that has been done by Nurhamidah et al. (2020) saying that the practicality of teaching material can be easily used in the teaching and learning process by teachers and students. An overview of the practical results can be seen in the following graph.

3. Assessment Phase

The effectiveness test is part of the Plomp Phase, the assessment phase. The effectiveness of e-modules can be measured from the learning outcomes achieved by students (Agustia & Fauzi, 2020). In this study, the effectiveness of e-modules is seen from student learning outcomes (cognitive aspects).

E-modules are called effective if the ability to master the student's material is improved (Santika & Sylvia, 2021). The effectiveness of the e-modules developed is seen by comparing the learning outcomes of experimental classes and control classes. Experimental classes learn using e-modules and control classes without e-modules. Before learning begins first, a pretest is done to find out the initial ability of students. After learning is done in each class after that post-test is done using the same problem.

Based on Tabel 5 it is known that the average pretest grade of the experimental class is 47 and the control class is 41.81. The results of this pretest are very useful for teachers to see which materials should be taught more deeply in the learning process so that the time achieved in the learning process is more effective.

In the second class, the sample is given a posttest after the learning process ends to analyze students' abilities in the cognitive realm (Asda & Andromeda, 2021). The average posttest grade of the experimental class was 80 and the control class was 66.94. This indicates an increase in grades for both classes. Based on these data, it can be known that the experimental class value is higher than the control class.

This proves that students' study outcomes before and after using the e-module electrolyte and nonelectrolyte solution based on problem-based learning integrated demonstration video and science literacy were seen to improve during the initial test and final test.

Based on Table 5, N-Gain scores in experimental and control classes of 0.63 and 0.43 mean that N-Gain grades for both classes have moderate criteria. From the data, it appears that the N-Gain value for the experimental class is higher than the control class, this shows differences before and after the treatment is given.

Conclusion

E-modules electrolyte and nonelectrolyte solution based on problem-based learning integrated demonstration video and science literacy to improve student learning outcomes have been generated through research and development with Plomp development model. This e-module has a high level of validity, very practical practicality, and moderate effectiveness.

The advice from this study for further research is that e-modules can be further researched in improving the results of science literacy, learning outcomes in the affective and psychomotor realm of students.

The conclusions are written briefly and clearly in one paragraph, which contains a summary of the results and discussion. The conclusions also emphasize the novelty of the research. If there are suggestions or implications for further study, they can be clearly stated at the end of the paragraph.

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