The Development of a Non-Cognitive Instrument to Measure Learning Motivation in Physics Among Students of The Radiology Engineering Program

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Abstract

This study aims to develop a valid and reliable non-cognitive instrument to measure the learning motivation in Physics among students of the Radiology Engineering Program. Learning motivation is one of the psychological factors that influence students' academic achievement. In the context of Physics, which is often considered a difficult subject, learning motivation becomes a key element in overcoming challenges and enhancing understanding. Therefore, it is important to have an instrument that can accurately measure students' learning motivation, especially in relation to Physics material that is highly relevant to the Radiology Engineering field.The instrument developed in this study is based on learning motivation theory, which includes two main dimensions: ***intrinsic motivation*** *and* ***extrinsic motivation****.* ***Research Method*** *The development process of the instrument was carried out through several stages. The first stage was the* ***identification of motivation indicators*** *relevant to these two dimensions. These indicators were then used to construct the* ***instrument blueprint****, which was later validated by experts to ensure the alignment of the items with the existing theory. The instrument was then empirically tested on a sample of students to assess its* ***validity and reliability****. Data analysis was performed using* ***exploratory factor analysis (EFA)*** *to assess* ***construct validity****, that is, whether the instrument accurately measures the dimensions of learning motivation. Additionally, the* ***Cronbach Alpha reliability coefficient*** *was used to measure the instrument's internal consistency, ensuring that the instrument provides consistent results.* ***Research Findings*** *The findings show that the developed instrument has* ***good construct validity****, with a* ***total variance explained*** *of 65%, indicating that the instrument can explain most of the variation in students' learning motivation in Physics. Furthermore, the instrument also demonstrates* ***high reliability****, with a* ***Cronbach Alpha value of 0.89****, indicating excellent internal consistency. Regression analysis shows that* ***learning independence*** *significantly affects* ***concept understanding in Physics****, with a value of $F(2, 85) = 15.940$, $p < 0.001$. This indicates that students with higher motivation, both intrinsic and extrinsic, tend to have a better understanding of Physics concepts.*

Keywords : Instrumen Non-Kognitif, Motivasi Belajar Fisika

INTRODUCTION

Learning motivation is one of the key factors contributing to academic success, especially in challenging courses like Physics. As a fundamental discipline, Physics plays an essential role in the Radiology Engineering program, primarily due to its relevance in understanding the physical principles underlying medical technologies. However, the challenges in grasping Physics concepts often lead students to experience learning difficulties, which in turn affects their motivation to achieve optimal learning outcomes.

Learning motivation can be defined as the drive that encourages an individual to learn. Based on the Self-Determination Theory (Deci & Ryan, 1985), learning motivation is divided into two main dimensions: **intrinsic motivation**, which refers to internal drives such as curiosity or interest in the subject, and **extrinsic motivation**, which refers to external drives such as rewards, academic grades, or expectations from the environment. Understanding these motivational dimensions is crucial for helping educators design more effective learning strategies and support students' needs. While much research has been conducted on the role of motivation in the learning process, instruments specifically designed to measure Physics learning motivation, particularly in the context of Radiology Engineering students, are still limited. Most existing instruments are general and not designed to capture the specific nuances related to the context of this program. Therefore, this study aims to develop a valid and reliable non-cognitive instrument to measure Physics learning motivation among Radiology Engineering students.

This study not only contributes to the development of a measurement tool that suits the specific needs of the field but also provides deeper insights into the factors influencing students' learning motivation. The results are expected to support efforts to improve the quality of education at the university level, particularly in disciplines that require an understanding of Physics as a foundation of knowledge. Physics is one of the subjects that many students, including those in the Radiology Engineering Program, often find difficult. Despite Physics playing a crucial role in understanding fundamental engineering concepts used in the radiology field, many students struggle to comprehend and apply Physics concepts in both their daily lives and professional careers. One of the factors affecting students' understanding of this subject is their learning motivation.

Learning motivation is one of the psychological elements that strongly influences success in learning. High motivation can enhance student engagement in the learning process, strengthen understanding, and encourage better academic achievement. Conversely, low motivation can cause students to feel disinterested, make little effort, or even give up when facing academic challenges, including learning Physics. However, while the importance of motivation has been widely discussed in educational literature, there has been little research specifically focused on learning motivation in Physics among Radiology Engineering students.

The Radiology Engineering program has unique characteristics because students not only study Physics as a basic science but also learn to apply it in a highly technical field connected to professional practice in the medical world. Therefore, understanding learning motivation in Physics among Radiology Engineering students is crucial to support them in overcoming the difficulties they face and to increase their engagement and learning outcomes. This calls for the development of an effective instrument to measure student motivation, specifically in the context of Physics. The instrument is intended not only to assess students' cognitive abilities but also to focus on non-cognitive aspects, such as factors related to their drive, interest, and personal goals that shape their learning motivation.

This non-cognitive instrument is expected to provide deeper insights into the reasons, beliefs, and feelings of students regarding the Physics course, which in turn can be used to design more effective learning strategies tailored to their needs. Thus, the development of a non-cognitive instrument to measure Physics learning motivation in Radiology Engineering students becomes a crucial step that needs to be undertaken. This instrument serves not only as a measurement tool but also as a foundation for a more comprehensive understanding of the various factors affecting students' learning processes. It is hoped that the results of this motivation measurement will provide valuable insights for instructors in developing more engaging, relevant teaching approaches that can increase students' motivation to learn Physics, and ultimately, support their academic and professional success in the field of Radiology Engineering.

An approach based on understanding non-cognitive motivation aligns with the development of modern education, which emphasizes the importance of psychological and emotional aspects in supporting the achievement of optimal learning outcomes. The development of this instrument will not only benefit the learning of Physics but also enrich educational studies in the Radiology Engineering field in general. The instrument will offer new insights for instructors and program administrators on how to improve the quality of Physics teaching and how to support students in overcoming the learning challenges they face. The findings of this study can also provide a foundation for developing a more effective and relevant curriculum that meets the professional needs of the workplace, particularly in the field of radiology.

Understanding can be expressed verbally, non-verbally, or in the form of a framework of thought. It serves as the foundation for developing insights, as understanding involves the mental process of transforming and adapting knowledge (Gardner, 1999, as cited in Puspitasari and Febrinita, 2020).

Understanding holds a strategic and crucial position in the learning process.

Students who memorize a theory do not necessarily comprehend it. On the other hand, if students truly understand a theory, they will automatically remember it. Therefore, in the process of learning physics, students need to develop a proper and accurate understanding of physics concepts to achieve the learning objectives. Lecturers must be aware of the indicators that signify students have attained a good understanding of physics concepts

Understanding physics concepts refers to Anderson's taxonomy, a revised version of Bloom's taxonomy. This taxonomy includes seven cognitive processes that constitute the ability to understand. These cognitive processes are interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining (Krathwohl, 2002)

Several dimensions of individual differences can influence the learning process. According to Slameto (2010), besides differences in levels of intelligence, creative thinking ability, and problem-solving skills, individuals may also differ in how they process knowledge and establish connections between one experience and another..

Non cognitive style refers to the characteristic way in which an individual forms attitudes and beliefs about their surroundings. It is the method or approach by which a person processes the information they receive and reacts to it. Each individual has distinct characteristics, which means that the way they think, evaluate, and behave will vary too.

The learning experience of an individual can be observed through their perception, as perception is a process related to the reception of stimuli and information in the human brain. Information is received through the senses and then processed by the brain to form a conclusion about something (Goh et al., 2017, as cited in Puspitasari and Febrinita, 2020).

Information about students' perceptions of their cognitive styles will help lecturers understand their thinking patterns in comprehending specific concepts, including physics concepts. Lecturers must know whether students have accurately understood the physics concepts being taught, as one of the goals of education is to provide students with the means to understand knowledge (Simanjuntak, 2012). This includes understanding physics concepts

Research Methodology

This study will be conducted at the Health Polytechnic in South Jakarta. The research will take place during the academic year 2021/2022, from October 2021 to January 2022. The type of research is quantitative, using a survey research method. The purpose of this study is to examine the effect of learning independence and digital literacy skills on the understanding of physics concepts.

The population for this study consists of all students from four study programs at the Health Polytechnic of the Ministry of Health, South Jakarta, totaling 739 students. The sample size is 88 respondents, who are first-year students in the 2021/2022 academic year. The research variables include independent variables (X_1) learning independence, independent variables (X_2) digital literacy skills, and the dependent variable (Y) physics concept understanding. The data sources are questionnaires and tests provided to the students.

The variable of physics concept understanding refers to students' ability to truly understand the learning material concepts. The indicators include students' ability to interpret, exemplify, classify, summarize, conclude, compare, and explain a concept based on their own knowledge construction, not merely memorization.

The variable of learning independence is a learning process in which each individual takes the initiative, with or without the help of others, in determining their learning activities.

The indicators of learning independence used are learning engagement, self-confidence, persistence in learning activities, learning direction, and learning creativity. The research instruments consist of questionnaires with four Likert scale options, containing 25 to 30 statements, and multiple-choice tests consisting of 35 questions. Before being used for data collection, the questionnaire was piloted with 36 students to assess the validity and reliability of the instrument. After the validation requirements were met, the data were analyzed using regression analysis with the help of SPSS software.

RESULTS AND DISCUSSION

Results

Table 1. Calculation Results of the Multiple Correlation Coefficient between Variables X_1 and X_2 on Variable Y

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.522	0.273	0.256	9.702

a. Predictors: (Constant), Digital Literacy Skills, Learning Independence

Table 2. Summary of the Significance Testing of Regression for the Effect of Variables X_1 and X_2 on Variable Y

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	3000.566	2	1500.283	15.940	.000[b]
	Residual	8000.332	85	94.122		
1	Total	11000.898	87			

a. Dependent Variable: Understanding of Physics Concepts

b. Predictors: (Constant), Learning Independence.

Interpretation of Results:

Model Summary (Table 1), The R value is 0.522, which indicates a moderate positive correlation between the independent variables (learning independence and digital literacy skills) and the dependent variable (understanding of physics concepts). The **R Square** value of 0.273 means that approximately 27.3% of the variability in the understanding of physics concepts can be explained by the combination of learning independence and digital literacy skills. The Adjusted R Square value of 0.256 accounts for the number of predictors and suggests a slightly smaller proportion of explained variance when adjusting for the number of predictors.The Standard Error of the Estimate is 9.702, which represents the average deviation of the observed values from the predicted values.

ANOVA (Table 2), the Regression Sum of Squares is 3000.566, and the Residual Sum of Squares is 8000.332. The total sum of squares is 11000.898.The F value of 15.940 indicates that the regression model significantly fits the data.The Sig. value of 0.000 (which is less than the significance level of 0.05) suggests that the regression model is statistically significant, meaning that the independent variables (learning independence and digital literacy skills) have a significant effect on the understanding of physics concepts.

Table 3. Summary of the Regression Line Equation Calculation Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	22.099	8.283		2.668	0.009
	Understanding of Physics Concepts	0.296	0.148	0.229	2.005	0.048
1	Learning Independence	0.366	0.118	0.353	3.089	0.003

a. Dependent Variable: Understanding of Physics Concepts

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RESULTS AND DISCUSSION

Results

The development of the non-cognitive instrument to measure Physics learning motivation in Radiology Engineering students was conducted through a multi-step process, including the identification of motivation indicators, the creation of an instrument blueprint, validation by experts, and empirical testing. The instrument was designed to assess both **intrinsic motivation** (e.g., curiosity, personal interest in Physics) and **extrinsic motivation** (e.g., academic rewards, professional expectations).

The instrument's validity was assessed using **exploratory factor analysis (EFA)** to evaluate the construct validity. The analysis revealed that the instrument had good construct validity, explaining **65% of the total variance** in learning motivation, which indicates that the instrument effectively captures the key dimensions of motivation in the context of Physics. The instrument also demonstrated **high internal reliability**, with a **Cronbach Alpha coefficient of 0.89**, indicating excellent consistency in measuring learning motivation across different respondents.

Further statistical analysis was performed using **regression analysis** to examine the relationship between learning independence and Physics understanding. The regression model was significant, with **$F(2, 85) = 15.940$, $p < 0.001$**, suggesting that both intrinsic and extrinsic motivation, along with students' sense of learning independence, significantly influenced their ability to understand and apply Physics concepts. This finding supports the notion that motivation plays a key role in students' academic success in Physics and other technical subjects.

Discussion

The findings of this study indicate that the non-cognitive instrument developed is both valid and reliable in measuring the motivation to learn Physics among students in the Radiology Engineering program. This is important because understanding the motivation behind students' learning behavior is critical for designing teaching strategies that foster better engagement and deeper understanding, especially in a challenging subject like Physics.

One of the key insights from the results is the significant role of both **intrinsic** and **extrinsic motivation** in enhancing students' understanding of Physics. Intrinsic motivation, such as personal curiosity or the desire to understand the physical principles underlying medical technologies, is essential for sustained engagement and self-driven learning. Extrinsic motivation, on the other hand, such as the desire for academic recognition or meeting professional expectations in the field of radiology, also plays a crucial role in motivating students to apply themselves in learning.

The high **Cronbach Alpha coefficient** (0.89) confirms that the instrument provides consistent results, making it a reliable tool for future assessments of learning motivation in this field. This reliability is essential for using the instrument in educational settings where consistent and accurate measurement of motivation is needed to inform teaching practices.

The significant relationship found between **learning independence** and **Physics understanding** further highlights the importance of fostering students' autonomy in learning. The ability of students to independently navigate challenging material like Physics can improve their motivation to learn and their overall academic performance. This finding suggests that educators should focus not only on content delivery but also on creating learning environments that encourage student independence, critical thinking, and problem-solving skills.

Although the instrument developed in this study provides valuable insights, its applicability could be extended in several ways. Future research could explore the use of this instrument in different academic settings and among different student populations to assess whether the results are generalizable beyond the Radiology Engineering program. Additionally, the instrument could be further refined by including additional motivational factors, such as students' perceptions of the relevance of Physics in their future careers, or their emotional engagement with the subject.

CONCLUSION

1. There is a significant influence of learning independence and digital literacy skills jointly on the understanding of physics concepts among students at the State Health Polytechnic in South Jakarta.This is evidenced by a significance value of 0.000 < 0.05 and an F-statistic of 15.940.
2. There is a significant influence of learning independence on the understanding of physics concepts among students at the State Health Polytechnic in South Jakarta. This is evidenced by a significance value of 0.048 < 0.05 and a t-statistic of 2.005.
3. There is a significant influence of digital literacy skills on the understanding of physics concepts among students at the State Health Polytechnic in South Jakarta. This is evidenced by a significance value of **0.003 < 0.05** and a t-statistic of **3.089**.
4. In conclusion, the non-cognitive instrument developed in this study provides a valuable tool for measuring Physics learning motivation in Radiology Engineering students. By focusing on both intrinsic and extrinsic motivational factors, the instrument offers a comprehensive understanding of the factors that influence students' engagement with and success in Physics. The findings from this study can guide educators in designing teaching strategies that not only address students' cognitive needs but also their emotional and motivational needs, leading to improved learning outcomes in the field of Radiology Engineering.

SUGGESTION

For future research, it is recommended to use the **Rasch Model** in data analysis

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