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Development of Colloid System Electronic Module Based On Problem Solving Integrated Ethnochemistry for High School Students

Alvin Nur Zahro*, Woro Sumarni, Cepi Kurniawan

Master of Chemistry Education, Postgraduate, Semarang State University, Indonesia
*Corresponding Author: alvinzahro12@students.unnes.ac.id

Abstrak. The colloid system is one of the chemical materials that contains many concepts and is related to everyday life, so that students still find it difficult to understand. The aim of this research is to evolve a module electronic based on problem solving integrated ethnochemistry on colloid system. The exploration method applied is Research and Development (R & D) with a 4D research design modified into 3D (define, design, and develop). Data was collected using interview techniques, expert validation, user response questionnaires, and implementation observation sheets. The results of the feasibility assessment by the expert validator were 86.73% with a very feasible category. The results of the readability, practicality, and student answers to the e-module each attained a score of 87.9%; 91.3%; and 86.9% in the veritably practicable category. The results of the learning implementation test using the e-module obtained a score of 96.4% in the very well implemented category. The conclusion of this exploration is that the expansion of an e-module based on problem solving integrated ethnochemistry is very feasible to use and gets a positive response by users to the e-module that has been evolved.

Keywords: Electronic module, colloid system, problem solving, ethnochemistry

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INTRODUCTION

Learning chemistry is still difficult for students. This may be because chemistry covers very broad and abstract material. Besides, chemistry according (Middlecamp & Kean, 1985) chemistry includes a very broad material consisting of facts, concepts, rules, laws, principles, theories and problems. From the scope of chemistry material, most of it consists of abstract concepts.

One of the chemical materials that contains many concepts and is related to everyday life is colloidal system material (Akbar *et al*., 2015). The application of the properties of colloidal systems are widely encountered in various fields, both in the agricultural and medical industries. Therefore, colloidal system material becomes very important to be studied and understood, not just memorized. In fact, students are only required by the teacher to simply memorize without requiring students to understand the material in depth. Learning by rote or theoretical makes students less understand what they are learning (meaning). This is due to the lack of learning experiences that stimulate their curiosity and motivation to learn. This learning obstacle also occurs in several schools, one of which is MA Riyadhotul Thalabah Sedan

The results of observations and debriefings with chemistry educators at MA Riyadhotul Thalabah Sedan stated that in learning colloid systems some students didn't understand the concept, this can be seen from the learning results of some students who are still below the KKM. According to the chemistry teacher on colloidal system material, students consider the material to be abstract and in understanding it needs to be linked to real examples. The results of the dissection of handbooks operated in varied academies such as MAN 2 Rembang, SMA N 1 Pamotan and MA Riyadhotul Thalabah Sedan still use printed textbooks, there is no development of online-based textbooks such as e-modules. The teaching materials used aren't all problem solving based. Abstract chemistry material so that it is delicate for learners to reason the subtance, one strategy to overcome abstract chemistry problems by using easy teaching materials and appropriate learning models.

The existence of obstacles in the education proceeding can be minimized by the existence of learning media that can present applicable material. Learning media can provide knowledge about colloid systems and be developed by

applying problem solving elements based on local culture. The learning media is expected to generate interest and invite students to actively build their knowledge so that learning objectives are achieved.

Learning media can prevent the saturation of the learning process of students. One of the education media that can be evolved is electronic tutoring accountrements similar e-modules. Module electronic is a tutoring accountrements that's relatively suitable for the prevalent scene because it can be accessed anytime and anywhere through computers, tablets, androids, and others. Module electronic permit learners to be suitable to get singly and laboriously. E-modules don't just contain subtance or textual definitions, but audio, moving pictures, or videos can be fitted that brace mastership of concepts and are suitable for use (Herawati & Muhtadi, 2018).

One of the appropriate learning models is by using a problem solving learning model. Problem solving is one of the innovative learning models that can provide more active learning conditions for students (Nugroho *et al*., 2017). Problem solving is a learning model that trains students' ability to solve a problem through the stages of the scientific method so that students can learn knowledge related to the problem and at the same time have the skills to solve problems (Nugroho *et al*., 2017). The development of teaching materials developed with problem solving-based learning models can improve problem solving abilities (Aji *et al*., 2017).

Learning base on problem solving will be more expressive if it's integrated with ethnochemistry which is wisdom of pearson's comprehensions of some natural sensations and is bonded to the community's original wisdom (Sudarmin, 2014). Ethnochemistry is delineated as the implementation of chemical concepts in people's lives which are reflected in cultural traditions, cultural symbols, value systems, social systems and cultural products identified as having relevance to the concept or practice of chemistry (Norolayn, K. & Said-Ador, 2017). The integration of local wisdom in chemical materials can be done through providing examples of chemical concepts that are integrated with cultural products, or through the use of cultural products as natural laboratories (Wahyudiati *et al*., 2020). Chemical material that is integrated with ethnochemistry can make students understand more understanding in absorbing new knowledge in scientific concepts (Wahyudiati, 2021).

The ethnochemistry that is integrated into the colloid system material is local wisdom related to the kinds of colloids, the nature of colloids and the process of making colloids. The ethnochemistry that supports all of this is the process of making *es cincau, lontong tuyuhan, dumbeg cake, and batik tulis Lasem* which are local wisdom in Rembang Regency.

Grounded on the problems over, in this research an e-module of colloidal system based on problem solving integrated ethnochemistry will be developed for high school students. The developed e-modules are bargained in the form of a flipbook. Flipbook includes tutoring subtances in the form of electronic media. Flipbooks can be run with the help of smartphones, computers, laptops and others. The advantage of tutoring subtances in the form of flipbooks is that they can display pictures and videos that make it simple for learners to reason the learning material or give the impression of learning that is more real to students. The development of this flipbook was chosen for the reason that it can be used as a practical independent learning resource that can be used anytime and anywhere.

METHODS

This exploration is an elaboration exploration that will produce tutoring substance products shaped of a module electronic in the form of a *flipbook.* The research method used is Research and Development (R & D). Research and Development is an exploration system with the goal of having given outputs, and sampling the conclusiveness of these yields (Sugiyono, 2015). The design of the research and development applied is a 4D research and development design which's quanlified into 3D so that the steps taken are define, design, and develop. The design stages of developing an e-module for a colloid system based on problem solving an integrated ethnochemistry are presented in Figure 1.

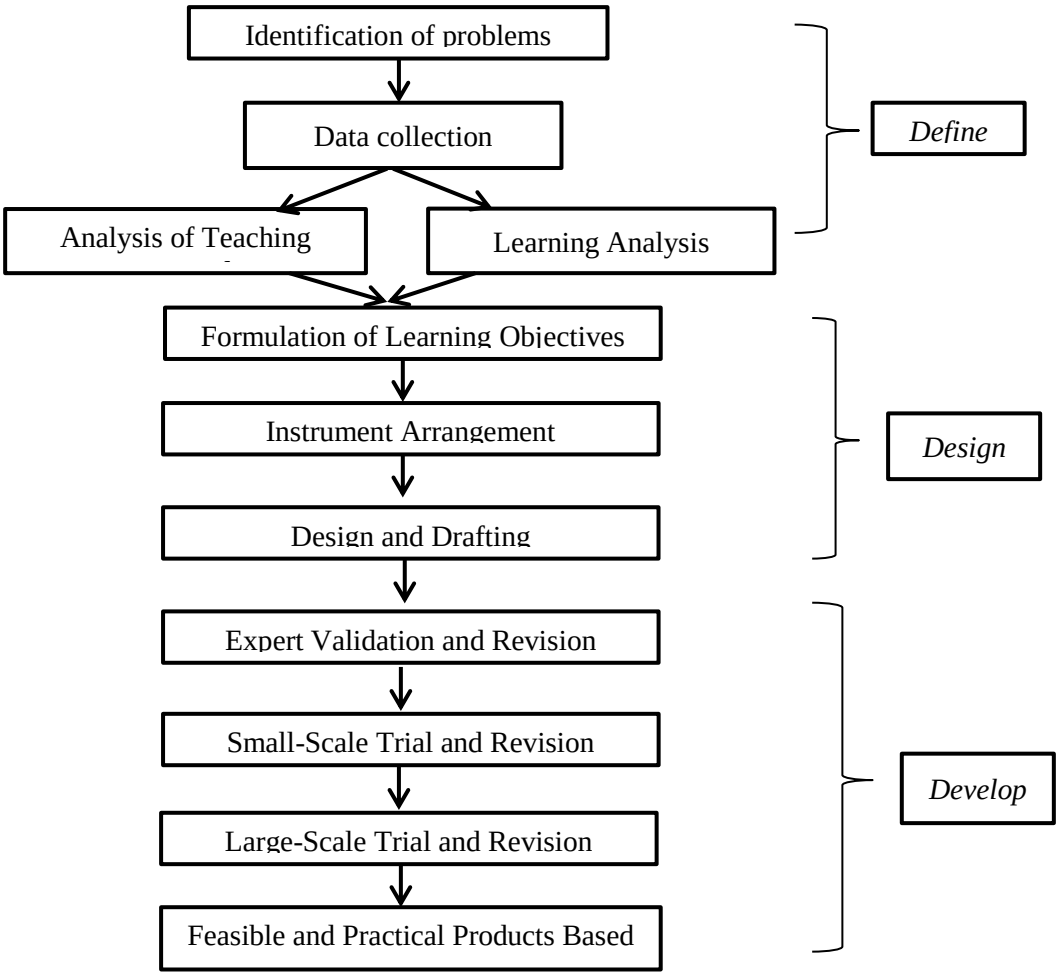

Figure 1. Diagram of research and Development Research Procedure Diagram (4D model adaptation of (Thiagarajan, 1974) modified into 3D

The research was carried out at MA Riyadlotut Thalabah Sedan in the even semester of the 2021/2022 educational time. The research problems for the small group were 20 students of class XI specialization in Mathematics and Natural Sciences, while the large group trials were 65. The small group trials were used to see the readability of the e-module, while the large group trials were to see the students' responses to the e-module.

The research instruments used were teacher interview sheets as an initial study, e-module validation sheets, legibility questionnaire sheets, practicality, student responses, and implementation observation sheets. Validation in question is to provide assessments, suggestions and input from the validators. Assessment of the validity of the module electronic consists of 4 assessment scores, namely explosively agree = 4, agree = 3, differ = 2, and explosively differ= 1. Suggestions and inputs from the validator are then followed up to improve the e-module and obtain an e-module that is suitable for use. E-modules that were suitable for use are then tested into small groups to see the readability of learners towards the module electronic. The results of the small group trial improvement were then tested in large groups. Eligibility criteria for e-modules can be looked in Table 1.

Table 1. Percentage of module electronic eligibility criteria (Riduwan, 2003)

Percentage	Criteria
21 - 40	Not feasible
41 - 60	Feasible enough
61 - 80	Feasible
81 - 100	Veritaly feasible

RESULTS AND DISCUSSION

Results

This research was conducted with the aim of developing an e-module based on a problem

solving colloid system that was integrated with ethnochemistry in class XI specialization in Mathematics and Natural Sciences and to analyze the feasibility of the module electronic. This product research and development is obtained through a 4D development model which's qualified to 3D (define, design, and development). The explanation of the stages of the development model can be described as follows:

Define Phase (Problem Observation)

The define stage begins with a literature study and unstructured interviews with high school chemistry teachers about the learning models and teaching materials used so far. In addition, interviews related to ethnochemistry related to the colloid system were also conducted.

Unstructured interviews were conducted on initial observations to find out the teacher's opinion on several things. The questions given to the teacher were about the teaching materials used, learning models, problem solving learning, ethnochemistry learning, and other facts in the field. The interview method chosen by the researcher is an unstructured interview to help researchers if in the interview process there is a problem development (Sugiyono, 2015).

The informants in this interview were three teachers from different schools consisting of 1 MAN teacher, 1 high school teacher, and 1 MAS teacher. The results of observances and interviews with chemistry educators at MA Riyadhotul Thalabah Sedan stated that in learning colloid systems some students did not understand the concept, this can be seen from the learning results of some students who are still below the KKM. According to the chemistry teacher on colloidal system material, students consider the material to be abstract and in understanding it needs to be linked to real examples. The results of the dissection of handbooks used in varied schools such as MAN 2 Rembang, SMA N 1 Pamotan and MA Riyadhotul Thalabah Sedan still use printed textbooks, there is no development of online-based textbooks such as e-modules. The teaching materials used are not all problem solving based and in the learning process not all materials are integrated with ethnochemical concepts. Ethnochemical contexts that can be related to colloidal system materials include local wisdom in Rembang Regency including the process of making *es cincau, lontong tuyuhan, batik tulis Lasem, and dumbeg cakes.*

The next stage after analyzing the problems that exist in the school is compiling the material according to the ethnochemistry context and the content of the colloid system. The material can be presented between original science and scientific science or called ethnochemistry, so that students can understand the relationship between the two. The ethnochemistry that is integrated into the colloid system material is local wisdom related to the kinds of colloids, the nature of colloids and the process of making colloids. The ethnochemistry that supports all of this is the process of making *es cincau, lontong Tuyuhan, batik tulis Lasem, and dumbeg cake* which are local wisdom in Rembang Regency. In the process of making *es cincau,* there is a colloid system concept related to the type and manufacture of colloids, while in the process of making *lontong tuyuhan* and making *dumbeg cakes* there is a colloid concept related to the types and properties of colloids. The concept of colloid related to the adsorption properties of colloid is found in the dyeing process of *batik tulis Lasem.*

Design Phase (Design)

The design phase begins with designing an e-module based on problem solving integrated ethnochemistry on colloidal system. The design of the e-module is done by making a module matrix and a draft module. The e-module matrix contains a design in the form of an initial framework. The sections displayed in the matrix include the frontal cover, introduction (foreword, table of problems, material description, learning objects, and concept maps), content (learning activities 1, 2, and 3), closing (final evaluation of learning, answer keys, and feedback), glossary, bibliography, about the author, and back cover.

The matrix that has been created is then developed into a draft whose content is written in more detail than the matrix. The face and back covers of the module are made applying the canva operation, while the content of the material is made using Microsoft word which is then converted into pdf form. Making e-modules with the help of flipbook applications. The colors used in the e-module are dark blue, light blue, and white. The type of font used is Times New Roman with size 16. The e-module draft is completed with figures and videos supporting the material in accordance with the colloid and ethnochemical system concepts in *es cincau, lontong tuyuhan, batik tulis Lasem, and dumbeg*

cake.

The design of this research e-module contains three main points, namely introduction, content and closing. E-modules are made with links to videos or additional information related to the subject of colloid systems. The addition of links goals to make it simple for learners to browse all learning resources. The e-module design was produced by the researchers as the initial product of developing an e-module for a colloid system based on problem solving integrated ethnochemistry. The e-module cover design can be looked in Figure 2.

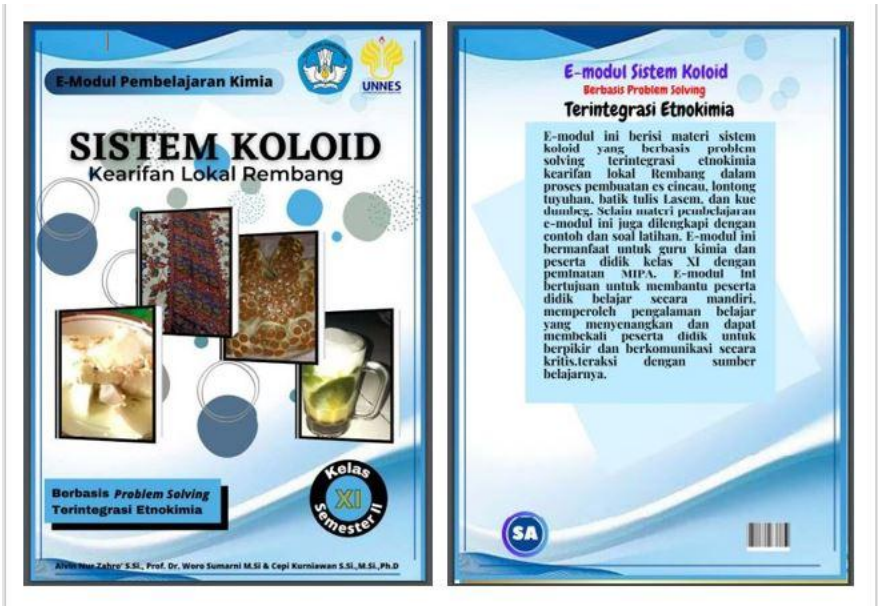

Figure 2. E-module cover design

The content section of the module electronic consists of learning activity 1 (types of colloids), learning activity 2 (colloidal properties), and learning activity 3 (making and using colloids). Each learning activity is equipped with learning success indicators, material definitions, learners worksheets, and resumes. The design of the contents of the e-module can be looked in Figure 3.

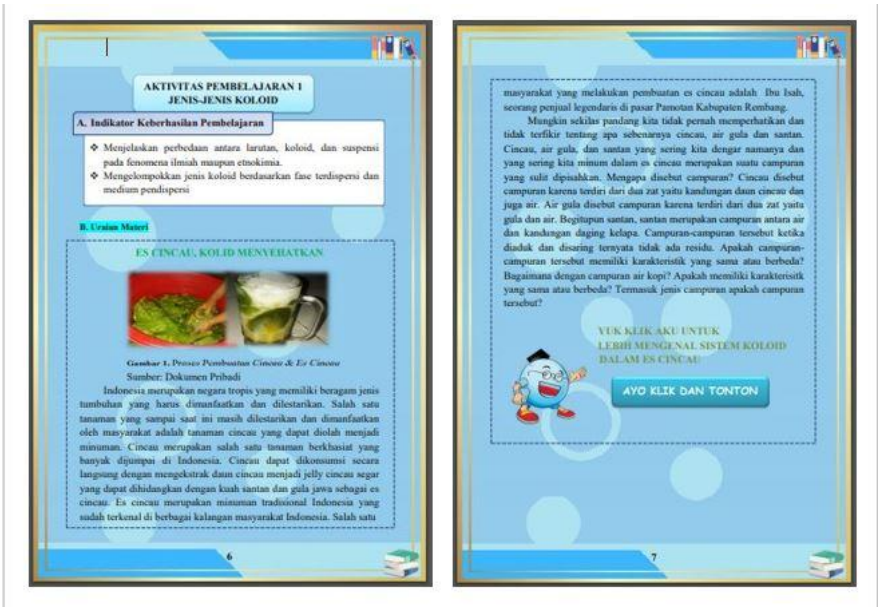

Figure 3. E-module content snippet design

The last part of the module electronic that was developed is the cover which contains the final evaluation of learning, answer keys, feedback, glossary and bibliography. The design of the module electronic cover can be looked in Figure 4.

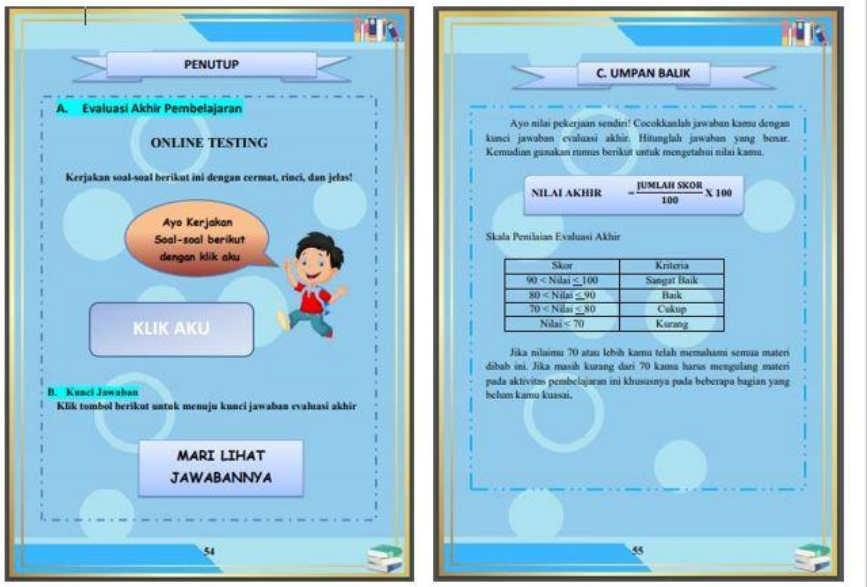

Figure 4. E-module cover piece design

Develop Phase (Development)

The development phase is applied to test the feasibility of the module electronic base on problem solving integrated ethnochemistry on colloid system carried out by an expert validator. Components assessed in the research instrument include components assessed in the research instrument which include aspects of content assessment, presentation, language, graphics, and ease of use. The data on the results of the validator assessment of the research instrument are shown on Table 2.

Table 2. Validator Assessment Results on E-modules

No.	Assessment Aspect	V1 (%)	V2 (%)	V3 (%)	Average (%)
1	Contents	90.63	96.88	78.13	88.55
2	Presentation	95	90	80	88.33
3	Language	87.5	91.67	75	84.72
4	Graphics	89.29	85.71	78.57	84.52
5	Ease of use	87.5	100	75	87.5
	Amount				86.73

Based on Table 2, the data from the validator's assessment on all aspects of the feasibility of the e-modules attained a mean of 86.73% with a veritably decent category. After the e-module was declared feasible by the validators, it was followed by a small group trial. The small group trials are intended to see the readability of the module electronic. The results of small group trials are used as input to researchers about products developed before being tested in large groups. E-module readability data in small group trials are presented in Table 3.

Table 3. Readability Test Results for E-modules

No.	Assessment Aspect	Average Score (%)
1	Learning	88.1
2	Contents	88.75
3	Appearance	86.25
4	Language	87.5
	Amount	87.9

Table 3 shows that the students' readability of the e-module obtained an average of 87.9% with a very decent category. After the e-module readability test, the practicality test is filled in by the practitioner (teacher). The results of the practicality test on the module electronic are

shown in Table 4.

Table 4. Practicality Test Results for E-modules

No.	Assessment Aspect	Average Score (%)
1	Layout	91.67
2	Language	87.5
3	Contents	90
4	Development	87.5
5	Ethnochemistry	100
	Amount	91.3

The results of the practicality test in Table 4 state that the e-module is very practical to use with a mean score of 91.3%. After the e-module is said to be feasible by the validator and tested in small groups, then it is tested in large groups. The results of student responses in large groups are shown in Table 5.

Table 5. Results of Student Responses to E-modules

No.	Assessment Aspect	Average Score (%)
1	Learning	86.8
2	Contents	85.2
3	Appearance	89.6
4	Language	88
	Amount	86.9

The oucomes of learners responses to module electronic based on Table 5 show that students respond strongly to e-modules with an average score of 86.9%. The results of the observation of learning implementation using module electronic can be looked in Table 6.

Table 6. Results of Learning Implementation on E-modules

Meeting-	Score	Percentage (%)
1	17	100
2	16	94
3	16	94
4	17	100
5	16	94
Amount		96.4

Based on Table 6, the results of the observation of the execution of getting using e-modules stated that it was implemented very well with a percentage of 96.4%.

DISCUSSION

Grounded on the results of the e-module exploration that has been developed in accordance with the 2013 curriculum which includes basic competencies (KD) and indicators of competency achievement (IPK). Learning subtances can be said to be valid if they are in accordance with the existing curriculum (Hafsah *et al*., 2016). The e-module is said to be valid by looking at several aspects. First, the aspect of the module electronic material that has been evolved has the correctness of the material, the suitability of the practice questions with the material and the e-module can increase students' knowledge. Second, aspects of language and attractiveness. E-modules have been developed using communicative language and do not cause double meaning. Teaching materials must be prepared using clear and easy-to-read sentences and language (Yerimadesi *et al*., 2016). The e-module has an attractive appearance, layout placement, font selection, font size and overall display design is considered good and attractive. However, there are some suggestions from the validator including writing words, adding sources to figures and videos, and smoothing figures. All suggestions are accepted and improvements have been made.

The e-module has a very practical category value from the readability test, the practicality of the teacher and the response of the students. This shows that the module electronic that has been developed can be used to help learners understand the subject problem, especially the colloid system material. E-modules are prepared using a problem solving model that is integrated with local wisdom or called the ethnochemistry approach. Problem solving is a learning model that trains the ability of students to break a trouble through the stages of the scientific method so that learners can learn wisdom communed to the trouble and at the same once have the skills to break troubles (Nugroho *et al*., 2017). Chemical material that is integrated with ethnochemistry can make learners understand more about absorbing new knowledge in scientific concepts (Wahyudiati, 2021). Based on this, the module electronic is decent and practical to use in the studying process.

This finding is reinforced by previous research which states that the development of teaching materials developed with problem solving models can increase problem solving abilities (Aji *et al.*, 2017), improve students' critical thinking skills (Wahyuni *et al.*, 2020), improve student learning results and critical thinking (Sugihartini & Jayanta, 2017)**,** and improve oral and written communication skills (Maridi *et al.*, 2019). Learning by integrating ethonychemistry can be used to measure

learning results (Yusnidar & Epinur, 2021) and creativity skills (Mirnawati *et al.*, 2021).

CONCLUSION

The module electronic based on problem solving integrated ethnochemistry on colloidal system material has been developed with results of the feasibility evaluation by expert validators are 86.73% with very decent category. The results of the readability, practicality, and learners reactions to the module electronic each attained a score of 87.9%; 91.3%; and 86.9% in the veritable applicative category. The results of the learning implementation test using the e-module obtained a score of 96.4% in the very well implemented category. The conclusion of this research is that a module electronic based on problem solving integrated ethnochemistry is very feasible to use and has received a positive response from users.

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