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Research Article

Development of Interactive Organic Chemistry E-Module Using Macromedia Flash Improves Concept Mastery

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ABSTRACT

This study was examining to produce e-modules as teaching materials in interactive organic chemistry courses using macromedia flash through the development process and determine the effect of interactive organic chemistry e-modules using macromedia flash on student concept mastery. This research method is development research known as Research and Development (R & D) Borg and Gall model with the following research stages, 1) Preliminary Study, 2) Planning, 3) Initial product development, 4) Small-scale field test, 5) Revision of small-scale field test results, 6) Main field test, 7) Revision of main field test results, 8) Operational field test, 9) Final product revision, and 10) Product implementation. The research instrument was a questionnaire with 33 statements and a multiple choice written test with 20 questions. The instrument was used to measure the category of interactive organic chemistry e-module interpretation using macromedia flash through the development stages using a questionnaire based on language, material and media aspects and to measure students' conceptual mastery using a multiple-choice written test. Based on the results of the study, it was found that the interactive organic chemistry e-module using macromedia flash through the development stages was in the very good category with a score of 3.6. The hypothesis test of this research was obtained that the value of sig (2-tailed) was 0.000 < 0.05, this means that there is an effect of implementing an interactive organic chemistry e-module using macromedia flash as a result of development on concept mastery. The amount of increase that occurs in the mastery of students' concepts is 66.74%.

Keywords: *E-module of Organic Chemistry, Macromedia Flash, Mastery of Concepts*

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Introduction

The 21st century is marked by the development of science and information technology. mastery of science and technology is an important key to face future challenges. 21st century skills can be trained through science education. Digital media is very important in life. With the development of technology, educators must be able to develop multimedia-based learning systems. Organic chemistry is a branch of chemistry that studies the reactions, mechanisms, and structures of organic compounds (Negra, 2017). The level of representation of chemistry includes, macroscopic, microscopic, and symbolic. Analysis based on the group of reactions on organic compounds is a symbolic level while the mechanism and structure of organic compounds includes groups of macroscopic and microscopic levels (Fakhri et al., 2018). Science is closely related to how to find out about nature systematically. Organic chemistry learning in recent years has become more complex and varied, so it is necessary to update when carrying out lectures. The results of research on the implementation of learning using the discussion method and the presentation method obtained data on student concept mastery of 47.86. It can identify that they do not understand the concept being taught so that when the same concept is caused by an abstract concept (Smith, 2020).

Based on the results of a student satisfaction survey related to the implementation of learning using electronic modules (e-modules) students prefer to use handout slides. Giving handout slides to students during lectures makes learning passive and less involving students (Fibonacci et al., 2021). Meanwhile, the provision of e- modules makes students better master the concepts of the material provided so as to encourage students to be actively involved in feedback activities. The faculty claims that the application of concept mastery into the chemistry education curriculum will have advantages in terms of: student learning. This includes supporting revision, increasing student understanding, increasing interest/engagement, and perspective and forward thinking (Mekwong & Chamrat, 2021).

Macromedia flash is software designed to create motion-based animations with small results. Macromedia Flash is a standard application program for animation and design tools to create interactive, interesting and dynamic learning media. animations can be made simpler, faster, and more attractive by using Macromedia Flash Professional. The existence of a media is not a coincidence in improving student learning outcomes, but because of the differences in the treatment given to each class. Based on the results and analysis of research related to the use of digital modules can improve student achievement as seen from the percentage of students who get post-test results more than or equal to 70. However, post-test results from 26 students who get scores are greater than or equal to 70 (Jackson & Hurst, 2021). This means that there are 90% of students who pass the test. So it can be concluded that the digital macromedia flash module is very effective when used in learning.

An e-module is an electronic version of a printed module that can be read on a computer and designed with the required software. E-module is a learning tool or tool that contains materials, methods, limitations, and evaluation methods that are designed systematically and attractively to achieve the expected competencies according to the level of complexity electronically (Hermanns, 2020). In organic chemistry courses, e-modules are used by lecturers to support learning activities so that to explain material in organic chemistry courses that require the help of pictures, videos, and animations, e-modules can be provided. Several types of E-module applications have been successfully developed, one of which is making E-Modules using macromedia flash. Macromedia flash has more advantages and ease of use for learning. The E-Module that is made is expected to have a good interpretation from material, language, and media experts. This also shows that e-modules with this application are suitable to meet the demands of learning in the era of the industrial revolution 4.0 which can achieve achievements in the form of "skill complexes" needed in the global era (Mananda, 2017).

Multimedia is a computer-mediated software or interactive application that integrates text, color, graphic images, animations, audio sounds, and full motion video in one application. One of the learning media that can attract

students' interest in lecture activities is macromedia flash (Permana, 2021). The application of macromedia flash in the development of organic chemistry modules in the world of education is the solution to assist students and lecturers in lecture activities that aim to improve students' conceptual mastery skills during learning activities (Ma, 2020). With the development of technology, lecturers must be able to develop teaching materials in the form of multimedia-based e-modules in learning activities. This software is a program for designing graphic animations that is very popular and widely used by graphic designers. The use of the macromedia flash program is expected to increase learning activities in the classroom, so as to increase students' mastery of concepts (Permana et al., 2021). In addition, another purpose of using the macromedia flash program is to provide new variations in learning methods so that students are not bored with the display presented and are able to answer questions that have been given properly prepared (Tanang, 2014).

Organic chemistry learning essentially consists of structure, reaction, and reaction mechanism. The learning process of organic chemistry is seen as important as an opportunity to provide meaningful experiences for students to have ways to build knowledge, skills, abilities or other competencies that are considered important (Gall et al., 1996). Experimental activities in the organic chemistry learning process cannot be separated because they can train students in how to think and how to work. The ability to experiment can be said as a combination of knowledge and skills to build an important process in scientific investigation. Through experimental learning, students will have the ability to investigate and uncover basic concepts that can be developed to solve problems (Koth et al.,2021). So that students can solve problems, it is very important to master the basic concepts of organic chemistry in depth. So, there is a relationship between the ability to experiment with students' mastery of concepts.

In general, this research looks according to the state of the art drawing as follows:

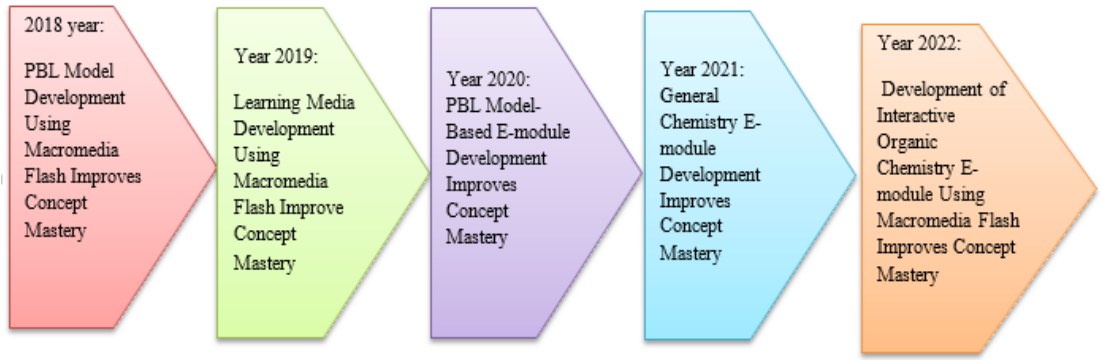

Figure 1. State of The Art Researcher

This research has relevance to RIRN 2017-2045 in the field of social humanities, on the theme of education. Then according to PRN 2020-2024 on the topic of education and learning technology. This research is also in line with the focus of the 2018-2022 University HKBP Nommensen Pematangsiantar (UHKBPNP) research strategic plan with the main field of Research and Development (R & D). This research umbrella is in accordance with the researcher's roadmap, namely Digitalization-Based Teaching Materials (E-modules) (Boholano, 2017).

Methods

This research is a development research or known as the Research and Development (R&D) Borg and Gall model. The subjects of this study were students of the chemistry education study program in the odd semester of 2021/2022 FKIP, University of HKBP Nommensen Pematangsiantar (UHKBPNP), totaling 30 people. The development of an interactive organic chemistry E-module using macromedia flash consists of 10 stages, namely: 1) Preliminary Study, 2) Planning, 3) Initial product

development, 4) Small-scale field test, 5) Revision of small-scale field test results, 6) Main field test, 7) Revised main field test results, 8) Operational field test, 9) Final product revision, and 10) Product implementation. Testing the hypothesis of this study using the one-way ANOVA test.

Research data

This study uses primary data in the form of literature studies, interviews, surveys and tests. The data obtained in this study is quantitative data. Quantitative data will be analyzed through descriptive statistical analysis to describe the interpretation of the product (e-module) developed using macromedia flash and increase students' mastery of concepts (Uz et al., 2019).

Process and stages of research flow

The research process starts from: 1) Preparing RPS, 2) Creating interactive chemical products (e-modules) using macromedia flash whose material is in accordance with CPMK organic chemistry, 3) conducting product trials to obtain the final product, 4) Determining the population and samples, 5) Conducting Pre-Test of student concept mastery, 6) Implementation of the final product, 7) Conducting Post-Test , 8) Processing data, 9) Analyzing data, 10) Conclusions, and 11) Mandatory and additional outputs, 12) Completing progress reports , up to 13) Completing the final report.

This study uses primary data in the form of literature studies, interviews, surveys and tests. The data obtained in this study is quantitative data. Quantitative data will be analyzed through descriptive statistical analysis to describe the interpretation of the product (e-module) developed using macromedia flash and increase students' mastery of concepts.

Analysis of quantitative data development through interpretation of very bad, bad, good and very good based on the Likert rating scale range on a scale of 1 - 4 to describe the quality of the product (e-module) as well as increasing students' mastery of concepts through the N-Gain test. The data obtained from the results of the material assessment instrument, media reviewer, language reviewer, and analyzed descriptively with calculations using a rating scale. The score scale is: 0 – 1,0 very bad, 1.1 – 2,0 bad, 2.1 – 3,0 good, 3.1 – 4,0 very good.

Results and Discussion

Descriptive Test

the results of measuring students' conceptual mastery through multiple-choice written tests with 20 items. The data obtained in the form of pretest data and posttest data are presented as follows:

Table 1. Pretest and Posttest Score

Statistics	Pretest	Posttest
mean	49.67	83.83
median	50.00	85.00
Mode	45 [a]	85
Std. Deviation	8,899	6,909
Variance	79,195	47,730
Range	35	25
Minimum	30	70
Maximum	65	95
Sum	1490	2515

Based on Table 1. The lowest pretest score was at a score of 35 and the highest score was 65. However, after the next measurement, namely the post-test, it was found that the lowest score was at a score of 70 and the highest score was at a score of 95.

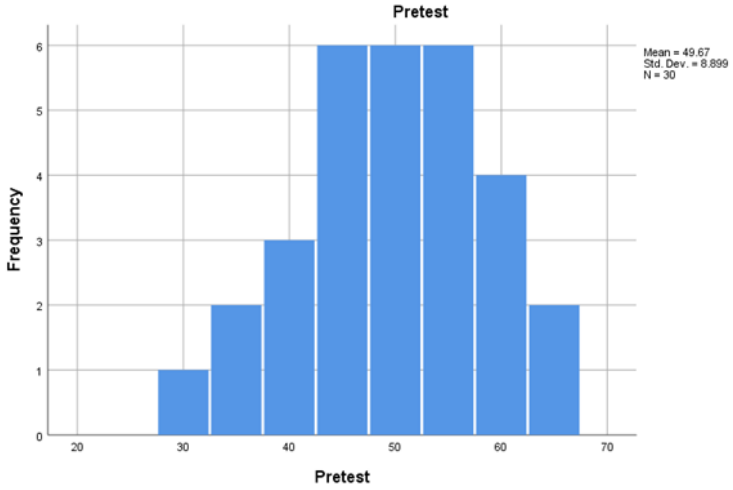

Figure 2. Pretest histogram

Based on Figure 2, it is obtained that thedominating score range is in the 40-60 range

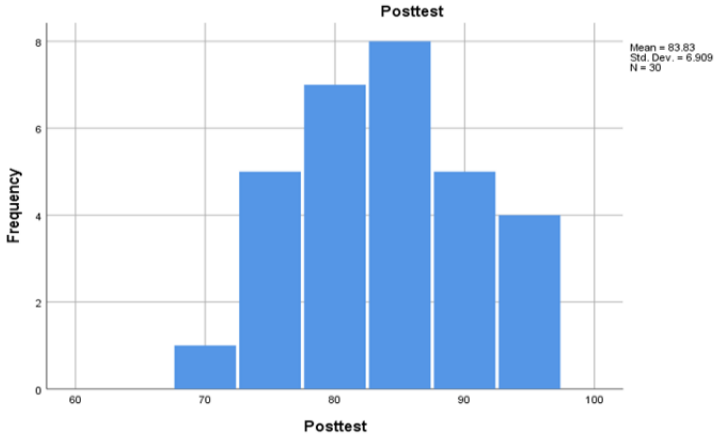

Figure 3. Posttest Histogram

Based on Figure 3, it is obtained that the dominating score range is in the 75-90 range

Data Analisis

Normality test

Normality test is used to see whether the data obtained comes from a population that is normally distributed or not. In this normality test using the SPSS Version 25 program with the Kolmogorov-Smirnov program with the Liliefors significance correction criteria. The basis for making decisions in this test are:

a. if the value of sig> 0.05 then the data is no mally distributed.
b. if the value of sig <0.05 then the data is not normally distributed.

Table 2. Normality test

Class	Kolmogorov-Smirnov [a]			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
Pretest	0.126	30	.200 *	0.964	30	**0.401**
Posttest	0.144	30	0.115	0.937	30	**0.075**

In the table above, it can be seen that the significance value in the Kolmogorov-Smirnov column is > 0.05, it becomes the basis for concluding that the data is normally distributed.

Homogeneity Test

The homogeneity test was carried out to find out that two or more groups of sample data came from a population that had the same variance or not (Yulkifli et al., 2022). In this homogeneity test using SPSS version 25. The basis for making decisions are:

a. if the value of sig> 0.05 then the data is homogeneous
b. if the value of sig <0.05 then the data is not homogeneous.

Table 3. Homogenity Test

statistics	Levene Statistics	df1	df2	Sig.
Based on Mean	1.416	1	58	0.239
Based on Median	1,453	1	58	0.233
Based on Median and with adjusted df	1,453	1	55.040	0.233
Based on trimmed mean	1.355	1	58	0.249

Based on the table above, it is found that the significance value is more than 0.05, meaning that the data is homogeneous.

One Way Anova Test

The Anova test is used to compare the population averages to find out the significant differences between two or more data groups. One-way anova serves to analyze data that has only one independent variable or one factor. Decision-making:

If sig < 0.05 then there is a difference in learning outcomes

If sig > 0.05 then there is no difference in learning outcomesa

Table 4. F Test Table

ANOVA					
Hasil					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	17510,417	1	17510,417	275,917	0,000
Within Groups	3680,833	58	63,463		
Total	21191,250	59			

In the SPSS version 25 output above, it is found that the value of sig < 0.05, it can be concluded that there are differences in learning outcomes before and after treatment.

N-Gain

This test was conducted to see how effective the learning model used was. In this test, it will be seen what percentage of the increase that occurs in the learning outcomes carried out. This test uses the SPSS version 25 program.

Table 5. N -Gain

Why		
N	Valid	30
	Missing	0
Effectiveness (percent)		66.7429

From the results of the SPSS output, it was found that in the experimental class there was an increase of 66.74 %

The development of an interactive organic chemistry e-module using macromedia flash was adjusted to the results of the initial needs analysis through a literature study and interviews conducted to 4 lecturers of chemistry education study program and 30 students of chemistry education study program at HKBP Nommensen Pematangsiantar University, faculty of teacher training and education. The results of the development of the organic chemistry e-module obtained that the initial e-module product has gone through a validation process developed by material, language, and media experts that will be applied for learning. The material chosen in conducting the research is cell biomolecules. Based on the calculation of the results of the questionnaire given to material experts and linguists, the following data were obtained:

Table 5. Interactive organic chemistry e-module assessment using macromedia flash using a questionnaire by material and language experts

No	Indicator	Aspect		Average	Category
		Material	Language		
1	Module topics follow the material from cell biomolecules	3		3	Good
	The accuracy of the sentence structure in the e-module		3		
2	The content of the material follows the CPMK to be achieved in the cell biomolecule material	3		3	Good
	The effectiveness of sentences in presenting the material of cell biomolecules		3		
3	The materials and problems developed in the module represent material indicators of achievement in the achievement of cell biomolecules	4		4	Very Good
	The standard of the sentence in explaining the material		4		
4	The questions contained in the module are clear	4		3,5	Very Good
	Understanding of messages or information		3		
5	The questions contained in the module are applied	3		3	Good
	Language skills motivate students		3		
6	The material contained in the module is easy to understand	3		2,5	Good
	Language skills encourage critical thinking		2		
7	Explanation of material about cell biomolecules	3		3	Good
	The suitability of language with the intellectual and emotional development of students		3		
8	Explanation of the material contained in the module media with cell biomolecule material	4		4	Very Good
	Grammar and spelling accuracy		4		

No	Indicator	Aspect		Average	Category
		Material	Language		
9	Questions and explanations in the media use simple and communicative language	4		3,5	Very Good
	Consistency in the use of terms and symbols or icons		3		
	Total Score	31	28	29,5	
	Average Score	3,4	3,1	3,3	Very Good

Based on the calculation of the results of the questionnaire given to material and language experts in table 5, it shows that the material aspects presented in the interactive organic chemistry e-module using macromedia flash are in the very good category. However, when compared to the language aspect, it is found that the organic chemistry e-module is in the very good category.

Table 6. Interactive organic chemistry e-module assessment using macromedia flash using a questionnaire by media experts

No	Indicators	Media Aspect	Category
1	Selection of word layout and picture suitable	4	Very Good
2	The layout is a neat layout and regular	4	Very Good
3	The background is correct and suitable	4	Very Good
4	Decent Proportion of colors used in obedience	3	Good
5	Image that shown clear	4	Very Good
6	Posts that used clear	4	Very Good
7	Fonts used are simple and easy to read.	3	Good
8	The font size used is in accordance with layout	3	Good
9	the voice that used suitable	4	Very Good
10	Media can be used repeated times	3	Good
11	Decent Function easy to operate touch on the media	4	Very Good
12	Instructions for using media clear	3	Good
13	Easy media operated	3	Good
14	The quality of the media produced is already good	3	Good
	Total Score	50	
	Average Score	3,6	Very Good

Based on the calculation results in Table 6, it is found that the media aspect of the interactive organic chemistry e-module using macromedia flash is in the very good category as seen from the total media aspect score of 3.6. The data is the validation provided by the expert validator.

Based on the results of media, language, and material experts, the addition of various illustrations can make it easier for readers to understand the material. Also, linguists and material experts suggest the use of communicative language modules because communicative language can increase interactive activities between lecturers and students (Adawiyah et al., 2020). The results of the revised organic chemistry module using Macromedia Flash are shown in the following image:

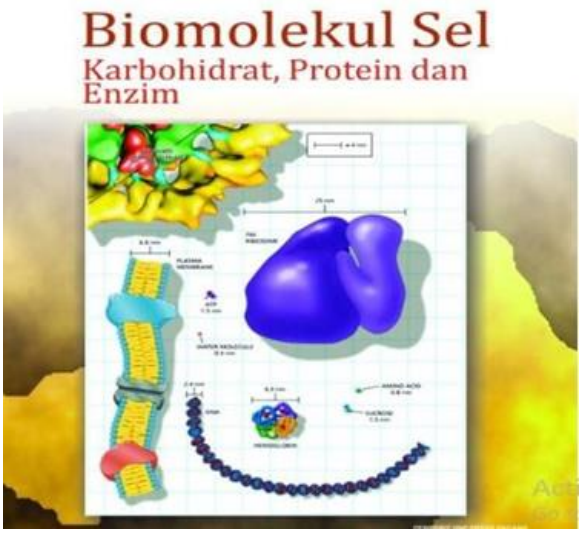

Figure 4. Cell Biomolecular e-Module Cover Macromedia Flash

The role of the module as a medium of learning in this century is quite effective and good because the module is more dynamic and interactive. In the research of Asri et al., (2019) on the Development of Electronic Module Text Writing of Discovery-Based Learning Procedures in Senior High Schools, it is mentioned that apart from being practical and light in storage, the module can be carried anywhere and anytime (Asri et al., 2019). In line with the relevant research conducted by Handayani, D., Elvinawati, E., Isnaeni, I., & Alperi, M. (2017) with the title In line with the relevant research conducted by Handayani, D., Elvinawati, E., Isnaeni, I., & Alperi, M. (2021) with the title Development Of Guided Discovery Based Electronic Module For Chemical Lessons In Redox Reaction Materials, research results show results of the research obtained the percentage of feasibility of e-modules on the material aspect is 86.315% while from the media aspect is 91.425% so that based on the results of validation. Modules are also considered effective and efficient media for independent study. This was done by Ferdianto et al., (2019) a previous study on Professional 3D Macromedia Flash: Improving Mathematical Representation Ability in Linear Equations in One Variable.

Conclusion

Based on the results and discussion above, the conclusions and suggestions from the development of the interactive organic chemistry e-module using macromedia flash are as follows: the value of sig < 0.05, it can be concluded that there are differences in learning outcomes before and after treatment, it indicates that there is a significant difference between the values of pretest and posttest on the two samples , so it was found that in the experimental class there was an increase of 66.74 % . The results also show that the development of the organic chemistry module has the interpretation of the term media in the very good category with a score of 3,6, and material interpretation in the very good category with a score of 3,4. In terms of the material aspect, it is included language in the very good category with a score of 3.1. So, it can be concluded that the interactive organic chemistry e-module on cell biomolecule material developed using the macromedia flash application is suitable for use in the learning process.

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