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Integrating Ethnoscience on Critical-Thinking Oriented Web-Based E-Module of Secondary School Science

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Abstract: As a strategy to create learning environment by integrating culture into learning, ethnoscience fits perfectly with the aims of science lesson in the national curriculum of education in Indonesia, which is to understand how nature works, and to improve awareness toward conserving and maintaining balance in nature. Leading toward Education for Sustainability Development (ESD), science learning could serve to develop students' ability in thinking, learning, and building awareness towards natural and physical environment. In this study, we aimed to design a web-based e-module integrated with both ethnoscience and critical thinking orientation to facilitate students' learning dan thinking. The product is developed with 4D-model consisting of 4 stages namely: Define, Design, Develop, and Disseminate. Product's validity and practicality was assessed using instruments with Likert—scale items and analyzed with descriptive statistics. From Define and Design stage, four themes of ethnoscience are embedded in the e-module, namely: gold panning, salt farming, the making of virgin coconut oil, and Jamu– a folk drink. From develop and disseminate stage, the web-based e-module was tested to be highly valid and practical to be used as teaching materials. The product received positive feedbacks students especially related to the implementation of Kurikulum Merdeka.

Keywords: Critical thinking; Ethnoscience; Science learning; Web-based e-module

Introduction

With the advances of science and technology in this current decade, along with the pandemic of Covid-19 which severely damaged Indonesian education system, Ministry of Education and Culture (MoEC) has decided to modified the nearly ten years old Kurikulum 2013 – the national education curriculum. Since March 2020, Indonesia has experience three adjustments of curriculum in accordance with the development of Covid-19 outbreak in this country. The first adjustment was to simplified the content on the syllabus of Kurikulum 2013, and by then called Kurikulum Darurat (translated as Emergency Curriculum). The next adjustment is called Kurikulum Prototype, which is implemented in 2021 in order to "heal" the learning loss that happened almost in every school in Indonesia. In 2022, Kurikulum Prototype is modified into Kurikulum Merdeka, and now become the national curriculum in Indonesia.

Given the situation that education in Indonesia is entering the "transition" phase, from Kurikulum 2013 to Kurikulum Merdeka, schools all over Indonesia are still varied in terms of curriculum they used. In Padang city, the capital of West Sumatra province, a majority of grade seventh students learn with Kurikulum Merdeka, while grade eighth and ninth still learn with Kurikulum 2013. According to Kurikulum 2013, there are three dimensions of science learning, namely: product, process, and scientific attitudes. In the new curriculum, there is no change has been made on the content of science lesson. Thus, the three dimensions are expected to be covered through learning process by implementing scientific approach or innovative learning models, which trains students' ability in observing, thinking, experimenting, analyzing, and communicating their findings. Either way, to help with efficiency and effectiveness of learning process, learning media is required.

Among all types of learning media, e-module is one of the most emerging in current research of science

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education in Indonesia. E-module is electronic form of module, which contains the same component as printed module but the operation requires computer or technology assisted devices (Muthmainnah et al., 2021). The difference between these two versions is in physical form, the navigation tools, printing cost, and device needed to access them. With the advance in technology, e-module is now gaining more popularity since it does need to be printed and carried out whenever or wherever one wants to study. E-module can be access via mobile phone or smartphone, either in the form of portable document file (pdf), html, application, or as a content in learning management system. E-module is also interesting for young learners since it can be embedded with high-resolution images or illustrations or audiovisual media such as experimental videos, podcast, or video explainer. Printing cost for colored pages is no longer a problem as well as the weight to carry the module around. Interactive feature of e-module is also appealing to students in terms of classroom interactions, either with fellow students or teacher. E-module as learning media for science instruction in Indonesia has been studied since many years ago. In these studies, e-modules are combined, developed, or integrated with thinking skills, learning models, or methods to improve the quality of science instructions. For instance, e-module could be developed based on STEM approach (Nurhayati et al., 2021), E-module's unique feature as learning media come from its flexibility, adaptability, self-instruction, and stand-alone mode.

The idea of web-based e-module came from the constraint of application-based e-module that requires big storage capacity in students' gadget. In addition, the file size of such applications often requires a lot of internet's quote to download and access it. Since internet access in Indonesian's schools are still not evenly available, students prefer practical, available, and ready-to-be used learning media, which is either printed module, textbook, or worksheet. However, these printed module, textbooks, or worksheets provided in schools are not as colorful, interactive, comprehensive as e-module and charge extra cost to parents. The availability of an interactive evaluation in e-module is found to improve both learners' motivation and learning outcomes (Lestari & Parmiti, 2020; Sudarmin et al., 2017). In addition, interactive features of e-module enable students to learn at any pace, any place, or any time (Linda et al., 2021). Web-based e-module also offer limitless opportunity for developer to enhance any features such as colorful images, videos, or online testing form (Novitasari et al., 2022).

Learning process is considered a success when students could understand the concepts and apply those concepts in various context such as solving daily life problems (Pertiwi et al., 2018). Without suitable contexts, all knowledge can only be memorized and become separated and inapplicable which eventually be forgotten. Ethnoscience could help providing context and sources for students learning and knowledge building by integrating culture as a part of the learning process (Pertiwi & Firdausi, 2019). However, conceptual understanding and knowledge building often requires critical thinking ability. Critical thinking is one of the skills that students of 21st century should master, along with collaborations skills, creativity, and communication skills (Fahrozy et al., 2022). Mastering critical thinking skills require a process and ability to understand concepts, applying it, synthesize and evaluate any given information (Jamaluddin et al., 2020). There are five indicators of critical thinking skills, that is: to provide simple explanation, to develop basic skills, to make inference, to provide advance explanation, and to choose strategy and technique (Ennis & Weir, 2013).

Ethnoscience is an activity of transforming native science which consist of all knowledge from the society, inherited in the form of belief or traditions, and still commonly contain myths (Sudarmin et al., 2017). The steps of reconstructing indigenous knowledge into a scientific knowledge involve five steps, namely: observation and exploration, reduction and verification, and then followed by validation and conceptualization (Izzah et al., 2020). Ethnoscience was originated from trial and error of multiple experiments, for example: the art of Reog Ponorogo and Pencak Silat – a kind of martial art (Novitasari et al., 2017). Ethnoscience can also be defined as the study of folk culture areas that approximate the various exact sciences, especially when it comes to environmental knowledge (e.g., ethnobotany) (Ellen, 2018).

Ethnoscience in secondary school science learning is expected to trigger students' motivation to study their culture further and to build awareness to improve the prosperity of local community's based on available resources (Hadi & Ahied, 2017). In broader sense, ethnoscience is bridge to integrate scientific and indigenous form of knowledge toward sustainable management of natural resources for the future (Rist & Dahdouh-Guebas, 2006). Nowadays, facing the global impact of global warming in the middle of rapidly advancing technology, students are encouraged to develop critical thinking skills and important cultural conservation skills. Ethnoscience has been found to enhance the character of conservationist (Rahayu & Sudarmin, 2015). Ethnoscience was expected to explore students' thoughts in order to accommodate concepts, principles, or personal beliefs. Ethnoscience has been proven to increase learners' scientific character, such as

hard work, curiosity, environmental care, social care, and responsibility (Atmojo et al., 2019), and scientific literacy (Atmojo et al., 2019; Dewi et al., 2019; Citra Ayu Dewi et al., 2021; Mardianti et al., 2020; Sastradika, 2020). Eventually, it is expected that students would realize that ethnoscience was built upon local community's habits and culture.

Since 2012, critical thinking has been stated in national curriculum as one of the targets of education in Indonesia. Ethnoscience promotes learners' attitude toward science, which is correspond with the goals of science lesson in Indonesia (Fasasi, 2017). Besides, ethnoscience also has been found to promote critical thinking skills (Arfianawati et al., 2016; Atmojo et al., 2019; Fitriani & Setiawan, 2017) and learning outcomes (Mahendrani & Sudarmin, 2015; Senjawati, 2020). Students will be more interested in science and find it easier to understand lessons prepared from the perspective of local culture and organized local wisdom relating to specific natural occurrences and events (Dewi et al., 2019). Ethnoscience integration in media for science learning emerge in the form of Batik (Atmojo et al., 2019; Izzah et al., 2020), Batik Bakaran (Damayanti et al., 2017), Batik designing (Fitria & Wisudawati, 2018), and also salt farming (Hadi & Ahied, 2017).

Interactive multimedia based on local culture has been proven to play an important role in science learning to improve students' learning mastery and achievement (Dwipayana et al., 2020). Therefore, in this study we tried to develop a web-based e-module on the topic of mixture separation for seventh grade students which integrates ethnoscience as a part of learning process and embedded with critical thinking question. In this study, we measure the validity and practicality of web-based e-module to be used as a media of instruction for secondary school science learning. The findings from this study are expected to contributes to the realm of research and practice in science education.

Method

This research and development study use 4-D model, which consists of 4 stages, namely: Define, Design, Develop, and Disseminate (Thiagarajan, 1974). This model has been found to be simple, flexible to modification, and offer systematic flow in developing product (Irawan et al., 2018). In Indonesia, numerous studies have used this model in developing instructional media for science learning, such as integrated student worksheet (Fitriyah & Pratiwi, 2023), teaching materials (Fahmi et al., 2022; HL et al., 2023; Imran et al., 2020; Purwaningsih et al., 2020), web-based e-module (Nugraha et al., 2022) and instructional multimedia (Hidayati et al., 2020). Define stage include the front-analysis, learners' analysis, learning task analysis, content analysis (concept), and analysis of learning objectives. Design stage includes deciding the media of instruction, which is an e-module; choosing the format of that media which is a web-based e-module, and drafting the initial design of the e-module such as what features should be provided, the layout, and the pictures and illustration to be used. Develop stage is when the design is used as an outline to develop the entire e-module by adding information, pictures, illustrations, and evaluation problems. In this stage, the prototype of web-based e-module would be tested for validity and feasibility. The procedure of this study can be seen in Figure 1 below.

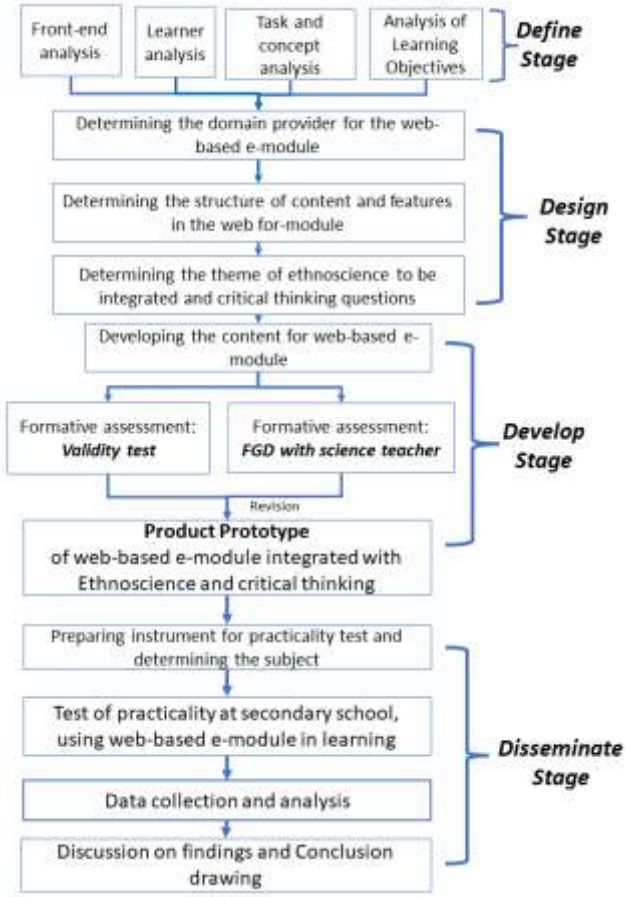


Figure 1. Research procedure

Validity test was conducted through experts' judgement, involving three lecturers in science education field who assessed 4 aspects of an e-module. The indicators for these four aspects were modified from the Criteria for Assessing Teaching Module by Indonesia's National Education Standards Agency (BSNP, 2008). The criteria in assessing the validity of a module are: the feasibility of content, feasibility of graphic, feasibility of presentation, and feasibility of

language of instruction. Each aspect contains several indicators to which experts would assign their agreement respectively (Table 1).

Table 1. Indicators for Validity Testing

Parameters of Validity	Indicators
Content feasibility	a.Compatibility with targeted competencies b. Relevancy of problems in e-module to the concepts of mixture separation c. Compatibility with students' cognitive development level d. Compatibility of pictures and illustration in leading students' understanding e. Relevancy of information in broadening students' knowledge f. Integrativeness of content
Presentation feasibility	a. Relevancy of problems being presented to students' mastery of indicators b.Integration of ethnoscience c.Critical-thinking oriented questions and information d. Systematical presentation of e-module's component
Language of Instruction feasibility	Clarity of information in e-module Absence of ambiguity Consistency with Bahasa's grammatical rule Consistency in using terms or symbols
Graphic/ Layout feasibility	Clarity of font type and size Legibility based on font size and shape Presentation of cover and text layout Clarity of pictures and illustration Overall design of web-based e-module.
Total	19 validity indicators

Meanwhile, the practicality of the e-module would be assessed through 3 aspects, namely: ease of use, study time efficiency, and benefits of use with several indicators respectively (Table 2). Instruments for both validity and practicality testing were questionnaire containing Likert scale with score ranging from 1 to 4. Score 1 is assigned to "Strongly Disagree" response, while 4 is assigned for "Strongly Agree" response. All responses were then tabulated and calculated for percentage and average scores, and then assigned to each category for interpretation. According to Riduwan (2013), the percentage score between 0 – 20 is interpreted as Highly Invalid whereas 81-100 is interpreted as Highly Valid. With interval 20 points, other categories are Valid (61-80), Adequately Valid (41-60) and Not Valid (21–40). The same category also applied in practicality testing, only the label of category change into Highly Practical, Practical, Adequately Practical, Not Practical, and Highly Impractical.

Validity testing require some revision on the e-module, such as regarding the resolution of the picture, features, or access to the feature of the e-module, and some of the information contained in it. As soon as the revision complete, dissemination stage took place in the form of limited field test. A class of 24 ninth grade students and their science teacher participated in this field test. Students learned to use the web-based e-module in the laboratory, do the evaluation problem, and then were asked to fill out the questionnaire about the practicality of the e-module. Interview with science teachers was conducted at the end of the dissemination to get feedback about the learning process with web-based e-module.

Table 2. Indicators for Practicality Testing

Parameters of Practicality	Indicators
Ease of Use	a. Easy to understand the direction of use b. Clarity of learning materials c. Easy to follow learning activities d. Easy to understand the language of instruction e. Easy to see the connections between concepts f. Legibility of the font type and size g. Easy to understand the questions/ problems h. Clarity and relevancy of picture and illustrations i. Logic behind the presentation of science concepts in e-module j. Ease to carry e-module k. Repeatability in using e-module at home
Study time Efficiency	a.Effectiveness and efficiency of study time of learning in class with e-module b. Students' understanding of the learning materials.
Benefits of use	a.Pictures and readings can motivate students to find concepts b. The critical thinking skills-oriented questions e-module lead students to grasp the concepts c. E-module helps students to draw conclusion d. Web-based e-module helps students to understand the concept of mixture separation e. The questions provided help students to understand concept f. Web-based e-module increase students' participation in learning
Total	19 practicality indicators

Result and Discussion

Define Stage

The define stage was conducted in five steps, namely: Front-end analysis, Learner's analysis, Task Analysis, Concept Analysis, and Analysis of Learning Objectives. Front-end analysis was conducted through

interview with science teachers in three schools in Padang city using a questionnaire. From the interview, we found out that the instruction materials being used were varied, from government-issued textbook, online learning platforms called Geschool, and MGMP-issued students' worksheet. MGMP (Musyawarah Guru Mata Pelajaran) is a group of teachers who teach the same subject. Another finding is that the illustrations and pictures in the textbook or worksheet were not clear and lack in colors. Further interview with students confirms that they preferred more colors and pictures in learning instructions. Regarding the content, separation of mixture is considered difficult among the students. One of the reasons behind this statement is that lack of practicum in the laboratory and lecture mode of instruction which did not allow students to explore the practical steps of mixture separation on their own. The common lecture mode of teaching this topic in schools rarely introduce the application of the concepts in daily life, which creates a gap between students' understanding and their daily life.

Since ethnoscience is a relatively new concepts to most teachers in Indonesia, and despite the fact that a number of development studies have integrate ethnoscience on teaching materials, we could not find such instruction materials being used in classroom, especially in Padang city. Previous studies also confirmed this findings, students does not use any teaching materials that integrates local culture (Fitriani & Setiawan, 2017). Though in fact, ethnoscience could be used by teachers to help students achieve one of the purposes of science learning, which is to master learning skills and be innovative which includes critical thinking and problem-solving skills (Damayanti et al., 2017), creativity, skills in communication and collaboration, and eventually scientific literacy (Dewi et al., 2019; Novitasari et al., 2017; Pertiwi & Firdausi, 2019).

To achieve the purpose of science learning, students need to master some competencies such as: to build religious attitude and good etiquette in living with the society; to master the required knowledge; and to be able to apply knowledge and understanding in doing scientific investigation, solving problems, and making creative products which are relevant and beneficial to their daily life (Kemdikbud, 2017). Ethnoscience can be used as a learning context (Novitasari et al., 2017), and thus help students to go back to their own culture by investigating ideas and thoughts existing in the society and do scientific investigation for better understanding about the ideas.

The topic of mixture separation is closely related to daily life since human's life relies most on water and liquid. In Indonesia for instance, when it comes to rainy seasons, the concept of filtration could help areas being damaged by flood or landslides to provide clean fresh water. Another situation is that in dry season when limited amount of water could turn into muddy or sandy fresh water supply, filtration could help too. Through generations, society has passed on ideas and strategy to live side by side with nature without harming each other. These ideas could be transformed into knowledge in science class through ethnoscience. We really hope that this integration of ethnoscience in web-based e-module could help students know their culture better and live in a good relationship with nature.

Learners' analysis was conducted by giving questionnaires to seventh-grade students regarding their preferences for science instruction materials. We found that both textbook and literacy textbook used in school already have pictures and illustrations in it but some of them were too small to see, blurry, or not colorful. Students even stated that they did not know what is the relation between of the pictures and the concepts being explained next to it. This indicate that students could not relate the concepts with the picture since the picture did not serve its' function to represent or to illustrate the concepts.

Table 3. Targeted Competency and Indicators of Mixture Separation Topic

Targeted Competency	Indicators
1. To explain the concepts of mixture and single substance (element and compound), physical and chemical properties in daily life	1.1. Define the concept of mixture separation 1.2. Explain the method of mixture separation 3.3.3. Explain the work principle of each method of separation. 3.3.4. Explain the application of each method of mixture separation in daily life.
2. To present a report of investigation on properties of solution, physical and chemical changes, or separation of mixture	2.1. Conduct an experiments of mixture separation using simple tools and local materials

The next steps in define stage is task analysis, in which we break down all the task that students need to complete to achieve the basic competency. The topic of mixture separation exist in Basic Competency 3.3 for grade seventh, that is: to explain the concepts of mixture and single substance (element and compound), physical and chemical properties in daily life (Kemdikbud, 2017). Basic Competency 3.3 specifies the knowledge that students have to master, meanwhile Basic Competency 4.3 states the skill sets to learn, that is: to present a report of investigation on properties of solution, physical and chemical changes, or separation of mixture (Kemdikbud, 2017). From these two basic competencies, we broke

down the indicators of these competencies (Table 3). Based on these indicators, we designed the structure of e-module to facilitate students' learning. We also analyzed the essential concepts which should be included in the e-module and came up with the concept map as shown in Figure 2.

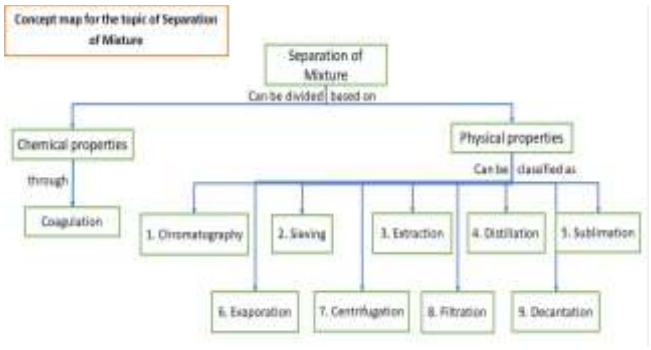


Figure 2. Concept map for the mixture separation topic for indonesia's secondary school science

Figure 2 shows that students will notice that the methods for mixture separation are differentiated based on the properties of the substances: chemical or physical. Separation based on chemical properties can be done through coagulation by adding coagulant into the mixture followed by filtration. While separation based on physical properties offer more options. Each of the nine methods has different work principle, thus students would be expected to understand each method and explain when or in what context they could apply the method. Among the nine methods, filtration is the most common one to be used in Sijunjung City, West Sumatra province, for panning gold out from the river. Therefore, we used this context to as an integration for ethnoscience together with salt farmers who use evaporation method. In addition to that, we also used "Jamu" – a traditional drink made from spices, salt farming, and Virgin Coconut Oil (VCO) as the context to integrate ethnoscience into the e-module.

In analyzing learning objectives, we used ABCD principles, abbreviated from Audience, Be-havior, Competency, and Degree to formulate learning objectives based on the indicators we have from task analysis. The learning objectives can be stated as: through study literature, students could define the concept of mixture separations accurately; 2) through exploring the e-module, students could explain the application of mixture separation methods in daily life context; 3) through exploring the e-module, students could explain the basic principle of each methods for mixture separation accurately; and 4) through group discussion, students could explain the science behind gold panning and salt farming conceptually and accurately. We then transformed these learning purposes into learning activities in the web-based e-module in the Design stage.

Design Stage

In this stage, the media of presentation is a web-based e-module with .html format. The features on the web are the component of e-module stated by Indonesia National Education Standards Agency, such as: description of e-module, direction of use, core competency, basic competency, learning objectives, introduction, essential concepts, concept map, experimental activity, evaluation problem, references, answer key, and profile of the developers. For cover image, we used Canva application and for "Critical Thinking Corner" and Q&A feature we used google form which was embedded into the blog. For the text of the e-module we refer to various sources, ranging from international science textbooks, government-issued textbooks, and recent journal articles.

For critical thinking orientation, we presented question in each ethnoscience context (Fig.6), and require students to provide answer through the "critical thinking corner". Some of the critical thinking questions are: "Poor quality of drinking water contain odor, dirty, and cloudy could harm our health. What should we do about this? Do we have other options (Fig. 4a)?"; "Could you explain what the relevance between water purification and mixture separation (Fig. 4b)?"; "Rainfall is one example of evaporation process. Could you explain how evaporation could result in rainfall (Fig. 4c)?"; "How sublimation occur to naphthalene (Fig. 4d)?"; and "What were you thinking when you see different colors of water in the picture (Fig. 4e)? What would happen if we consume all the water in those different colors?"

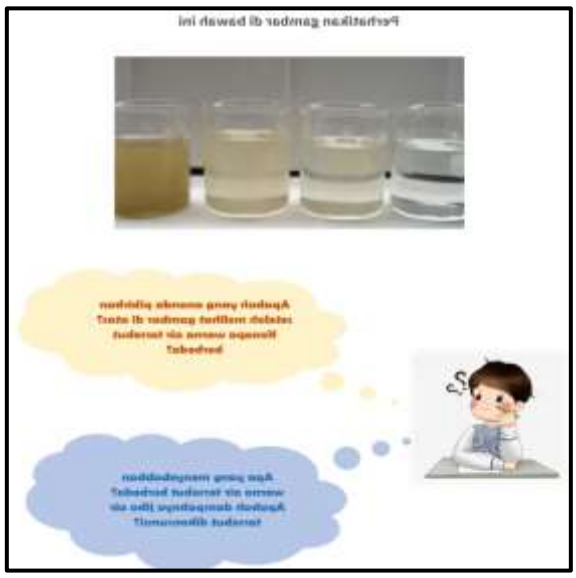
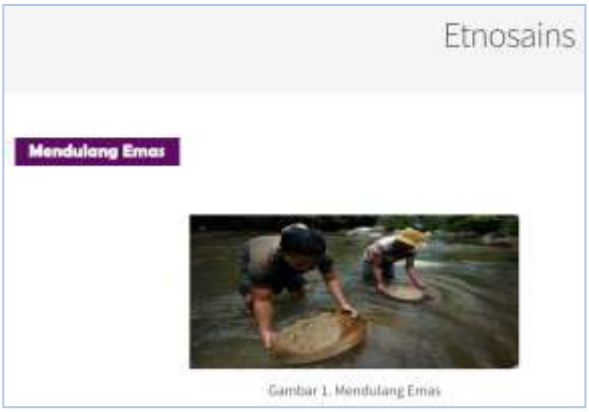


Figure 3. Sample of critical thinking-oriented questions presented in web-based e-module



(a)

(b)

(c)

(d)

Figure 4. Ethnoscience integration in Web-based e-module

Ethnoscience is integrated through picture and passage, accompanied by leading and critical thinking questions. Ethnoscience could come from local wisdom, tradition, myth (to be investigated scientifically), or local beliefs (Fatkhiyani & Dewi, 2020). Integration of ethnoscience in science learning is highly dependent to students' local culture and knowledge (Arfianawati et al., 2016). Mixture separation has been identified as one of the science concepts that can be reconstructed from indigenous knowledge (Izzah et al., 2020).There are four items on ethnoscience we chose to be embedded in the web-based e-module, they are: The activity of local community filtering the river to obtain gold in Sijunjung Regency, West Sumatra Province, Indonesia (Fig. 4a); The Process of Harvesting Salt (Fig. 4b); Jamu, a traditional drink made from local spices (Fig. 4c); VCO – Virgin Coconut Oil commonly made by elders in villages (Fig. 4d). The integration of ethnoscience in this e-module was also intended in the cover image, learning direction, learning objectives, concept map, activity sheet, worksheet, evaluation problem and answer key.

Development Stage

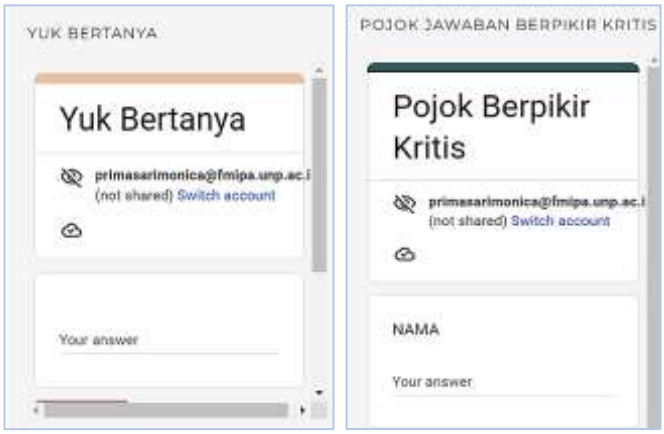
The website was developed using blogspot software with menus which make it easier for students to operate the website. The main purpose of using the blogspot format is because students are more familiar with the appearance of the web. The first step is to entry the website domain on the blogspot main page. After getting the domain, the blog display is installed automatically with the initial display. The next step is to install the main theme that will be displayed on the blog page. The next step is to adjust the menu, writing, and format so that important points such as the ethnoscience approach, and the critical thinking approach become more graphic. The next parts are the apperception column and the critical thinking corner, then integrating the google form format so that student answers can be directly stored for evaluation or assessment.

After confirming that the menu and written text are fit with the feasibility indicators of an electronic teaching material and the variables to be measured appear, the next step is to make an evaluation. The evaluation is meant to be formative assessment and made by integrating the .html word wall into the blog so that the evaluation provided can be interactive. Furthermore, for essay evaluation questions, G-form is integrated to make it easier to answer and so that answers are directly stored.

The web-based e-module was designed to look like a blog, in which students could access several menus, such as: home, introduction, lesson material, evaluation, and references (Fig. 4). For the ethnoscience, we integrate two contexts of mixture separation methods

which are common to natives of West Sumatra province. Meanwhile for the critical thinking orientation, we provide the "Critical Thinking Corner" and Q&A column in the web-based e-module (Fig.5) to facilitate students participation during learning, especially through online learning mode.

To ensure the validity on the text, the critical thinking questions, and the ethnoscience integration, we invited three experts in science educator and learning media to assess the validity through expert judgement. From these experts' suggestions, we did some revision on the text such as sentence structure, graphical presentations, fixing picture layout, adding more information on ethnoscience, and adding more critical thinking questions on the evaluation problems. Validity test in the development stage have significant roles in determining whether the product is consistent with the intended design (Fahmi et al., 2022; Fitriyah & Pratiwi, 2023). Validity assessment was conducted on four aspects, namely content feasibility, presentations, graphical layout, and language of instruction (in Bahasa Indonesia).



(a) (b)

Figure 5. The critical thinking corner and Q&A feature in web-based e-module

Table 4. Result of Validity Testing on Content Feasibility

Content feasibility's indicators	Percentage/ category of validity
a. Compatibility with basic competency and learning indicators	83%/ highly valid
b. Problems given in the evaluation are relevant to the learning content	91%/ highly valid
c. The content of e-module is designed to be match teenagers' cognitive and social development stage.	83%/ highly valid
d. Illustrations and pictures in the e-module could help students to better understand the content.	91%/ valid
e. Content of e-module is up to date showing integration of ethnoscience relevant to the content.	83%/valid
f. Critical thinking questions embedded in the e-module stimulates students' thinking on the application of concepts.	75%/ valid
Average percentage of content feasibility	83.3%/ Highly valid

Table 5. Result of Validity Testing on Presentation feasibility

Presentation feasibility's indicators	Percentage/ Category of validity
a. Systematic presentation of features in e-module's, starting from introduction until evaluation.	91%/ Highly valid
b. The information and problems in e-module has been integrated with ethnoscience.	91%/ Highly valid
c. E-module contains critical thinking-oriented questions.	83%/ Highly valid
d. The problems presented in the e-module lead students to master indicators and eventually the basic competency.	83%/ Highly valid
Average percentage of presentation feasibility:	87%/ Highly valid

Table 6. Result of Validity Testing on Graphical/ Layout Feasibility

Graphical layout feasibility's indicators	Percentage/ Category of validity
a. The legibility and clarity of font type and size in the text of e-module	83%/ Highly Valid
b. The proportionality of layout for e-module's cover image	75%/ Valid
c. The clarity of pictures presented in the e-module	83%/ Highly Valid
d. The color harmony in presenting e-module's content	75%/ Valid
e. Overall layout design of the e-module	75%/ Valid
Average percentage of presentation of graphical layout feasibility:	78.2%/ Valid

Table 7. Result of Validity Testing on Language of Instruction

Language feasibility's indicators	Percentage/ Category of validity
a. The clarity of information presented in the e-module	83%/ Highly valid
b. The sentences in the e-module do not contain ambiguity.	83%/ Highly valid
c. The structure of sentences in the e-module is compatible with	75%/ Valid

Language feasibility's indicators	Percentage/ Category of validity
learners' cognitive development stage.	
d. The sentences follow the grammatical rules of Bahasa Indonesia as the language of instruction.	91%/ Highly valid
e. Consistency in writing symbols	83%/ Highly valid
Average percentage of language feasibility	83%/ Highly valid

Dissemination Stage

For the dissemination stage, we introduced the web-based e-module to 24 ninth graders in secondary school for practicality test. At the beginning, students were seemed excited but nervous at the same time to explore the e-module. It seemed that students were still unaware of the presence of all the ethnoscience elements presented in the e-module. They saw the pictures and raised questions about the pictures, but they did not read the passage. This behavior confirms the idea that the presence of ethnoscience through pictures and videos as learning context trigger students' curiosity and their critical thinking (Nalarita & Listiawan, 2019). As soon as their focus shifted to the more challenging features of the e-module, such as critical thinking corner, Q&A box, and evaluation problems, they competed to finish the assignments.

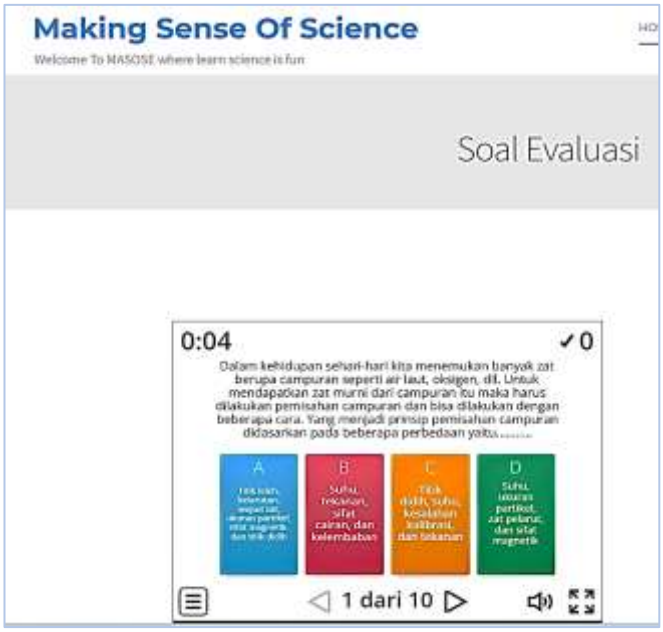


Figure 6. Sample of evaluation problem in the web-based e-module

When students were introduced to activities pictures in Figure 4a, they started asking each other and trying to guess what people were trying to find in the river. Some students even guessed that the photo was taken near a lake, some others said near a river. This serves as evidence that pictures and illustration in e-module stimulate students' interest to learn the topic (Muthmainnah et al., 2021; Novitasari et al., 2022). None of the students focused on the methods or the tools being used in the picture until they were told the name of the activity. Apparently, a majority of students were not familiar with the activity of gold panning, some of them even never saw people doing the activity. Students were seemed more familiar with the other three elements of ethnoscience that can be seen more often in coastal area or in the city. This finding confirms previous studies which found that ethnoscience helps students connect to their own culture (Atmojo et al., 2019); those who never know or see gold panning or salt farming now can relate those activity to themselves.

Students' reactions were so different when it came to evaluation (Figure 6) where they could do interactive quiz. Since they have studied the topic in the previous year, these students provide feedbacks to improve the web-based e-module on mixture separation. Students' feedbacks were collected through questionnaire of practicality which measures three aspects regarding this web-based e-module in learning, that is: ease of use, time efficiency, and advantage of use. These three aspects are compatible with four criteria of quality assessment of web-based e-module based on ISO/IEC 9126 standards which includes functionality, efficiency, portability, and usability (Nalarita & Listiawan, 2019). The result of measurement for each aspect can be described as follows.

Table 8. Practicality Testing on Ease-of-use Indicators

Ease-of-use indicators	Percentage/ Category of practicality
a. Easy to understand direction to use e-module	80%/ practical
b. Easy to follow the steps of learning activities in e-module.	79%/ practical
c. Easy to comprehend the content in e-module	80%/ practical
d. Easy to understand the relationships among concepts in the e-module	75%/ practical
e. Easy to understand the language of instruction used in e-module.	79%/ practical
f. Integration of activities of local community using mixture separation in daily life.	79%/ practical
g. Information on ethnoscience integrated into the text help students to relate the concepts to the daily life context.	78%/ practical
h. Critical thinking questions following each ethnoscience	75%/ practical

Ease-of-use indicators	Percentage/ Category of practicality
context help me think and better understand the concept for mixture separation.	
Average percentage of Ease-of-use indicators	78%/ Practical

Table 9. Practicality Testing on Study Time Efficiency

Study Time efficiency indicators	Percentage/ Category of Practicality
a. The utilization of web-based e-module helps make time of learning in class more effective and efficient	79%/ Practical
b. The utilization of web-based e-module helps students to better understand the learning materials.	83%/ Highly Practical
Average percentage of time efficiency indicators	81%/ Highly Practical

Despite the highly practical category in time-efficiency indicators, students responded moderately in terms of ease-of-use indicators. This could be due to their first-time experiences learning science with learning media on the web. None of the indicators for benefits-of-use indicators that were tested in very practical category.

Table 10. Practicality Testing on Benefits of Use

Benefits-of-use indicators	Percentage/ Category of practicality
a. Pictures and readings presented in the e-module can motivate students to find concepts	79%/ Practical
b. The questions contained in the critical thinking skills-oriented e-module lead students to find the concepts of mixture separation	78%/ Practical
c. E-module helps students draw conclusion	78%/ Practical
d. Web-based e-module helps students to understand the concept of mixture separation	75%/ Practical
e. The practice questions provided help students to understand the concept of mixture separation	74%/ Practical
f. Web-based e-module can increase students' participation in learning	74%/ Practical
g. Average percentage on advantage of use indicators	76%/ Practical

Discussion

In addition to filling the practicality questionnaires, we interviewed the teacher for feedbacks. From the interview, we found that compared to daily learning atmosphere, using e-module seemed to be more effective in triggering interaction and discussion among the students. Teacher also stated that the evaluation problem in the web was probably perceived like a game to the students, thus they are excited to do it well and get high score. Out of ten questions in the evaluation, 90% students managed to get 8 points. However, when it came to essay questions, almost all students failed to provide the adequate or acceptable responses. Most students provide one or two-words answers even though the question demand an explanation. We take a closer look to students' responses to ten essay questions in evaluation problem.

Table 11. Students' Responses to Essay Questions in Valuation

Question	Students' responses
Problem 1: If a volatile solution is put into a beaker as shown in the picture, is the above method of separating the mixture still appropriate and applicable?	95.8% students responded that the methos is still applicable while the remaining 4.2% did not answer the question.
Problem 2: Why does the thermometer have to be located at the junction of the distillation flask pipe?	Students' responses varied in explaining the position of the thermometer. 41.7% stated that it must be done for the purpose of separating the mixture; 45.5% stated that it helps to show the temperature; 8.3% stated that it helps for the mixture of substances; and the remaining 4.2% did not answer the question.
Problem 3: When can a distillation process be stopped?	79.2% students stated that the distillation process should be stopped when the liquid is gone; 8.3% stated that it should be stopped when distillate appear clear and transparent, while the other 12.5% did not give clear answer.
Problem 4: Give an example of a solution that can be separated using the method according to the picture! Explain the principle of separation that occurs in this method!	Given this question, only 4.2% of students who manage to give example of solutions, such as tea, coffee, and oil. Another 4.2% students did not answer, while the remaining 91.7% provide answers that did not correspond to the questions. Most of the examples we found among students' answers are: thermometer, filtration, principle of mixing, and uniformity.
Problem 5: What will happen if the filter paper is replaced with another paper, such as HVS paper? Can the separation process still occur?	58.3% students predicted that the separation process will not occur, 25.0% did not provide coherence answers, and the remaining 4.2% did not answer the question.

Question	Students' responses
Problem 6: The picture above shows water to be mixed with sugar. If water and sugar have mixed into a solution, what method can be used to separate the water and sugar back?	58.3% students chose distillation, 25% chose coagulation, the remaining 16.7% did not give coherence answer.
Problem 7: Based on the picture, how can the parts of the blood be separated? Explain!	62.5% students chose sedimentation, 25% chose centrifugation, 4.24% chose evaporation, and the remaining 8.3% did not answer
Problem 8: Based on the picture, will the process of separating the mixture still occur if there are no ice cubes on the top of the glass?	50% students stated that the process will not occur, 25% chose sublimation, 4.2% stated that the process will occur, and 20.8% students did not answer.
Problem 9: Explain the process that occurs in the picture above!	45.8% students stated that the solution is volatile; 33.3% wrote "distillation", 4.2% stated no evaporation, and the remaining 16.7% did not answer.
Problem 10: If the salt solution is replaced with plain water in a beaker, which evaporation process occurs faster?	16.7% students did not answer this question; 8.3% chose heated water; 25.0% chose coagulation; and 50% chose plain water.

From ten questions in table 11, students are found to provide different type of answer according to the type of questions. If it is yes/no confirmatory questions (problem 1, 5 and 8), students tend to write short answer, using one or two words. The same tendency also applies for predicting questions (problem 6 and 10). For explanation question (problem 2, 4, 7, and 9) students wrote longer answer but still were not sufficient to answer the questions. Based on our observation, students were easily triggered to think critically by presenting ethnoscience contents but they are not familiar with critical thinking questions and how to answer them. We admitted the limitation of this study in which students only got one chance to study with the web-based e-module. Therefore, further study could be done to measure the effectiveness of this web-based e-module on students critical thinking for a certain length of intervention time.

Due to the nation-wide transition period of curriculum implementation in Indonesia, we recommend that students should be exposed more to web-based e-module, since it could easily enhance students' participation and interactions during learning. Since teenagers nowadays are native to technology, they could easily adapt with the new type or learning media and quickly master how to access each feature in the web. Ethnoscience is also receives interesting feedbacks from students since some of them are born and raise in the city thus they are not familiar with traditions. In this term, ethnoscience could help bridging the science concepts in class with cultural context in order to raise students' awareness and pride of their own home and country as expected in Kurikulum Merdeka.

Students' critical thinking skills have been targeted since the implementation of Kurikulum 2013. However, this skill is cannot be instantly taught and developed in classrooms. In order to teach critical thinking, teacher must master the skill itself beforehand. Only then, teacher could figure out method or strategy to teach their students such skill. Since ethnoscience integration into science learning media and instructions has been studied many times, and have been found to give positive impacts on students learning achievement {Formatting Citation}, teachers could be willing to learn and apply the findings from those studies into their daily teaching.

The e-module was designed originally based on Kurikulum 2013, the national curriculum of Indonesian education until the middle of 2022. Content-wise, there is no significant different of science content in both curiculums. In Kurikulum 2013, the basic competency was established by MoEC, and must be applied by all schools in Indonesia. Meanwhile, in Kurikulum Merdeka, each school has the freedom to arrange the content in the syllabus which is now called ATP-Alur Tujuan Pembelajaran (translation: the flow of learning purposes). School has the authority to arrange the topic, the learning objectives, lesson hours on weekly basis and how they will help students master the minimum criteria of learning mastery. Therefore, even though the curriculum has changed, integration of ethnoscience in the e-module are still relevant since it helps students to know their cultural context and environment better. Eventually, it will help school to build Pancasila learners' profile, as intended by MoEC since science learning that is taught in connection to local culture and tradition could strengthen students' patriotism and nationalism (Damayanti et al., 2017).

Conclusion

In this study, there are four items of ethnoscience embedded in the e-module, namely: gold panning, salt farming, the making of virgin coconut oil, and Jamu– a folk drink. The web-based e-module was tested for validity and practicality resulting in very valid category and practical category. There are some room for improvements on the practicality, such as in colors, lay out, and ease of access for each picture in the web. Despite this need, we received positive feedback from

teacher and students on field test especially related to the implementation of Kurikulum Merdeka, where teacher has the freedom to arrange the lesson material according to the need and resources available around the school sites. Students exhibits enthusiasm during the dissemination stage, they seemed excited learning with computers and internet connection and easily started discussion whenever they encounter challenging problems or confusion accessing the feature in the web. The dissemination stage for this web-based e-module could be expanded into Kurikulum Merdeka.

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