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Psychometric Properties of The Course Interest Survey (CIS) : A Confirmatory Factor Analysis

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Abstract: This study aims to evaluate the psychometric properties of the Indonesian version of the CIS using Confirmatory Factor Analysis (CFA). This research used an analytical approach and psychometric methods. Participants comprised 112 high school students aged 15 to 17 in Pekanbaru, Indonesia. CIS consists of 34 statement items with four subscales: attention, relevance, confidence, and satisfaction. Data analysis in Confirmatory Factor Analysis was carried out through Mplus 8.11 and SmartPLS. The results showed that CIS performed well on all psychometric indicators: CFI, TLI, RMSEA, outer loading, and AVE. The RMSEA value is 0.107 > 0.08, the CFI value is 0.710 < 0.90, the TLI value is 0.689 < 0.90, and the SRMR value is 0.098 > 0.08. All items and subscales in the motivation variable are valid with outer loading item values > 0.7 and AVE values > 0.5. Based on CFI and TLI, the CIS model is a good fit and can be accepted. Furthermore, the four dimensions or subscales of the CIS—namely, attention, relevance, confidence, and satisfaction—demonstrate adequate psychometric properties. Based on the findings of this study, it can be concluded that the Indonesian version of the CIS is a valid, reliable, and robust instrument for assessing motivation. The implication of this research is that educators can assess student motivation using the CIS instrument because it has been proven to be able to measure elements of motivation.

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Introduction

Researchers from various countries have agreed that the study of motivation is highly complex, considering the many concepts, constructs, and theories of motivation that have been developed to understand related aspects. In addition, environmental, cultural, and personal factors that interact with each other also add to the complexity of influencing individual motivation at a certain time (Eccles and Wigfield 2020; Howard, Gagné, and Morin 2020; Vu et al. 2022; Wigfield and Koenka 2020). Motivation is related to human psychology because it includes decision-making about priorities to be carried out, staying focused on choices that have been made, and self-development and improving performance in various fields (Hattie, Hodis, and Kang 2020; Maslow 2023; Schunk and DiBenedetto 2021).

Motivation is evident in students' choice of learning tasks, the time and effort they allocate, their persistence, and their ability to overcome obstacles during the learning process (Wolters and Brady 2021; Yates et al. 2021). As a process, motivation begins with physiological or psychological needs that drive behavior toward a goal or incentive (Ify 2024; Reeve 2024) and is the main reason behind an individual's actions (Bureau et al. 2022; Guay

Vol. 10, No. 4 : December 2024
E-ISSN: 2442-7667
pp. 1341-1354
Email: jklppm@undikma.ac.id

et al. 2021). Students assign personal meanings and attitudes to academic activities that uniquely trigger and direct their energies (Seven 2020; Yu, Gao, and Wang 2021).

There is increasing evidence that motivation has an impact on learning outcomes (Amtu et al. 2020; Caldeiira et al. 2020; Chengjun and Mustakim 2022; Gomes et al. 2018; Torbergsen, Utvær, and Haugan 2023). However, studies conducted, especially in Indonesia, have been dominated by measuring student motivation using instruments in questionnaires developed by researchers based on intrinsic and extrinsic aspects. Empirical research in Indonesia that focuses on measuring motivation using standardized instruments used in various studies in the world is still limited and rarely carried out, which may be partly because so far, researchers have developed their instruments (Sudibyo, Jatmiko, and Widodo 2016; Trisnawati 2021; Yuniarto 2017).

In recent years, activities have increased to develop and validate instruments to measure motivation—for example, instruments in motivation tests and instruments in questionnaires. One of the instruments that have been developed to measure motivation (Keller 2009) is the Course Interest Survey (CIS). Keller initially validated his survey by administering it to 45 undergraduate students, yielding relatively high internal consistency estimates. A pre-test version was then prepared by converting the items into the future tense and administered to 65 undergraduate students. Although the internal consistency estimates remained high, further revisions were made to refine the instrument. This standardized version of the survey was then distributed to undergraduate and graduate students in the School of Education at a university in the Southeast. As a questionnaire instrument based on the ARCS aspects, the CIS has been used in various countries and has been shown to be reliable and valid in measuring student motivation (Bhagat, Chang, and Chang 2016; Gomes et al. 2018; Naveed and Bhatti 2017; Simanjuntak 2022).

CIS is designed to fit the theoretical foundation represented by the concept and theory of motivation consisting of four subscales: Attention, Relevance, Confidence, and Satisfaction (ARCS). Attention is a cognitive process involving the selection and processing of stimuli from the environment, which is temporary and related to the individual's interest in the stimulus (Brady, Crockett, and Van Bavel 2020; Cowan et al. 2024). Interest is permanent, while attention is temporary. Relevance reflects the relationship between learning materials and students' needs and conditions. Students' learning motivation will be maintained if they view that the material being studied meets personal needs, provides benefits, and aligns with their values (Anderman 2020; Bayes et al. 2020; Blum and McHugh 2020).

Confidence or self-confidence is related to an individual's ability to recognize the limits of their competence and feel comfortable with their abilities. If someone has confidence in the individual's capacity to learn independently and develop their potential, it is essential to provide the opportunity or freedom for the individual to determine the learning method that is appropriate for them (Crawford and Burns 2020; Toktas and Bas 2019). Therefore, this freedom in learning can only be done by teachers who do not hesitate but fully believe in the abilities of students. Success in achieving goals will produce a certain level of satisfaction. The satisfaction of achieving this goal is influenced by the consequences received from internal and external factors in the students themselves (Ali and Anwar 2021; Hava 2021; Tang, Vezzani, and Eriksson 2020).

The dimensions or subscales of the CIS integrate psychological constructs derived from the empirical literature on human motivation so that it is widely used in motivation assessment. This instrument has been proven to have good psychometric qualities. The CIS is often used to assess the motivation felt by individuals towards motivationally adjusted

Vol. 10, No. 4 : December 2024
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pp. 1341-1354
Email: jklppm@undikma.ac.id

instructions (e.g., (Ali and Anwar 2021; Hava 2021; Tang et al. 2020). However, this survey has not fully revealed its statistical and theoretical strengths and weaknesses related to all aspects of the ARCS theory on which it is based, mainly when used on participants with different languages and cultures from its initial use. Although the CIS has been widely applied in various countries, this instrument still needs to be tested for its psychometric properties when used in different cultures so that the measurement results are in accordance with local conditions. Therefore, this study aims to produce an Indonesian version of the CIS intended for high school students and to validate its psychometric properties in the Indonesian context.

To date, researchers have primarily used classical test theory to assess the psychometric properties of developed instruments. Psychometric properties can also be assessed using item response theory (e.g., Confirmatory Factor Analysis/CFA) because it has advantages in certain aspects. Several additional studies have used confirmatory factor analysis to test the fit of the original model and alternative models derived from EFA or theory (Douglas et al. 2020; Esposito et al. 2023; Hauze and Marshall 2020; Manzano-León et al. 2021). CFA has the advantage of testing a priori hypotheses about factor structure. Like exploratory research, these CFAs have produced mixed results supporting a variety of different factor structures. However, most CFAs have tested only a small subset of currently available models (Moshagen and Bader 2024; Sureshchandar 2023).

Exploratory factor analysis often produces factors that consist of components that can be categorized as either positive or negative. However, this approach has limitations in assessing the results' characteristics (Fabrigar and Wegener 2012; Watkins 2018). However, this approach has limitations in evaluating the properties of the results generated (Hauze and Marshall 2020; Luong and Flake 2023; Marsh et al. 2020). In contrast to exploratory factor analysis, constraints can be imposed on different parameter estimates, including factor loadings, variances, covariances, and residual variances, leading to more efficient models. Within the CFA framework, if the number of elements in the input variance/covariance matrix surpasses the number of parameters that can be estimated freely, it becomes possible to identify correlated errors among the indicator residuals. This allows for the reflection of various methodological effects, such as significant content overlap, similar wording, differential sensitivity to specific characteristics, and issues related to carelessness or comprehension difficulties with the presented items (Luong and Flake 2023; McNeish and Wolf 2023). Referring to the background described. This study aims to evaluate the psychometric properties of the Indonesian version of the Course Interest Survey using Confirmatory Factor Analysis (CFA).

Research Method

This research used an analytical approach and psychometric methods. This study validates the CIS instrument for senior high school students, we included students from various levels, namely grade X, grade XI, and grade XII, in the age range of 15 to 17 years, and we did not exclude gender. One hundred twelve students from seven senior high schools in Pekanbaru City agreed to be research participants using random sampling

The CIS consists of 34 items with response options ranging from one (not confirmed) to 5 (very true). An example item reads, "The teacher knows how to make us feel enthusiastic about the subject matter of this course." Following standard translation procedures, the English version of the CIS was first translated into Indonesian by an English lecturer with good English skills. During the translation process, the research team was involved in double-checking the translation and resolving any discrepancies through discussion.

Vol. 10, No. 4 : December 2024
E-ISSN: 2442-7667
pp. 1341-1354
Email: jklppm@undikma.ac.id

Data analysis for confirmatory factor analysis (CFA) was conducted through Mplus 8.11 and SmartPLS. In confirmatory factor analysis (CFA), we used the weighted least squares estimator adjusted for mean and variance. This method has proven more effective than other estimation methods, especially for Likert-type rating scales. To assess the extent to which our proposed model fits the single-factor structure proposed in the original study, we conducted an analysis using several commonly used model fit indices. These indices include the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). According to the guidelines proposed by Hu and Bentler, CFI and TLI values greater than 0.90 indicate that the proposed model is a good fit for the data. On the other hand, RMSEA values less than 0.08 are also considered to indicate adequate fit. Thus, we evaluated the values of these indices to determine whether our CFA model meets the expected fit criteria. This approach is important to ensure the validity and reliability of the instruments used in the study.

Construct validity using CFA analysis aims to test whether the indicators reflect the variables. Factor analysis is one of the statistical techniques used to identify a structure (either items within indicators or indicators within variables). The indicator is declared valid if the outer loading value exceeds 0.7 or the variable AVE value exceeds 0.5. For reliability using Cronbach's Alpha, it is declared reliable with a number greater than 0.7, and using Composite Reliability, it is declared reliable with a number greater than 0.7 (Marsh et al. 2020; Shi, Maydeu-Olivares, and Rosseel 2020)

Results and Discussion

Student motivation is an essential element that educators need to know in the learning process because motivation influences student behavior and directs and contributes to ensuring that the learning process runs well. When educators know the factors that influence student motivation, they can adjust their teaching methods to suit the needs and interests of students better. This is expected to create a pleasant learning environment so that the learning process runs more effectively and students can achieve optimal learning outcomes (Hadi Mousavi 2020; Looney et al. 2018) . Measuring motivation requires the right instrument and how motivational instruments are used to support learning. In this study, we examine one of the instruments for measuring motivation, namely the Course Interest Survey (CIS), with four subscales or dimensions: attention, relevance, confidence, and satisfaction.

This study translated the CIS into Indonesian and tested its psychometric properties based on CFA modeling. Overall, the four subscales or dimensions in the CIS were confirmed, which aligns with previous studies (Elizondo-Noriega et al. 2024; Hauze and Marshall 2020), with the model presenting a fairly good model fit. The CFA results support the validity of the original CIS model. Furthermore, the four dimensions revealed good internal consistency, with values similar to those found in previous studies (Cook and Skrupky 2024; Loorbach et al. 2015). The CIS has good reliability and validity. CFA produced mixed results to assess model fit with CFI, TLI, and RMSEA values indicating acceptable model fit. The model fit results using Mplus can be seen in Figure 1.

Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index
Vol. 10, No. 4 : December 2024
E-ISSN: 2442-7667
pp. 1341-1354
Email: jklppm@undikma.ac.id

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MODEL FIT INFORMATION

Number of Free Parameters                       106

Loglikelihood
          H0 Value                       -2343.634
          H1 Value                       -1931.441

Information Criteria
          Akaike (AIC)                    4899.269
          Bayesian (BIC)                  5101.943
          Sample-Size Adjusted BIC        4769.227
            (n* = (n + 2) / 24)

Chi-Square Test of Model Fit
          Value                            824.386
          Degrees of Freedom                   523
          P-Value                           0.0000

RMSEA (Root Mean Square Error Of Approximation)
          Estimate                           0.107
          90 Percent C.I.                    0.093  0.121
          Probability RMSEA <= .05           0.000

CFI/TLI
          CFI                                0.710
          TLI                                0.689

Chi-Square Test of Model Fit for the Baseline Model
          Value                         1600.705
          Degrees of Freedom                561
          P-Value                        0.0000

SRMR (Standardized Root Mean Square Residual)
          Value                              0.098
```

Figure 1. Results of the Course Interest Survey (CIS) Fit Model

Regarding the results based on CFA, we found that CIS performed well on all psychometric indicators, namely CFI, TLI, and RMSEA. The results of this analysis indicate that there is still potential to improve the model to fit the existing data better. RMSEA (Root et al. of Approximation) is the most commonly used measure to evaluate model misfit and is often reported in studies that apply the Structural Equation Modeling model (Greene and Jones 2020; Maydeu-Olivares 2017). Asymptotic statistical theory provides the basis for constructing confidence intervals for the RMSEA, where a commonly accepted threshold value is around 0.05 or lower, indicating that the model fits the data. However, it should be noted that the RMSEA is an unstandardized effect measure of model misfit. The RMSEA for a population is an unstandardized parameter, so its value may exceed the recommended reference limit of 0.05, depending on the number of indicators per factor, with other factors held constant (Greene and Jones 2020; Maydeu-Olivares 2017; Shi et al. 2020).

Based on CFI and TLI, we found a good fit of the CIS model and acceptable. The model fit results showed a CFI value of 0.710 <0.90. Generally, a good CFI value is ≥ 0.90, indicating that the model fits the data well. A CFI value of 0.710 indicates that this model fits the empirical data poorly. However, this value is not too far from the limit of 0.90, so it can still be considered a marginal fit because each number is not too far from the limit (Lai 2021). CFI compares the existing model with an independent model or null model, which is a model that assumes that all variables are uncorrelated. How to see the relative fit of the model by taking into account the complexity of the model and using the difference between the hypothesized model and the independent model as a reference (Padgett and Morgan 2021; Parady, Ory, and Walker 2021).

TLI called the Non-Normed Fit Index, is an incremental fit measure considering model complexity. The results of the study show a value below 0.90, which means that this

Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index
Vol. 10, No. 4 : December 2024
E-ISSN: 2442-7667
pp. 1341-1354
Email: jklppm@undikma.ac.id

model still needs to have an optimal fit. However, considering this value is not too far from 0.90, we can call it a marginal fit. Further model development could improve this TLI value. Since TLI is based on the principle of incremental fit assessment, we have reason to believe that its application to IRT may be less influenced by the number of categories (Cai, Chung, and Lee 2023; McNeish and Wolf 2023; Montoya and Edwards 2021). By examining the three psychometric properties of the CSI instrument, we can see that this instrument can be used to measure student motivation because the numbers are at marginal fit.

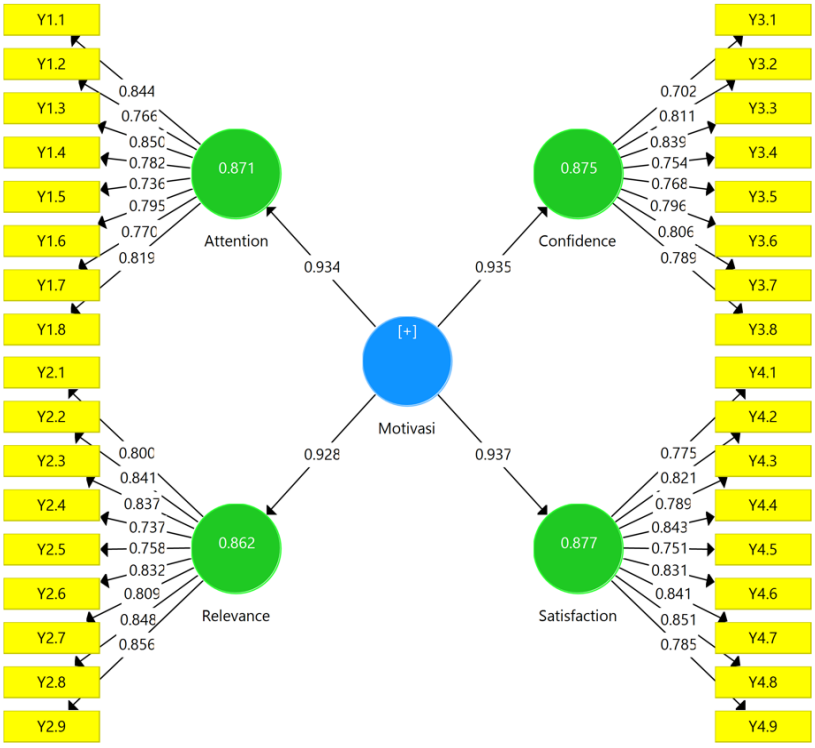

Figure 2. The Factor Loadings of CIS

In this study, we also conducted Confirmatory Factor Analysis (CFA) to test the relationship between latent variables in the CIS and the measured indicators and their statement items. CFA is essential in assessing the validity and reliability of a measurement instrument in research, especially when we want to ensure that each indicator accurately reflects the hypothesized factors. One software often used to conduct CFA is SmartPLS, which is based on Partial Least Squares Structural Equation Modeling (PLS-SEM). In this analysis, SmartPLS helps visualize a structural model that displays the relationship between latent variables and their indicators. Figure 2 below shows the CFA results obtained through SmartPLS, which will be the basis for evaluating model fit and more in-depth data interpretation.

Based on Figure 2, all constructs (Attention, Relevance, Confidence, and Satisfaction) significantly influence motivation. The loading factor value above 0.8 in the relationship between each subscale and motivation indicates that all these variables are relevant and essential. Motivation as the main construct has a loading factor value that shows the strength of the relationship between the construct and the other four subscales. The subscale with the highest loading factor value is satisfaction, which indicates that satisfaction has a strong influence on motivation. Satisfaction affects the level of student motivation. The results of a study by Indarti et al (2021), who surveyed students, found that valuable student satisfaction can be used to improve an educational program. Satisfaction is related to feelings of

Vol. 10, No. 4 : December 2024
E-ISSN: 2442-7667
pp. 1341-1354
Email: jklppm@undikma.ac.id

happiness and joy when individuals get or have fulfilled their needs and desires (Harefa et al. 2023; Zheng 2022). The level of student satisfaction in lessons is a very important component for them to acquire knowledge or skills. A student can be considered satisfied if the lesson meets his needs and expectations. This can motivate students to put more effort into learning, increase positive attitudes toward learning, and carry out learning optimally (James 2021; Mandal 2018; Wong and Chapman 2023).

The lowest factor loading value among the four subscales is attention (0.871). Although the value is lower than the others, the attention construct still has a significant influence because the figure is above 0.8. Attention has several indicators (Y1.1 to Y1.6), with each factor loading value of more than 0.7, which is generally considered vital. This shows that attention is an important factor influencing motivation in this context. Research examining attention and working memory shows that attention plays an important role in controlling activity, maintaining, and manipulating working memory representations to facilitate the interpretation of information (Angelopoulou and Drigas 2021). During the learning process, the attention given by teachers or classmates can create a friendly environment and a school climate that encourages constructive relationships to achieve learning objectives. Teachers who pay less attention to the development of student learning in class or are less concerned can emphasize negative aspects of learning so that more comprehensive teacher and student participation in class is needed (Angelopoulou and Drigas 2021; Chiu, Lin, and Lonka 2021; Moreno-Medina et al. 2023).

The relevance subscale in this model has a loading factor value of 0.862 on motivation, indicating that relevance is important in increasing a person's motivation. The high loading factor on the relevance indicator (Y2.1 to Y2.9), most of which are more than 0.7, indicates that this construct is well measured and the indicators used are strong enough to explain the relevance. This means that in a certain context, the relevance of a material, topic, or experience to an individual's needs or interests greatly influences their motivation to engage further. When students are given tasks that are relevant to their lives, they become more motivated. Several studies support this finding and show that relevance plays an important role in shaping motivation (Alamri et al. 2020; Anderman 2020; Bureau et al. 2022).

The confidence construct has a loading factor value of 0.875 on motivation, showing a high influence. The indicators (Y3.1 to Y3.6) show strong loading factor values, indicating that an individual's self-confidence is important in determining the level of motivation. Strong loading factor values indicate that each indicator consistently explains the overall confidence construct. This shows that the higher a person' level of self-confidence, the greater the motivation they have to engage in a particular activity or task. When students have self-confidence, they are ready to face the dynamics of life in the school environment. An attitude of confidence in one's abilities and not covering up one's weaknesses can lead students to become successful and independent adult individuals. Self-confidence will make individuals more capable of motivating themselves to learn to develop themselves to carry out various innovations (Newton et al. 2024; Pedler, Willis, and Nieuwoudt 2022a, 2022b).

To determine the validity and reliability of each subscale and item in the CIS instrument, we use several parameters, namely Outer Loading, to ensure the validity of each item. The Average Variance Extracted (AVE) value is used to measure the construct validity of each indicator; the Cronbach's Alpha and Composite Reliability values are displayed to measure the internal reliability of each subscale, as seen in Table 2.

Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index
Vol. 10, No. 4 : December 2024
E-ISSN: 2442-7667
pp. 1341-1354
Email: jklppm@undikma.ac.id

Table 2. Summary Results of CFA Analysis

Variable	Subscale	Item	Outer Loading	AVE	Label	Cronbach's Alpha	Composite Reliability	Label
Motivation								
	Attention			0.634	Valid	0.917	0.933	Reliable
		Y1.1	0.844		Valid			
		Y1.2	0.766		Valid			
		Y1.3	0.850		Valid			
		Y1.4	0.782		Valid			
		Y1.5	0.736		Valid			
		Y1.6	0.795		Valid			
		Y1.7	0.770		Valid			
		Y1.8	0.819		Valid			
	Relevance			0.663	Valid	0.936	0.946	Reliable
		Y2.1	0.800		Valid			
		Y2.2	0.841		Valid			
		Y2.3	0.837		Valid			
		Y2.4	0.737		Valid			
		Y2.5	0.758		Valid			
		Y2.6	0.832		Valid			
		Y2.7	0.809		Valid			
		Y2.8	0.848		Valid			
		Y2.9	0.856		Valid			
	Confidence			0.615	Valid	0.910	0.927	Reliable
		Y3.1	0.702		Valid			
		Y3.2	0.811		Valid			
		Y3.3	0.839		Valid			
		Y3.4	0.754		Valid			
		Y3.5	0.768		Valid			
		Y3.6	0.796		Valid			
		Y3.7	0.806		Valid			
		Y3.8	0.789		Valid			
	Satisfaction			0.657	Valid	0.934	0.945	Reliable
		Y4.1	0.775		Valid			
		Y4.2	0.821		Valid			
		Y4.3	0.789		Valid			
		Y4.4	0.843		Valid			
		Y4.5	0.751		Valid			
		Y4.6	0.831		Valid			
		Y4.7	0.841		Valid			
		Y4.8	0.851		Valid			
		Y4.9	0.785		Valid			
Motivation				0.559	Valid	0.976	0.977	Reliable
	Attention		0.934		Valid			
	Relevance		0.928		Valid			
	Confidence		0.935		Valid			
	Satisfaction		0.937		Valid			

For construct validity, the CFA results support four subscales, which reflect motivation theory's constructs: attention, relevance, confidence, and satisfaction. The findings of this study are consistent with validation studies by other researchers (Cook and Skrupky 2023, 2024; Hauze and Marshall 2020). Overall, this table shows that all items and indicators in the motivation variable meet the validity and reliability requirements, which means that the instrument can measure student motivation well. This research provides implications for

educators that the CIS instrument will be valuable and applicable to the assessment of situational motivation in the classroom. This research can be used as a comparison with other studies that use similar instruments to measure student motivation

Conclusion

The results showed that CIS performed well on all psychometric indicators: CFI, TLI, RMSEA, outer loading, and AVE. The RMSEA value is 0.107 > 0.08, the CFI value is 0.710 < 0.90, the TLI value is 0.689 < 0.90, and the SRMR value is 0.098 > 0.08. All items and subscales in the motivation variable are valid with outer loading item values > 0.7 and AVE values > 0.5. Based on CFI and TLI, the CIS model is a good fit and can be accepted. Furthermore, the four dimensions or subscales of the CIS—namely, attention, relevance, confidence, and satisfaction—demonstrate adequate psychometric properties. Based on the findings of this study, it can be concluded that the Indonesian version of the CIS is a valid, reliable, and robust instrument for assessing motivation

Recommendation

The research that has been conducted provides direction regarding using the Course Interest Survey to measure student motivation. For further research, analysis can be conducted on a larger sample or at different age levels. For educators, the CIS instrument can be used as an alternative to measure student motivation because it contains motivational dimensions.

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Vu, TuongVan, Lucía Magis-Weinberg, Brenda R. J. Jansen, Nienke van Atteveldt, Tieme

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