

Development of A Chemoentrepreneurship Oriented Electronic Module (e-Module) On the Concept of Buffer Solutions

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ARTICLE INFO	ABSTRACT
<p>Article history: Received: April 2, 2024 Revised: Mei 23, 2024 Accepted: June 19, 2024</p> <p>Keywords: ADDIE; Chemo-Entrepreneurship; Buffer Solution; Electronic Module (E-Module).</p> <p>Kata Kunci: ADDIE; Chemoentrepreneurship; Larutan Penyangga; Modul Elektronik.</p>	<p><i>Innovation in technology-based teaching materials is one of the innovations brought by technological advances in the 21st century in the field of education, one of which is module innovation in electronic form (e-module). However, millennial students currently do not really like learning science, one of which is chemistry because they think it is boring. This can be overcome by learning with a contextual approach, one of which is chemo-entrepreneurship in the form of electronic modules in buffer solution material. Through e-modules, students obtain information about chemical concepts in the processing of materials into chemical-based entrepreneurial products. The aim of this development research is to create a chemo-entrepreneurship oriented electronic module (e-module) based on the buffer solution concept. The final product is an electronic learning module focusing on chemo-entrepreneurship on possible buffer solutions used by students as a source of independent learning. To develop this product and assessing their effectiveness, we used of analysis with research and development method. The ADDIE model which includes the stages of analysis, design, development, implementation and evaluation was used to plan this research. After going through validation by five material experts and media experts, this e-module was declared valid because the V value exceeded 0.80 in the Aiken's test. A total of 19 students of XI MIPA 4 SMA Negeri 8 Serang City were used for limited e-module testing and obtained a percentage of 92% in the "very good" category.</i></p> <p>Inovasi bahan ajar berbasis teknologi salah satunya inovasi modul dalam bentuk elektronik (e-modul). Peserta didik saat ini juga kurang begitu menyukai pembelajaran sains salah satunya mata pelajaran kimia karna dianggap membosankan. Hal ini dapat diatasi dengan pembelajaran berpendekatan kontesktual salah satunya yaitu chemo-enterpreneurship dalam bentuk modul elektronik pada materi larutan penyangga. Tujuan dari penelitian pengembangan ini adalah untuk membuat modul elektronik (e-modul) berorientasi chemo-enterpreneurship pada konsep larutan penyangga. Model ADDIE yang meliputi tahapan analisis, desain, pengembangan, implementasi, dan evaluasi digunakan untuk merencanakan penelitian ini. Setelah melalui validasi oleh lima orang ahli materi dan ahli media, e-modul ini dinyatakan valid karena nilai Vhitung melebihi 0,80 pada uji Aiken's. Sebanyak 19 siswa XI MIPA 4 SMA Negeri 8 Kota Serang digunakan untuk pengujian e-modul secara terbatas dan memperoleh persentase sebesar 92% dalam kategori sangat baik</p>

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INTRODUCTION

The era of globalization or the 21st century is an era where all aspects of life, one of which is science and technology, are becoming open. Fundamental changes in educational patterns are needed to meet the characteristics of 21st century learning, namely creative and innovative, critical thinking skills, able to combine all the knowledge gained and apply it in real life, technological and information skills, and good communication and collaboration skills. (Hasibuan & Prastowo, 2019).

Technological developments in the world of education, especially distance learning innovations and technology-based learning tools that can be accessed online using a computer, laptop or cellphone (Matondang et al., 2022). In the chemistry learning process, one of the learning tools that students can use to study independently is learning media in the form of teaching materials such as textbooks. The use of teaching materials influences students in gaining knowledge and understanding the concept of knowledge. The use of teaching materials in the form of chemistry textbooks is less interesting to use and not effective enough to be used in chemistry learning which is considered difficult, thereby reducing students' willingness to learn (Agusti et al., 2021). Creating up-to-date and independent alternative learning resources is one way to increase students' enthusiasm for learning.

One technology-based learning resource that students can use as a learning reference is an electronic module or E-Module. To help students better understand lessons, interactive electronic modules include animated illustrations, audio, and video. (Hafsah et al., 2016).

However, students find chemistry as a subject difficult due to lack of understanding of the concepts and lack of motivation to learn (Priliyanti et al., 2021). Buffer solutions are one of the concepts that are considered difficult for students. Students find it difficult to relate chemical concepts to solving existing problems, which causes students to be unable to complete practice questions, students also think that chemical material, namely buffer solutions, does not suit their needs, abilities and expertise (Sanjiwani et al., 2018).

The concept of buffer solutions is complex, abstract, mathematical and applicable (Sariati et al., 2020). Learning styles that tend to memorize and use conventional learning resources from textbooks add to the difficulty of understanding concepts and students' lack of interest in studying buffer solution material (Triprapa et al., 2020). A learning process that does not emphasize the relationship of concepts to phenomena or real objects in the surrounding environment triggers students assumption that buffer solution material is difficult to understand and relate its relationship to real objects in the surrounding environment. Learning media is needed that to fulfill these characteristics (Wijayanti et al., 2020).

The chemo-entrepreneurship approach (CEP) is an entrepreneurial approach in chemistry with contextual learning which aims to improve the entrepreneurial nature and skills of students in a learning process that actively involves students to think critically about the

benefits and application of buffer solutions based on the concepts that have been obtained and then process them into products that have economic selling value and are able to improve life skills. Students are also able to understand the relationship and connection of chemical concepts that have been studied with real objects found in the surrounding environment. The Chemo-Entrepreneurship (CEP) approach is suitable for the concept of buffer solutions which are considered conceptual and theoretical, as well as uninteresting and difficult to understand.

Based on the description above, the researcher intends to develop an electronic module with the title "Development of a Chemo-Entrepreneurship Oriented Electronic Module (E-Module) on the Buffer Solution Concept".

METHOD

This type of research is Research and Development (R&D) to produce and test the effectiveness of products with limited trials of 19 students of XI MIPA 4 SMAN 8 Serang City. The research object is a chemoentrepreneurship oriented electronic module based on the buffer solution concept through validity value suddenly appear. Purposive sampling was used as a sampling technique. This research uses a modified R&D method with the ADDIE model, namely analyze, design, develop, implement, and evaluate (Sugiyono, 2013). Data collection techniques by developing products by ensuring the validity of the e-module products derived from use of material expert and media expert validation sheets. The data collection technique was carried out by collecting material expert and media expert validation sheets carried out by 5 experts, student response questionnaires to obtain data regarding student responses to the e-module products being developed. The data analysis techniques in this research are 1) expert validation sheet using the Aiken's test analysis technique, 2) student response questionnaire using a Likert scale.

RESULTS AND DISCUSSION

This research aims to produce a chemoentrepreneurship-oriented electronic module that is suitable for use. After the calculated V value is obtained, it is adjusted to the V Aiken table. Based on the number of assessors, namely five validators with 5 categories choice at 5% error level or $p < 0.05$, then the V table value is 0.80. This means that if the calculated V value is greater than 0.80 then it is declared valid. The following are the results of e-module development using the ADDIE development model.

Analyze Stage

The initial stage in developing this electronic module is the analysis stage in the form of material analysis, analysis of the availability of teaching materials, as well as analysis of the components and framework of the e-module using several relevant journals (literature study). Based on the results of the needs analysis, conclusions can be drawn as in Table 1 below:

Table 1. Conclusions of Needs Analysis Results

Conclusion

- Buffer solution material is considered difficult because of its abstract and complex nature
 - In learning, there is not much connection with real objects
 - The teaching materials used in the form of textbooks are less attractive and are not permitted to be taken home
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The results of the material analysis carried out are in accordance with (Permendikbud Number 37 of 2018 concerning Amendments to Minister of Education and Culture Regulation Number 24 of 2016 concerning Basic Competencies for Lessons in the 2013 Curriculum in Primary and Secondary Education, 2018). The KD obtained then determines the competency achievement indicators (GPA) which are included in the e-module, as well as the results of the analysis of the framework and components that will be used in developing a chemo-entrepreneurship orientation based on the buffer solution concept.

Table 2. KD Analysis Results and Competency Achievement Indicators (GPA)

KD	GPA
3.12 Explain the working principles, pH calculations, and the role of buffer solutions in the body of living creatures	3.12.1 Understand the concept of buffer solutions correctly 3.12.2 State the working principles of buffer solutions correctly 3.12.3 Determine the pH and pOH values of the buffer solution correctly 3.12.4 Apply the role of buffer solutions in everyday life 3.12.5 Projecting the use of buffer solutions in the field of entrepreneurship (chemo-entrepreneurship)
4.12 Make a buffer solution with a certain pH	4.12.1 Analyze buffer solution experiments based on pH changes that occur due to the addition of a little acid, a little base or dilution 4.12.2 Creating an entrepreneurial product with the concept of a buffer solution (chemo-entrepreneurship)

Design Stage

The second stage is design. At this stage, the initial design process is carried out, namely preparing the buffer solution material, making a learning video using the Canva application, recording sound as audio to support learning in the e-module, and collecting images and animations related to the buffer solution material. Collecting information for use in the media being developed, especially electronic modules presented in storyboard form using the Canva application integrated with Heyzine.

After the initial design of the e-module was completed, validation sheets from media experts and material experts were prepared based on the National Education Standards Agency

(BNSP) with slight modifications as well as preparation of student response questionnaires and then modified according to the researcher's needs.

Development Stage

Development is the third stage. Validation of product design results is carried out at this stage. The supervising lecturer provides suggestions on how to revise the e-module product before validation with media and material experts. Experts validate the e-module product after revision by the supervisor. Five validators, namely four chemistry teachers and one science education lecturer, were used in this validation process.

After the expert validation process is complete, the e-module product is revised again according to the suggestions of each validator. It tries to overcome the shortcomings of the e-module product to produce a better final product for testing on students. The following is a summary of the suggestions obtained from the validation results from media experts and material experts, which can be seen in Table 3:

Table 3. Summary of Suggestions from Validators

No.	Page/Section	Improvements/Suggestions
1	Cover	Added e-module profile page
2	Introduction	The KD and GPA tables are loaded on one page
3	Apperception	The size of the apperception video is increased
4	Business Opportunities: Chemoentrepreneurship	Tools and materials as well as work steps for points (Bullets) are replaced by letters or numbers
5	Closing	Added a closing page containing a summary
6	Author profile	Added photos and brief profiles of supervisors

After being revised and validated again, the Aiken's V data analysis technique was then used to obtain validation data as explained in Appendix 8. Based on Aiken's analysis, the calculated V value was greater than 0.80. This shows that the e-module product is valid and suitable for limited trials with students. The following are the results of Aiken's analysis on each aspect of the assessment:

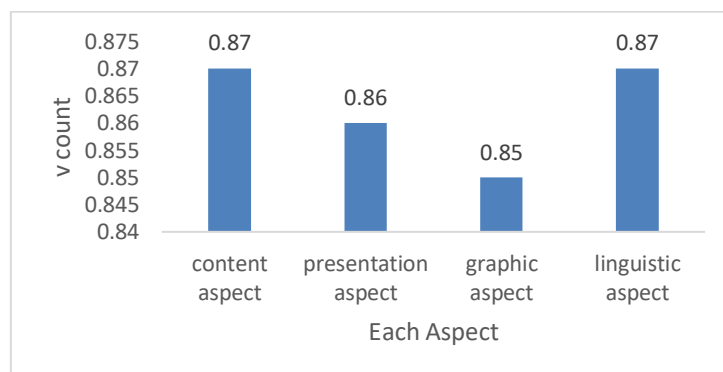


Figure 1. Validity Results for Each Aspect

Based on this image, in each aspect has a Vcount greater than 0.80 and is declared valid.

Implementation Stage

The fourth stage is Implementation. At this stage, a small-scale trial was carried out on students to find out how they responded to the e-module product being developed. A limited trial was carried out at SMA Negeri 8 Serang City on Friday, June 23 2023 involving 19 respondents from class XI MIPA 4. Students gain knowledge about entrepreneurship and buffer solutions, as well as a better understanding of how this solution is used in the real world. Students too Mentioning that the use of this e-module creates an atmosphere learning chemistry becomes more fun and not drab. The following is the percentage of student response questionnaire results:

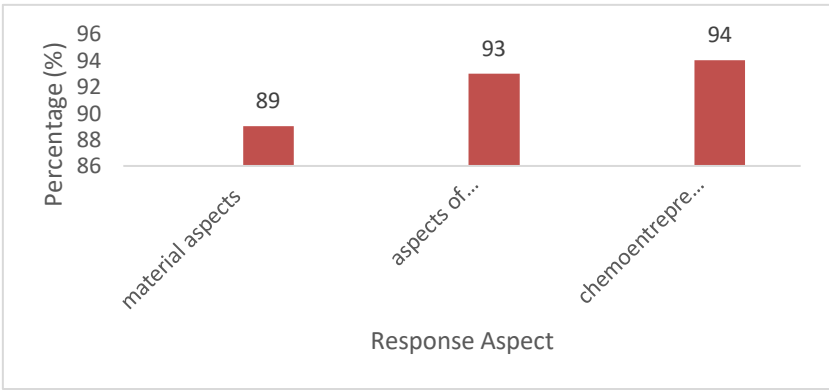


Figure 2. Student Response Questionnaire Results

The student response to the e-module developed was very good, as evidenced by the score of 92% in the "very good" category obtained based on the results of the student response questionnaire. This is in line with research (Jamiludin, 2023) that the use of e-module media using integrated Canva heyzine flipbook obtained "very good" results.

Evaluate Stage

The final stage is Evaluate. Starting from the analysis stage to implementation, evaluation is carried out to improve and perfect the results at each stage of ADDIE. This e-module needs to be perfected, especially in terms of content components of buffer solutions. Apart from that, the application of this e-module is to determine its effect on entrepreneurial motivation and students understanding of concepts, large-scale trials are needed to determine the effectiveness of using e-modules. The evaluation results obtained at each stage are as follows:

Table 4. ADDIE Stage Evaluation Results

Stage	Evaluation
Analyze stage	The initial stage in developing is analysis. What is done is analyzing needs and analyzing material using literature studies based on relevant journals and previous research. The evaluation results obtained are that researchers must carry out journal analysis well and thoroughly so that journal analysis results are obtained that are accurate and can be adapted

Design stage	to media development needs. The results of the evaluation at this stage are that the preparation of the e-module must be adjusted to the storyboard that has been created so that the resulting e-module is structured and systematic.
Develop stage	The results of the evaluation at this stage are expert validation more than once. This aims to obtain better module validity by revising the module again according to the validator's suggestions. The more valid the module, the more appropriate it is to be tested. The researcher also added an observation sheet according to the supervisor's suggestion to assess activities during the limited trial.
Implementation stage	The results of the evaluation at this stage are limited trials of students making products at home and not marketing the products that have been made. For further research, the product packaging and marketing process should be carried out so that the influence of using e-modules on students' entrepreneurial understanding and interest can be determined.

CONCLUSION

The chemo-entrepreneurship oriented electronic module on the buffer solution concept was successfully developed through the R&D method with the ADDIE development model, the validity of the electronic module in each aspect had a V count greater than 0.80 and was declared valid, students' responses to the electronic module had an average percentage value of 92% in the very good category.

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