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Implementation of Structural Equation Modeling for Analyzing Factors Influencing Students' Learning Motivation

Implementasi *Structural Equation Modeling* untuk Menganalisis Faktor-Faktor yang Mempengaruhi Motivasi Belajar Mahasiswa

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Abstract

Learning motivation is the driving force that ensures the continuous learning process to achieve educational goals. This study analyzes the factors influencing students' learning motivation. The sample consists of active students from the Faculty of Science and Technology at Jambi University. The research employs a quantitative survey method, with data collected through a Likert-scale questionnaire. Data analysis is conducted descriptively using Structural Equation Modeling (SEM). Three exogenous variables are examined: learning strategies, learning facilities, and learning environment, while learning motivation serves as the endogenous variable. The results indicate that learning strategies contribute the most to learning motivation, followed by the learning environment and learning facilities. Overall, these latent variables have a positive impact on learning motivation.

Keywords: *Learning Motivation; Structural Equation Modeling; Students.*

Abstrak

Motivasi belajar adalah dorongan yang memastikan berlangsungnya proses pembelajaran secara berkesinambungan agar tujuan pembelajaran dapat tercapai. Penelitian ini melakukan analisis terhadap faktor-faktor yang memengaruhi motivasi belajar mahasiswa. Sampel yang digunakan adalah mahasiswa aktif di Fakultas Sains dan Teknologi Universitas Jambi. Metode digunakan adalah survei kuantitatif dengan pengambilan data melalui kuesioner berskala Likert. Analisis data dilakukan secara deskriptif menggunakan Structural Equation Modeling (SEM). Ada tiga variabel eksogen yang digunakan yaitu cara belajar, fasilitas belajar, dan lingkungan belajar. Sedangkan motivasi belajar digunakan sebagai variabel endogen. Hasil penelitian menunjukkan bahwa cara belajar memberikan kontribusi paling besar terhadap motivasi belajar, diikuti oleh lingkungan belajar dan fasilitas belajar. Secara keseluruhan, variabel-variabel laten tersebut memiliki pengaruh positif terhadap motivasi belajar.

Kata Kunci: *Mahasiswa; Motivasi Belajar; Structural Equation Modeling.*

Introduction

Motivation is an effort aimed at driving, directing, and supporting human activities, encouraging actions to achieve specific results or objectives. In the context of learning, motivation can be described as a general driving force that produces learning activities, ensuring the continuity of the learning process so that course objectives are achieved. Thus, motivating students means encouraging them to take actions that will help them reach their learning goals.

Recently, some students at the Faculty of Science and Technology (FST) at Universitas Jambi (UNJA) have shown a decline in learning motivation, as evidenced by suboptimal grades achieved during the learning process. The reasons for this decline have not been recorded or analyzed properly. Several academic supervisors have conducted interviews with students whose motivation to study has decreased, and various reasons were found, such as because of financial concern, family concern, learning method, etc.

A student's learning motivation is influenced by various factors, one of which is their learning approach. Learning outcomes are determined by the quality of the learning methods. Good learning habits lead to effective learning, while poor study habits often result in academic setbacks or failure[1]. Many students fail to achieve satisfactory results simply because they are unaware of effective learning methods. Therefore, it can be concluded that positive learning outcomes are generally the result of good study habits, and vice versa[2].

To achieve optimal learning outcomes, students should organize study schedules, read and take notes, review study materials, maintain concentration, and complete practice assignments. Aside from the role of educators, students' desire and motivation to learn significantly influence their success. Motivation is a driving force in the learning process, and learning facilities are one component that can enhance this motivation [3]. Learning facilities impact students' ability to learn effectively; thus, a lack of equipment or resources can hinder academic progress [4].

Learning motivation is also affected by the learning environment. According to Muhib [5], The school environment, family environment, and community environment are part of the learning environment. To examine the factors that influence students' learning motivation, one method used in the research is the SEM (Structural Equation Modelling) method. The SEM method

[1] The Liang Gie, *Cara Belajar Yang Efektif* (Yogyakarta: Liberty, 2010).
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[5] Achmad Muhib, *Pengantar Ilmu Pendidikan* (Semarang: UPT UNNES Press, 2013).

is an appropriate analysis used in social research [6]. SEM analysis combines regression techniques, factor analysis, and path analysis simultaneously to assess the relationships between latent variables, calculate the loading values of the indicators of these latent variables, and create a path model for those variables [7].

SEM is used to analyze relationships between variables involving latent variables and their indicators [8]. In SEM, latent variables are categorized into two types: exogenous and endogenous variables [9]. In this study, three exogenous variables are examined: learning methods, learning facilities, and the learning environment. The endogenous variable being analyzed is learning motivation.

Previous studies on SEM, such as Putlely's research [10], explored Structural Equation Modeling to assess the influence of service, pricing, and safety on user satisfaction levels of public transportation services in Ambon City during the COVID-19 pandemic. This study found that, generally, passenger satisfaction with public transportation services in Ambon City was very high during the pandemic. Widyasari also conducted research on the use of Structural Equation Modeling to analyze factors affecting students' learning motivation at FIP UMJ. However, there were certain indicator variables not included in this research, while some others were added. Then, Herry also used SEM to examine the effect of brand awareness on brand image, the effect of brand image on perceived value, the effect of perceived value on satisfaction,

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the effect of brand image on satisfaction, the effect of satisfaction on loyalty[11]. Based on this background, the researcher is interested in analyzing the factors influencing the learning motivation of FST UNJA students using the SEM method.

Method

This study uses primary data collected by the researcher in the field through the distribution of questionnaires. The sample used in this research consists of students from the Faculty of Science and Technology at Universitas Jambi. A purposive sampling technique was employed to select the sample. The data analysis methods utilized include descriptive analysis and Structural Equation Modeling (SEM) analysis. Based on interviews with students and references from research results by previous researchers [12], we found factors which can affect students' motivation in learning. We consider those factors as variables in this research as presented in the Table 1.

Table 1. Research Variables

Latent Variables		Manifest Variables (Indicators)
Exogenous Variables	Learning Method (X_1)	Study Schedule (X_{11})
		Reading and Taking Notes (X_{12})
		Reviewing Lessons (X_{13})
		Concentration (X_{14})
		Completing Assignments (X_{15})
	Learning Facilities (X_2)	Campus Building (X_{21})
		Classroom (X_{22})
		Laboratory or Practice Room (X_{23})
		Library (X_{24})
		Wifi Facilities (X_{25})
	Learning Environment (X_3)	Parenting Style (X_{31})
		Home Atmosphere (X_{32})
		Family Economic Status (X_{33})
		Campus Environment (X_{34})
		Social Friends (X_{35})
		Teaching Style of Lecturers (X_{36})
Endogenous Variables	Learning Motivation (Y)	Duration of Activities (Y_1)
		Frequency of Activities (Y_2)
		Attitude Toward Achieving Goals (Y_3)
		Teaching Techniques of Lecturers (Y_4)

[11] Herry Mulyono, "Brand Awareness and Brand Image of Decision Making on University," *Jurnal Manajemen Dan Kewirausahaan* 18, no. 2 (September 1, 2016): 163–73, https://doi.org/10.9744/jmk.18.2.163–173.

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In conducting research, the initial step is careful and systematic planning to ensure accurate and accountable results. Steps in data collection are as follows:

1) Determining the object. In this step, we need to establish the research object. In this research, our object is the respondents of the questionnaire.
2) Determining the sample from the research population.
3) Testing the research instruments which consist of validity and reliability tests on 30 samples.
   a. Validity test is conducted by measuring the correlation between item scores and total scores.
   b. Reliability test is doing by using the Alpha method which is suitable for likert scale.
4) Distributing questionnaire.

Then, steps in modeling with SEM are as follows:

1) Data Transformation. i.e. convert ordinal data to interval data using the MSI (Method of Successcive Interval).
2) Normality Test, i.e. use multivariate normality.
3) Model Specification, i.e. define variables and path diagrams with a hybrid model.
4) Model Identification, i.e. assess the ability to obtain unique values for each parameter.
5) Model Estimation, i.e. estimate parameter with Maximum Likelihood Estimation.
6) Goodness of Fit Test, i.e. test for Goodness of Fit, validity, and reliability.
7) Model Respecification, i.e. adjust the model based on the fit results.

Results and Discussion

The data was collected directly from questionnaires distributed to 341 randomly selected students in the Faculty of Science and Technology at UNJA.

1. Data Transformation

The questionnaire data collected was averaged for each indicator with multiple questions per respondent. This data was initially on an ordinal scale. Using ordinal data may result in an unsuitable or inaccurate model. Consequently, the data was converted to an interval scale through the Method of Successive Interval (MSI), utilizing Microsoft Excel.

2. Normality Test

In modeling with SEM, a normality test is necessary, as SEM assumptions require a normal distribution across all variables (multivariate normality). In this study, normality assumptions can be tested using the z-statistics for skewness and kurtosis. A distribution is considered normal if the $Z_{skewness}$ and

$Z_{kurtosis}$ values fall between -2.58 and $+2.58$ [9]. Refer to Table 2, the $Z_{skewness}$ and $Z_{kurtosis}$ values are within the range of -2.58 to +2.58, indicating univariate normality. Furthermore, multivariate normality is also satisfied as the value is less than 2.58. The results of the normality test after transformation are shown in Table 2.

Table 2. Normality Test Results After Transformation

Variable	$Z_{skewness}$	$Z_{kurtosis}$
Y_4	-2,573	0,530
Y_3	-2,533	-0,343
Y_2	-2,573	0,143
Y_1	-2,533	0,302
X_{31}	0,141	2,323
X_{32}	-1,473	-1,323
X_{33}	-2,739	1,134
X_{34}	-0,833	-1,041
X_{35}	-1,231	-0,307
X_{36}	-0,586	-0,597
X_{21}	-2,414	2,535
X_{22}	-0,364	-0,181
X_{23}	-2,430	0,467
X_{24}	-2,759	0,062
X_{25}	-1,673	-0,710
X_{15}	-2,256	-1,042
X_{14}	-0,785	0,233
X_{13}	-2,217	-1,243
X_{12}	-1,948	-0,733
X_{11}	0,036	-0,134
Multivariate		**2,216**

Source: Data processed

3. Model Specification

In the model specification stage, the initial model is constructed and depicted in a path diagram to facilitate the understanding of the relationships between latent variables and the relationships between latent variables and manifest variables, based on relevant theories. The diagram illustrating the relationships between constructs can be seen in Figure 1.

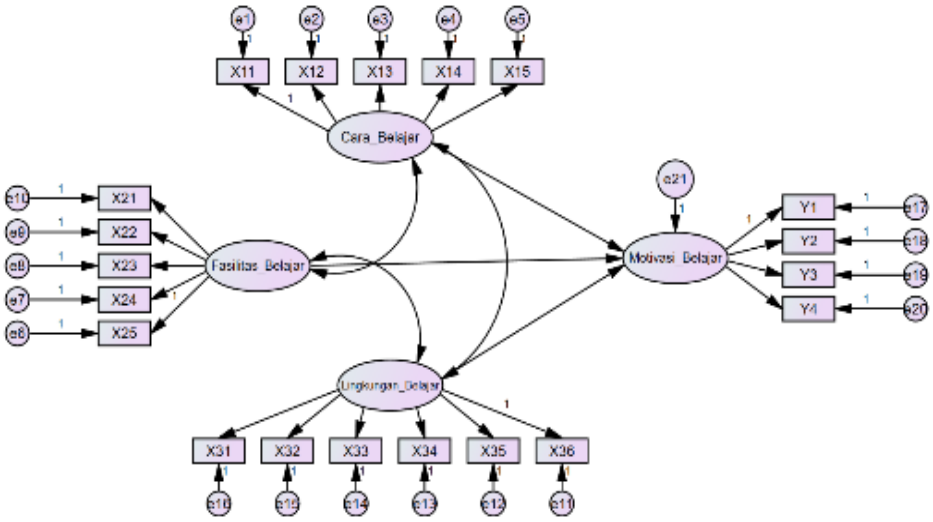

Figure 1. Path Diagram of Causal Relationships

4. Assessing Model Identification

In SEM, it is expected to obtain an over-identified model (positive degree of freedom). Model identification begins with determining the quantity of manifest variables and the parameters that need to be estimated. The degree of freedom is computed as 210 - 46 = 164, which exceeds 0, signifying that the model is over-identified and appropriate for the estimation phase.

5. Conducting Model Estimation

Once the research model meets the model specification and identification stages, model estimation can be performed. Maximum Likelihood Estimation (MLE) is used for estimation. MLE is chosen due to the sample size of 200-300 data points. AMOS 2.2 software is employed during the estimation stage to assist in generating parameter values.

6. Testing Model Fit

1) Overall Model Fit Test

The overall model fit test in this study produced a chi-square value of 248.906, which exceeds the critical value of 194.88, signifying that the model is a good fit. Besides the chi-square statistic, model fit was also assessed using various goodness-of-fit indices, which were as follows: GFI = 0.871, RMSEA = 0.076, RMSR = 0.035, TLI = 0.836, NFI = 0.802, AGFI = 0.835, IFI = 0.860, and AIC = 151.49, which is lower than the critical value of 156. The complete results of the overall model fit test are presented in Table 3.

Table 3. *Goodness of Fit*

Goodness of Fit Index	Cut of Value	Model Index	Description
GFI	GFI ≥ 0,90 *good fit* 0,80 ≤ GFI ≤ 0,90 *marginal fit*	0,871	*Marginal Fit*
RMSEA	RMSEA ≤ 0,08 *good fit*	0,076	*Good Fit*
RMSR	RMSR ≤ 0,05 *good fit*	0,035	*Good Fit*
TLI	TLI ≥ 0,90 *good fit* 0,80 ≤ TLI ≤ 0,90 *marginal fit*	0,836	*Marginal Fit*
NFI	NFI ≥ 0,90 *good fit* 0,80 ≤ NFI ≤ 0,90 *marginal fit*	0,802	*Marginal Fit*
AGFI	AGFI ≥ 0,90 *good fit* 0,80 ≤ AGFI ≤ 0,90 *marginal fit*	0,835	*Marginal Fit*
IFI	IFI ≥ 0,90 *good fit* 0,80 ≤ IFI ≤ 0,90 *marginal fit*	0,860	*Marginal Fit*
AIC	The AIC value of the model that approaches the Saturated AIC value indicates a good fit	151,49 < 156	*Good Fit*

Source: Data processed

Based on Table 3, the average goodness-of-fit indices indicate that the model is fit, so model respecification is not required.

2) Measurement Model Fit Test

a. Evaluation of the validity of the measurement model

Table 4. The Factor Loading

	Factor Loading
X_{11}← Learning Method (X_1)	0,664
X_{12}← Learning Method (X_1)	0,654
X_{13}← Learning Method (X_1)	0,696
X_{14}← Learning Method (X_1)	0,616
X_{15}← Learning Method (X_1)	0,615
X_{25}← Learning Facilities (X_2)	0,566
X_{24}← Learning Facilities (X_2)	0,722
X_{23}← Learning Facilities (X_2)	0,820
X_{22}← Learning Facilities (X_2)	0,746
X_{21}← Learning Facilities (X_2)	0,709
X_{36}← Learning Environment (X_3)	0,575
X_{35}← Learning Environment (X_3)	0,647
X_{34}← Learning Environment (X_3)	0,611
X_{33}← Learning Environment (X_3)	0,590
X_{32}← Learning Environment (X_3)	0,729
X_{31}← Learning Environment (X_3)	0,589
Y_1 ← Learning Motivation (Y)	0,567
Y_2 ← Learning Motivation (Y)	0,756
Y_3 ← Learning Motivation (Y)	0,649
Y_4 ← Learning Motivation (Y)	0,527

Source: Data processed

Based on Table 4, all factor loadings are above 0.5. This indicates that all manifest variables or indicators can adequately explain the latent variables.

b. Evaluation of Measurement Model Reliability

The reliability of a construct can be calculated using construct reliability and average variance extracted. In this research.

$$\text{construct reliability } (CR) = \frac{[\sum_{i=1}^{n} \lambda_i]^2}{[\sum_{i=1}^{n} \lambda_i]^2 + [\sum_{i=1}^{n}(1 - \lambda_i^2)]}$$

$$\text{average variance extracted (AVE)} = \frac{\sum_{i=1}^{n} \lambda_i^2}{\sum_{i=1}^{n} \lambda_i^2 + \sum_{i=1}^{n}(1 - \lambda_i^2)}$$

Table 5. Measurement Model Reliability

Latent Varibles	Sum of Factor Loadings $(\sum_{i=1}^{n} \lambda_i)$	Sum of Squared Factor Loadings $(\sum_{i=1}^{n} \lambda_i^2)$	Sum of Measurement Error $\left(\sum_{i=1}^{n}(1 - \lambda_i^2)\right)$	Construct Reliability (CR)	Average Variance Extracted
Learning Method	3,245	2,111	2,889	0,785	0,607
Learning Facilities	3,563	2,573	2,427	0,840	0,732
Learning Environment	3,741	2,349	3,651	0,793	0,602
Learning Motivation	2,499	1,592	2,408	0,722	0,513

Source: Data processed

Based on table 5, the construct reliability for all latent variables are more than 0.70. Similarly, the calculation of average variance extracted shows that all latent variables have an AVE ≥ 0.50. This indicates that the questions used to measure the indicators have a high consistency in measuring their latent variables.

3) Model Fit Test

Hypotheses in this research are as follows:

H_0 = no relationship between latent variables

H_1 = there is a relationship between latent variables

Decision Rule for hyphotheses are

If P-value < 0.05 or $|z| > 1.96$, then H_0 is rejected.

If P-value > 0.05 or $|z| < 1.96$, then H_0 is not rejected.

Table 6. Hypothesis Test

	P-value	Z	Relationship Coefficients
Learning motivation ← Learning methods	***	3.537	γ_{11}= 0.376
Learning motivation ← Learning facilities	0.002	1.979	γ_{12}= 0.228
Learning motivation ← Learning environment	0.003	2.968	γ_{13}= 0.362
Learning methods ↔ Learning facilities	***	5.461	φ_{12}= 0.469
Learning facilities ↔ Learning environment	***	5.314	φ_{23}= 0.573
Learning method ↔ Learning environment	***	5.953	φ_{13}= 0.715

Source: Data processed
***: P-value < 0.001

According to Table 6, the relationship between learning motivation and learning facilities has a z-value of 1.979, the relationship between learning motivation and learning methods has a z-value of 3.537, and the relationship between learning motivation and the learning environment has a z-value of 2.968. Since these values are all greater than 1.96, this indicates that H_0 can be rejected. This confirms that there is a significant relationship between learning motivation and learning facilities, learning motivation and learning methods, as well as learning motivation and the learning environment.

7. Respecification

In this study, there is no need for model respecification or modification, as the model fit test results show that the model is already a good fit. The model illustrated in the path diagram is transformed into a set of structural and measurement model equations. The study produces the following structural equation:

$$Y = 0.376X_1 + 0.228\,X_2 + 0.362X_3 + 0.62$$

The measurement model equations are as follows:

$$X_{11} = 0.664X_1 + 0.260$$
$$X_{12} = 0.654\,X_1 + 0.277$$
$$X_{13} = 0.696\,X_1 + 0.298$$
$$X_{14} = 0.616\,X_1 + 0.331$$
$$X_{15} = 0.615\,X_1 + 0.214$$
$$X_{21} = 0.709\,X_2 + 0.244$$
$$X_{22} = 0.746\,X_2 + 0.310$$
$$X_{23} = 0.820\,X_2 + 0.149$$
$$X_{24} = 0.722\,X_2 + 0.237$$
$$X_{25} = 0.566\,X_2 + 0.699$$
$$Y_1 = 0.567\,Y + 0.314$$
$$Y_2 = 0.756\,Y + 0.163$$
$$Y_3 = 0.649\,Y + 0.187$$
$$Y_4 = 0.527\,Y + 0.38$$

The relationship coefficients $\gamma_{11} = 0.376$, $\gamma_{12} = 0.228$, and $\gamma_{13} = 0.362$ indicate that learning methods (X_1) affect learning motivation (Y) by 0.376, learning facilities (X_2) influence learning motivation (Y) by 0.228, and the learning environment (X_3) impacts learning motivation (Y) by 0.362. This means that based on our research, motivation of the students in FST UNJA will improve when the learning facilities are improved. Similarly, if students improve their learning methods, their motivation will increase, and a better learning environment will also boost their motivation.

The correlation coefficient $\varphi_{12} = 0.469$ implies that learning methods (X_1) are correlated with learning facilities (X_2) by 0.469. Meanwhile, the coefficient $\varphi_{23} = 0.573$, suggests that learning facilities (X_2) are correlated with the learning environment (X_3) by 0.573, and $\varphi_{13} = 0.715$ indicates a correlation of 0.715 between learning methods (X_1) and the learning environment (X_3).

Conclusion

The research findings indicate that learning methods (X_1) have the most significant impact on learning motivation, with a positive relationship coefficient (γ_{11}) of 0.376. This suggests that if students at FST UNJA enhance their learning methods such as by establishing study schedules, reading and taking notes, reviewing lessons, maintaining focus, and completing assignments, their motivation to learn will increase accordingly. Furthermore, both learning facilities (X_2) and the learning environment (X_3) positively influence learning motivation (Y). This means that improved learning facilities and a better learning environment will lead to higher motivation among students. Thus, enhancing the learning environment and facilities can further boost students' motivation to learn. Future research is expected to include additional indicator variables related to learning methods, learning facilities, learning environment, and learning motivation.

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