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ARTICLE

Development of an E-module Chemistry Based *Discovery Learning* in *Oriented Chemoentrepreneurship* Buffer Solution Material for class XI SMA/MA

Weni Syafitri[a], Rahadian Zainul[b],
[a]Department Of Chemistry, faculty of Mathematics and Natural Science, Universitas Negeri Padang, Jl. Prof. Hamka, Padang 25132, Indonesia.
[b]Department Of Chemistry, faculty of Mathematics and Natural Science, Universitas Negeri Padang, Jl. Prof. Hamka, Padang 25132, Indonesia.

*Coresponding email: wenisyafitri6@gmail.com , rahadianzmsiphd@fmipa.unp.ac.id

ABSTRACT
This research was conducted to develop teaching materials in the form of e-learning. E-modules that relate chemistry to everyday life. The purpose of this study is to develop an e-module based on *the discovery learning* oriented *chemoentrepreneurship* in a valid and practical class XI SMA/MA buffer solution material. This research is development research with a 4D development model. The 4D development model consists of 4 research stages, namely (1) *define*, (2) *design*, (3) *develop*, and (4) *disseminate*. The e-module validity test was carried out by three Chemistry lecturers, FMIPA UNP, four chemistry teachers, and 4 lecturers in Informatics Engineering, FT UNP. The practicality test was carried out by 2 chemistry teachers, and 32 class XII students of SMA Negeri 5 Solok Selatan in the 2021/2022 school. Data processing was obtained by distributing validity questionnaires and the e-module was generated by analyzing using *the formula* Aiken V data from the practicality questionnaire using descriptive statistical percentages. From the results of the research conducted, the results of the validity test of material experts and media experts were 0.90 and 0.93 with valid categories. While the results of the practicality test of e-modules by teachers and students are 94,6% and 89,6% with very practical categories. Based on the results of these studies, it can be concluded that the development of *the discovery of learning-oriented chemoentrepreneurship* on the material of the XI SMA/MA class XI buffer solution is valid and practical.

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1. Introduction

Entering the world in the era of globalization in the 21st century makes education have a major influence in improving the quality of human resources. The government's efforts to improve education include improving the curriculum, developing learning media, providing facilities and infrastructure, as well as providing educational scholarships.

Teaching materials are one form of learning media that are developed to improve the quality of education. The purpose of designing teaching materials is to make the learning process more realistic, interesting, and practical.Good teaching materials are teaching materials that apply the 4C skill curriculum standards, namely critical thinking, creativity, collaboration, and communication (Yusliani, E., Burhan, H. L., & Nafsih, 2019). Currently, the teaching materials used are still very limited and not all of them can improve the skills of students to think critically, creatively, innovatively, communicatively, and collaboratively (Rhaudatul Hapsyari, 2021).

Corresponding: Weni Syafitri; wenisyafitri6@gmail.com

E-module is one form of modification of printed teaching materials into teaching materials in electronic form that can be accessed with the help of electronic media such as laptops, computers, or cellphones. E-module is an independent teaching material that is presented in an electronic format, which is arranged systematically into certain learning units, where each learning activity is equipped with pictures, videos, audio, animations, and interactive quizzes, to create effective learning. active and attractive (Kemendikbud, 2017)**.** The advantages of e-modules are that they can increase the effectiveness and flexibility of learning, are not limited by space and time, and the learning process is more interesting (Sanova, 2018). Research conducted by (Farenta et al., 2016) shows that using e-modules can improve student learning outcomes. (Julia, I., & Utami, 2020) e-modules can make students play an active role and can help students achieve learning goals.

One of the learning models that can be used in e-modules is discovery learning(Dinata & zainul, 2020)**.** According to (Wenning, 2011)**,** discovery learning can make students create important concepts at the beginning of the meeting, where students are centered on providing dynamic inclusion to build their understanding. The discovery learning model is a learning model that encourages students to learn actively by discovering and investigating the material concepts themselves so that they are led to think critically and the important concepts found will last a long time in memory (Hosnan, 2014)**.** Research conducted by (Uside et al., 2013) reported that discovery learning can instill students' self-confidence, increase students' memory retention, and stimulate students to find concepts correctly.

One approach that supports the learning process is Chemoentrepreneurship (Lestari & Premono, 2019). Chemoentrepreneurship is a chemistry learning approach that links the concept of material with real objects or phenomena in the surrounding environment, in addition to obtaining subject matter, students can also learn the processing of a material into a useful product, has economic value and can improve entrepreneurial spirit, so that with this approach learning chemistry will be more fun, and students are allowed to able to optimize their potential to produce useful products of economic value.

Buffer solution material is a chemical material that has relevance to everyday life, in understanding this material students not only memorize the theory but also need to relate the material to everyday life. So in studying the material, appropriate teaching materials are needed to support the learning process of students to improve student learning outcomes. Especially the buffer solution material. (2) As many as 68.4% of students stated that the teaching materials used were still not able to help students in supporting learning, and (3) 89.5% had never used media or chemoentrepreneurship that could produce products. E-module that can improve students' learning skills and can increase students' entrepreneurial spirit necessary chemistry. get a positive response from students. research 2017 on chemoentrepreneurship-oriented guided inquiry learning can improve student learning outcomes and entrepreneurial interest in entrepreneurship. Research conducted by (Lestari & Premono, 2019) concluded that the research carried out could be carried out very well in the learning process by using guided inquiry-based chemistry module teaching materials oriented to chemoentrepreneurship in solution colligative properties. research (Dinata & zainul, 2020) concluded that the discovery learning-based buffer solution e-module developed was valid and practical. Research from (Arianti & Zainul, 2020) concluded that the discovery of learning-based chemistry e-modules on electrolyte and non-electrolyte solution materials for class X SMA/MA is valid and practical. Research conducted by (Sa'adah & Supartono, 2013) concluded that learning using the CEP approach showed an influence on students' conceptual understanding. In addition, it is also able to increase life skills by 23% with an average percentage of life skills of 84.49% in the very good category, and

students' science process skills showing an average percentage of 95.91% in the very good category.

2 Research Methodology

The type of research used in this study is the type of research and development or Research and Development (R&D) (Sugiyono, 2017). The development model used in this research is the 4D model (four D Models). The 4D model consists of 4 stages of development, namely the defining stage (define), the design stage (design), the development stage (develop), and the dissemination stage (Trianto, 2012)**.** Time and cost limitations made this research limited to the development stage, namely validity and practicality tests. The research was conducted at SMA Negeri 5 Solok Selatan for the academic year 2022/2023. The subjects of this study were 3 chemistry lecturers, FMIPA UNP, 3 IT lecturers, 4 high school teachers, and 32 students of class XII MIPA at SMA Negeri 5 Solok Selatan.

The defining stage (define) aims to determine and define learning requirements based on KI, KD, indicators, and learning materials used in the preparation of e-modules. The definition stage consists of five analyzes carried out, namely (1) front-end analysis, (2) student analysis, (3) task analysis, (4) concept analysis, and (5) formulation of learning objectives.

The design phase aims to design e-module chemistry based on the discovery learning oriented chemoentrepreneurship in the buffer solution material based on KD, GPA, and learning objectives that have been obtained at the definition stage. The planning stage has three steps of activities carried out, namely (1) Selection of teaching materials (media), (2) selection of formats, and (3) initial product design.

The development phase that aims to produce an e-module based on discovery learning oriented to chemoentrepreneurship is valid and practical. The development stage has three steps, namely (1) validity test, (2) revision, and (3) practicality test on previously designed e-modules. The validity test was carried out by filling out a validity questionnaire by 3 chemistry lecturers at FMIPA UNP (material experts), 4 chemistry teachers (material experts), and 3 IT lecturers (media experts). The revision stage was carried out to improve the part of the e-module which was considered to be still not fixed. The practicality test phase was carried out by distributing teacher and student response questionnaires for Class XII MIPA at SMA Negeri 5 Solok Selatan.

The type of data in this study is primary data obtained directly from the research subject. The data collection instrument in this study was a validation questionnaire which was analyzed using Aiken's V (Aiken, 1985)**.**

$$V = \frac{\Sigma s}{n(c-1)}$$

$$s = r - lo$$

Description :

V = Expert agreement index/ Aiken's index V
lo = lowest validity score (*lo*= l)
c = highest validity score (c= 5)
r = validator choice category score
n = number of validators
s = the difference in the scores set by each rater with the lowest score

Table 1.Aiken's V scale categorical judgments table.

No. of Items (m) or Raters (n)	Number of Rating Categories (c)											
	2		3		4		5		6		7	
	V	p	V	p	V	p	V	p	V	p	V	p
2							1.00	.040	1.00	.028	1.00	.020
3							1.00	.008	1.00	.005	1.00	.003
3			1.00	.037	1.00	.016	.92	.032	.87	.046	.89	.029
4					1.00	.004	.94	.008	.95	.004	.92	.006
4			1.00	.012	.92	.020	.88	.024	.85	.027	.83	.029
5			1.00	.004	.93	.006	.90	.007	.88	.007	.87	.007
5	1.00	.031	.90	.025	.87	.021	.80	.040	.80	.032	.77	.047
6			.92	.010	.89	.007	.88	.005	.83	.010	.83	.008
6	1.00	.016	.83	.038	.78	.050	.79	.029	.77	.036	.75	.041
7			.93	.004	.86	.007	.82	.010	.83	.006	.81	.008
7	1.00	.008	.86	.016	.76	.045	.75	.041	.74	.038	.74	.036
8	1.00	.004	.88	.007	.83	.007	.81	.008	.80	.007	.79	.007
8	.88	.035	.81	.024	.75	.040	.75	.030	.72	.039	.71	.047
9	1.00	.002	.89	.003	.81	.007	.81	.006	.78	.009	.78	.007
9	.89	.020	.78	.032	.74	.036	.72	.038	.71	.039	.70	.040

source : (Aiken's , 1985)

The analysis of the practicality of the chemical e-module based on discovery learning oriented to chemoentrepreneurship in the material for class XI SMA/MA buffer solutions were analyzed using the following percentage formula:

$$Practicality\ percentage = \frac{Total\ Value}{Maximum\ Value} \text{ x } 100\%$$

Table 2. Practicality assessment category

Achievement Level	Category
81 % - 100%	Very practical
61% - 80%	Practical
41% - 60%	Quite practical
21% - 40%	Less practical
0 – 20%	Impractical

source : (Yanto, 2019)

2. Results and Discussion

2.1 *Define*

2.1.1 ***Front End Analysis.*** Based on the results of teacher interviews and filling out questionnaires with 38 students, it shows that (1) 71.1% of the buffer solution material is still difficult for students, and (2) the learning resources used are still in the form of printed books, worksheets, Youtube videos and ppt, (3) 65.8% of the teaching materials used have nothing to do with everyday life, (4) teaching materials are used, not given an internship that produces products (chemo-entrepreneurship). Based on these results, it is necessary to design teaching materials that relate the material to everyday life and the application of chemoentrepreneurship in order to motivate students to make the learning process more meaningful.

2.1.2 ***Learner Analysis .*** Based on data obtained from the distribution of student questionnaires, namely 88.4% of students have operated cellphones in doing school assignments, the teaching materials used 57.9% have not been packaged with an attractive appearance, so they need interesting teaching materials to improve student learning outcomes. , as evidenced by 100% of students wanting to study chemistry with more interesting teaching materials, 89.5% of the absence of teaching materials equipped with practicums that produce a product, meaning that students want more meaningful teaching materials with the *chemoentrepreneurship*. Therefore, teaching materials are needed that can improve student learning outcomes.

2.1.3 Taks Analysis. Task analysis is based on the 2013 curriculum by analyzing the basic competencies (KD) that must be mastered by students. These basic competencies are KD 3.12

(explaining working principles, calculating pH, and the role of buffer solutions in living organisms) and KD 4.12 (making buffer solutions with a certain pH). Based on KD 3.12 and 4.12, it can be formulated indicators of competency achievement in the buffer solution material, namely 1) understanding of buffer solution, 2) distinguishing buffer and non-buffer solutions, 3) identifying components of buffer solutions, 4) analyzing the working principle of buffer solutions. 5) calculate the pH of the buffer solution, 6) calculate the pH of the buffer solution with the addition of a little acid, a little base, or dilution. 7) analyze the role of buffer solutions in living organisms, 8) analyze the role of buffer solutions in daily life.

2.1.4 Concept Analysis. Concept analysis is determined from the attributes of the concepts studied in the buffer solution material. The main concepts in the material of buffer solutions are buffer solutions, acid buffer solutions, alkaline buffer solutions, weak acids, conjugate bases, weak bases, conjugate acids, pH values, the role of buffer solutions in the body and daily life. Based on these concepts, it is analyzed in the form of a concept table and poured into the form of a concept map.

2.1.5 Specifaying Instructional Object. Based on KD 3.12 and 4.12 regarding the buffer solution material, it can be determined the learning objectives in the material, namely through a *discovery learning* -oriented *chemoentrepreneurship* digging information from various learning sources, simple investigations, and processing information, students are actively involved in the process learning takes place, has a religious attitude, is curious, thorough, disciplined, think critically in making observations, can work together in groups, is responsible for expressing opinions and answering questions, students can explain working principles, calculate pH, and the role of buffer solutions in the body of living things and can make a buffer solution with a certain pH.

2.2 Design

in designing the e-module is *Microsoft Word 2010, Google Form, and Flip PDF Professional*. The e-module developed is based on the e-module components contained in the Education and Culture, 2017 consisting of cover, introduction, table of contents, glossary, instructions for use, learning competencies, time, concept maps, activity sheets (using *chemoentrepreneurship-oriented discovery learning syntax*), student worksheets, evaluation question sheets, answer keys and bibliography.

2.3 Develop

2.3.1 Validity Test. Evaluation of the designed e-module uses a product validity test. The tested product validity consisted of material validation and media validation. To analyze the results of the validity test using the *Aiken's V* Material expert validation consists of 4 components that are assessed, namely the content component, the linguistic component, the presentation component, and the graphic component. Based on the research, the material validity analysis data is obtained in Figure 1.

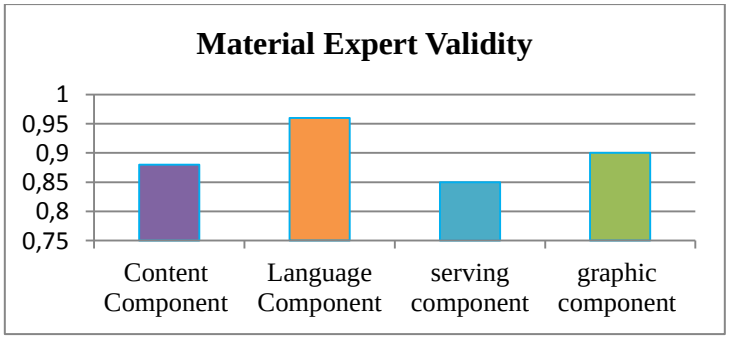

Figure 1. The results of the overall material expert validity analysis

Based on the data above, 1) the content component contains questions about the content of the developed e-module. the results of the analysis obtained the value of V for the content component of 0.88 with a valid category. This shows that the developed e-module is by KD. 3.12 and 4.12. 2) the linguistic component is related to the use of the author's language in explaining the material, the results of the analysis obtained a V value for the linguistic component of 0.96 with a valid category. This shows that the developed e-module already uses good, simple, and clear Indonesian rules. 3) the presentation component of the developed e-module obtained a V value of 0.85 with a valid category. This shows that the e-modules that have been compiled have been systematically based on the e-module components in the e-module compilation guidelines (Kemendikbud, 2017). 4) the graphic component is related to the appearance or design of the e-module. Based on the data, the V value of the graphic component is 0.90 with a valid category. So overall the average validity value generated in the material expert validation is 0.90 with a valid category, this shows that the *discovery learning* -oriented *chemoentrepreneurship* in the class XI SMA/MA buffer solution material developed has been valid. The value of the validity of the media in the study is shown in Figure 2.

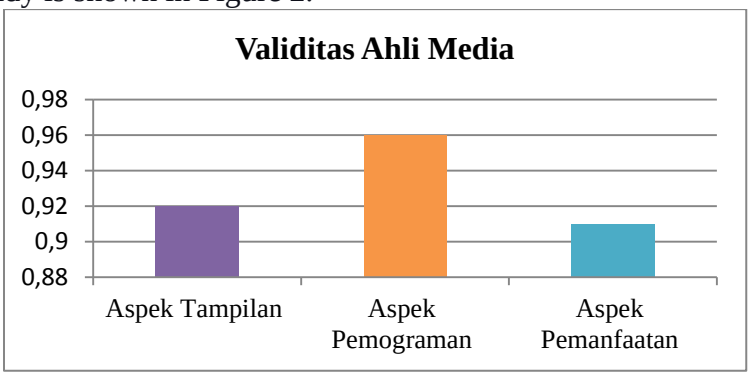

Figure 2. The results of the analysis of the validity of the media experts as a whole.

Media validation includes aspects of the display, programming aspects, and aspects of utilization, based on the data obtained that the display aspect gives a V value of 0.92 with a valid category, the programming aspect gives a V value of 0.96 with a valid category, the utilization aspect gives a V value of 0.91 with a valid category. Based on this assessment, the overall average for media validation is 0.93 with a valid category. This shows that the *discovery of learning-oriented chemoentrepreneurship* in the buffer solution material is valid and can be continued for the next stage.

2.3.2 Practical Test. Test The practicality test of the e-module can be seen from the results of the practicality analysis in Figures 3 and 4. The e-module practicality test by the teacher obtained the following results.

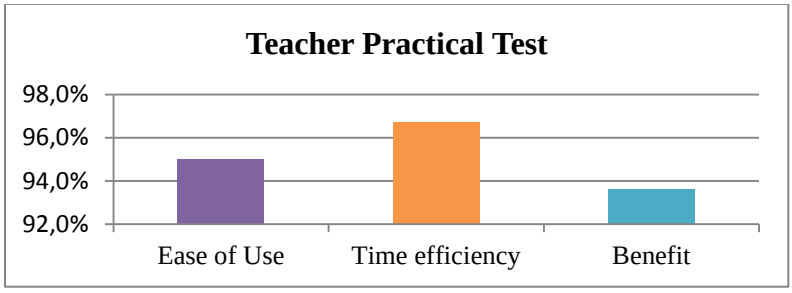

Figure 3. Results of Teacher Practical Test Analysis

Based on the data obtained the practicality value of the ease of use aspect is 95% in the very practical category, time efficiency is 96.7% in the very practical category, and the benefit aspect is 93.6% in the very practical category. Overall the average value of the practicality of teachers is 94.6% with a valid category. Based on the results of the data analysis, it can be seen that the *discovery learning* oriented to chemoentrepreneurship in the material for the XI SMA/MA class XI buffer solution that was developed is easy to use, and the instructions for use in the e-module are interactive, the content of the material in the e-module as a whole is easy. to be understood, and one of its advantages is that it can be used repeatedly.

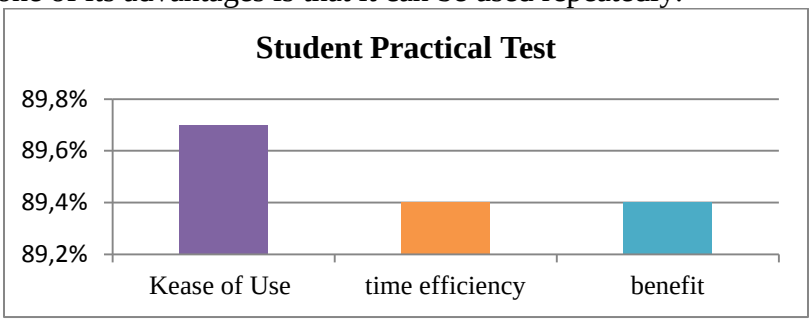

Figure 4. Results of Student Practicality Test Analysis

Based on the processing of practicality test data by students, it was found that the aspects of ease of use, time efficiency, and benefits were 89.7%, 89.4%, and 89.4% in the very category. practical. Overall the practicality value of students is 89.6% in the very practical category. In the learning process using an e-modul based on discovery learning oriented chemoentrepreneurship in class XI SMA.MA class buffer solution students are enthusiastic to use the e-module and get a good response seen from the student's statements which reveals that the learning process using this e-module is very interesting and practical.

3. Conclusion

The conclusion of this research is:

1. The conclusion section should emphasize the main contribution of the article to literature. Authors may also explain why the work is important, what are the novelties or possible applications and extensions. Do not replicate the abstract or sentences given in main text as the conclusion Development of chemical e-modules. *Discovery learning* orientation *based chemoentrepreneurship* on the buffer solution material can be developed using the 4D model development model (*four D models*).
2. The results of the test of the validity and practicality of the chemical e-module based on *discovery learning* oriented *chemoentrepreneurship* in the class XI SMA/MA buffer solution material that was developed was valid and practical, with a material validity test value of 0.90 with a valid category, and a validity test value. media is 0.93 with a valid category. The practicality test of the teacher's and student's responses obtained a score of 94.6% and 89.6% with a very practical category.

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