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# Analysis of Validity and Practicality of Ethno-STEM Based Science E-Modules to Enhance Critical Thinking Skills and Independence of Students

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**ABSTRACT**

*This study aims to assess the validity and practicality of the development of an ethno-STEM-based IPA (Natural Sciences) E-module in the theme of Jamu (traditional herbal drink) to train students' critical thinking skills and independence. The research type is research and development (R&D) using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) instructional design. The research focuses on validity and practicality by using a questionnaire research instrument assessed by experts and practitioners with Likert scale categories techniques. The data analysis results indicate that the e-module validity in the media aspect is 40.8, the material and learning aspects is 50.9, and the language aspect is 15. The validity is distributed within the very valid category. Additionally, the practicality of the e-module of a small group of students is 80 and teachers is 85.5 and it is distributed in the very practical category. The operational practicality data suggest that student assessment is 76 or in the practical category and teacher is 82.5 or in the very practical category. The results of validity and practicality imply that the development of the ethno-STEM based science e-module in the theme of Jamu is valid and practical to be implemented to improve critical thinking skills in IPA learning.*

**Keywords**: *critical thinking skills, e-module, independence, practicality, validity*

## INTRODUCTION

The 21st educational paradigms aim to train skills, attitudes, and essential values to comprehend and overcome complex and multicultural issues (Nieto, 2017). Critical thinking is one of the fundamental skills needed by individuals to develop in-depth comprehension, identify and solve complex problems, and make a rational decision (Zubaidah, 2016). Individuals, using their critical thinking skills, can think logically by involving appropriate analysis processes, evaluations, and conclusion drawing to find solutions to a problem (Johan, 2014). Good critical thinking skills could encourage a person's ability to adapt and to wisely self-regulate in making decisions (Negru-Subtirica et al., 2016; Zubaidah, 2016).

Critical thinking skill training should be programmed and planned so it becomes a mature skill for students (Palavan, 2020). IPA (natural sciences) learning that studies natural phenomena based on the nature of the process, procedures, and products can be used to develop students' critical thinking. As a learning process, IPA involves observations and scientific reasoning and as a procedure, it covers systematical research methods. Moreover, IPA, as a product, produces

applicable knowledge (Dewi et al., 2017; Manassero-Mas & Vázquez-Alonso, 2022; Oviana, 2015). Therefore, the implementation of IPA learning based on its nature is able to encourage critical thinking to find scientific answers (Santos, 2017).

Several limiting factors in the development of students' critical thinking skills include (1) the implementation of curriculum focusing on material mastery; (2) the lack of skills of teachers in instructional models and approaches comprehension; (3) the low interest and motivation in learning and implementing critical thinking skills; (4) the lack of facilities and infrastructures to support learning activities (Chusni et al., 2020). A preliminary study generated information that the dominant learning process is centered on students and less utilization of contextual models and approaches, such as ethnoscience that can encourage students' critical thinking. The available learning media have not been designed according to students' needs and characteristics leading to less optimum learning.

Based on (OECD, 2023a), the level of proficiency in mathematics, reading, and science shows that Indonesia is at level 1a. This level indicates the low critical thinking skills among Indonesian students since they can only solve simple and general problems or problems that require explicit instruction to solve them (Suharyani & Siswanto, 2022). Full participation in the 21st-century community requires a minimum proficiency level of level 2. In this level, students are able to interpret problems and solve them without direct instructions (OECD, 2023b). Therefore, IPA learning process should be able to train students' critical thinking skills at level 2 so that students can participate in the 21st century.

Practicing critical thinking skills training can be done by implementing contextual, student-centered, and multidisciplinary learning and involving the use of technology (Mayasari et al., 2021; Saavedra & Opfer, 2015). Ethno-STEM combines local wisdom elements and STEM into a contextual and multidisciplinary learning process (Sudarmin et al., 2019). The integration of ethnoscience elements allows a learning process related to daily life that encourages active participation from students in the learning (Arfianawati & Woro Sumarni, 2016). Learning could utilize technology by integrating it through interactive teaching materials, namely electronic modules or e-modules.

The development of e-modules requires an assessment to evaluate the feasibility of the development results. This is the basis to conclude whether the e-modules meet the development goal aspects and are ready to be implemented in learning. (Asyafah, 2019) states that the development of a good e-module must fulfill the validity or feasibility aspects in terms of content and practicality or ease of use in learning. Therefore, the current study aims to assess the validity and practicality of an ethno-STEM-based IPA e-module to train students' critical thinking skills and independence.

## METHODOLOGY

The research was research and development by implementing the ADDIE instructional design (Branch, 2009). The selection of the procedure was based on the model's ability to review various stages in the development procedures and the nature of each interrelated phase of the development (Allen, 2006). The ADDIE procedure includes analysis, design, development, implementation, and evaluation.

The validity of the e-module was carried out in the development stage based on the findings and evaluations in the analysis and design stages. The validity consisted of the assessment of media, material, and learning validation by 4 (four) experts, and language validation by 2 (two) experts. The validation aimed to produce a product that is feasible and can be applied to learning.

The e-module practicality was conducted in two stages, namely small group tests that involved 10 students and 2 (two) IPA teachers and operational tests on 55 students and 6 (six) IPA teachers. The practicality test involved teachers and students of SMP Negeri 1 Tempuran and SMP Negeri 2 Tempuran. The purpose was to produce a practical product that can be used in learning. The instruments of the e-module validity and practicality assessments were questionnaires with Likert scale categories. Data generated from the e-module validity and practicality were analyzed and categorized using the feasibility assessment interval by (Azwar, 2007) as presented in Table 1.

**Table 1. Feasibility Category Interval**

| Interval score of Assessment result | Category |
|---|---|
| Mi + 1,5 Sbi < X | Very Valid |
| Mi + 0,5 sbi < X ≤ Mi + 1,5 Sbi | Valid |
| Mi - 0,5 Sbi < X ≤ Mi + 0,5 sbi | Quite Valid |
| Mi - 1,5 Sbi < X ≤ Mi - 0,5 sbi | Less Valid |
| X ≤ Mi - 1,5 Sbi | Exceptionally Less Valid |

Note :
X : Assessment score
Mi : Mean ideal
($^1/_2$ maximum score + minimum score)
Sbi : Ideal standard deviation
($^1/_6$ maximum score – minimum score)

The results of the validation analysis for the ethno-STEM-based IPA e-module for *Jamu* theme were interpreted based on Table 2.

**Table 2. Interpretation of E-module Validation**

| Interval score for media validation | Interval score for material and learning validation | Interval score for language validation | Category |
|---|---|---|---|
| 35,75 < X | 55,25 < X | 13 < X | Very Valid |
| 30,25 < X ≤ 35,75 | 46,75 < X ≤ 55,25 | 11 < X ≤ 13 | Valid |
| 24,75 < X ≤ 30,25 | 38,25 < X ≤ 46,75 | 9 < X ≤ 11 | Quite Valid |
| 19,25 < X ≤ 24,75 | 29,75 < X ≤ 38,25 | 7 < X ≤ 9 | Less Valid |
| X < 19,25 | X < 29,75 | X < 7 | Exceptionally Less Valid |

The results of the practicality analysis for the ethno-STEM-based IPA e-module were interpreted based on Table 3.

**Table 3. Interpretation of Practicality**

| Interval Score of the Assessment Results | Category |
|---|---|
| 13 < X | Very Practical |
| 11 < X ≤ 13 | Practical |
| 9 < X ≤ 11 | Quite Practical |
| 7 < X ≤ 9 | Less Pratical |
| X < 7 | Exceptionally Less Practical |

## RESULT AND DISCUSSION

The validity and practicality analyses of the ethno-STEM-based science E-module in the theme of *Jamu* to enhance students' critical thinking skills and independence was based on the development stage in the ADDIE development procedure. The module development also referred to the results of findings and evaluations in the analysis and design stages.

The findings in the analysis stage indicate that the learning aspect requires learning activities that support ease of material comprehension, student-centered, and oriented to the enhancement of critical thinking skills and independence. This is supported by the results of teachers' responses stating that students' critical thinking skills and independence are low. Referring to the critical thinking indicators by Facione (2015), distributed indicator often performed is only analysis, whereas interpretation, inference, evaluation, explanation, and self-regulation indicators are rarely performed.

Based on the independent dimension of Pancasila student profile from the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek (2022)), good mastery in independence element is found in the elements of self-understanding and understanding of situations faced, while the elements of self-regulation are less mastered by students indicated by the low ability to manage emotions in discussion activities and responsibility in collecting learning assignments.

The school environment of SMP Negeri 1 Tempuran and SMP Negeri 2 Tempuran which has *Jamu* village offers the potential to become an ethnoscience content that is contextual to student characteristics. The results of interviews and scientific explanations indicate that *Jamu* production process comprises the selection of equipment, handling of *jamu* raw materials, and production process. These processes are applicative in explaining IPA materials integratedly related to the topics of elements, mixed compounds, plant classification, and form of substances and their changes. The results of the mapping of ethno-STEM elements of *Jamu* in the e-module are presented as follows.

**Table 4. Mapping of the Ethno-STEM Elements in the E-Module**

| Ethno | Science | Technology | Engineering | Mathematics |
|---|---|---|---|---|
| Review the selection of *jamu* production equipment | a. Explain the concept of elements, compounds, and mixtures<br>b. Classify the grouping of elements, compounds, and mixtures<br>c. Analyze the physical and chemical properties in substances<br>d. Apply the concept of elements, compounds, and mixtures, and the physical and chemical properties of substances to perform the selection of *jamu* production equipment | Use various equipment for *Jamu* boiling | Design an experiment on *jamu* equipment utilization | Determine the selection of *jamu* equipment that is able to enhance the effectiveness and quality of *jamu* production |
| Review the *jamu* production process | a. Identify characteristics of medicinal plants based on the morphological characteristics<br>b. Analyze physical and chemical changes of substances | Utilize PlantNet & PlantAmor application to identify plants | Design an experiment of the selection process and handling of *jamu* raw matrials | Present a comparative graph of the ratio of water content in the material drying process |
| Review the *jamu* production process | a. Identify types of mixtures<br>b. Compare characteristic differences in the types of mixtures<br>c. Perform mixture separation | Utilize various equipment in jamu production | Design an experiment activity of *jamu* production process | Carry out measurement and calculation of mixture composition |

The design stage was carried out by designing components of the e-module based on the analysis results. This included (1) determination of learning achievements, (2) formulation of learning objectives, (3) formulation of learning objective achievement indicators, and (4) design product concept. The results of the product concept design contain 10 components consisting of

main menu, user manual, learning information, *jamupedia*, learning materials, learning activities, assessments, glossary, about us, and Ask the Teacher. The e-module components are arranged into a storyboard as a basis for presenting the e-module learning flow.

## Development Stage

The display of the e-module development results containing findings in the analysis and design stages can be accessed at the following link https://kevinaditia469.wixsite.com/etnho-stemjamu or as indicated in Figure 1.


**Figure 1. Display of E-module**

Figure 1 indicates that the e-module developed in the form of a website contains 10 main components as follows: (1) The main menu contains information on the title, authors, and learning menu; (2) The user manual consists of information on the use of module and the functions of buttons and pre-test questions; (3) Learning information contains learning achievements, learning objectives, achievement indicators, and IPA integration map; (4) Learning activities comprise 3 (three) learning activities including experiments in selecting *jamu* equipment, experiments in selecting and handling materials, and experiments in *jamu* production. The learning activity syntax uses guided inquiry design, namely open, immerse, explore, identify, gather, create, share, and evaluate (Kuhlthau et al., 2007); (5) *Jamupedia* contains information on each stage in the *jamu* production; (6) Learning materials contain information on materials in the topics of elements, compounds, mixtures, plant classification, and forms of substances and their changes; (7) Assessment contains posttest questions on critical thinking skills and independence; (8) About Us contains information on the e-module design; (9)Glossary contains important terms in the e-module; (10) Ask the Teacher is a pop-up feature to ask teachers using *WhatsApp*.

## E-module Validity

The e-module feasibility evaluation is based on expert validation (Nieveen, 1999). The e-module validation consisted of media validation and material and learning validation each by 4 (four) experts, and language validation by 2 experts. The results of the e-module validation are presented in Table 5.

**Table 5. Validation Analysis of the Ethno-STEM-based IPA E-module in *Jamu* Theme**

| Media validation aspect | Average score | Material and learning validation aspect | Average score | Language validation aspect | Average score |
|---|---|---|---|---|---|
| Visual communication | 22 | Content feasibility | 28 | Communicative | 7,5 |

| Media validation aspect | Average score | Material and learning validation aspect | Average score | Language validation aspect | Average score |
|---|---|---|---|---|---|
| Technical | 18,8 | Presentation feasibility | 31,3 | Term accuracy | 7,5 |
| Total score | 40,8 | Total score | 59,3 | Total score | 15 |
| Category | Very valid | | Very Valid | | Very Valid |

Table 5 indicates that the overall results of the IPA e-module validation meet the feasibility aspects regarding media, material and learning, and language. This is suggested by the average total score of the media aspect of 40.8, the material and learning aspect of 59.3, and the language aspect of 15, which are within the very valid category based on the assessment interpretation in Table 2. According to (Azwar, 2007), a product is feasible if the three assessment aspects meet the minimum sufficient criteria.

The media validity obtained an average score of 40.8 which consisted of feasibility in the visual aspect of 22 and technical aspect of 18.8. Good validity is affected by module characteristics containing multimedia elements suitable to the closeness of students' visual communication thus encouraging learning interest and motivation. This drives students' independence since learning motivation is a factor that develops independence (Setianingrum et al., 2022). The development of technology-based media also allows students to be more initiative in achieving learning objectives (Jaleel & O.M., 2017). The technical aspect of electronic modules is integrated thus stimulating the achievement of self-instructional, adaptive, and user-friendly principles (Elisa et al., 2022). These advantages are the basis that the developed product has media elements feasible to be used in learning.

The average score obtained in the material and learning validity was 59.3 consisting of content feasibility aspect of 28 and presentation feasibility aspect of 31.3. Good validity indicates that the product development carried out meets the criteria that support the learning process (Utami et al., 2022). (Puspita, 2019) stated that good modules contain learning achievements, substance of materials, and evaluation, and the developed module has met these aspects. The presentation of the e-module is equipped with guided inquiry learning models that encourage students to make discoveries using the scientific method approach (González et al., 2015). This can assist students in developing critical thinking skills and concept understanding (Ravista et al., 2021). Learning presentation that contain ethno-STEM elements makes learning contextual so that it encourages active participation from students in learning (Arfianawati & Woro Sumarni, 2016).

The language validity score of 15 consisted of communicative aspect of 7.5 and a term accuracy aspect of 7.5. The result indicates that the language presentation in the e-module is communicative and has the correct language rules. (Ravista et al., 2021) suggest that communicative languages can improve students' learning interests. A communicative and simple language presentation facilitates students' comprehension on learning information and has conformity with the development level of junior high school (SMP) students (Sudibyo & Rahdiyanta, 2021).

Despite the feasible results of the ethno-STEM-based IPA e-module validation, suggestions and inputs are provided to improve the e-module quality. Suggestions and improvement conducted are presented in Table 6.

**Table 6. Suggestions and Improvements based on Expert Assessment**

| No | Validator | Suggestion | Revision |
|---|---|---|---|
| 1. | Media | Add a back button on each e-module part | Added a back button on each e-module page |
| | | Improve the display ratio and color contrast between buttons and background | Fixed the display ratio of the module to be accessible on one screen and made changes to the button color contrast |

| No | Validator | Suggestion | Revision |
|---|---|---|---|
| | | Add download feature for student experiment report results and online discussion feature | Added download icon for report result and online discussion icon through WhatsApp group. |
| 2. | Material and Learning | Display learning indicators that show engineering elements | Added indicators with designing KKO that reflect engineering elements in learning |
| | | Add depth to the materials and their relationship to the *jamu* theme. | Added depth to the materials and provided examples in *jamu* production process |
| | | Display mentor questions in each activity that reflect guided inquiry | Added mentor questions in the problem formulation and LKPD |
| | | Add concept understanding test in the exploration stage (let's understand) | Added a concept understanding quiz after the "let's understand" activities. |
| 3. | Language | Correct spelling, punctuation, and preposition accuracy | Revised spelling, punctuation, and preposition in the e-module. |

## E-module Practicality

Product practicality is based on the assessment of teachers and students with a goal to consider ease of use in learning (Mckenney & Reeves, 2013). The practicality assessment in this research was carried out in two stages, namely a small group test that involved 10 students and 2 teachers and an operational scale test that involved 55 students and 6 teachers. The analysis description of the e-module practicality results is presented in Table 7.

**Table 7. Small Group Practicality Analysis**

| Aspect | Student average score | Teacher average score |
|---|---|---|
| Easy of use | 18 | 19,5 |
| Efficiency of learning time | 7 | 7 |
| Attractivenes | 10 | 15 |
| Benefits of critical thinking skills | 20 | 22,5 |
| Benefits of independence | 24 | 25 |
| Total | 80 | 85,5 |
| Category | Very practical | Very practical |

Table 7 suggests that the practicality results in the small group test based on the student and teacher assessments were 80 and 8,5, respectively or within the very practical category referring to Table 3. These results imply that the developed e-module is easy to use, attractive, and supports learning effectiveness. In the small group practicality test, several findings need to be considered in the operational test, namely making sure the setting of the smartphone screen color is not in the dark mode and requiring a backup internet data source to anticipate obstacles to the effectiveness of learning time. Moreover, teachers need to supervise students' accuracy in following the learning flow.

**Table 8. Operational Practicality Analysis**

| Aspect | Average student score | Average teacher score |
|---|---|---|
| Easy of use | 16 | 18,7 |
| Efficiency of learning time | 7 | 7 |
| Attractiveness | 10 | 11 |
| Benefits of critical thinking skills | 20 | 21,3 |
| Benefits of independence | 23 | 25 |
| Total | 76 | 82,5 |
| Category | Practical | Very practical |

Table 8 indicates the results of the practicality test on the operational scale. The average score for the student assessment was 76 or within the practical category, whereas the teacher assessment's

score was 82.5 or within the very practical category based on the assessment interpretation in Table 3. A product is practical if practitioners such as teachers and students view the product as having good quality such as being useful, easy, and interesting to use (Asrizal et al., 2021). This implies that the developed ethno-STEM-based IPA e-module meets the aspect of ease of use in learning from the perspective of teachers and students. The ease of use of the e-module is due to the complete instructions for use and explanatory description in each learning stage. The e-module presentation supports the user-friendly principle that allows flexible access in various conditions (Suastika, 2023). E-modules with images, videos, and interactive quizzes are attractive and support smooth learning. Activities in modules that apply ethno-STEM approaches give rise to experimental activities that are beneficial to enhance students' independence and critical thinking skills.

The comparison of practicality test results in the small group and operational suggests a decrease in the main score in students' assessment results. In the small group test, the e-module practicality is in the very practical category, while in the operational test is in the practical category. This is influenced by differences in the number of users. The more the number of users, the more the variation in the assessments that depend on the users' perception. However, overall, the e-module practicality is above the minimum feasibility criteria, which is sufficient (Azwar, 2007).

## CONCLUSION

Based on the research results, the development of the ethno-STEM-based IPA e-module on the theme of *Jamu* to enhance students' critical thinking skills and independence is valid and practical; therefore, the product meets product feasibility in the aspects visual communication, technical, content feasibility, presentation feasibility, communicative, and term accuracy. The developed product meets the practical and very practical from the perspective of students and teachers in the aspects easy of use, efficiency of learning time, attractiveness, benefits of critical thinking skills, and benefits of independence. Suggestions from experts include teachers and students are the basis in improving the e-module quality for use in the learning process.

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