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Development of STEAM-Based Ethnomathematics Modules for Enhancing Students' Problem-Solving Skills in Social Arithmetic

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Abstract: Fostering problem-solving skills in social arithmetic is challenging as students often find the topic unengaging, hindering effective teaching and participation. This study aimed to design and develop STEAM and ethnomathematics-based e-module as a valid, practical, and effective learning resource for Grade VII junior high school students studying social arithmetic. By integrating the cultural context of Kudus culinary traditions, the e-module sought to enhance students' problem-solving abilities and engagement. The research utilized Hannafin and Peck's development model combined with Tessmer's formative evaluation approach, involving expert validation, individual trials, small group evaluations, and field testing. The findings revealed that the e-module was highly valid, with expert evaluations scoring it at 91.5%. Practicality assessments yielded scores of 98.3% for individual trials and 98.2% for small group evaluations, both categorized as "very practical." The module significantly improved learning outcomes, with an average score improvement of 43.6% and an N-Gain score of 71.6%, indicating its effectiveness. Moreover, the e-module enhanced students' problem-solving abilities by 41.8%. This study highlights the potential of integrating STEAM and ethnomathematics with cultural elements to create engaging learning materials, offering an innovative approach to improving students' mathematical understanding and problem-solving skills.

Keywords: etnomathematics, problem solving, STEAM.

▪ INTRODUCTION

Mathematics plays a critical role in various aspects of life and serves as a fundamental element in the current success of communication and information technology(Irfan, Suryaningrum, Pusporini, & Widodo, 2023; Zaenuri, Mukeriyanto, & Mulyono, 2020). In school, mathematics is a core subject that requires students to develop critical thinking skill. Recent studies have focused on analyzing problem-solving processes in education processes as one of the essential skill in 21st century (Herlinawati et al., 2024). According to Nunokawa (2001), an important perspective in problem-solving is understanding how the problem solver comprehends the situation as it begins to change and adapt. In educational settings, this ability involves several stages, including understanding the problem, formulating a solution strategy, implemeting the strategy, and evaluating the outcomes (Nindiasari et al., 2024; Park & Kwon, 2022).

The STEAM learning approach is an interdisciplinary approach integrating five core fields: Science, Technology, Engineering, Arts, and Mathematics. This approach offers a comprehensive learning experience by combining creativity with technical skills. In STEAM-based learning, students are encouraged to address real-world problem through projects that require the application of knowledge from these five domains (Adriyawati, Utomo, Rahmawati, & Mardiah, 2020; Hawari & Noor, 2020). Therefore, STEAM is a suitable approach for enhancing problem-solving abilities.

Learning tools is an integral aspect of the teaching and learning process. Appropriate learning tools can aid teachers in delivering effective lessons to accomplish

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the desired educational objectives. One of the commonly used tools is teaching materials, which can be classified into various types. As per Suarman, Hendripides, & Hikmah (2018) the form of teaching materials can be classified into printed and non-printed materials. Printed teaching materials include lecture notes, problem-solving guides, and learning guides, while non-printed teaching materials may take the form of audio, video/film, or other multimedia resources essential in the learning process. Among these learning tools, teaching modules play a crucial role, serving as guides for both teachers and students. In light of the growing emphasus on technology integration in education and the increasing demand for online instruction, self-regulated e-learning modules have emerged as an innovative teaching strategy to enhance student success and outcomes (Logan, Johnson, & Worsham, 2021). Additionally, the term ethnomathematics is used to describe the relationship between culture and mathematics (D'Ambrosio, 2020).

One of the cultural aspects of Indonesia is the traditional food of Kudus-a city in Central Java, Jenang Kudus, Lentog Tanjung, and Getuk Nyimut. Kudus's traditional foods' production and distribution processes are related to social arithmetic concepts in mathematics learning. These processes were used to illustrate arithmetic operations with integers, calculate real numbers, and calculate costs, profits, losses, and discounts. Meanwhile, netto, bruto, and tare is used to illustrate arithmetic by calculating the net weight of a product, the overall weight of a product, and the weight of a product's packaging. Integrating mathematics with local culture, which is familiar to students, contextualizes learning and enhances its appeal. The integration of the concept of culture and mathematics is effective in improving students' mathematical abilities and love of their culture, abits that are carried out every day will make it easier for students to understand mathematics and be motivated in learning mathematics (S. Rezeki, Andrian, Wahyuni, & Nurkholisah, 2020; Sri Rezeki, Andrian, & Safitri, 2021; Zubaidah Amir, Risnawati, Nurdin, Azmi, & Andrian, 2021)

Suprapto, Rizki, & Kholiq (2024) emphasized that through the analysis of culture, interdisciplinarity, and real-world analysis, the view of the role of mathematics and its use can be improved. By integrating ethnomathematics and STEAM, students can learn tangible aspects of learning with culture in the surrounding environment and engage directly in learning activities related to science, technology, engineering, and art. There is a mathematical connection between ethnomathematics and STEAM in practice. Das (2020) highlighted that implementing hands-on STEAM education at the elementary school level significantly transforms students' learning methods. This approach enables students to develop critical thinking and problem-solving skills through project-based activities involving science and technology. Similarly, Supriyadi et al. (2024) found that this approach significantly benefits students' understanding of mathematics. The e-module connects mathematical concepts with cultural elements, particularly the Sundanese gamelan, making learning more contextual and relevant for students.

This study was motivated by a preliminary investigation conducted by the authors, which assessed students' problem-solving skills using Polya's problem-solving indicators. The results revealed that students demonstrated low levels of problem-solving ability in the material previously studied. The problem solving test carried out using Polya's problem solving indicators, the result showed that the level problem solving skills among students' is low. To improve students' problem-solving skills, an e-module was developed to explore how local culture can be incorporated into a STEAM learning tool. Referring

to previous research findings and the issues identified, this study offers a novel contribution by developing a STEAM-based culture of Kudus e-module. This research and development was conducted to develop STEAM and ethnomathematics-based e-modules for grade VII junior high school students who are learning social arithmetic, a Valid, Practical, and Effective Product, titled "Belajar Aritmetika Melalui Eksplorasi Makanan Tradisional Kudus". By incorporating local culture into STEAM education, this research seeks to improve students' problem-solving abilities and create a more engaging and relevant mathematics learning experience.

▪ METHOD

Participant

The population in this study comprised all seventh-grade students at a junior high school in Semarang City who were learning mathematics as part of their curriculum. From this population, class 7A, consisting of 30 students, was selected as the sample through purposive sampling. This method was chosen to align with the study's objectives, as class 7A, had already been taught the Whole operations, Fraction operations, required for understanding social arithmetic, making them more prepared to learn this topic compared to other classes at the school.

Research Design and Procedure

This study employed a Research and Development (R&D) design to develop a valid, practical, and effective e-module for teaching social arithmetic. The R&D approach focuses on systematically designing, testing, and refining educational products to meet specific learning needs (Hannafin & Peck, 1988). The development process followed the Hannafin and Peck model, which includes three key phases: needs assessment, design, and development and implementation. To ensure the e-module's quality, Tessmer's formative evaluation approach was integrated into the design, involving expert reviews, individual trials, small group evaluations, and field testing Tessmer (1998). This iterative process allowed for continuous refinement of the e-module, ensuring its validity through expert validation, practicality through user feedback, and effectiveness through improvements in students' problem-solving skills and learning outcomes. The integration of Hannafin and Peck's design model with Tessmer's formative evaluation is illustrated in Figure 1 below.

Need Assessment

The first phase involves conducting a needs assessment to identify the challenges and requirements teacher face when teaching the topic of whole number operations. Explore what strategies they have implemented to address these challenges and, most importantly, determine what additional support they need to enhance their teaching within the classroom learning environment. Interviews were conducted with mathematics teacher and 7th-grade students from junior high schools in Semarang to gather insights into the obstacles and needs in mathematics learning.

Design

The second phase focuses on designing the product to address the specific learning needs of teacher and students identified during the needs assessment. This phase aimed to create an engaging and effective e-module to support mathematics learning activities

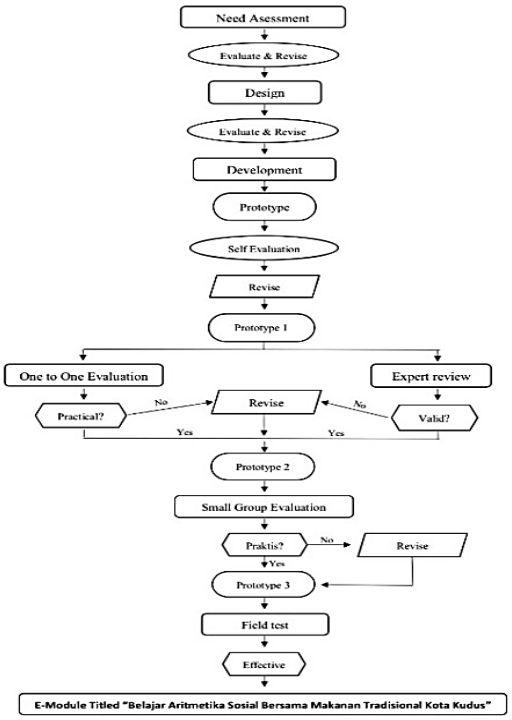

Figure 1. Development modification procedure of hannafin and peck and tessmer formative evaluation (Ariesta, 2015)

by connecting mathematical concepts to real-world contexts. The design incorporated material, context, and a visually appealing cover for the e-module. To make the learning experience contextual and meaningful, the e-module integrated the production and distribution processes of Kudus City's traditional foods, such as Jenang Kudus, Lentog Tanjung, and Getuk Nyimut, as practical applications of social arithmetic concepts. These processes were used to illustrate key topics such as arithmetic operations with real numbers, calculating costs, profits, discounts, and distribution shares, as well as making predictions and solving problems based on real-world scenarios. By exploring how local foods are produced, priced, and distributed, the e-module contextualizes abstract mathematical concepts in students' everyday experiences.

Develop and Implementation

The third phase involves development and implementation of the product to meet the learning requirements of 7th graders, based on issues and requirements identified in interviews. After identifying the issue and creating the product to aid learning, the researcher finalizes the product. This e-modul aimed to be valid, practical, and efficient in helping students grasp the subject. During this stage, the necessary actions are performed, which include the self-evaluation Phase; the researcher will self-evaluate the advice from the guiding lecturer. From the results of the self-evaluation process, the researcher is going to revise the E-Module prototype, and then the researcher will revise the interface based on the criticisms and suggestions from the guiding lecturer; Expert Review, the developed module is going to be reviewed by experts using questionnaires. The expert reviewers consist of two math education lecturers, two junior high school math teachers, one ICT teacher, and one learning design expert; One-to-One Evaluation, the

researcher presents the e-module prototype (prototype 1) to the subjects along with a questionnaire to review the content of the product. The subjects were three 7th-grade students consisting of low, medium, and high-achieving students from different classes as samples. The students' academic achievements can be analyzed from report cards or a list of test scores; Small Group Evaluation, the researcher presents prototype 2 to the subjects along with a questionnaire to review the content of the product. The subjects consist of nine students coming from different classes as samples. Out of the nine students, three are high achievers, three are medium achievers, and three are low achievers; Field Test, the researcher is going to conduct a pre-test, and then the researcher will give prototype three, for which the validity and practicality have been tested. A post-test is administered at the end of this phase to identify enhancements in student learning the post-test is conducted to ensure the researcher that the product is effective.

Instruments

The data collection in this study employed two types of instruments. Non-test instruments included response questionnaires using a Likert scale, while test instruments consisted of essay-based test sheets. Researchers developed pre-test and post-test items, which were been tested in the 9th grade. Response questionnaires were used to collect feedback from subject matter experts, experts in learning media and design. The test items had varying levels of difficulty levels and problems but included similar indicators for problem-solving.

Data Analysis

The quantitative data in this study includes problem-solving ability scores obtained from pretest and posttest assessments. Data distribution was described using descriptive statistics, including displaying data in graphical form and appropriate measurement statistics. The effect of e-modules was analyzed using inferential statistics involving mean difference tests and N-Gain tests to assess the impact of using e-modules on students' problem-solving abilities.

To evaluate the effectiveness of the product *"Belajar Aritmetika Melalui Eksplorasi Makanan Tradisional Kudus"*, which integrates Kudus' local culture, in enhancing middle school students' problem-solving abilities in social arithmetic, mean tests (pretest and postest) and N-gain tests were utilized The procedure for examining test score information is outlined as follows: determine the scores obtained before and after the test; find out the average scores before and after the test; find out the extent to which the pre-test and post-test scores vary. Compare the pre-test and post-test outcomes for discrepancies; to determine students' problem-solving skills, organize the average results of the post-test. Problem-solving abilities were evaluated using a five-point scale, divided into five categories: "Very Poor" (0-20), "Poor" (21-40), "Fair" (41-60), "Good" (61-80), and "Very Good" (81-100).

The N-Gain test was employed to measure the efficacy of the intervention using a one-group pre-test and post-test design. The N-Gain test can also assess the efficiency of studies with a control group. By measuring the difference in scores before and after the test (Gain Score), we can ascertain whether the use of the STEAM-based Ethnomathematics E-module, incorporating Kudus' local culture in social arithmetic, improves problem-solving skills in middle school students. The formula used to compute the Normalized Gain (N-Gain) is according to Hake (1999). Once the N-Gain score is

obtained, classify it to evaluate the efficiency of the created e-module. N-Gain efficiency by group as outlined by Meltzer (2002) remains were evaluated using a five-point scale, divided into three categories: "High" ($g \geq 0.7$), "Moderate" ($0.7 > g \geq 0.3$), and "Low" ($g \leq 0,3$).

▪ RESULT AND DISSCUSSION

Need Assessment

The needs evaluation of needs took place at a Junior High School in Semarang. Through interviews with teachers with more than 5 years of experience teacher and seventh-grade students, several issues were identified. During math lessons, the teacher noted that students were not engaged or interested in learning due to the absence of interactive materials in the e-module, which was limited to textbooks, workbooks, and teacher slides. The e-module did not address the actual challenges faced by students. Students mentioned that the math textbook could be monotonous at times despite the school's excellent facilities and infrastructure that align with technological advancements at Junior High School.

Design

Following the Needs Analysis Phase, the subsequent step involves the Design Phase for Learning Arithmetic Through the Exploration of Traditional Holy Foods. During this phase, an outline of the e-module content and the flipbook design for the e-module is created. The e-module Outline includes important sections such as title, foreword, table of contents, learning instructions, objectives, material map, content, STEAM-based exercises, and references. This outline adheres to the curriculum and syllabus guidelines. The results of converting the e-module into a flipbook format involve creating a cover image and designing the layout for each page of the e-module. The e-module can be accessed through this link: https://heyzine.com/flip-book/8cd107d3a1.html

Development

The item has been deemed valid, practical, and efficient following multiple assessment phases. The evaluation aims to ascertain the product's quality before being used by students.

Self-Evaluation Phase

The researcher conducted a self-assessment based on suggestions from the guiding lecturer. From the results of the self-evaluation, the researcher made corrections by organizing the table of contents, refining the text in the e-module, adding averages in the e-module, and adjusting image descriptions. Additionally, the researcher adjusted the layout following feedback from the guiding lecturer. This phase's result is denoted as prototype one. Below is the revised version of the product.

Expert Review Phase

This assessment was conducted using a questionnaire sheet involving three expert validations: content validation, learning media expert validation, and learning design expert validation. The expert evaluations of the " Belajar Aritmetika Melalui Eksplorasi Makanan Tradisional Kudus " are as follows:

Table 1. Validation result

Validator	Result
Expert Material	94%
Expert Material	79%
Expert Material	93%
Expert Material	88%
Design Expert	95%
Media Expert	99%
Total Average	91.3%

According to the expert validity questionnaire results, prototype one attained an average validity score of 91.3%, classifying it as highly valid. The revision of the product's ethnomathematics content must include details, STEAM integration, and writing accuracy. Below is the revised version of the product.

Figure 2. Ethnomathematics content before Revision

Figure 3. Ethnomathematics content after Revision

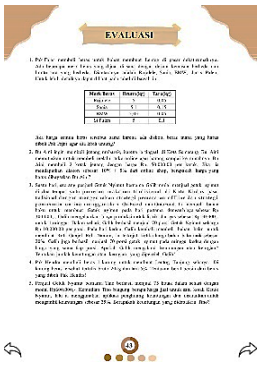

Figure 4. Writing accuracy before revision

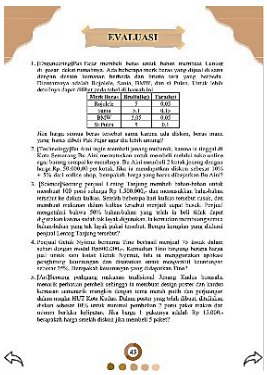

Figure 5. Writing accuracy after revision

Figure 6. STEAM content before revision

Figure 7. STEAM content after revision

One-to-One Evaluation

In the one-to-one evaluation phase, the researcher involved three students with varying abilities, which are low capability, medium capability, and high capability, based on the teacher's recommendations. This stage aimed to determine the practicality of prototype 1 through an independent practicality questionnaire completed by each student. Feedback and suggestions from the students served as valuable input for the researcher. The questionnaire Score is provided in Table 4 below.

Table 2. Recapitulation of student responses at one to one evaluation

Name	Score
NHM	99%
NCP	97%
AASD	99%
MAF	94%

According to the expert validity questionnaire results, prototype one attained an average validity score of 91.3%, classifying it as highly valid. The revision of the product's ethnomathematics content must include details, STEAM integration, and writing accuracy. Below is the revised version of the product.

Small Group

After revising prototype one based on student feedback and suggestions, prototype two was created. Subsequently, prototype two was tested in a small group setting. In this phase, the researcher involved nine seventh-grade students to evaluate prototype two of the product. The students completed a response questionnaire for prototype two to assess its practicality. The student response scores prototype 2 are illustrated in Table 5 below.

Table 3. Recapitulation of student responses at small group evaluation

Name	Indicator			Total
	Appearance	Material	Benefit	
CD	38%	27%	29%	94%

AN	39%	30%	30%	99%
TAS	39%	30%	30%	99%
MAF	37%	28%	29%	94%
CNA	39%	30%	29%	98%
CR	39%	30%	30%	99%
ADNA	38%	28%	28%	94%
TAI	40%	30%	29%	99%
DASN	38%	29%	29%	96%

Regarding the student responses to the STEAM-based ethnomathematics e-module, the average score of 96.9% is in the very practical. The results are depicted in the figure below for a visual comparison of the students' questionnaires in one-to-one evaluation and small group. Chart of students' questionnaires in one-to-one evaluation and small group.

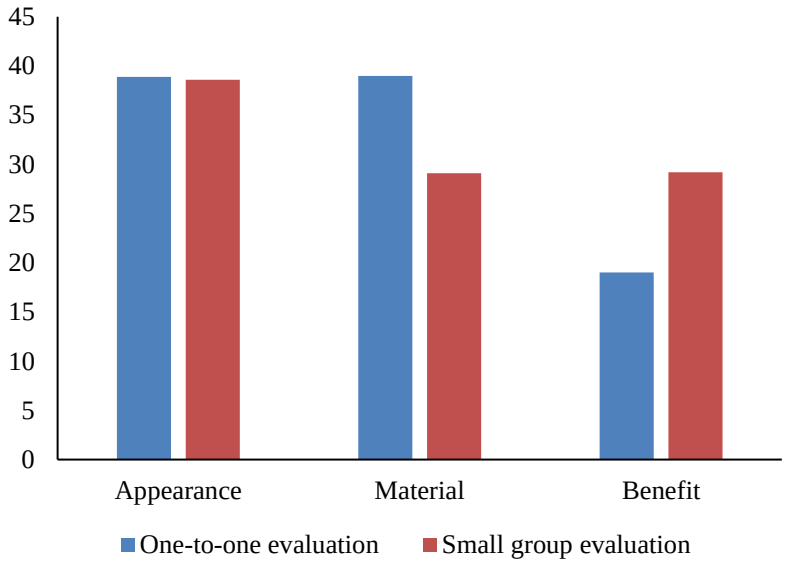

Figure 8. Students' questionnaire in one-to-one and small group evaluation

Field Test

Following the data analysis procedure, the initial steps included determining the pre-test and post-test scores, calculating the average (mean), and then comparing these scores. The pre-test and post-test data in this study consisted of essay questions covering seventh-grade Social Arithmetic material, comprising a total of 3 questions. The pretest was conducted before the STEAM-based e-module treatment, while the post-test was conducted after the STEAM-based e-module treatment had been provided.

Table 4. Post-test results on field test

Total of Students	Precentage
7	23.33 %
17	56.67 %
5	16.67 %

1	3.33 %
0	0 %

After calculating and comparing the mean test scores for seventh-grade students, they are illustrated in the images below for a visual comparison of the students' pretest and post-test performance. Figure 10. Chart of Post-test – Pre-test Score.

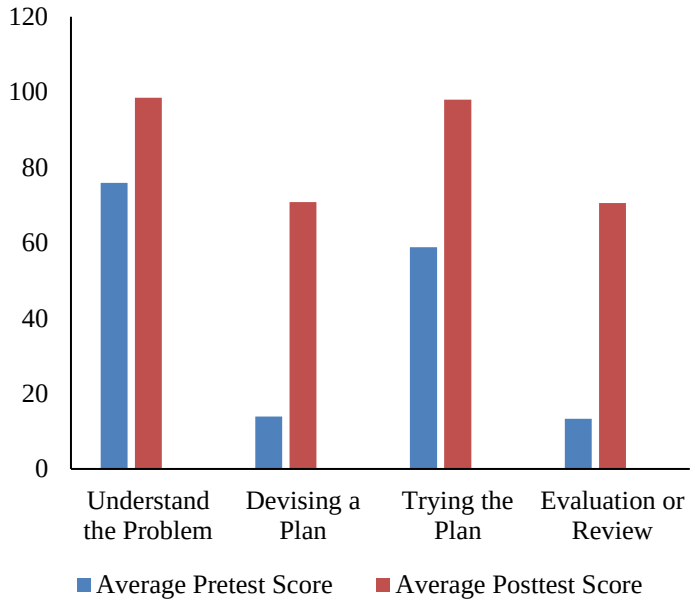

Figure 9. Chart of posttest-pretest score

Based on the analysis results, it can be observed that the average score in the seventh-grade class for the pre-test was 43.2, with an achievement rate of 43.2%. In contrast, the post-test average increased to 85 with an achievement rate of 85%. This represents an increase in the average score of 41.8 or a percentage increase of 41.8%. The post-test results are in the Good category for the level of students' problem-solving abilities.

Normality Test

The Kolmogorov-Smirnov method was utilized for the normality test in this research. According to the analysis findings, the p-value for the Kolmogorov-Smirnov test is higher than 0.05 for both the pretest and post-test variables. The pretest yielded a significance result of (0.2 > 0.05), while the post-test resulted in a significance of (0.054 > 0.05). This shows that the variables in this research follow a normal distribution. Following this, an N-Gain examination was carried out due to the confirmation that the information and factors in this research are distributed in a normal manner. N-Gain Test.

N-Gain Test

After performing the statistical calculation procedures using SPSS, the N-Gain results were provided.

Table 5. N-Gain result

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain	30	.17	.97	.7167	.15623
N-Gain(Persen)	30.00	17.24	96.88	71.6733	15.62309

Based on Table 7 N-Gain calculations shown in the image above, the average (mean) N-Gain value is 0.716 or 71.6% in percentage. Thus, referring to the standard interpretation of N-Gain effectiveness as outlined in the table above, the N-Gain test results fall within the High category or Effective.

These findings are in line with Beisly & Moffitt (2024) conclusion that integrating art within the STEAM (Science, Technology, Engineering, Art, and Math) approach can help make science concepts easier for students to understand. This research shows that art can be an effective visualization tool in teaching abstract science concepts, providing a more in-depth and meaningful learning experience for students. In addition, Putri, Zulkardi, & Riskanita (2022) found that the use of the local cultural context of Palembang, in learning algebra is able to improve students' mathematical problem solving skills, they more easily understand the problem and find relevant solutions and show that the integration of cultural context not only improves students' understanding of the material, but also motivates them to be more active in solving problems. The following section presents the N-Gain results across various indicators of problem-solving skills.

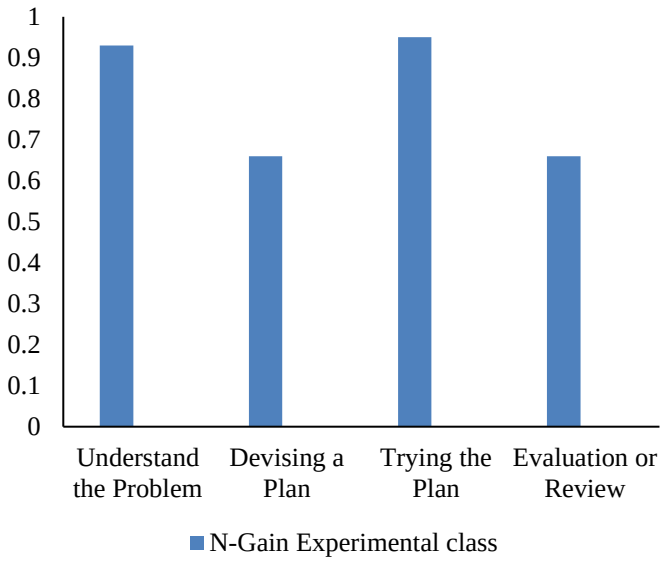

Figure 10. Chart N-Gain score

The diagram shows that the "understanding the problem" indicator achieved the N-Gain score of 0.93 followed by "devising a plan" at 0.66, "trying the plan" at 0.95, and "evaluation or review" at 0.66. These results indicate that although students excel in understanding the problem and working on the problem, they have more difficulty in devising a plan and evaluation.

Students' low scores on the “devising a plan” indicator may stem from their lack of confidence and hesitation in explaining how they solve problems, even though they can

address existing issues. Similarly, the low value on the evaluation indicator may stem from students' limited involvement in responding to solutions from peers and teacher, along with restricted time for classroom learning activities. The N-Gain value indicates that STEAM-based e-modules integrated with Kudus specialties can enhance problem-solving skills. This finding is in line with Hawari & Noor (2020) research which concluded that STEAM project-based pedagogical design can improve creative and problem-solving skills, students are more motivated to explore innovative solutions and work collaboratively in a learning environment.

Implementing this e-module poses significant challenges, as students frequently face difficulties in effectively applying the indicators during learning activities. Further analysis uncovered that the evaluation indicator primarily focuses on assessing discussion or analysis outcomes, playing a crucial role in the problem-solving process. Moreover, in the devising a plan indicator, students frequently struggle to interpret instructions, leading to a lack of confidence in formulating a plan despite their ability to solve the current problem.

Therefore, it is important for students not to neglect the little things they learn during the learning process. It should be instilled in them that thoroughness and attentiveness are essential to ensure that they truly understand a given learning topic, especially when formulating.

Students Preception of E-module

Interviews were conducted with 3 randomly selected students. Based on the interview results, several obstacles faced by students in using e-modules were identified. After the material is created, it is converted into PDF and converted into flipbook. A significant of this format is its reliance on a stable internet connection when accessed online, which poses significant challenges for some students with limited network connectivity. Another challenge arises when students attempt independent learning; some parts of the material require a further explanation from the teacher, particularly when connecting mathematical concepts. Some students still need help solving a particular problem that requires connecting mathematical concepts (de Gamboa, Badillo, & Font, 2023). The subsequent excerpt presents the interview findings:

"My obstacle is because my network is bad, it causes when I open there is white loading, so the book has no color. The material in the module is easy to understand, mom. I also like the appearance because it's good."

"I had no problems when I opened the module, but when I studied, there was material that was difficult to understand, namely the double discount section. The appearance of the module is quite interesting."

"My network is bad, so it takes a long time to open the module. I think the material is easy to understand, and I have no difficulty understanding it. For my display, it's okay, ma'am."

These findings indicate that while students generally found the material in the e-module comprehensible and appreciated its design and appearance, technical issues and the need of teacher guidance impacted their overall experience. Future iterations of the e-module could benefit from offline accessibility and enhanced guidance for complex concepts to support independent learning more effectively.

▪ CONCLUSION

The results indicate that the ethnomathematics e-module, centered on Social Arithmetic through electronic STEAM, titled *"Belajar Aritmetika Melalui Eksplorasi Makanan Tradisional Kudus"* is Valid, Practical, Effective, and successful in improving students' problem-solving abilities. In the Expert Review phase, the e-module underwent validation assessment, attaining a rating of 91.3% and being deemed highly valid. The e-module's practicality was appraised through individual and small group evaluations, yielding a student practicality rating of 98.3% in individual sessions and 98.2% in small group assessments, indicating its high practicality. The effectiveness of the e-module, *"Belajar Aritmetika Melalui Eksplorasi Makanan Tradisional Kudus"*, is evidenced by a significant improvement in students' problem-solving skills. This improvement is quantified through an N-Gain calculation of 0.716, equivalent to 71.6%, which indicates a high level of effectiveness. The pre-test and post-test results of 30 participating students clearly demonstrate that the e-module successfully enhanced their mathematical problem-solving abilities.

▪ REFERENCES

Adriyawati, Utomo, E., Rahmawati, Y., & Mardiah, A. (2020). Steam-project-based learning integration to improve elementary school students' scientific literacy on alternative energy learning. Universal Journal of Educational Research, 8(5), 1863–1873. https://doi.org/10.13189/ujer.2020.080523

Ariesta, W. (2015). *Pengembangan bahan ajar e-learning berbasis microblogging tumblr pada pembelajaran pendidikan kewarganegaraan di sekolah menengah atas.* Palembang: Pascasarjana Universitas Sriwijaya.

Beisly, A., & Moffitt, A. (2024). Sense-making and steam: using art to make science visible. Early Childhood Education Journal, (November 2023). https://doi.org/10.1007/s10643-023-01615-3

D'Ambrosio, U. (2020). In my opinion: what is ethnomathematics, and how can it help children in schools? Teaching Children Mathematics, 7(6), 308–310. https://doi.org/10.5951/tcm.7.6.0308

de Gamboa, G., Badillo, E., & Font, V. (2023). Meaning and structure of mathematical connections in the classroom. Canadian Journal of Science, Mathematics and Technology Education, 23(2), 241–261. https://doi.org/10.1007/s42330-023-00281-2

Hake, R. (1999). Analyzing change/gain scores. amaerican: area-d american education research association's division, masurement and research methodology.

Hannafin, M. J., & Peck, K. L. (1988). The design, development, and evaluation of instructional software. New York: Macmillan Publishing Company.

Hawari, A. D. M., & Noor, A. I. M. (2020). Project based learning pedagogical design in STEAM art education. Asian Journal of University Education, 16(3), 102–111. https://doi.org/10.24191/ajue.v16i3.11072

Herlinawati, H., Marwa, M., Ismail, N., Junaidi, Liza, L. O., & Situmorang, D. D. B. (2024). The integration of 21st century skills in the curriculum of education. Heliyon, 10(15), e35148. https://doi.org/10.1016/j.heliyon.2024.e35148

Irfan, M., Suryaningrum, C. W., Pusporini, W., & Widodo, S. A. (2023). Online learning effect of post pandemic COVID-19: A survey at universities in Indonesian.

Perspektivy Nauki i Obrazovania, 61(1), 575–588. https://doi.org/10.32744/pse.2023.1.34

Logan, M. R., Johnson, E. C., & Worsham, W. J. (2021). Development of an e-learning module to facilitate student learning and outcomes. Teaching and Learning in Nursing Journal, 16(2), 139–142. https://doi.org/10.1016/j.teln.2020.10.007

Nindiasari, H., Pranata, M. F., Sukirwan, Sugiman, Fathurrohman, M., Ruhimat, A., & Yuhana, Y. (2024). The use of augmented reality to improve students' geometry concept problem-solving skills through the steam approach. Infinity Journal, 13(1), 119–138. https://doi.org/10.22460/infinity.v13i1.p119-138

Nunokawa, K. (2001). Interactions between subgoals and understanding of problem situations in mathematical problem solving. Journal of Mathematical Behavior, 20(2), 187–205. https://doi.org/10.1016/S0732-3123(01)00069-4

Park, W., & Kwon, H. (2022). Research trends and issues including computational thinking in science education and mathematics education in the Republic of Korea. Journal of Baltic Science Education, 21(5), 875–887. https://doi.org/10.33225/jbse/22.21.875

Putri, R. I. I., Zulkardi, & Riskanita, A. D. (2022). Students' problem-solving ability in solving algebra tasks using the context of Palembang. Journal on Mathematics Education, 13(3), 549–564. https://doi.org/10.22342/jme.v13i3.pp549-564

Rezeki, S., Andrian, D., Wahyuni, A., & Nurkholisah, H. (2020). The sustainability concept of Riau cultures through development of mathematics learning devices based on Riau folklore at elementary schools. Journal of Physics: Conference Series, 1538(1). https://doi.org/10.1088/1742-6596/1538/1/012066

Rezeki, Sri, Andrian, D., & Safitri, Y. (2021). Mathematics and cultures: A new concept in maintaining cultures through the development of learning devices. International Journal of Instruction, 14(3), 375–392. https://doi.org/10.29333/iji.2021.14322a

Suarman, S., Hendripides, H., & Hikmah, N. (2018). Development of innovative teaching materials through scientific approach. Journal of Educational Sciences, 2(2), 14. https://doi.org/10.31258/jes.2.2.p.14-22

Suprapto, N., Rizki, I. A., & Kholiq, A. (2024). Exploring the cultural fabric: a study on indonesia's unique architectural marvels for Ethno-STEAM education system. TEM Journal, 13(3), 2249–2255. https://doi.org/10.18421/tem133-52

Supriyadi, E., Turmudi, T., Dahlan, J. A., & Juandi, D. (2024). Development of sundanese gamelan ethnomathematics e-module for junior high school mathematics learning. Malaysian Journal of Learning and Instruction, 21(2), 147–186. https://doi.org/10.32890/mjli2024.21.2.6

Tessmer, M. (1998). Planning and conducting formative evaluations: Improving the quality of education and training. London: Kogan Page.

Zaenuri, Mukeriyanto, & Mulyono. (2020). Cooperative learning model with ethnomathematics nuances to improve the love of local culture and ability of problem solving. Journal of Physics: Conference Series, 1567(3). https://doi.org/10.1088/1742-6596/1567/3/032017

Zubaidah Amir, M. Z., Risnawati, Nurdin, E., Azmi, M. P., & Andrian, D. (2021). The increasing of math adversity quotient in mathematics cooperative learning through metacognitive. International Journal of Instruction, 14(4), 841–856. https://doi.org/10.29333/iji.2021.14448a