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Tulungagung Batik Ethnoscience-Oriented E-Module Design On Chemical Bonding Materials

Desi Dwi Anissa[1*], Ifah Silfianah[2]

[1,2]Universitas Islam Negeri Sayyid Ali Rahmatullah Tulungagung
Program Studi Tadris Kimia Fakultas Tarbiyah dan Ilmu Keguruan UIN Sayyid Ali Rahmatullah Tulungagung. Jl. Mayor Sujadi Timur No. 46 Tulungagung. Kab. Tulungagung. Kode Pos, 66221
.
*Correspondinge-mail: desidwianissa1712@gmail.com

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Abstract: Tulungagung Batik Ethnoscience-Oriented E-Module Design On Chemical Bonding Materials. As time goes by, the field of education requires innovation in learning, especially in chemistry subjects, which does not diminish the culture inherent in Indonesia. Therefore, innovation is needed in the form of an ethnoscience-oriented e-module with the theme of Tulungagung batik culture on chemical bonding. The aim of this research is to create a product that adapts to the times but does not fade the culture, to find out the feasibility of this e-module product and to find out the level of student response to this e-module. This research uses the RnD (Research and Development) research method or research and development with a development model, namely 4D which was modified into 3D by Thiagarajan. The instrument used was a student response questionnaire. The results of this research on the feasibility aspect of the material got a percentage of 90% and on the aspect of media feasibility got a percentage of 94% with very feasible criteria, while the student responses showed a percentage of 86%. Therefore, this e-module product is very suitable for use.

Keywords: E-Module, Tulungagung, Batik, Ethnoscience, Chemical Bonding

Abstrak* : *Desain E-Modul Batik Tulungagung Berorientasi Etnosains Pada Bahan Ikatan Kimia *Seiring berkembangnya zaman pada bidang pendidikan membutuhkan inovasi dalam pembelajaran khususnya pada mata pelajaran kimia yang tidak melunturkan budaya yang melekat di Indonesia. Oleh karena itu, dibutuhkan inovasi berupa e-modul yang berorientasi etnosains dengan tema budaya batik Tulungagung pada materi ikatan kimia. Tujuan dari penelitian ini yaitu menciptakan produk yang menyesuaikan zaman namun tidak melunturkan budaya, mengetahui kelayakan dari produk e-modul ini dan mengetahui tingkat respon siswa terhadap e-modul ini. Pada penelitian ini menggunakan metode penelitian RnD (Research and Development) atau penelitian dan pengembangan dengan model pengembangan yaitu 4D yang dimodifikasi menjadi 3D oleh Thiagarajan. Instrumen yang digunakan yaitu angket respon siswa. Hasil dari penelitian ini pada aspek kelayakan materi mendapatkan persentase sebesar 90% dan pada aspek kelayakan media mendapatkan persentase 94% dengan kriteria sangat layak, sedangkan pada respon siswa menunjukan persentase sebesar 86%. Oleh karena itu, produk e-modul ini sangat layak digunakan.*

Kata kunci: *E-Modul, Tulungagung, Batik, Etnosains, Ikatan Kimia*

▪ INTRODUCTION

The rapid development of the times there are many problems that occur. There are challenges that demand creativity, innovation and work development, especially in the field of education. The educational revolution in Indonesia has launched various strategies for better expectations, so that the parties concerned create or design a brilliant education(Masjid & Yogyakarta, n.d.; Maytrea & Namirah, 2020; Naila et al., 2022; Safi'i, 2018; Setyaningsih, 2022) Education is an important and strategic component of life in determining the future of the nation(Fajar et al., 2021; Simanjuntak et al., 2019). Therefore, in education innovation and development are needed in learning.

This is in accordance with what was proclaimed by Mr. Nadiem Makarim as the Minister of Education, Culture, Research and Technology of the Republic of Indonesia stating that the applicable curriculum is rooted in the Indonesian nation and the culture inherent in it. This statement comes from the philosophical foundation of the independent curriculum, so that the curriculum opens opportunities for students to learn local to national culture so they can learn to develop and implement the values contained in that culture(Bungawati, 2022; Nugraheni Erryka Putri, 2019; Simanjuntak et al., 2019). One of the efforts to create culture in the future is to increase understanding of the surrounding environment, especially understanding of culture which is a national heritage that requires preservation(Rahmi et al., 2021; Setyaningsih, 2022). However, this is not in line with the application in the world of education which places less emphasis on local cultural science.

We all know that Indonesia has the motto Bhineka Tunggal Ika which has different meanings but is still one(Azima et al., 2021; Rahmi et al., 2021). Indonesia has a high level of diversity ranging from religion, ethnicity, language, race, culture and so on. Indonesia's heterogeneous geography and socio-cultural conditions are strong reasons for collaborating between science and culture. Based on this multicultural perspective, learning can be seen from the cultural side (Azima et al., 2021; Irmania et al., 2021). The education system that applies adopts from countries in America and Europe, while the education system that applies in Indonesia follows the western education system which is relatively modern and does not relate to the local culture that surrounds it(Anggriani & Mangkurat, n.d.; Apriani, 2022; Darman, 2017; Safi'i, 2018). Therefore, learning that is linked between culture and science is needed.

Learning by associating local culture with *indigenous knowledge* and scientific knowledge is called ethnoscience learning(Fiteriani et al., 2021; Nazifah, 2022; Widyaningrum et al., 2021) One of the cultures related to ethnoscience is batik. Batik is in the form of cloth made with scratches with wax using a tool in the form of a canting and one of the local wisdoms or indigenous culture in Indonesia which holds a lot of high artistic value(Art et al., 2019; Pendidikan et al., n.d.; Pitri, 2022). We need to know that batik was *de jure* recognized by UNESCO on October 2, 2009, so that it was designated as National Batik Day. Each region has its own uniqueness, there is one area that has distinctive batik, namely Tulungagung, which has penetrated the international scene (Muna Lia et al., 2016; Regina & Wijayaningputri, 2022; Tresnawati, 2018; Triwulandari, 2021)

Batik is an example of this type of ethnoscience. This potential can be combined with the learning process because it has ethnochemical value (Bantul, 2021; Nazifah, 2022; Nurhayati et al., 2021). The aim is to understand, study and develop local culture which can become a new source of learning for students and students to love local culture

(Asih & Mursiti, 2018; Fiteriani et al., 2021; Naila et al., 2022; Nazifah, 2022) . However, there are problems in educational institutions, especially Tulungagung, which are lacking in elevating local culture into the learning process(Afifah et al., 2020)

If we examine more deeply the relationship between culture and the learning process, one of the materials that is closely related is chemical bonding. The dyes used are polar and nonpolar covalent applications (Ragam et al., 2021; Uniba, n.d.). The dyes used in the process of making batik are napthol, indigosol, and remazol. Naphthol dyes are a mixture of naphol (1-naphtol / $C_{10}H_7OH$), and TRO (*Turqies Red Oil*), which is dissolved in warm water. Napthol is insoluble in water, so it needs a caustic and dispersed with TRO (protective colloid) to dissolve it. Diaxo salt napthol dye dissolved in water as a color lock or generator. Indigosol dye is a mixed batik dye between indigo and sodium nitrite ($NaNO_2$) which uses HCl as a lock. Remazol dyes are dyes whose application process uses a dab technique (such as painting, using a brush) with a color lock in the form of *waterglass* ($Na_2(SiO_2)$/sodium silicate(Arifah et al., 2022; Muna Lia et al., 2016; Syafei, 2016)

The dyes in batik are closely related to chemical bonding material, but the mastery of the concept of the material is still relatively low, and the learning media is not yet supportive, so students find it difficult to understand(Art et al., 2019; Fiteriani et al., 2021; Khairunnisa et al., 2022; Klasik et al., n.d.; Shanti, 2016; Triwidyati & Hadiyati, 2020). Students cannot distinguish between covalent bonds and ionic bonds. Students do not understand the concept of metallic bonds, so they cannot explain how metallic bonds are formed (Fahrozy et al., 2022)

Chemical bonds are one of the abstract chemical materials. Abstract What is meant by chemical bonds is that there are chemical bond phenomena that cannot be imagined only by looking at them macroscopically, besides that most of them contain concepts and there are many terms for each reaction that occurs (Widyaningrum et al., 2021). In general, students will find it easier to understand chemical bond material provided in audio-visual form so that it can help visualize explanations of the concepts contained in chemical bond material (Studi et al., 2018; Tresnawati, 2018).

Every chemistry lesson, especially chemical bonding material, requires media and teaching materials that can contain material visualization in order to make it easier for students to understand the material presented (Arifah et al., 2022; Fiteriani et al., 2021). Teaching materials can be used as an external factor that is used to increase student learning efficiency. Teaching materials are the most important part of the learning process. One example of the majority of teaching materials used in chemistry learning is in the form of modules (Fatmawati & Andromeda, 2021; Lia, 2016; Nurhayati et al., 2021).

Learning media are necessary for all learning processes, including Chemistry Learning Strategies. Electronic learning materials that run on computers or Android devices are one type of learning resource(Herman & Herman, n.d.). One way to make modules more attractive is to create e-modules that contain visualizations in the form of pictures, animations and videos that are arranged in an attractive way (Fatmawati & Andromeda, 2021; Lia, 2016; Maytrea & Namirah, 2020; Muna Lia et al., 2016). One form of module that can contain several kinds of visualization in electronic form is called an e-module. Electronic modules (e-modules) can be used as interesting, interactive and varied teaching materials because they can contain several other animated media such as two-dimensional images, audio, video in them (Maytrea & Namirah, 2020; Nurhayati et al., 2021).

Based on the description above, the location of novelty or novelty, namely in the material contained in Tulungagung batik, requires innovation in the form of ethnoscience-oriented e-modules with the cultural theme of Tulungagung batik. However, previous studies have not found research on e-modules that are oriented towards the ethnoscience of Tulungagung batik on chemical bonding materials. The purpose of this development is to develop an e-module that can visualize abstract chemical bonding material, determine the feasibility level of the e-module, and students' responses to the product.

▪ METHOD

This research is product-oriented development research in the field of education, including in the type of research and development or *Research and Development* (RnD) (Lia, 2016; Modul et al., 2016; Muna Lia et al., 2016; Nurhayati et al., 2021). *Research and Development* (RnD) is a strategy or research method that produces products and tests the effectiveness of the products that have been produced in improving educational practice . This study used the research method from Thiagarajan, namely 4D which was modified to 3D, namely *development* (development) can be seen in the picture below:

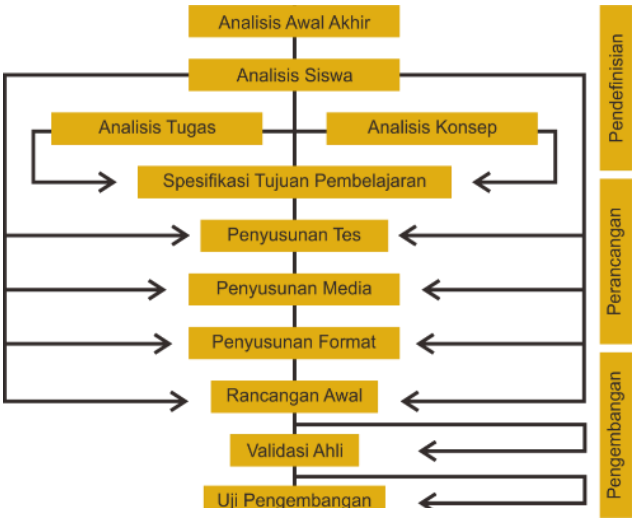


Figure 1. The Flow of a 4-D Research and Development Model

The research instrument used in this study was an interview sheet containing questions posed to the chemistry teacher at school as initial data prior to the development of the chemistry learning module. The validation sheet was used to determine the validity of the ethnoscience-based e-module on the chemical bond material being developed and to obtain information about the quality of the ethnoscience-based module based on the assessment of two expert validators (chemistry lecturers) and one chemistry teacher. The validation sheet is given using a *Likert scale* , as well as a student response questionnaire to assess the e-module.

The instruments (validation and response) in this study used a Likert scale with the following conditions:

Table 1. Likert Scale Criteria

Score	Criteria
5	Very good
4	Good
3	Good enough
2	Not so good
1	Not good

Calculating the percentage of feasibility

$$P=\frac{\Sigma x}{\Sigma xi}$$

Description:

P : Percentage of eligibility

$\sum$ x : Number of validator answer values in one item

$\sum$ xi : Number of ideal values in the item

Criteria for determining validation

Table 2. Likert Scale Interpretation (Expert Validation)(Nurhayati et al., 2021)

Value	**Criteria**
0% - 20%	Invalid
21% - 40%	Less Valid
41% - 60%	Fairly Valid
61% - 80%	Valid
81% - 100%	Very Valid

Table 3. Criteria for determining student response(Alvyonita, 2012)

Interval	**Criteria**
81%≤P≤100%	Very good
61%≤P≤80%	Good
41%≤P≤60%	Simply
21%≤P≤40%	Less Good
P≤20%	Very Poor

The subjects in this study were two chemistry lecturers and one chemistry teacher who acted as module feasibility test validators before being tested in the field.

Meanwhile, in the module trial to find out student responses involved students of class XI IPA 5 at MAN 2 Tulungagung.

In research and development or RnD, two types of data are collected, namely qualitative data in the form of narrative or descriptive input from the validator. Qualitative descriptive analysis was divided into two, namely the results of interviews and suggestions from the validator. This analysis concerns the results of interviews, namely by describing and drawing conclusions based on data from the results of structured interviews with teachers and students in madrasas. There are suggestions and comments from the validator on the interview instrument. While quantitative data obtained in the form of data processing using the formulation of numbers. The score of the validator's assessment questionnaire and the assessment of student responses.

▪ RESULT AND DISCUSSION

Define Stage

In the *define* or defining stage, it begins with several main activities, namely end-beginning analysis, student analysis, curriculum analysis, analysis of learning objectives, analysis of multiple representations and analysis of character values.

Initial Final Analysis

This preliminary analysis aims to identify basic problems that focus on learning chemistry and knowing the process of making batik at UD Satrio Manah Tulungagung. The existence of this final initial analysis will obtain facts, solving problems related to the development of learning media.

Student Analysis

This student analysis was carried out with the aim of knowing the problems that occur in students and the characteristics in the learning process. Based on the results of interviews at MAN 2 Tulungagung class XI MIA 5, the majority stated that chemistry is an abstract material because there are no illustrations or pictures and there is no practice so it is difficult to understand. Based on the results of the analysis of the characteristics of the majority of students do not like learning chemistry because it is included in one of the subjects that are difficult to understand.

Curriculum Analysis

The purpose of the analysis was carried out to determine the content in learning. This analysis includes an analysis of the content, procedures, and learning objectives of the chemical bonding material that refers to the syllabus.

Concept Analysis

The purpose of the concept analysis is to find out the suitability between the material and the syllabus. In determining the presentation of the concept in the material including the concepts, facts, procedures and principles.

Analysis of Learning Objectives

Analysis of learning objectives can be carried out after the concept analysis is carried out based on learning indicators.

Multiple Representation Analysis

This analysis is needed in integrating multiple representations of chemical bonding material into e-modules.

Character Value Analysis

The purpose of character value analysis is to find out the character values applied in e-modules (electronic modules). This value refers to the value contained in the Core Competency (IC).

Design

At the design stage there are four stages that must be carried out, namely:

Preparation of Criteria Tests

In this study, in the stage of preparing the criteria test, it was carried out by compiling instruments that referred to the 2014 BNSP and student responses were used to assess the feasibility of the product.

Media Selection

In the development process, the media used are *Microsoft Word*, *Corel Draw*, *ChemBioDraw*, *Wondershare Filmora9*, and *Fliphtml5.com applications.* This is used because there is a connection, namely the final product is an e-module product.

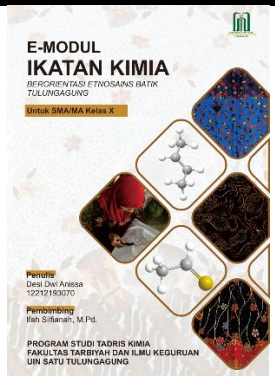
Format Selection

This format selection is used to set the layout and appearance of the contents of the e-module. At this stage the choice of format determines the attractiveness of the e-module design being developed. The choice of format, margins, space, shape and size of the text determines and considers the quality of the resulting product in the form of an e-module.

Making an Initial Design

Making ethnoscience-oriented e-module products on chemical bonding material, namely the cover layout, learning objectives and content adapted to the characteristics of the module.

Table 2. Story Board E-Module

No.	Image	Explanation
1		The cover is designed to combine culture and chemical bonding.

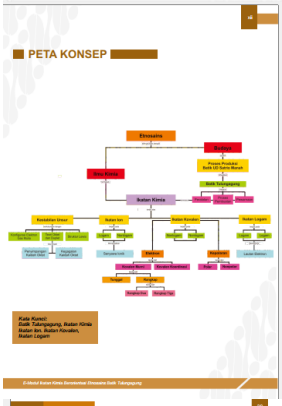
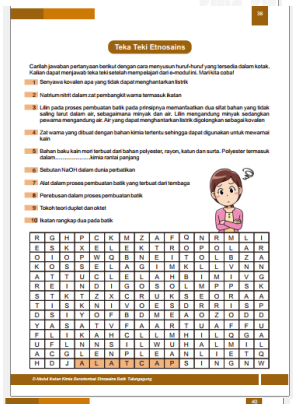
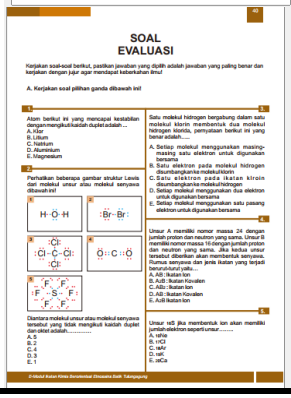
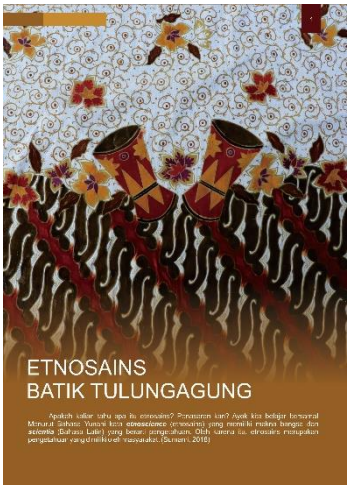
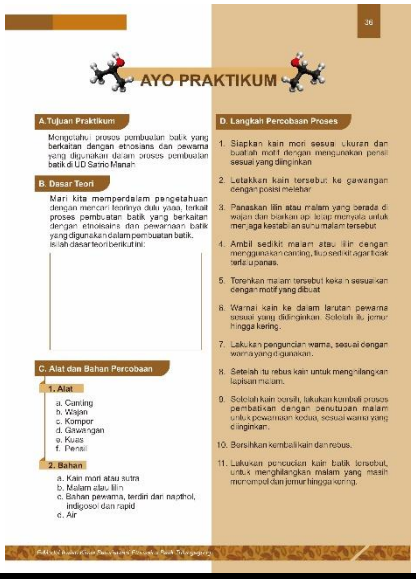
2		These instructions for use are used to make it easier for students to understand how the stages are in the e-module.
3		Concept maps are used to make it easier for students to understand the sequence of topics discussed.
4		This ethnoscience puzzle was made to attract students' interest and critical thinking about the relationship between batik culture and chemical bonds.
5		Evaluation questions are made to measure the level of student understanding after using this e-module.

Table 3. Ethnoscience Studies

Contents	Ethnoscience	Description
Local culture	Tulungagung Batik	Instructions for using the e-book, ethnoscience studies, concept maps and evaluation questions.
		
Local Culture	Batik Tulungagung in relation to chemistry	An early introduction to ethnoscience
		
	In the process of making batik, soap is needed to clean the wax that is still attached.	The use of soap in the batik washing process that has gone through the pelorodan stage to remove traces of wax/night that are still attached.
		

In batik coloring there are double bonds that can emit color	In this batik coloring process, NaOH is used to lock in the color.
	
Metal bonds	Metal bonds in the tools of the hand-written batik making process, such as stamp stamps, canting, pans, stoves and so on.
	

The e-module contains a practicum, where the activity is to attract students to recognize the process of making batik and can relate it to chemical material, especially chemical bonds.



Development Stage (*Development*)

There is a validation stage carried out by expert validators with various aspects to be assessed and limited trials. The goal at this development stage is to find out the suggestions and input given by the validator to e-module products before being tested on a limited scale on students. The following are the results of the limited trial:

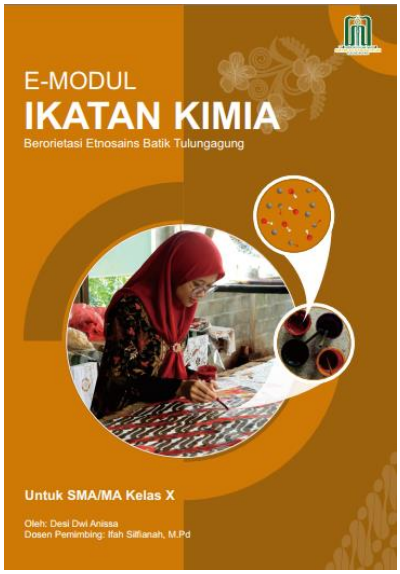
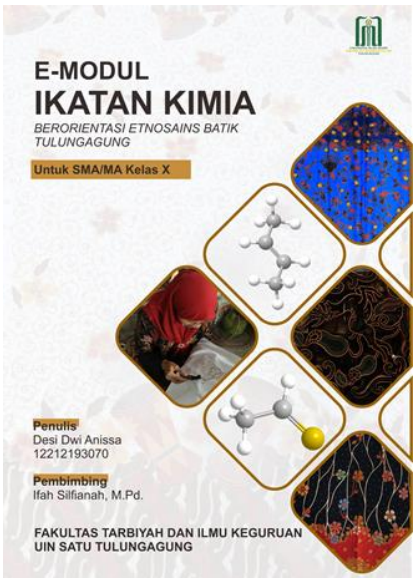
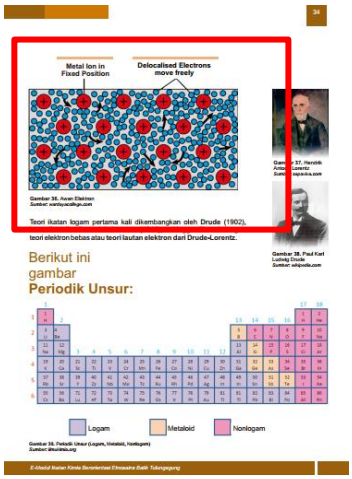
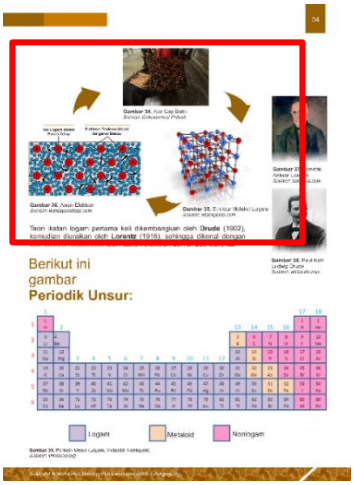
E-Module Product Validation

E-module products developed to be suitable for use by students are validated. This validation test was carried out by expert validators consisting of a lecturer in the Chemistry Tadris Study Program at UIN Sayyid Ali Rahmatullah Tulungagung namely Mr. Ivan Ashif Ardana, M.Pd as validator I and one chemistry teacher at MAN 2 Tulungagung namely Mrs. II. The following is the result of the validation and revision carried out by the researcher before being disseminated to students as follows:

Changing the cover page with the title page because the title page contains aspects of ethnoscience and chemical bonding material. Swapping the cover page with the title page because the title page already contains aspects of ethnoscience and chemical bonding material.

Table 5. Product Revision Results

Display Before Revision	Display After Revision

Less representative of the ethnoscience of chemical bonding material related to batik	Has been representative of chemical bonding and batik materials so that it is more relevant
	
Added copper metal images related to ethnoscience to the metal bonds to make them more suitable.	Copper metals related to ethnoscience have been added.
	

Limited Trial

After the ethnoscience-oriented e-module product was validated and revised, it was then tested on a limited scale, namely at MAN 2 Tulungagung class XI MIA 5 with a total of 36 students. This limited trial used student response questionnaires as quantitative data through scoring.

E-Module Product Feasibility Test Results

The next stage after the e-module is developed is the feasibility test or validation stage of the learning media. Validation was carried out by 2 expert validators. At this validation stage, the media feasibility instrument is used which contains predetermined criteria. The test results can be seen in the following **figure 2:**

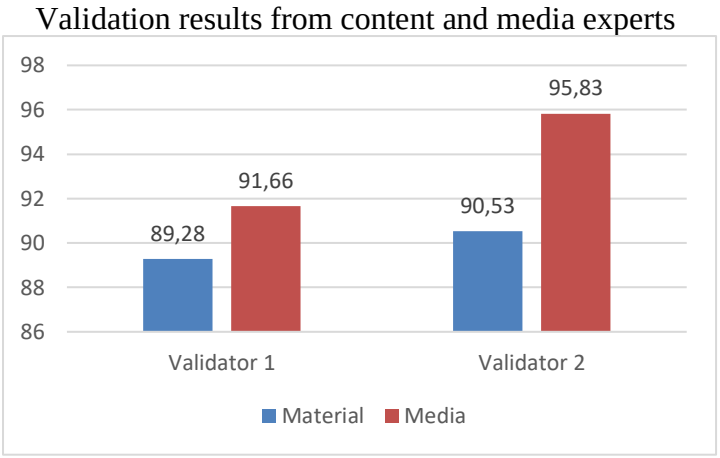


Figure 2. Instrument Validation Results

According to the validator, the presentation of concepts in this e-module can be said to be very good, because it is presented from global to the point. In addition, the e-module also presents comprehension test exercises in each sub-chapter of material discussion, ethnoscience review and evaluation questions located at the end of the material in this e-module. The purpose of this question exercise is to determine the level of student understanding and invite students to think critically. Apart from the validation results, researchers have also received input as a reference for improving this e-module product. The input starts from the front cover, title cover, material content and overall this product. Suggestions from validators on this e-module add and replace with appropriate and related to the discussion of ethnoscience.

From the layout of the e-module with the e-module design between the front and back covers are mutually sustainable, but there are suggestions from the validator, namely adding the study program, faculty and university of the researcher and exchanging the front cover with the title cover because this title cover covers the content of chemical bonding material associated with Tulungagung batik ethnoscience. In addition, the media validation assessment received an average percentage of high can be seen from the design and content of the material that is more interactive and closely related to the culture of the community(Aza Nuralita, 2020)

In the ethnoscience-oriented e-module, Tulungagung batik is presented with social and spiritual attitudes related to chemistry. This is in line with previous research which states that an invitation to be grateful becomes a person of gratitude for life(Science, n.d.).

This e-module has included the completeness of the contents of the e-module which consists of introduction, content and closing so as to get a percentage result of 100% with very valid criteria because it is appropriate. According to research from Nurhayati et al which states that the completeness of the contents of the module is an important point to determine the quality of the e-module product.(Nurhayati et al., 2021)

Response Results

After the product feasibility test is carried out, the next step is a limited scale trial to produce a response. The average student response results get a percentage of 86% with predetermined aspects.

After testing the feasibility of the product, the next step is a limited scale trial to generate responses. The average student response results get a percentage of 86% with predetermined aspects.

The results of the students' responses to the interactive e-module

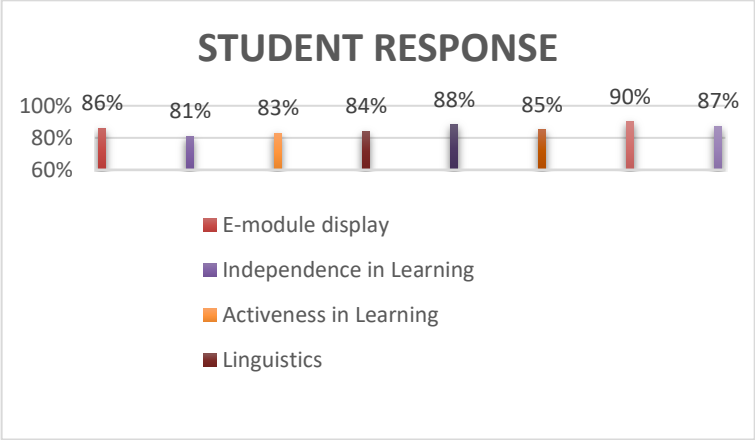


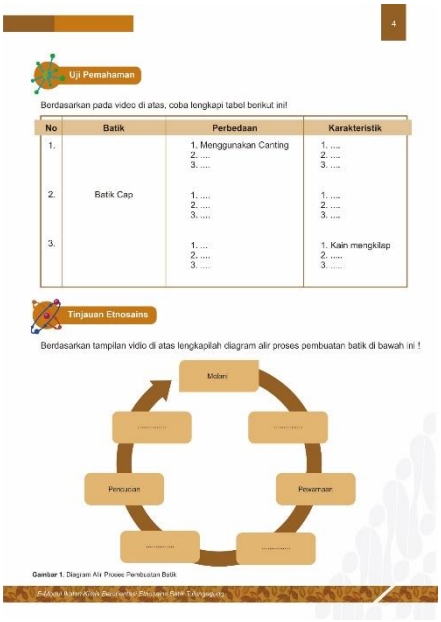
Figure 3. Students Response

The e-module display shows that students agree with the e-module display that there are images and video links that can be heard clearly. This is in accordance with previous research which states that a good e-module can display images, video links and text that can be accessed easily.(Nazifah, 2022; Nurhayati et al., 2021; Zakiyah & Sudarmin, 2022).

Students can easily understand the ethnoscience of Tulungagung batik, can know the relationship between chemical bonds and the ethnoscience of Tulungagung batik and students give an agreeing response to knowing the characteristics of the batik making process with the concept of chemical bonds. This is supported by previous research which states that indeed the process of making batik has to do with polarity, double bonds and metal bonds.(Astarina et al., 2019).

Table 6. Content E-module

No	Picture	Explanation
1		This e-module product contains character values that are applied and related to chemical bonding materials
2		This e-module product highlights the ethnoscience of Tulungagung batik.

3		This e-module product is made to show learning independence because students are able to observe and work on comprehension test questions with the video link provided

▪ CONCLUSION

Based on the results of research, development and discussion, the following conclusions can be drawn:

Based on the results of the research, the development of a product in the form of an ethnoscience-oriented e-module with the theme of Tulungagung batik culture on chemical bonding material. This e-module product is presented with images, audio and video to support students' understanding of the surrounding culture, especially Tulungagung batik. This product can be accessed by various electronic devices connected to the internet network. This e-module is also equipped with audio, images and videos to support student understanding, this product can be accessed by links from various electronic devices connected to the internet network and equipped with an understanding test at the end of each sub-chapter and evaluation questions at the end of the e-module. This module consists of 25 multiple choice questions, 5 essay questions, 10 matchmaking and self-reflection. This e-module was developed using the 4D method which was modified to 3D by Thiagarajan due to time and cost constraints. Based on the validation results obtained the feasibility level of ethnoscience-oriented e-module products with the theme of Tulungagung batik culture on chemical bonding material obtaining very valid criteria. average percentage of 94%. Based on the results of the response test conducted in class XI MIPA 5 MAN 2 Tulugagung, a percentage of 86% was in the very good category. The research is important because it links between culture, namely Tulungagung batik and science. Therefore, it can be concluded that ethnoscience-oriented e-module products with the theme of Tulungagung batik culture are very suitable to be used, developed and can be disseminated for chemical teaching materials.

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