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E-Module Development on Hydrocarbon Compounds Material for Class X Agricultural Vocational High School

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A B S T R A C T

The research on the development of e-modules on hydrocarbon compound material for agricultural vocational school education units aims to develop e-modules that are in accordance with the demands of the agricultural vocational curriculum. This study used a research and development (R&D) method with the ADDIE development model which only consists of 3 stages, namely analysis, design and development. The object of research was the e-module on the material of hydrocarbon compounds. The research subjects were 3 educators who taught chemistry subjects at the Agricultural Vocational School and 23 Agricultural Vocational Schools students. Data collection was done through validation sheets and response questionnaires. The results showed that the e-module developed was very valid or very feasible to be tested in the field with an overall average percentage value of material validation of 91.69% and an overall average percentage of media validation of 94.13%. Based on the results of the test, the response of educators obtained an average percentage of 85.18% with the very good category and the results of the students' responses obtained an average percentage of 72.72% with the attractive category. Thus it can be concluded that the e-module of hydrocarbon compounds is very good and interesting to be applied in the learning process on a larger scale.

1. Introduction

The use of ICT in education is known as computer-based instruction and e-learning or web-based learning. E-learning has been developed in all forms of communication technology to create, manage and provide information. In accordance with Rusman's (2018) statement, E-learning is related to the use of ICT such as computers, internet, telephones, television / videos and other audiovisual aids used in education.

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E-module is a form of e-learning, which is used using computer equipment (ICT). In today's digital era, it demands the availability of learning resources in the simplest way to use and access them so that users (students) can easily learn and understand their subject matter. In line with the opinion written by Syamsurizal et al (2015) that e-modules can answer the availability of learning resources that can be accessed easily and can be used anywhere by students.

E-module is a module that is embedded in a multimedia technology so that it can be a better learning resource than the usual print media module. As stated by Cecep Kustandi (2011) that multimedia is a tool for delivering messages that combines two or more elements, which include text, images, graphics, photos, sound, film and animation in an integrated manner. Multimedia provides benefits for learning and students alike, among others: the learning process is more interesting, interactive, the amount of time can be reduced, the quality of teaching and learning can be improved, the learning process can be done anywhere and anytime. The use of e-modules in the learning process will make it easier for educators to deliver lessons to students. This can deliver the role and function of learning content to be broader, more effective and efficient.

The use of e-modules in chemistry subjects at SMK is very helpful for students to understand chemistry. In the 2013 revised curriculum for the SMK unit level, there were several changes in several subjects both in terms of the number of hours of face-to-face and in terms of basic competency (KD) content. This also occurs in chemistry subjects where the material for hydrocarbon compounds and their derivatives is in class X even semester. The material studied includes the specificities of carbon atoms, alkanes, alkenes and alkyne compounds, compound nomenclature (alkanes, alkenes and alkyne), derivatives of hydrocarbons (alcohols, ethers, aldehydes, ketones, carboxylic acids and esters) and their nomenclature and uses. hydrocarbon compounds in food processing.

2. Methodology

This research used a research and development (R&D) approach, which is research used to produce certain products and test the effectiveness of the products being developed (Sugiyono, 2019). The product produced in this study is an e-module of hydrocarbon compounds for Vocational High Schools for Agriculture. The validity of the e-module was carried out by 3 material expert validators and 3 media expert validators, while for the good and interesting category the e-module was carried out by 3 people (educators who teach chemistry subjects and 23 students). This e-module was developed using the ADDIE model, which is a systematic learning product development model. The ADDIE framework can be fragmented according to the stages desired by the researcher (Rusdi., 2018). The same thing was also conveyed by Nunuk (2018) that the superiority of the ADDIE model is seen from its systematic work procedure, where every step that will be taken always refers to the previous steps that have been corrected so that it is hoped that an effective product can be obtained. According to Rusdi (2018), the ADDIE model development procedure

can be seen in Figure 1, where in this study the procedure is carried out only up to the development stage.

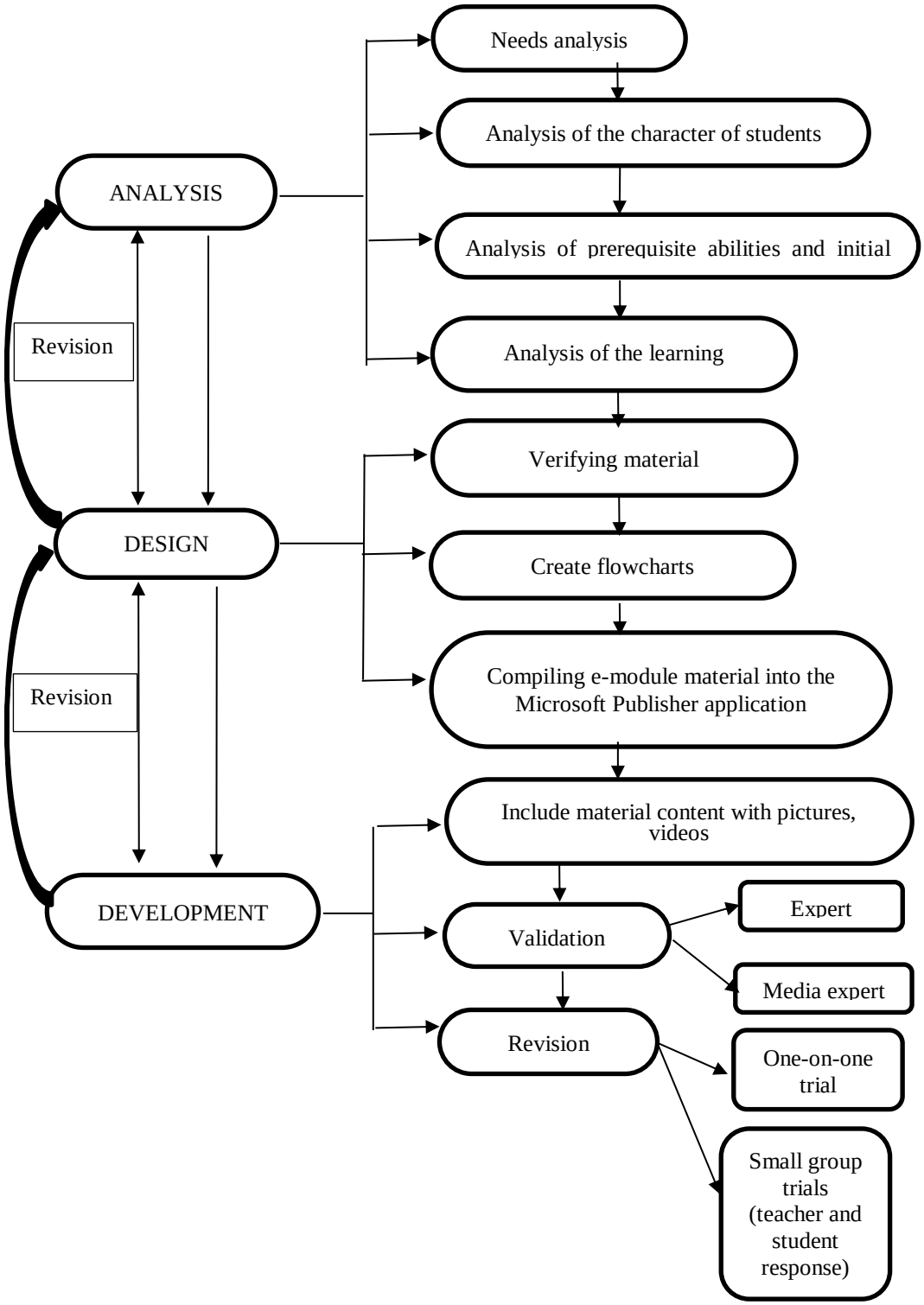


Figure 1. Schematic of ADDIE Model Development Steps in E-module of Hydrocarbon Compounds

Analysis Stage (Analyze)

According to Rusdi (2018), at this analysis stage there are several things that must be considered, namely:

(1) Needs analysis
At the analysis stage the activities carried out include (a) examining the causes for the need for development, (b) identifying the necessary resources such as content, technology, facilities and teaching staff, in which aspects need to be improved and added, (c) determine the delivery system potential to achieve learning objectives and (d) compile an e-module development processing plan.

(2) Character analysis of students
Analysis of the characteristics of students includes individual interests, talents, limitations and strengths.

(3) Analysis of the prerequisite abilities and initial abilities
Learning products developed in the form of e-modules certainly require prerequisite abilities and initial abilities that users must have in this case are students.

(4) Analysis of the learning environment
The analysis of the learning environment can include learning culture in schools, learning culture in the classroom, interaction of educators with students and interactions of students with students, potential involvement of students in the learning process, availability of learning resources, availability of information technology and other supporting facilities.

Design Stage (Design)

At this design stage the activities carried out are (a) verifying the material that the e-module user wants to master, basic competency and learning objectives and preparing chemical content, namely hydrocarbon compounds, collecting or making images, collecting or making videos, collecting or making animation support the selected subject matter in making e-modules, (b) make flowcharts of the structure of the hydrocarbon compound material, (c) compile the initial e-module draft product, in publisher and pdf form, (d) create testing strategies and make instruments .

Development Stage (Development)

Research activities in this third stage are development activities which include the following activities:

(1) integrating material content with images, graphics, videos, animations or simulations, into Microsoft Publisher,

(2) Expert Validation consisting of 3 material experts and 3 media experts. The data obtained is in the form of a Likert scale with a score of 1-4 according to table 1 below:

Table 1. Likert Scale Rating Categories

No.	Scoring Scale	Information
1.	4	SS: Strongly Agree
2.	3	S: Agreed
3.	2	KS: Don't agree
4.	1	TS: Don't agree

(Sugiyono, 2017)

From the Likert scale rating category table table 1, the average percentage of each component will be calculated using the following formula:

P = "n" / "N" x 100%

Information:
P: Percentage of scores (rounded)
n: The number of scores obtained
N: The maximum number of scores

Giving meaning and making decisions about the quality of hydrocarbon compound e-module products will use the conversion as in table 2 below:

Table 2. Criteria for the Validity of the Material and Media Data Validation.

No.	Percentage	Criteria
1.	81% -100%	Very feasible / very valid / does not need to be revised
2.	61% - 80%	Eligible / valid / does not need revision
3.	41% - 60%	Inadequate / invalid / needs revision
4.	21% - 40%	Not feasible / invalid / needs revision
5.	< 20%	Very improper / very invalid / needs revision

(Suharsimi., 2013)

(3) Formative Revision which consists of two stages, namely (a) One-to-one trial, (b) Small group trial consisting of teacher response tests and student response tests. (Nunuk., 2018).

The e-module assessment through the teacher response questionnaire using the 1-4 Likert scale can be seen in table 1 and continued by calculating the percentage which is converted into a quantitative value according to Table 3. For the student response questionnaire assessed using a 1-4 Likert scale can be seen in table 1 and continued by calculating the percentage which is converted into a quantitative value according to Table 4.

Table 3. Categories of Educator Response Questionnaires

No.	**Percentage**	**Qualification**
1.	81%-100%	Very good
2.	61%-80%	Good
3.	41%-60%	Pretty good
4.	21%-40%	Not good
5.	0%-20%	Not very good

(Sa'dun Akbar., 2010)

Table 4. Student Response Questionnaire Categories

No.	**Percentage**	**Qualification**
1.	80%-100%	Very interesting
2.	60%-79%	Interesting
3.	50%-59%	Quite interesting
4.	< 49%	Less attractive

3. Results and Discussion

Sub-chapter (if any)

This development research resulted in an e-module product on hydrocarbon compounds. Product development is carried out with the following procedures:

Analysis Phase

At this stage of the analysis, there are several things that researchers do, namely:

(1) Needs Analysis

At this stage of analysis, the activities carried out include (1) examining the reasons for the need for development, including (a) analyzing teaching materials in the form of student textbooks and other learning resources. In this activity, the researcher found that there was a mismatch between the available chemistry textbooks and the existing KD at the SMK Agriculture unit level, especially in the hydrocarbon compound material, where the available textbooks contained hydrocarbons and petroleum, while in KD 3.7 the subject matter was includes hydrocarbon compounds and their derivatives as well as the use of hydrocarbon compounds and their derivatives in food processing, (b) analyzing the harmony of KD that must be mastered by students, indicators of competency achievement (GPA), and learning objectives listed in the chemical syllabus for the SMK Agriculture level. Researchers found that between the syllabus, GPA and learning objectives were aligned and in accordance with the 2013 revised 2017 curriculum (2) identifying the necessary resources such as content, technology, facilities and teaching staff, in which aspects needed to be improved and added. Researchers received information that at SMKN 1 Seberida, it has been using IT devices for several years both in learning and in conducting final semester

exams. IT facilities and teaching staff are very supportive. (3) determine the potential delivery system to achieve learning objectives and (4) prepare an e-module development processing plan, which is divided into two stages, namely (a) dividing e-module development into initial, middle and final stages, (b) measuring time e-module development, managing time is needed so that e-module development can be completed according to the expected time.

(2) Character analysis of students
Analysis of the characteristics of students includes individual interests, talents, limitations and strengths (Rusdi, 2018). In a research conducted at SMKN 1 Seberida class X, where students have been divided based on their interests and grouped into separate majors. Based on the results of observations and interviews with educators, the following results were obtained: (1) The lack of understanding of concepts and the lack of independence of students in participating in chemistry learning, (2) Lack of motivation and enthusiasm of students in participating in chemistry learning, (3) Lack of students' interest in learning chemistry.

(3) Analysis of the prerequisite abilities and initial abilities
Learning products developed in the form of e-modules certainly require prerequisite skills and initial abilities that users must have in terms of students. This analysis is needed both from the material aspect or other basic skills aspects needed to use the product being developed (Rusdi, 2018). At this stage of the analysis, from the results of interviews and observations, students have the prerequisite skills and initial abilities in using e-modules. This is because students have used Android and laptops in a lot of learning so that the use of products in the form of e-modules is not a strange thing anymore.

(4) Analysis of the learning environment
Analysis of the learning environment can include learning culture in schools, learning culture in the classroom, interaction of educators with students and interactions of students with students, potential for student involvement in the learning process, availability of learning resources, availability of information technology and other supporting facilities (Rusdi , 2018). Based on the results of interviews and observations, the learning culture in schools based on agricultural vocational emphasizes learning outside the classroom so that students are more happy and excited if learning is carried out outside the classroom / agricultural land or in a computer laboratory so that learning chemistry is carried out in the classroom. students are less enthusiastic in following it and this also results in a lack of interaction of students in participating in chemistry learning, furthermore the availability of learning resources for chemistry is also still lacking while the availability of information technology facilities is very satisfying.

Design Stage

At this stage, it is carried out to design the expected learning media and appropriate testing methods (Nunuk., 2018). At this design stage, the activities carried out by researchers are:

(1) Verify the material that e-module users want to master, KD and learning objectives and determine the appropriate testing method / preparation of chemical material content, namely hydrocarbon compounds and their derivatives and their use in food processing, collecting or making pictures, collecting or making videos , collect or create animations that support the material of hydrocarbon compounds and their derivatives as well as their use in food processing in making e-modules. The formula for KD in chemistry subjects for the SMK level can be seen in Table 5.

Table 5. Formulation of KD for Chemistry Subject SMK Level Curriculum 2013 Revision 2017

KD	Description KD
3.7	Analyzing hydrocarbon compounds and their derivatives and their use in food processing
4.7	Integrating hydrocarbon compounds and their derivatives in the food processing process

(2) Creating a flow chart of the structure of the hydrocarbon compound material, which will serve as a designer guide in compiling the hydrocarbon compound material in the table of contents. The flowchart that the researchers compiled can be seen in Figure 2.

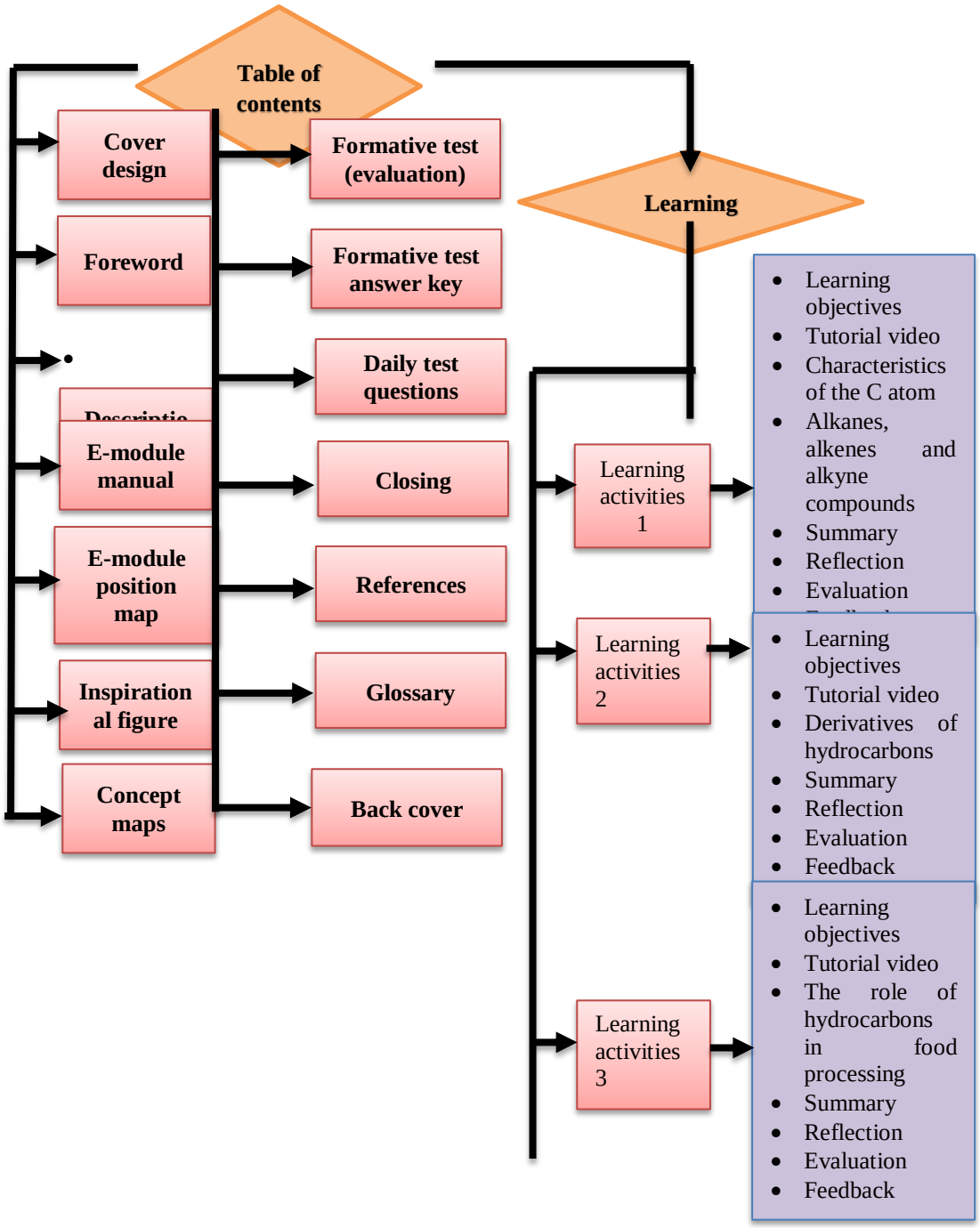


Figure 2. Flowchart of E-module on Material Hydrocarbons

(3) Prepare the initial e-module draft product, in publisher and pdf format. The material structure that has been determined is then arranged into e-module components based on the flow chart. The material description and test questions were developed based on the learning approach used, in this case the scientific approach. The initial draft of the e-module can be seen in Figure 3 and Figure 4.

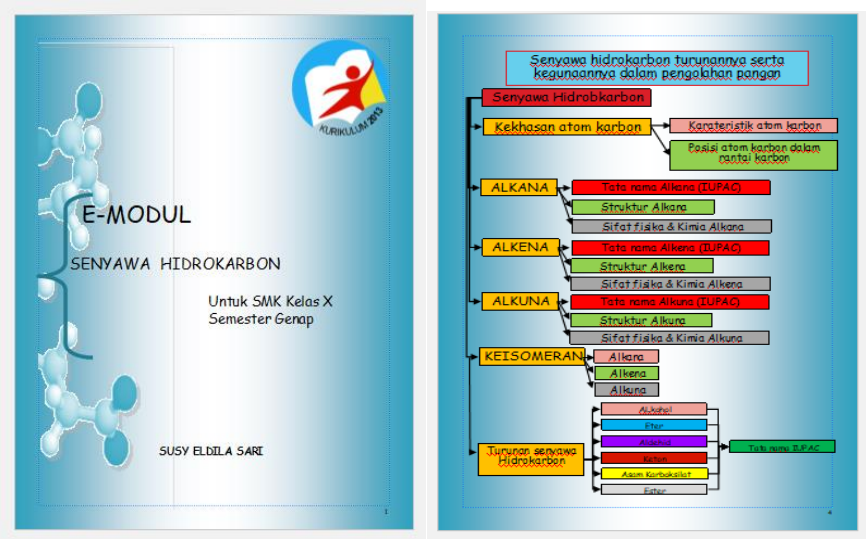


Figure 3. Cover Page and Concept Map

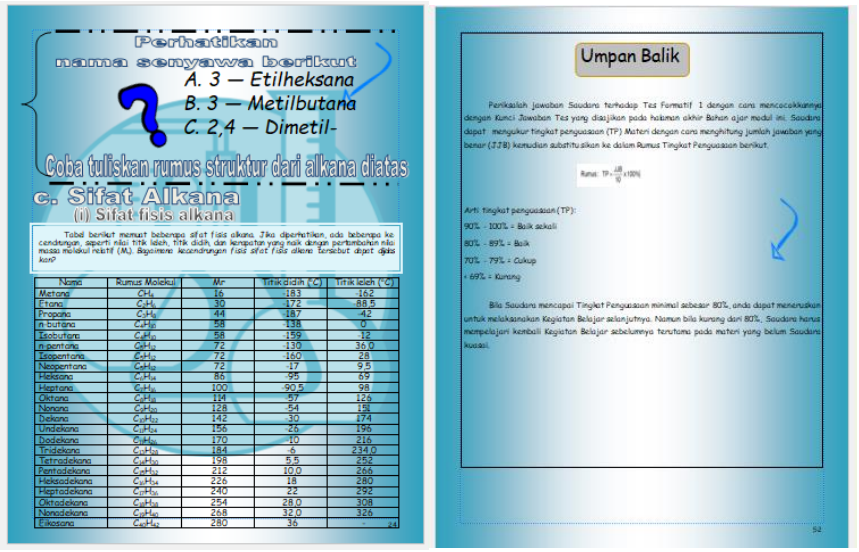


Figure 4. Sample Questions and Feedback Pages

Development Stage

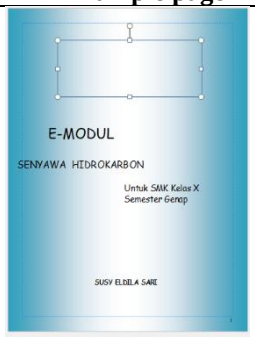
Research activities in this third stage are development activities which include: (1) combining material content with images, graphics, videos, animations or simulations, into Microsoft publishers to become e-module learning resource products, (2) Validation Experts, the e-modules that have been completed are made into products and then validated by a team of experts consisting of a team of 3 material experts and a team of 3 media experts. The validation test aims to determine the validity of the media produced (3) Perform formative revisions.

The steps taken at this development stage include the following activities:

a) Integrate material content with images, graphics, videos, animation into Microsoft Publisher.

The material of hydrocarbon compounds and their derivatives and their use in the food processing process that has been prepared in accordance with the lesson plan (RPP) is combined with pictures, videos, animations that are in accordance with the subject matter and practice question sheets (evaluation). The purpose of this procedure is to produce an e-module that matches the study plan. The e-module that was developed by researchers was made using the Microsoft Pulisher application. Microsoft Publisher is a Microsoft Office application program that is used for desktop publishing. Results from desktop publishing include newspapers, catalogs, brochures, magazines, books, modules, greeting cards, posters, wall magazine, calendars and others. In the Microsoft publisher application, various templates are available. So that if we want to make a work, we only need to choose a template that has been provided, then edit it according to our needs (Fahri., 2020). As the name implies, Microsoft publisher, taken from the word publish, which means publishing its main function as one of the Ms Office software used for desktop publishing. Desktop publishing is an activity of making documents that will later be published into products (Fahri., 2020). The images, structures, text and videos that the researchers combined into Microsoft Pulisher can be seen in table 6 below:

Table 6. Steps to integrate content into Ms. Publisher

No.	Blended content	Steps	Example page
1.	Text	• Open Publisher. • If you're already in Publisher, choose File> New. • Click Draw text box • Fill with the desired text	
2.	Picture	• On the publisher page, click the insert menu. • Select pictures / online pictures • Select the required image • Click insert	

3.	Video	• On the publisher page, click the insert menu. • Click the object • Select videos for windows • Select the required video (video must be in AVI format) • Save documents	

b) Expert validation

The e-module product that has been made will then be validated by material experts and media experts. The instrument used was a validation sheet for material experts which consisted of 3 aspects of assessment, namely the content aspect, the presentation aspect and the language aspect, while the validation sheet instrument for media experts consisted of 2 aspects of assessment, namely the graphic aspect and the language aspect. Validation is done repeatedly until the e-module is declared valid by the validator. Suggestions and input as well as the follow-up that have been done are presented in Table 7 and Table 8.

Table 7. Suggestions and Improvements from Material Experts

Validator	Feedback and Suggestions	Follow-up / Improvement
Validator I	• There is still a written incorrect compound nomenclature • There are still some examples of inaccurate questions. • There are exercises that do not match the indicators	• Correction was made to the wrong compound nomenclature • Correction of wrong example questions • Repair by changing the questions according to the indicator
Validator II	• The writing of the structure of hydrocarbons is still a lot wrong • It is better if the structure is made with the application not by copying the image • Glossary is still incomplete • The link between the material and the real world situation has not been seen	• Improvements to the wrong structure of hydrocarbons • Improvements by creating structures using the chemsketch application • Improvements by adding a glossary • Adding context to the material that is linked in everyday life
Validator III	• There are many pictures that are not annotated • The material presented does not encourage readers' curiosity • Add sources of university books to the bibliography • There are several sentences that are not standardized	• Improvements by adding sources from the image • Improvements by adding links to encourage curiosity • Improvements by adding sources from the Fessenden book • Improved standardization of terms

Table 8. Advice and Improvements from Media Experts

Validator	Feedback and Suggestions	Follow-up / improvement
Validator I	• The font size on the cover page is not proportional • Inconsistent placement of layout elements	• Improved e-module title font size which is more proportional to the e-module size • Improved consistent placement of layout elements based on patterns
Validator II	• The color of the subtitles is less clear and disturbs vision • Background used is distracting text	• Corrected the color of the subtitles so they don't contrast with the background color • Repair by changing the background
Validator III	• Inconsistent spacing between texts and sentences	• Improved spacing between text and between sentences that are not appropriate

The results of e-module validation on hydrocarbon material by material experts and media experts can be seen in Figure 5 and Figure 6.

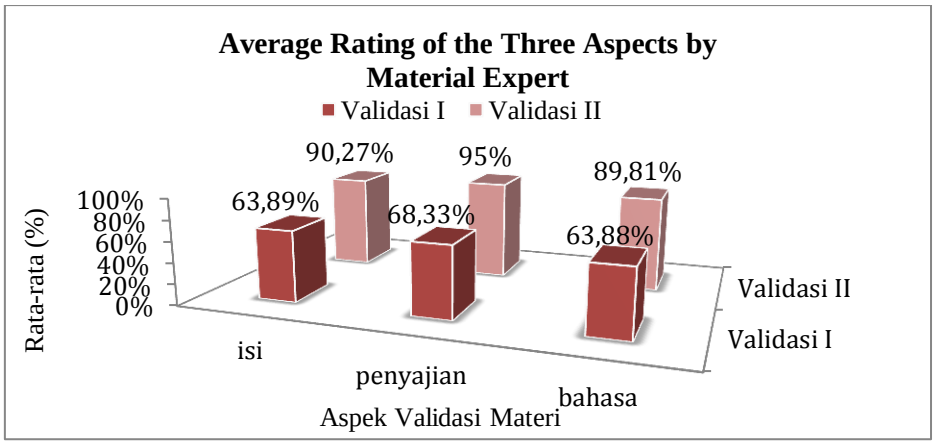


Figure 5. Material Expert Validation Results

Based on the graph in Figure 5, the e-module assessment by the validator consists of three aspects of assessment, namely the content aspect, the presentation aspect and the language aspect. The results of the e-module validation by material experts showed that there was an increase in the percentage of the second validation for each aspect of the assessment. In the content aspect, the percentage increased from 63.89% to 90.27%, the presentation aspect increased from 68.33% to 95%, the language aspect increased from 63.88% to 89.81%. The increase in the results of the second validation was due to the revision of the e-module based on suggestions and input from the validator, where in the content aspect, improvements were made to the indicators of material suitability with basic competencies, material accuracy, material finesse and encouraging curiosity. Revisions made to the presentation aspect consist of indicators of presentation techniques, presentation support, presentation of learning and coherence and

sequence of thought lines. In the language aspect, the revised indicators are straightforward, communicative, dialogical and interactive, conformity to the development of students, and conformity to language rules.

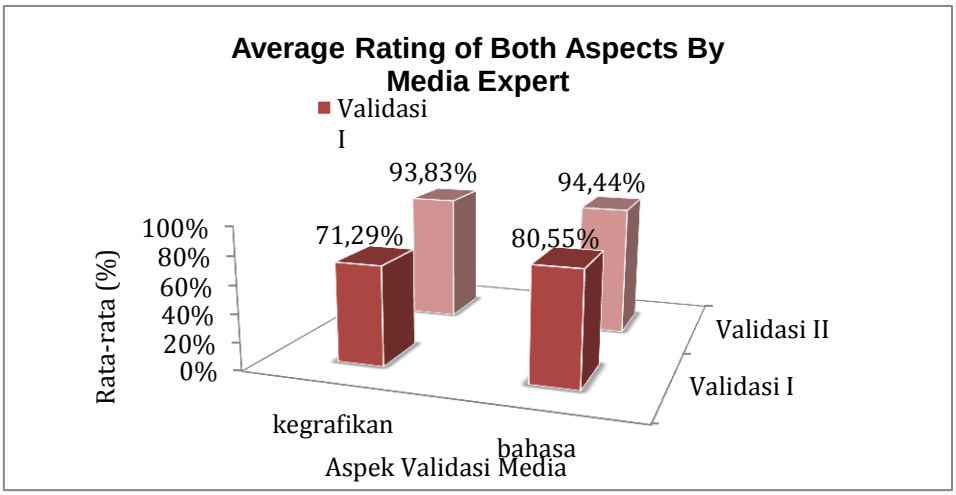


Figure 6. Validation Results of Media Experts

The results of the e-module validation by media experts in Figure 6 consist of 2 aspects of assessment, namely the graphic aspect and the language aspect. Validation was carried out in two assessments, where the validation results showed that there was an increase in the percentage of the second validation for both aspects. In the graphic aspect there was an increase in the percentage from 71.29% to 93.83%, while in the language aspect there was an increase in the percentage from 80.55% to 94.44%. The increase in the percentage of the results of the second validation was due to the fact that the e-module was revised according to suggestions and input from the validator. Improvements have been made to the graphic aspect, namely the cover design indicators and the e-module content design. While the improvements made in the language aspect are on the indicators of being straightforward, communicative, dialogical and interactive, conformity to the development of students, conformity to language rules and the use of terms, symbols and icons.

c) Formative Revision

Formative Revision aims to revise e-modules and processes that have been implemented prior to implementation. The procedures carried out at the formative revision stage consist of:

a. One-on-one trial

The purpose of conducting a one-on-one trial is to improve the procedure for using e-modules, identify and eliminate errors when using e-modules. Participants involved in the one-on-one trial were 3 students (high, medium and low categories) from SMKN 1 Seberida who had studied hydrocarbon compound

material. The suggestions and comments obtained based on user responses can be seen in Table 9.

Table 9. User Suggestions and Comments

Learners	Comments and Suggestions
AB	**Comments:** The appearance of this hydrocarbon compound e-module is quite attractive and easy to use. **Suggestion :** This hydrocarbon compound e-module only needs to improve the arrangement of words and sentences so that they are easily understood by readers
AC	**Comment:** The e-modul of hydrocarbon compounds is very good and it looks attractive because the e-modul has an attractive color. **Suggestion:** Be more careful in writing because there are extra or less letters in a word.
AD	**Comment:** This e-module is quite interesting and good. The material in the e-module is easy to learn and the material is complete. **Suggestion:** Pay attention to the writing of evaluation questions, there are some things that are not neat.

b. Small group trials

After the e-module goes through the revision stage based on participant responses in one-on-one trials, then a small group trial is carried out with the aim of assessing whether or not the e-module is good or the e-module's attractiveness is developed, where participants are involved in small group trials are 3 vocational chemistry teachers from 3 schools and 20 students from SMKN 1 Seberida and SMKN 1 Batang Gansal, who have studied the material of hydrocarbon compounds. The test results whether or not the e-module is good or not based on the response of the teacher and the e-module attractiveness test based on the responses of students can be seen in Table 10 below:

Table 10. Results of Educator and Student Response Test

Respondents	Percentage	Category
Educator	85,18%	Very good
Learners	72,72%	Interesting

Based on the results of the analysis of respondent data on the use of e-modules, an average score of 85.18% was categorized as very good, this shows that the e-module developed is very easy to operate, the presentation of material is continuous and systematic and the presentation of material material in accordance with the indicators and learning objectives to be achieved in accordance with the 2013 revised 2017 curriculum for the SMK Agriculture unit level. The results of the student response questionnaire data analysis obtained an average score of 72.72% with an interesting category, so it can be concluded that e-module is suitable for use in the learning process because based on the results of the analysis of the response questionnaire students agree with the use of e-module. in the

classroom. In addition, from the comments of students stating that e-modules are interesting to use, the existence of learning videos makes students more active and interested in digging deeper information about hydrocarbon compound material. Research on the effectiveness of using e-modules in the learning process has been carried out by Bella et al (2020), which states that the use of e-modules can improve students' critical thinking skills because e-modules make learning more fun with animated videos, pictures, text , and audio so that students are more active in asking questions and enthusiastic in learning the material. The results of research by Sri et al (2017) found that the use of learning media that is integrated with text, images, animation, audio and video effectively increases motivation, making it easier for students to understand the concept of the material. This is also in accordance with the statements of Hayati (2020) and Tuyuzsuz (2010) which explain that the learning process using media such as attractive video animations will make it easier for students in the learning process. The same statement was also explained by Muhammad (2018), Miftahul et al (2018) and Lilis et al (2020) who found that ICT-based media was effective and worthy of use in the learning process. In addition, research by Maria et al (2019) also found that teachers succeeded in improving students' critical thinking skills by using e-modules.

4. Conclusion

Based on the results of research and discussion, the following conclusions can be obtained: (1) With the successful development of e-module hydrocarbon compounds for students of SMK Agriculture, it will increase the types of chemical teaching materials that can be used by educators and students in the learning process, (2) the results validation of e-module hydrocarbon compounds by material experts with an average percentage result of 91.69% with a very valid category and by media experts with an average percentage of 94.13% with a very valid category and (3) Educator and student responses The e-module developed on hydrocarbon compound material received an assessment of the response of educators with an average of 85.18% with very good criteria and student responses with an average of 72.72% with attractive criteria.

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