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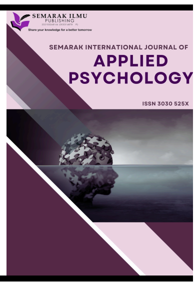

Development and Validation of Motivational Instrument for Form Four Physics Students in Secondary Schools: An Exploratory Factor Analysis (EFA)

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ABSTRACT

Education is recognized as a dynamic, interactive process involving students, teachers, and the learning environment, where motivation plays a pivotal role in both academic achievement and personal development. This study aims to validate a motivation questionnaire derived from the adaptation of the Goal Orientation and Learning Strategies Survey (Goal-S 2004) and the Students' Adaptive Learning Engagement in Science Questionnaire (SALES 2011). Utilizing Exploratory Factor Analysis (EFA), the questionnaire examines correlations, extracts factors, and rotates them. The motivation questionnaire comprises four sub-constructs: self-efficacy (SE), learning goal orientation (LGO), achievement goal orientation (AGO), and task value (TV). Involving 406 respondents, form four physics students from daily secondary schools in Perak, Negeri Sembilan, Kedah, and Kelantan, data analysis was conducted using Statistical Package of Social Sciences (SPSS) Version 29.0. Results indicate strong internal reliability (Cronbach's alpha = 0.951), surpassing the recommended threshold of 0.7. EFA reveals specific item representations: SE (9 items), LGO (6 items), AGO (4 items), and TV (8 items), with Eigenvalues exceeding 1. The Kaiser-Meyer-Olkin (KMO) value (0.929 > 0.6) confirms adequate inter-correlation among motivation construct items, supported by a significant Bartlett's Test (Chi-Square 9718.133, $p < 0.05$). The four factors collectively explain 72.54% of the variance. Overall, the study finds that the motivation questionnaire effectively measures its objectives, affirming its suitability for genuine research applications.

1. Introduction

Education is the process of teaching and learning that involves interaction among students, teachers, and the learning environment. In the context of education, motivation plays a crucial role as the main aspect of academic success and students' personalities. Motivation not only encourages students to achieve goals but also serves as a driving force that influences students' behavior and understanding of the learning process [1].

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According to Wahab and Sukri [2], motivation is the spirit driven by internal and external forces within an individual to achieve specific goals and needs. In the educational landscape, students' motivation becomes a critical element influencing dedication, effort, and perseverance in acquiring knowledge [3]. On the other words, this motivation involves the extent to which students feel engaged and have the desire to achieve excellence while understanding the importance of the learning process.

2. Problem Statement

Motivation is a highly crucial psychological factor in the academic context [4]. However, the impact of motivational factors on academic achievement in the field of science education is inadequately studied and understood. This is attributed to the majority of studies in physical education focusing more on the cognitive aspects of students rather than the affective aspects [5]. Existing studies tend to concentrate on isolated aspects of motivation, lacking comprehensive investigations that explore complex relationships involving self-efficacy, goal orientation, and task value [6].

As a consequence of this focus, the affective aspects may be overlooked. Students, teachers, schools, and the Ministry of Education Malaysia (KPM) may not fully realize the impact of affective aspects on achievement, as emphasis is solely given to cognitive aspects [7]. Some studies suggest that students who achieve outstanding success often have high motivation. However, there are students who have strong beliefs and enthusiasm towards the subjects they are studying but achieve only moderate results [8]. However, there are studies indicating that students with high motivation tend to exert more effort to achieve their learning goals [9]. Therefore, students with high motivation are expected to enhance their achievements.

The aim of this article is to discuss the process of constructing a motivation instrument for use as a measurement tool to identify the perceptions of fourth-grade physics students regarding internal confidence in organizing learning strategies based on four sub-constructs. The sub-constructs include self-efficacy, learning goal orientation, achievement goal orientation, and task value [10]. This article will focus on the use of Exploratory Factor Analysis (EFA) as a method to understand the most relevant and significant dimensions of motivation in the context of physics learning.

3. Literature Review

Motivation is the internal readiness of students during the knowledge acquisition process, enabling them to solve learning-related problems [11]. Furthermore, motivation is also the internal desire and willingness of an individual to maintain goal-oriented behavior [12-14]. In the context of this study, the researcher defines motivation as a measurement of fourth-grade physics students' perceptions of internal confidence in organizing learning strategies based on four sub-constructs: self-efficacy, learning goal orientation, achievement goal orientation, and task value [10]. The construction of motivational instruments is generally rarely focused on by previous researchers, involving sub-constructs such as self-efficacy, learning goal orientation, achievement goal orientation, and task value.

Studies that combine sub-constructs like self-efficacy, learning goal orientation, achievement goal orientation, and task value are only conducted by a few researchers, such as [10,15,16]. Meanwhile, a study by Subaşi [17] focuses only on self-efficacy and task value to measure the level of student motivation. Based on previous research, some researchers have measured motivation and self-efficacy separately [4,18,19]. The instruments used to measure motivation and self-efficacy also depend on the objectives of the respective researchers. Measuring motivation and self-efficacy separately aims to gain a deeper understanding of each construct's contribution to learning outcomes, behavior, and achievements [20]. This approach allows for the precise identification of individual strengths and weaknesses in each construct, enabling researchers to make specific interventions. Furthermore, separate analyses allow for a more detailed comparison and provide an overview of the role of the relationship between motivation and self-efficacy in learning outcomes [21]. With a more holistic understanding, this study contributes to a more detailed knowledge of the complex relationship between motivation and self-efficacy in the educational context [18].

Previous studies examining the relationship between sub-constructs of self-efficacy, learning goal orientation, achievement goal orientation, and task value have focused on different areas and have been less conducted in the Malaysian context of physics education by researchers. Combining sub-constructs of self-efficacy, learning goal orientation, achievement goal orientation, and task value into one motivation construct is essential in the educational context because they complement and reinforce each other to form holistic motivation. Self-efficacy reflects an individual's belief in their abilities, while learning goals and achievement orientations highlight learning and personal achievement goals. Task value provides concrete feedback on performance, shapes perceptions of effectiveness, and influences goal orientation. This combination can enhance the learning experience, motivate students to achieve meaningful accomplishments, and foster positive attitudes toward learning [4].

In this study, the developed motivation questionnaire aims to examine fourth-grade physics students' perceptions of an individual's internal confidence in organizing learning strategies based on four sub-constructs: self-efficacy, learning goal orientation, achievement goal orientation, and task value [10]. Therefore, the researcher conducts this study to construct a valid and reliable instrument to assess whether motivation can change the perceptions of high school students in Malaysia from the perspectives of self-efficacy, learning goal orientation, achievement goal orientation, and task value in school. Thus, it becomes one of the goals of teaching physics to motivate and empower students by enhancing their belief that they can succeed in learning physics. Additionally, it can develop necessary self-regulation learning strategies to lead them to success [12,16,24].

3.1 Importance of Motivation in Learning

In the context of learning and academic achievement, a student needs to understand their abilities, skills, and knowledge to complete learning tasks. Additionally, students need to set goals regarding grade achievements based on their efforts in completing these tasks. Ahmid *et al.,* [23] state that motivation is required when students set goals within themselves and believe in and are confident in their own efforts.

Motivation is a dynamic and multidimensional construct considered crucial in the process of conceptual change and students' learning strategies. In this study, the researcher utilizes Zimmerman's Self-Regulation Theory, which emphasizes that an individual's motivational beliefs play a vital role in influencing students' ability to control behavior during the teaching and learning process [24]. Based on this theory, an individual's belief and expectation of ability are self-motivating processes to achieve learning goals. The motivation construct consists of self-efficacy, learning goal orientation, achievement goal orientation, and task value [10,24].

3.1.1 Self-Efficacy

Self-efficacy refers to an individual's belief in their ability to perform a task [25]. This belief plays a crucial role in students' achievements. When students successfully achieve their desired goals, such as completing physics assignments, they receive positive or negative feedback from teachers that can influence their self-belief [4]. For example, when students successfully achieve their goals, such as completing a physics course, they receive feedback that can influence their self-belief.

3.1.2 Learning Goal Orientation

Learning goal orientation refers to an individual's competence and ability to master the subjects being studied by overcoming existing challenges and having curiosity [14,22]. According to Ijak [8], learning goal orientation focuses on students' ability to master knowledge and skills for self-satisfaction. These students believe that all efforts made can improve their achievements. Studies show that students with high self-efficacy tend to use good and more efficient learning strategies. Individuals with learning goal orientation use positive strategies more often to engage in learning activities [10,17].

3.1.3 Achievement Goal Orientation

Achievement goal orientation refers to an individual's desire to highlight their own abilities and capabilities, expecting recognition and attention from the environment [8,10]. Those with achievement goal orientation will stand out so that their performance or achievements are better than others without expecting assistance to maintain their excellence [16].

3.1.4 Task Value

Task value refers to students' initial self-assessment expectations of achievement [10] and is students' perception of the importance of specific tasks [26]. According to Ijak [8], students have the self-belief that learning is essential, interesting, and useful for completing tasks. In the context of motivation, the role of task value is crucial in increasing students' motivation [17]. Students show higher motivation when their attention is focused on a specific assigned task.

4. Research Objectives

To validate the motivation questionnaire for distribution to fourth-grade physics students in secondary schools based on the Exploratory Factor Analysis (EFA) procedure, which involves identifying correlations between factors, extracting factors, and rotating factors.

5. Methodology

5.1 Research Design

This study adopts a quantitative approach with a survey research design. Through this design, respondents are required to complete a motivation questionnaire comprising four sub-constructs: self-efficacy, learning goal orientation, achievement goal orientation, and task assessment. The instrument aims to validate the motivation questionnaire based on the Exploratory Factor Analysis (EFA) procedure, identifying correlations between factors, extracting factors, and rotating factors

[27,28]. To conduct this study, the researcher initiated a pilot study involving fourth-grade physics students. The pilot study serves as an initial procedure to establish the instrument's validity and reliability. Additionally, the pilot study is conducted to fulfill the requirements for implementing EFA. Through EFA, only items meeting the criteria indices proposed by Hair *et al.,* [29] are retained. The criteria indices are based on item analysis, instrument validity, and reliability.

5.2 Instrument and Measurement Scale

An instrument is crucial in investigating the extent to which the studied variables provide information to address the research questions [30]. The motivation questionnaire is adapted from two previous research instruments, Goal Orientation and Learning Strategies Survey, Goal-S [31] and the Students' Adaptive Learning Engagement in Science Questionnaire, SALES [32]. The developed motivation questionnaire is modified to suit the specific needs of physics students. The questionnaire has been translated from English to Malay by Jamaliah [8] and comprises four sub-constructs: self-efficacy, learning goal orientation, achievement goal orientation, and task assessment. The positions of the items used in this questionnaire can be found in Table 1.

Respondents provide responses on a 7-point Likert scale, ranging from strongly disagree to strongly agree. The choice of a 7-point Likert scale provides sufficient options for respondents to express their agreement level with statements or items [17]. Awang *et al.,* [33] state that the use of a 7-point Likert scale in social science research can reduce issues during the analysis of the model to be formed later on.

Table 1
Motivational assessment questionnaire

Subconstruct	Items	No of Items
Self-Efficacy	1, 2, 3, 4, 5, 6, 7, 8, 9	9
Learning Goal Orientation	10, 11, 12, 13, 14, 15	6
Achievement Goal Orientation	16, 17, 18, 19	4
Task Value	20, 21, 22, 23, 24, 25, 26, 27	8
Total		**27**

6. Data Analysis
6.1 Exploratory Factor Analysis (EFA)

In this study, data is analyzed through EFA. The analysis was carried out using the Statistical Package for Social Sciences (SPSS) version 29 software. The purpose of the EFA is to identify the number of items and the structural components formed within the developed questionnaire. The components' structure is based on feedback obtained from the study sample [34]. EFA is essential when an instrument is developed, adapted, or translated into another language [35]. The researcher has developed the instrument by adapting and modifying statements from previous research instruments. Therefore, EFA is necessary due to potential differences with earlier study populations, such as ethnicity, socio-economic status, location, and culture [36].

According to Yong and Pearce [37], EFA is conducted to (i) reduce somewhat ambiguous items, retaining key items for each construct; (ii) identify items with similar meanings and items that may be repetitive but under different questions; (iii) identify items that can be summarized in each construct without affecting related constructs; (iv) identify correlation structures between related factors; and (v) determine the number of factors present in a given construct.

Before conducting factor analysis procedures, researchers need to consider three stages: identifying correlations between factors, extracting factors, and rotating factors [38]. Factor analysis is performed when there is a correlation between items, with different strengths of correlation between items. Items with high correlations are grouped into the same construct because they have the potential to measure the same concept. Similarly, items with low correlations are placed in different constructs. Factor analysis can proceed when the recommended correlation coefficient value is 0.3 or higher [39].

Before factor extraction, the data should be checked to ensure sample adequacy. The adequacy of the sample is tested by looking at the Kaiser Mayer-Olkin (KMO) value and the Bartlett test of sphericity. The KMO value should range from 0 to 1, with a suggested minimum value of 0.60 [40,41]. For the Bartlett test of sphericity, it should be significant ($p=0.000$, $p<0.05$) to determine whether item relationships are suitable for EFA.

The next procedure is factor extraction, where specific factors are removed and the remaining factors are rearranged within a particular construct. The Total Variance Explained table shows eigenvalues. Based on the display, the largest eigenvalue will be at the top of the table, representing the first factor. This factor explains that it has contributed the most variance change to the change in the dependent variable as a whole [38]. Hair *et al.,* [29] set the minimum value for the total variance explained at 60 percent.

The Rotated Component Matrix table shows the correlation between items and their respective factors after Varimax rotation. Item elimination is performed when the factor loading value is less than 0.6, as recommended by [29-36]. Additionally, researchers need to review the internal reliability value of the newly constructed instrument, i.e., the new Cronbach's alpha value. According to Hair *et al.,* [29], a Cronbach's alpha value exceeding 0.70 indicates that the items have high internal consistency and should be retained.

7. Result

Factor analysis was conducted on 27 items using Principal Component Analysis with Varimax rotation. The results in Table 2 show that the Kaiser-Mayer-Olkin (KMO) test value is 0.93. This value is considered good as it meets the recommended values by Chua, Tabachnick, and Fidell [40,41] with a minimum value of 0.6. The KMO value indicates that the data does not have serious multicollinearity issues. Therefore, the items are suitable for factor analysis. Bartlett's Test is significant ($p=0.000$, $p<0.05$). This result indicates that there is sufficient correlation between items for factor formation, allowing for further factor analysis [29]. Thus, the data in this study is suitable for conducting Exploratory Factor Analysis (EFA) as all items in this analysis obtained usability values and demonstrated significant and appropriate values.

Table 2
Kaiser-Meyer-Olkin (KMO) and Bartlett's Test for motivation constructs

Kaiser-Meyer-Olkin	Measure of Sampling Adequacy	.932
Bartlett's Test of Sphericity	Approx. Chi-Square	4520.544
	df	351
	Sig.	.001

Table 3 presents the findings regarding the explained variances for the motivation constructs. There are four components with eigenvalues greater than 1. All four factors contribute to a total of 72.54 percent of the overall variance change. The total variance obtained exceeds 60 percent. Based on the sum of squared loadings during extraction, Factor 1 accounts for 44.47 percent of the variance, Factor 2 accounts for 13.72 percent of the variance, Factor 3 accounts for 8.00 percent of the variance, and Factor 4 accounts for 6.35 percent of the variance. This indicates that the number of components and items is appropriate for the field study.

Table 3 Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.007	44.472	44.472	12.007	44.472	44.472
2	3.706	13.724	58.196	3.706	13.724	58.196
3	2.160	8.001	66.198	2.160	8.001	66.198
4	1.713	6.345	72.542	1.713	6.345	72.542

Next, the researcher aims to identify the selected items to measure the components of the motivation construct. Figure 1 presents the overall factor loading values for all four components in the motivation construct. The analysis findings from the Varimax rotation matrix reveal that the factor loading values range from 0.677 to 0.842. These factor loading values for the items surpass the minimum threshold of 0.6, as recommended by Hair *et al.,* and Awang *et al.,* [29,36}. For items with a factor loading less than 0.60, they would be excluded from use in the field study. Therefore, all items were retained, and there was no need for removal in the motivation construct.

Rotated Component Matrix[a]

	Component			
	1	2	3	4
TV25	.842			
TV22	.840			
TV21	.838			
TV20	.834			
TV26	.822			
TV24	.815			
TV27	.791			
TV23	.783			
SE5		.823		
SE8		.798		
SE4		.794		
SE2		.793		
SE7		.788		
SE3		.776		
SE9		.772		
SE6		.753		
SE1		.677		
OMB11			.804	
OMB12			.783	
OMB10			.774	
OMB14			.767	
OMB15			.759	
OMB13			.754	
OMP16				.823
OMP17				.822
OMP19				.793
OMP18				.742

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 6 iterations.

Fig. 1. Factor loading for motivation constructs

Furthermore, the obtained Cronbach's alpha values in this study indicate that each measured item has high reliability, ranging from 0.907 to 0.959. Table 4 displays the Cronbach's alpha values for each motivation subconstruct after the EFA process. For the self-efficacy subconstruct with 9 items, the Cronbach's alpha value is 0.944. The reading of the Cronbach's alpha value for the learning goal orientation subconstruct with 6 items is 0.936. Regarding the achievement goal orientation subconstruct with 4 items, the Cronbach's alpha value is 0.907. Finally, the Cronbach's alpha value for the task value subconstruct is 0.959. Overall, the Cronbach's alpha value for the motivation construct is 0.971. Therefore, the obtained Cronbach's alpha values indicate that all four motivation subconstructs are suitable for the field study.

Table 4
Cronbach's alpha coefficients for individual motivation subconstructs assessed following exploratory factor analysis (EFA)

Subconstruct	Number of items	*Alpha Cronbach*
Self-Efficacy	9	0.944
Learning Goal Orientation	6	0.936
Achievement Goal Orientation	4	0.907
Task Value	8	0.959
Total	**27**	**0.971**

8. Discussion

This article sets the objective of discussing the process of constructing and validating a motivation instrument among physics students, with a focus on using EFA as a method to comprehend the most relevant and significant motivational dimensions. Through this analysis, the researcher aims to gain in-depth insights into the factors influencing student motivation and subsequently construct a more precise and effective instrument for measuring and enhancing motivation in the context of physics education.

The study underscores the importance of motivation in learning and asserts that motivation can not only impact individual success but also contribute to the overall academic achievement of schools. By understanding relevant motivational theories, educators can develop more effective approaches to boost student motivation. Research shows a positive correlation between motivation and academic achievement [42]. Furthermore, teachers should also emphasize the use of more effective teaching strategies.

9. Conclusions

This study is intended to develop and validate a motivation instrument using EFA among high school physics students. EFA is conducted to facilitate the measurement of motivation constructs that are suitable, accurate, and meaningful in the context of secondary school physics education in Malaysia. The results of the factor analysis suggest that the developed motivation instrument is appropriate, accurate, and meaningful for field studies, retaining the existing 27 items. The analysis indicates that each item has a factor loading value exceeding 0.6. Motivation subconstructs such as self-efficacy, learning goal orientation, achievement goal orientation, and task value are acknowledged as crucial dimensions of student motivation. The consistency and reliability of this instrument are also supported by high Cronbach's alpha values for each motivation subconstruct, indicating its suitability for use in this study.

By amalgamating self-efficacy, learning goal orientation, achievement goal orientation, and task value into one motivation instrument, this article contributes to a deeper understanding of the complexity of student motivation in physics education. Overall, this study makes a significant contribution to understanding student motivation, providing a valid and appropriate instrument for measurement. The results of this study can serve as a guide and be beneficial to the Malaysian Ministry of Education (MOE) and educators in developing more effective teaching strategies to enhance student motivation and achieve higher academic success. Additionally, it can improve the quality of physics teaching and learning at the school level in Malaysia.

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