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Measurability of the mathematics teaching modules on problem solving-skills in the concentration of agribusiness expertise in plantation

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Abstract
Preliminary research involving 30 mathematics teachers at the MGMP VHS of Ketapang district and interviews with business world and plantation industry representatives suggested that 81.7% of respondents voiced concerns over the current mathematics teaching materials, which do not adequately equip students with problem-solving skills in line with their expertise concentration. This issue reflects on the quality of VHS graduates who are expected to be job-ready and skilled. The objective of this study is to develop a measurable teaching module, conceptually and methodologically, that yields quantifiable results in alignment with the concentration of expertise and the requirements of the business and industry world. The research method adopted is a mixed method with a sequential explanatory design through the Van den Akker development study. A quantitative analysis of 20 respondents, comprising mathematics and productive teachers at a center of excellence vocational school, lecturers of Tanjung Pura STKIP, Ketapang State Polytechnic, and a team from the business and industry world in the plantation sector, resulted in a Pearson correlation of $Ryx_1x_2x_3$=0.949, a determination coefficient [r_2] of 0.900, and an F-calculation of 48.06 for the regression equation $Y\hat{} = 0.566 + 0.444\ X_1 + 0.278\ X_2 + 0.135\ X_3$. From these results, it is concluded that the concepts, methods, and outcomes utilized in this teaching module are appropriate. The relationship between concepts, methods, and outcomes in teaching modules on skills to solve mathematical problems is unidirectional. Expert validity on aspects of module content, presentation feasibility, language appropriateness, and problem-solving skills amounted to 96.88% in the Very Valid category. Practicality from the aspects of interest, material, and language places the category at 92.02, which is very practical

INTRODUCTION

Article 15 of the National Education System Law No. 20, 2003, identifies Vocational High Schools (VHS) as educational establishments committed to nurturing skilled students in distinct fields (Nuhdawati et al., 2023). Such institutions offer specific skills attuned to the expectations and necessities of the Business or Industrial World (WW/IW). Moreover, they foster the capacity to cultivate potential in technology adaptation and adoption, science, and arts (Maryanti, 2019).

VHS bears the responsibility of shaping students into superior, competitive individuals who are prepared for the workforce. It contributes to the nation's civilization through intellectual diversity (Sutono, 2020). Given the stake WW/IW holds in VHS, there is a necessity for solid connectivity between them. As Ibrahim (2021) articulates, such connectivity materializes in curriculum alignment, graduate standards, entrepreneurial learning, and industrial work practices. As per Satibi (2021), the objectives of curricula, particularly in mathematics education, should align with the Standard Operating Procedures for WW/IW.

Such curriculum alignment foresees implications for prospective insights and the assurance of VHS graduate quality (Une et al., 2021). The curriculum transcends a mere series of activities and is designed to be comprehensive, focusing on essential mathematics, and

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interlinks between each class at the level of knowledge and skills (Mazana et al., 2018). To accomplish curriculum alignment, all learning processes in vocational schools aim at knowledge and skill acquisition in line with the concentration of expertise. A key issue is the alignment of the VHS curriculum with WW/IW, and the teaching materials related to the concentration of expertise (Surianto et al., 2018).. Given the VHS curriculum operates on the principle of demand and supply, teaching materials present challenges in their development due to the content framework's scope and sequence not calculating the suitability of VHS mathematical concepts with concentrations of expertise and WW/IW SOPs (Fatah et al., 2021).

Students should be engaged in active learning, drawing new knowledge and skills from prior experiences (Wale & Bishaw, 2020). Consequently, educators need to devise a range of learning activities in the form of structured, student-centered modules (Al-Ansi, 2022). Preliminary research was conducted through a workshop titled "Enhancing the Competence of Mathematics Teachers at VHS in Ketapang District in the Implementation of the Independent Curriculum". The workshop took place from July 21–23, 2022, at SMKN 2 Ketapang. The activity reports are featured in the PKM journal by Kurnianto (2022), where an assessment of current mathematics teaching materials on problem-solving skills was conducted via a questionnaire, the results of which are shown in Figure 1 below.

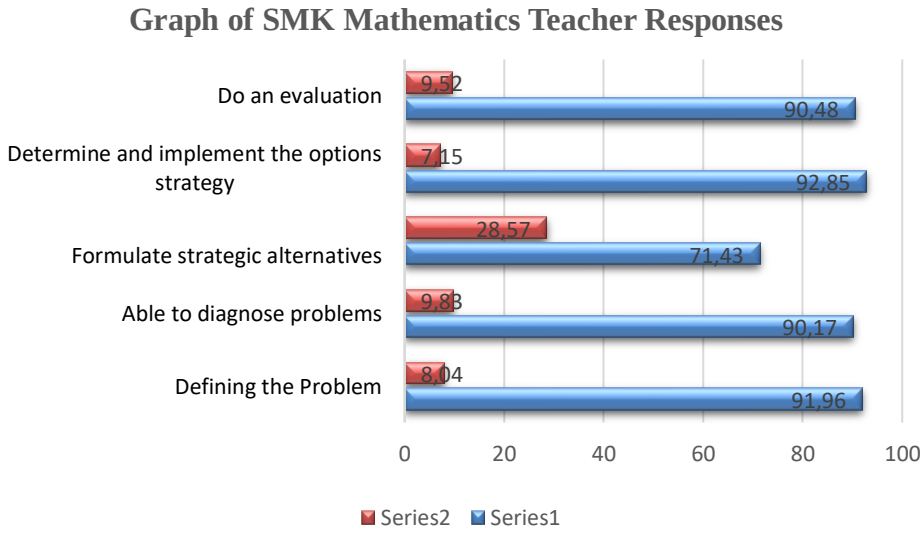

Figure 1. Response Graph of VHS Mathematic Teacher

Based on the pre-research findings depicted in Graph 1, it was observed that 90.48% of teacher respondents believed their problem-solving skills were not linked to their area of specialization. Moreover, 92.85% of the teachers thought the strategy selection and implementation aspect didn't align with their focus areas. From the alternative strategy formulation perspective, 71.43% of teachers reported that existing textbooks weren't integrated with their specialization. Meanwhile, 90.17% thought the available textbooks didn't enable students to diagnose problems according to their fields of study. Further, 91.96% claimed that current textbooks did not foster students' abilities to define problems effectively.

Overall, it's apparent that current mathematics textbooks at the VHS level fail to guide students to develop problem-solving skills relevant to their areas of focus. Interviews with several WW/IW plantations in the Ketapang district revealed that existing textbooks fall short

of WW/IW expectations in preparing VHS graduates with mathematical problem-solving skills relevant to the plantation sector. This situation could affect the projected quality of future VHS graduates expected to join the workforce in line with WW/IW requirements (Sinaga et al., 2022).

Aligning with the pre-research results, Hanafi (2014) expressed that vocational high school education should equip students with problem-solving skills in mathematics that align with their areas of focus. Furthermore, Wijayanti & Hartati (2018) noted that in VHS mathematics learning, students need to master concepts and theories in the way their teachers understand them. Hence, the learning often appears to be merely a transmission of textbook information. The existing mathematics teaching modules lack the measurability and applicability required by both WW/IW and VHS graduates (Saragih & Sitompul, 2021). Consequently, there is a need for concerted efforts from mathematics teachers, productive teachers, and WW/IW to develop teaching modules that are measurable in concepts, methods, and outcomes. These modules should integrate with basic competencies in the productive sector and align with WW/IW expectations, particularly in the plantation sector.

Previous studies in the context of mathematics teaching and learning have indicated that problem-solving based learning modules can enhance students' understanding and application of mathematical concepts (Sa'diyah & Istiandaru, 2021). Various modules developed so far have been aimed at enriching students' mathematical abilities (Fonna & Mursalin, 2018; Hartono & Noto, 2017; Prihatin et al., 2022; Rizqiyani et al., 2022). Modules grounded in problem-solving have been designed with several objectives, such as strengthening mathematical problem-solving abilities (As'ari et al., 2014), mathematical literacy (Nurdahwati et al., 2023), and student learning outcomes (Subekti & Akhsani, 2020). However, based on these studies, there is yet to be a development of problem-solving based modules specifically aiming to enhance problem-solving skills within the context of plantation agribusiness expertise. Therefore, this research is structured to produce a problem-solving-based module that is valid, practical, and effective for students in the plantation agribusiness field.

METHODS

The type of research used uses mixed method research methods or sequential explanatory designs, namely combination research methods that combine qualitative and quantitative research methods sequentially, where the first stage of research is carried out using qualitative methods and the second stage is carried out using quantitative methods.

Qualitative methods play a role in deepening the findings or terms of mathematics or text mining in productive textbooks and SOPs for plantation companies. While quantitative methods play a role in obtaining measurable quantitative data that play a role in determining the degree of correlation of concepts, the results method to the PAE expertise concentration teaching module (Monica & Yaswinda, 2021).

Based on the content framework of the teaching module according to the results of qualitative and quantitative analysis in accordance with the core competencies of productive books, WW / IW and the suitability of mathematical problem solving with the concentration of plantation corp agribusiness expertise carried out at VHS (Mujala et al., 2022).

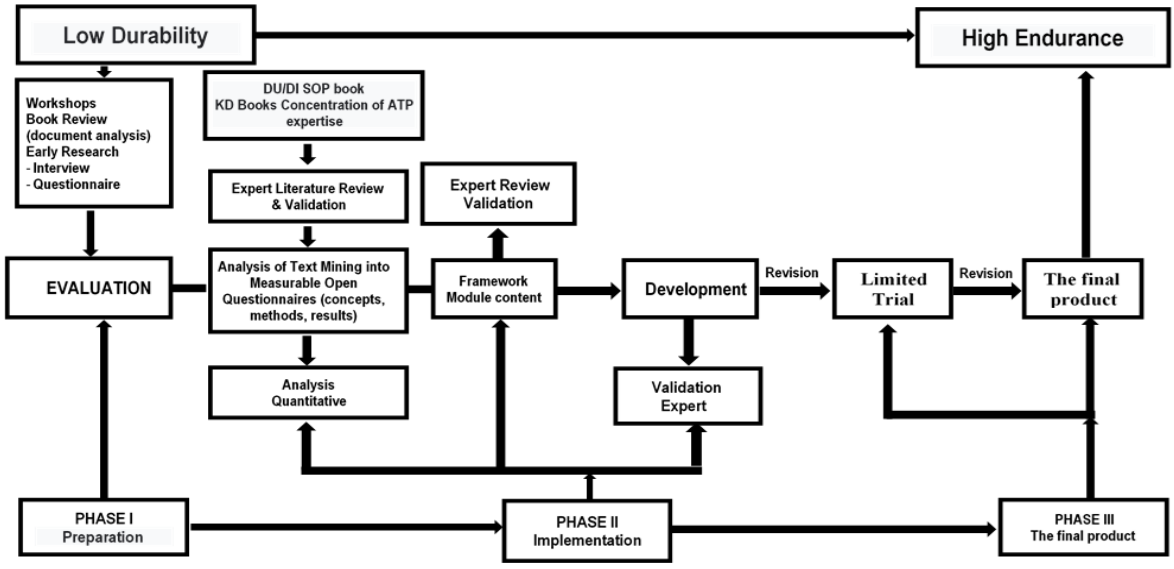

Figure 2. Flow of Design for the Development of VHS Mathematics Teaching Modules Based on Modifications from Theory According to Akker

Subject and Object of Research

The subject and object of research in the study are described in several stages as follows

1. The subject at the preparatory stage of pre-research activities is the mathematics teacher of VHS Ketapang district, who is gathered in the MTCG Mathematics organization of VHS Ketapang Regency. The object of research on textbooks used in VHS today is problem-solving skills according to the concentration of expertise.
2. Subject of activity The implementation stage, the validation of the content framework based on the results of the exploration of terms totaling 20 people, consisting of several elements and agencies, Listed in table 1 below.

Table 1. Subject Questionnaire Open Estimation of Concepts, Methods and Results

No	Subject	Elements/Agencies	Number of subjects
1	Math teacher and productive teacher	SMKN 1 Ketapang	2 people
2	Math teacher and productive teacher	SMKN 2 Ketapang	2 people
3	Math teacher and productive teacher	SMKN 1 Nanga Tayap	2 people
4	Math teacher and productive teacher	SMKN 1 Air Upas	2 people
5	Expert Team from WW/IW in the field of plantations	PT SISM	2 people
6	Expert Team from WW/IW in the field of plantations	PT MBK	2 people
7	Expert Team from WW/IW in the field of plantations	PT Sinar Mas	2 people
8	(Supervisor 1 and Supervisor II)	Master Study Program FKIP UNTAN	2 people
9	Lecturer in Mathematics	STKIP Tanjungpura	2 people
10	Lecturer in Mathematics Lecturer	Ketapang Polytechnic	2 people
Total subjects/respondents			20 people

3. The object of research at this stage is an open questionnaire that outlines concepts and methods. The trial participants were limited to 20 students from VHS class XII PAE SMKN 1 Nanga Tayap. With research objects in the form of draft teaching modules and posttests.
4. The subject is in the final stages of expert validation assessment by three mathematics lecturers from STKIP Tanjungpura, three heads of the VHS Center of Excellence, and six students from SMKN 2 Air Upas.

RESULTS AND DISCUSSION

Text Mining Analysis

The Texas Education Agency suggests that there are three requirements to ensure that the teaching modules presented are measurable, as follows: 1) If the concepts, methods, and outcomes/criteria specified in the objectives are quantified, then the objectives can be observed and measured. 2) The teaching module must provide sufficient detail for students or users who read and apply it in the same way, otherwise the data obtained will not be accurate. 3) To calculate how much progress is being made, the researcher must provide baseline data. The baseline data must be objective so that it can be observed and measured in the same way over time.

The measurability of the teaching module content framework according to the concentration of expertise carried out and integrated with the needs of WW and IW seen from the concept, method, and results is analyzed through text mining (term exploration). Exploration of terms is intended to determine the concept of productive material and mathematical concepts related to literature studies from basic competencies. C.2.1 productive books of agricultural machine tools, which contain 10 knowledge aspects and 10 skill aspects and WW/IW standard operating procedures related to land clearing with zero burning.

Table 2. Analysis of Text Mining (Term Exploration) Scalability of Concepts, Methods and Results

No	Learning Outcomes Of Agribusiness Plantation Crops			Standard Operating Procedures WW/IW	Text Mining Analysis (Term Exploration)					
	C2.2 (Aspects of Knowledge)	C2.2 (Skill Aspects)	FLOW		FLOW	Plantation Teaching Materials	FLOW	Productive Material	FLOW	Related Mathematical Materials
1	Understand agricultural production tools and machinery, laboratory, climatology, storage and processing	Identifying types of agricultural production tools and machinery, laboratory, climatology, storage and processing	⇒	Land Clearing with Zero burning Farm desaign planning includes several things - Garden size - Size of each block - Spacing - Plant density - Road system and its density	⇒	Get to know the types and types of driving motors, tractors, soil processing tools, atomizers, irrigation tools, post-harvest harvesting tools, laboratory tools, climatology tools, storage and processing tools (Ali, 2017)	⇒	Chapter Machine Performance Analysis on Agricultural Tools and Machinery 1.1 Tool capacity 1.2 Theoretical Field Capacity 1.3 Effective field capacity	⇒	- Ratio - Units of Time - Unit Area - Percentage

The concepts found in the exploration of terms from productive books, SOP WW / IW in the field of plantations in table 3 above, are arranged in the depth of the questionnaire The size

of the concepts of related mathematical material according to the findings of the term exploration. The shape of the concept scalability questionnaire is as shown in table 3 below.

Table 3. Questionnaire on the measurability of the Concept of the Semi-Open Teaching Module

Productive Material	Mathematics Of Agribusiness Plantation Crops	Related Mathematics Teaching Materials	Size Concept				
			5	4	3	2	1
Theoretical Field Capacity (K_{LT})	$K_{LT} = 0{,}36\ V_t . L_k$ Where/hinted at 0.36 = Conversion factor (1 m2/s = 0.36 ha/h) V_t = Forward speed of average units (ha/hour) L_k = working width of tillage tool (m)	Count operations (multiplication, division)					
		Equation					
		Formula (theory, postulate, law)					
		Units of time					
		Units of length					
		Unit Area					
		Unit conversion					
		……					

Method scalability questionnaire, compiled based on the scalability of concepts based on input from expert validation.

Table 4. Measurement Questionnaire for Semi-Open Teaching Module Methods

Productive Material	Mathematics Of Agribusiness Plantation Crops	Methods Of Finding Related Mathematical Solutions	Size Method				
			5	4	3	2	1
Theoretical Field Capacity (K_{LT})	$K_{LT} = 0{,}36\ V_t . L_k$ Where /hinted at 0.36 = Conversion factor (1 m^2/s = 0.36 ha/h) V_t = Forward speed of average units (ha/hour) L_k = working width of tillage tool (m)	With Problem solving					
		With the theory of constructivism					
		Graphs, tables and diagrams					
		Create a pattern					
		Think logically					
		Deductive & Inductive					
		Equation solving					
		Associate/condition simply					
		Trial & error, substantive theory					
		……					

Data Analysis

Based on the results of responses from 20 subjects, the tabulation of respondents' answers was then carried out in the Excel application. After tabulation, the data from the measurement of concepts and methods is carried out on average to obtain measurable data results.

Table 5. Data Recap of Subjects' Responses to the Questionnaire of Measurable Concepts, Methods, Results, and Value of Problem-Solving Skills

No	X1	X2	X3	Y
	Concept	Method	Result	Problem Solving Skills
1	91,62	91,77	91,70	79,12
2	90,07	89,14	89,60	77,57
3	91,38	90,86	91,12	78,88
4	87,40	87,33	87,36	74,90
5	89,81	89,38	89,59	77,31
6	90,66	90,53	90,60	78,16
7	92,64	93,25	92,94	80,14
8	92,18	92,35	92,26	79,68
9	89,41	88,97	89,19	76,91
10	91,99	91,77	91,88	79,49
11	92,34	91,60	91,97	79,84

12	90,84	90,70	90,77	78,34
13	91,26	91,60	91,43	78,76
14	90,38	90,12	90,25	77,88
15	90,89	91,11	91,00	78,39
16	90,90	90,45	90,68	78,40
17	91,65	90,86	91,26	79,15
18	92,58	92,35	92,46	80,08
19	91,60	91,28	91,44	79,10
20	90,65	90,37	90,51	78,15

The results of the distribution of open questionnaires measured concepts and methods to a research sample of 20 respondents consisting of VHS Mathematics Teachers at VHS Center of Excellence, Productive Teachers, Mathematics Ketapang Regency, and WW/IW Plantation Sector) on each variable, namely Skills in Solving Agribusiness Problems Plantation Crops [Y], Concepts [X_1], Methods [X2], and Results [X_3], as follows.

1. The relationship of concepts with problem-solving skills is and, so in the concept variables according to the assessment, there is a very strong correlation with problem-solving skills in the resulting PAE mathematics teaching module of 0.872 or 87.2%.
2. The relationship of the method with problem-solving skills is and, so in the concept variables according to the assessment, there is a correlation with problem-solving skills in the resulting PAE mathematics teaching module of 849 or 84.9 %.
3. The relationship of results that is measurably related to respondents' responses to concepts and methods to problem-solving skills is and, so in the variable results according to the assessment, there is a correlation with problem-solving skills in the resulting PAE mathematics teaching module of 0.817 or 81.7 %.

The relationship of concepts, methods, and outcomes to problem-solving skills is 0,949 and, so in the variables Concepts, Methods, and Results Together, there is a very strong correlation assessment [0.900] to the skills of solving agribusiness problems of plantation crops and an influence of 0.900 or 90.0%.

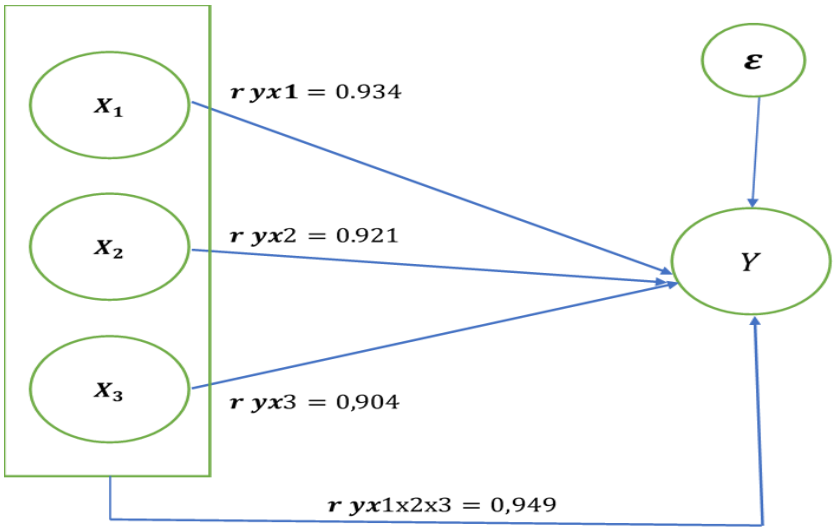

Figure 3. Flow of Measurability
Relationships of Concepts, Methods, and Results to problem solving

Information:
X_1 = Concept, X_2= Method, X_3= Result, Y = Problem solving skills
ε = Epsilon, another factor outsideX_1 , X_2 , X_3 that affects Y, but is not studied
$r\ yx1$ = correlation to X_1against Y
$r\ yx2$ = correlation to X_2 against Y
$r\ yx3$ = correlation to X_3 against Y
$R\ yx1x2x3$ = correlation X_1 , X_2, $and\ X_3$ together to Y

The F test is used to determine whether the concepts, methods, and results used are appropriate or not. The ANOVA table's F-Count must be compared to the F-table. F-count = 48,060. From the F-table test with a significance level of 0.05, the numerator is the number of variables (1-3) = 2, the number of variables (20-3) = 17.Sorry, F-table = 3.20 because F counts > F-table or it appears that Sig (1-tailed) or its probability =0.000 or less than the degree of significance (0.05), which means significant correlation or relationship, then Ha is accepted, meaning that there is a relationship between concepts, methods, and results that together affect the skills of solving mathematical problems and the concentration of PAE expertise.

Based on the results of the measurement of concepts, methods, and results as well as the analysis of correlation and regression tests as well as statistical tests of quantitative study results, a content framework is further compiled. Based on the content framework, a mathematics teaching module was developed entitled "Mathematics Module for Agricultural Tools and Machinery" (VHS: Concentration of Plantation Crop Agribusiness Expertise).

The results of the media assessment from the experts obtained a total score of 396 out of a total of 27 questions on each media expert assessment sheet. From the results of the data processing by material experts and media experts after the calculation process, a large percentage of validity was obtained, which is 96.88% and classified as very valid.

Table 6. Analysis of the Level of Validity of Mathematics Teaching Modules (Material Experts and Media Experts)

No	Aspects	Grain	Scores obtained	Percentage of validity
Material Expert (3 People)				
1	Eligibility of Contents	36	174	$P = \frac{R}{SM}\ X\ 100\ \%$
2	Eligibility of Presentation	27	126	
3	Language Eligibility	27	130	
4	Problem solving skills	15	75	$P = \frac{901}{930}\ X\ 100\ \%$
	Sum	105	505	
Media Member (3 persons)				= 96.88 % (Very valid)
1	Graphic feasibility	81	396	
Sum		81	396	
Total amount (Material + Media)		186	901	

The results of the questionnaire calculation of the responses of six students obtained a total score of 407 from 120 questions; each questionnaire had 20 questions. The entire teacher and student assessment score that has been converted into a percentage form from each questionnaire is then added together to find out the magnitude of the percentage level of practicality of the mathematics teaching module of agricultural tools and machinery.

Table 7. Percentage Level of Practicality towards Teaching Modules of Agricultural Tools and Machinery

Teacher Assessment		**Student Response (6 people)**	
Aspects	Assessment Score	Aspects	Assessment Score
Interest	26	Interest	177
Material	21	Material	140
Language	14	Language	90
Sum	61	Sum	407
Percentage of Practicality			
Teacher Assessment : $P_1 = \frac{61}{70} x\ 100\%$ = 87.14 %		*Student Response* : $P_2 = \frac{407}{420} x\ 100\%$ = 96.90 %	
$\frac{P_1 + P_2}{2} = \frac{87.14\ \% + 96.90\ \%}{2}$ = 92.02 % (Very Practical)			

CONCLUSIONS

Through quantitative study analysis, text mining analysis and exploration of terms to determine the scalability of concepts, methods, and results in the framework of the content of teaching modules, through questionnaires The size of concepts and methods can be concluded. Quantification Analysis Results: Pearson Correlation Ryx1x2x3=0.949, coefficient of determination =0.900, with the regression equation Y ̂= 0.566+0.444X1+0.278X2+0.135X3.

Based on the expert validation assessment of the resulting agricultural tools and machinery teaching module, it can be concluded as follows: Content feasibility, presentation feasibility, language feasibility, and problem-solving skills in the module have a validity percentage of 96.88%, which is in the "very valid category. The level of practicality of the teaching modules on agricultural tools and machinery resulting from the aspects of interest, material, and language is 92.02% in the category "very practical.

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AUTHOR CONTRIBUTIONS STATEMENT

S contributed to conceptualization, writing-original draft, editing and visualization. MR contributed to writing-review & editing, formal analysis, and methodology. AH contributed to validation and supervision.

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