International Journal of Education and Practice
2025 Vol. 13, No. 4, pp. 1502-1519
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/61.v13i4.4471

Identifying key factors influencing learning outcomes in natural science subjects among middle school students: A case study of Nam Tu Liem District, Hanoi, Vietnam

Nguyen Thi Hang Nga[1]
Do Thanh Trung[2]
Pham Thi Huong[3]
Nguyen Thi Phuong Nhung[4+]

[1,2]*Faculty of Biology, Hanoi National University of Education, Hanoi, Vietnam.*
[1]*Email:* hangnga@hnue.edu.vn
[2]*Email:* trungdt1985@hnue.edu.vn
[3]*Center For Digital Learning, Cyber School, Vinh University, 182 Le Duan Street, Vinh City, Vietnam.*
[3]*Email:* pthuong@vinuni.edu.vn
[4]*Department of Primary Education, Vinh University 182 Le Duan Street, Vinh City, Vietnam.*
[4]*Email:* nhungntp@vinhuni.edu.vn

(+ Corresponding author)

Article History
Received: 11 April 2025
Revised: 27 August 2025
Accepted: 25 September 2025
Published: 17 October 2025

Keywords
Learning environment
Learning outcomes
Middle school students
Motivation
Natural science
Principal component analysis.

ABSTRACT

This study identifies the key factors affecting students' academic performance in natural sciences among lower secondary school students in Nam Tu Liem district, Hanoi, Vietnam—among the implementation of a competence-oriented general education reform. A quantitative approach was employed with 300 eighth-grade students from 16 secondary schools. Data was collected using a structured questionnaire comprising 24 variables evaluated through a Likert scale. Principal Component Analysis (PCA) and multiple regression analysis were conducted using SPSS 20.0 to examine the influence of four independent variables: external motivation, internal motivation, learning environment, and learning methods. The findings reveal that all four factors positively and significantly affect learning outcomes. The learning environment emerged as the most influential factor followed by learning methods, internal, and external motivation. The study emphasizes the central role of an interactive and well-equipped learning environment and highlights the importance of self-directed and strategic learning practices. These results offer practical implications for teachers, policymakers, and school administrators seeking to enhance science education quality, particularly in developing countries undertaking curriculum reforms. The analytical framework presented may serve as a valuable reference for designing educational interventions and shaping policies that foster improved student outcomes in science learning.

Contribution/Originality: This study uniquely applies principal component analysis and regression to quantify the relative effects of motivational and environmental factors on science learning outcomes in a Vietnamese reform context highlighting the learning environment as the most critical determinant, a dimension often underexplored in prior competency-based education research.

1. INTRODUCTION

Natural sciences play a fundamental role in approaching high-tech fields (e.g., artificial intelligence (AI), data science, and automation), especially in the era of Industry 4.0. Natural sciences are not only a bridge between knowledge and practice but also a driving force for innovation, contributing positively to the educational transformation process.

According to Mekonnen (2014), natural sciences are regarded as the cornerstone of current technological advances, and people would struggle to explore the cosmos if they did not grasp them. According to Rull (2014), understanding the natural sciences helps people construct knowledge about natural phenomena by cultivating key competencies such as observation, comparison, analysis, and creative problem-solving skills. Scientific knowledge would address fundamental human needs and drive societal well-being when applied successfully. According to Wenno (2015), mastery of natural sciences is necessary for students through practical activities, experiments and scientific research in natural sciences. Students are aroused a passion for exploration, developing logical thinking, teamwork ability, autonomy, and self-responsibility.

Vietnam is renewing the general education program, including natural sciences. This is a subject designed in the direction of interdisciplinary integration to provide basic knowledge about scientific fields such as physics, chemistry, biology for students and help them practice critical thinking skills and the ability to apply science to creatively solve practical problems.

Natural science underpins the establishment and maturation of junior high school students' scientific worldview, making it significant for their overall development. According to the Ministry of Education and Training (2018), natural sciences along with mathematics, technology, and informatics help to advance STEM education, one of the educational paths being developed globally and in Vietnam, which helps to meet the need for young human resources during the nation's industrialization and modernization period.

Nevertheless, students have been facing considerable challenges in adapting to the revised curriculum demands and instructional approaches, which may potentially undermine their academic outcomes. Although Nam Tu Liem District in the city of Hanoi, Vietnam is one of the localities with a developed education system, there are 17 middle schools, including 11 and 6 public/private schools respectively. The district not only concentrates on many high-quality schools but also stands out for its diverse educational environment, meeting the needs of both the local people and the international community.

The purpose of the current study is to assess the influence of determinants on learning outcomes in natural sciences with a case study in a city of Vietnam representing a developing country of education with specific issues.

Question 1. How do external motivating factors, including parental involvement, teacher support, peer influence and learning needs impact the achievement indicators of secondary-level students in Nam Tu Liem district, Hanoi?

Question 2. How do intrinsic motivating factors, such as students' academic attitudes, learning goals, and interest in natural sciences affect their academic performance in this subject?

Question 3. How does the learning environment at the school, including teaching methods and facilities, and learning support equipment, affect the academic attainment of secondary-level students in natural sciences ?

Question 4. How do learning methods, especially critical thinking and self-study habits contribute to the academic performance of natural sciences students ?

Mapping influential predictors of scholastic achievement is carried out through the main component analysis method. This is a technique in factor analysis, which is used to condense the initial variables by creating a group of key constructs (Howard, 2016). The study's findings are expected to help develop effective education strategies that can augment motivational orientations and learning outcomes in countries with developing education and especially reforms. innovation in education.

2. LITERATURE OVERVIEW

Learning outcomes represent a key derivative of instructional delivery, identifying the results, controlling the factors affecting it and helping teachers on the one hand to choose appropriate content, teaching methods and learning environments to foster the ongoing development of learners. Conversely, it can count the output of learners compared to the requirements to be achieved of the program.

Student learning outcomes are a basis for teachers to correctly determine the current abilities of each student. The achievement or success of learning goals in each person can be seen from that learner's academic achievement (Wijaya & Bukhori, 2017). The first step in developing a teaching strategy to support students to overcome these issues is to identify instructional challenges that occur throughout the learning journey (University of Waterloo, 2019).

Numerous internal and external variables influence students' learning results in the natural sciences (Tatar, Tüysüz, Tosun, & İlhan, 2016). Attitudes, motives, interests, knowledge, abilities, expectations, presumptions, and individual objectives are examples of internal elements (Nyoni, Nyoni, & Bonga, 2017). The circumstances of the student's scholastic space (Byers, Mahat, Liu, Knock, & Imms, 2018), the teaching strategies of the teachers (Bal-Taştan et al., 2018), the home milieu, and the accessibility of didactic infrastructure and amenities are examples of external variables that affect students' learning results (Anom, Eliy, and Sabiroh, 2021) and difficulty of subject content (Sutriayu, Makhdalena, & Sumarno, 2020). The content of knowledge in natural sciences , especially in physics considered difficult content by students, especially knowledge related to mathematical calculations (Baran, 2016). In addition, gender differences also affect students' academic performance (Weimann-Sandig, 2020).

According to Kahu (2013) and Lenhard and Lenhard (2013), active student participation underpins academic performance and plays as core predictor of academic progression. Research of Rusli, Gusmaweti, Hendri, and Sari (2023) indicates a broad classification into internal and external impacts. Internal factors (intrinsic factors of students) include personal interests, academic motivation, attitudes, along with physical and mental health conditions. In contrast, external drivers to scholastic performance include the school environment, family environment, and social or community influences. The study conducted a clear analysis of the characteristics of a number of factors that contribute to variations in students' learning outcomes.

Motivation and learning outcomes: Motivation plays an important role which is the main factor determining the success of students' learning, affecting their participation and perseverance in didactic interventions (Al-Rahmi, Alias, Othman, Marin, & Tur, 2018; Al-rahmi, Othman, & Mi Yusuf, 2015). Sinatra, Broughton, and Lombardi (2014) emphasized that emotions serve as a mediating factor influencing science learning outcomes through mechanisms related to cognition, intrinsic motivational states, and learners' active participation in instructional activities. Motivation is widely recognized as a fundamental driver of academic emotions, shaping how students perceive and respond to learning experiences (Pekrun & Perry, 2014). Cahyono, Siregar, Sutrisna, Nurlaili, and Susanti (2024) suggest that learning motivation is related to energy change, emotional activation, and driving action to achieve goals.

This aligns with the self-determination theory proposed by Deci and Ryan (2000) which underscores intrinsic and extrinsic motivational orientations as key drivers of sustained academic engagement. Intrinsic motivation, driven by students' curiosity, interests, and goals promotes active and self-regulated learning. Conversely, extrinsic motivation rooted in external rewards, parental expectations, and social influences can lead to dependent learning behavior (Cook & Artino Jr, 2016). Research indicates that motivated students show higher resilience and academic success than inactive students (Ullah, Sagheer, Sattar, & Khan, 2013). Learning motivation helps students stay interested, overcome difficulties, and achieve high results, and underpins the success of developing scientific thinking and problem-solving abilities. According to Wati and Muhsin (2019), the following are some signs or traits of students that struggle or encounter barriers throughout the learning process: 1) poor academic achievement. 2) Efforts not being matched with outcomes. 3) Tardiness in task completion. 4) Maladaptive cognitive-emotional dispositions and 5) inability to regulate their self-directed emotions.

The role of parent and teacher support: The family is the first educational environment and has a profound influence on learner developmental trajectories. Studies show that family support, including parental involvement in educational activities and a favorable family environment, positively influences academic outcomes (Anggraini, Nas, & Sumarno, 2019; Harris & Goodall, 2008). The home environment fosters students' confidence and motivates them to proactively engage in learning or reduces the risk of delaying students' learning (Nurbaeti & Usman, 2019). Similarly, teachers exert a decisive impact on determining student learning outcomes through the teaching methods they apply. Appropriate teaching can have a strong impact on student progress. For example, collaborative learning is seen as a proactive and effective approach (Mbarute, Masengesho, & Ntivuguruzwa, 2023). When teachers use this method, it not only promotes students' personal development, but also helps to enhance motivation and positive learning attitudes, thereby significantly improving academic outcomes (Aporbo, 2023; Wu & Huang, 2010). Collaborative learning, (learner-centered teaching method) has been effectively applied in the natural sciences. Many studies have shown that this method not only elevates scholastic performance but also enhances learners' cognitive abilities and interest in the subject (Canelas, Hill, & Novicki, 2017).

The learning environment at the school and academic achievement: The learning environment includes familial, communal, institutional, and peer-related contexts — all of which collectively contribute to shaping students' academic performance and dispositions toward knowledge acquisition, the surrounding context functions as foundational scaffolds to attain high academic standards (Barmawi, 2016). Ardiyansyah, Prima, Hermuttaqien, and Bomans Wadu (2019) said that there are many students who exhibit diminished interest in learning due to environmental influences within their living contexts. This environmental factor affects the learning results of students at school, decreases interest in learning, makes them not focus on performing the tasks assigned by teachers at school, the environment becomes the foundation for success. Kahu (2013) argues that student engagement in learning is shaped by individual learner attributes and prior educational experiences. A well-equipped learning environment with access to state-of-the-art laboratories and interactive learning tools promotes better understanding and engagement in science subjects. Studies highlight that school facilities are inadequate and outdated teaching methods hinder students' enthusiasm for learning (Entwistle, 2018).

Learning methods, including critical thinking and self-study: Learning methods contribute significantly to academic achievement in addition to external factors and motivations. Critical thinking and self-study habits help students develop analytical skills and problem-solving abilities, which are essential skills in natural sciences education (Nyoni et al., 2017). Research shows that students with strong self-study habits learn better when they are actively involved in their knowledge acquisition (Tatar et al., 2016).

A review of existing materials highlights the multifaceted nature of factors that affect student learning outcomes. Motivation, parental involvement, teacher support, school infrastructure, and self-learning all represent core influences in shaping a student's academic achievement.

3. RESEARCH METHODS

3.1. Research Model

Studies on students' learning motivation have determined: Students' learning motivation includes internal and external motivations which are the two main motivations that affect students' learning outcomes (Nguyễn Thùy, Hoàng Thị Kim, & Lê Đình, 2017).

In addition, the learning environment and learning methods also affect students' learning outcomes (Hanrahan, 1998; Harefa et al., 2023). The above determining factors are considered research issues that need to be surveyed and evaluated to draw conclusions about their impact on the learning results of students in natural sciences in Quan Nam Tu Liem, Hanoi City.

The predictors of scholastic attainment are modeled from the analysis and identification of signs of learning motivation, environment and learning methods shown in Figure 1.

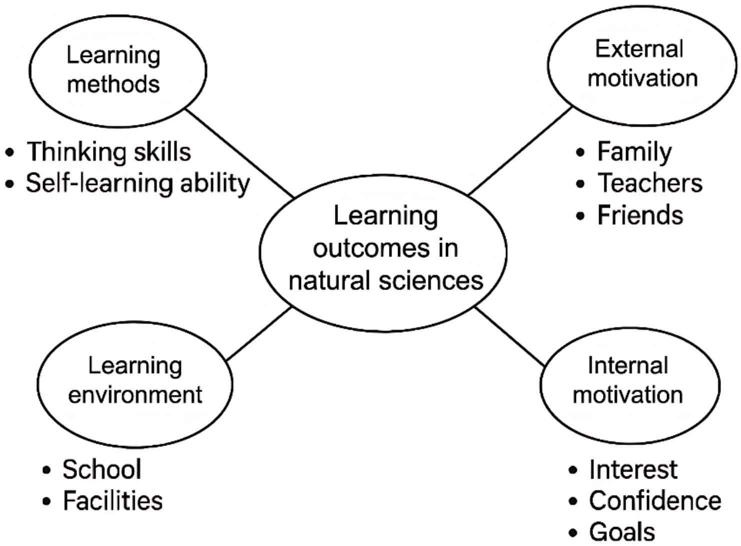

Figure 1. Research model on the impact of motivational factors on subject learning outcomes natural science of secondary school students in Nam Tu Liem district, Hanoi, Vietnam.

Following the suggestion of Hair, Anderson, Tatham, and Black (1998) about the sample size, a minimum subject-to-variable ratio of 5:1 is good for exploratory factor analysis (EFA). Furthermore, Tabachnick and Fidell (1996) argue that the sample size should be determined based on the formula: $n \geq 50 + 8.m$ (where n denotes the required sample size and m represents the number of independent variables in the model) to perform a statistically sound regression analysis.

The author employed a sample of 300 for empirical analysis. The sample selection method was conducted in a purposive, random and relatively consistent manner with the requirements for the research objectives. The Likert scale is used as a data collection tool with 5 orders: (5) fully agree. (4) Agree. (3) Neutrality. (2) Disagree. (1) Fully disagree. In addition, 6 questions about students' learning activities in natural sciences are included in the study. Table 1 presents observed variables along with their constructs used for the survey.

Table 1. Observed variables coding table.

STT	Encode	Observed variables
External motivation		
1	EM1	My parents always want me to be good at natural sciences.
2	EM2	Parents are more interested in natural science academic results than other subjects.
3	EM3	Parents regularly communicate with their natural science teachers about their studies.
4	EM4	The teacher often helps me when I have difficulty learning natural sciences.
5	EM5	Teachers regularly choose attractive content and always create interest for children in learning natural sciences.
6	EM6	Friends in the rooftop school regularly help me when I have difficulty studying natural sciences.
7	EM7	My friends often entice me to go out, not supporting me to study natural sciences.
Internal motivation		
1	IE1	I like the content of natural science knowledge more than other subjects.
2	IE2	When engaging with natural sciences, I find it difficult to concentrate or form clear thought.
3	IE3	Natural science is a very necessary, useful and practical subject.
4	IE4	Natural science helps me orient my career development in the future.
5	IE5	Natural sciences will help you have many options when applying for university.
6	IE6	She regularly spends time studying natural sciences.
Learning environment		
1	LE1	I have the opportunity to express my opinion in class.
2	LE2	The natural science teacher always asks questions for me and my classmates.
3	LE3	The teacher commented that my work was fair like other students.

STT	Encode	Observed variables
4	LE4	Natural science teachers actively use technological devices when teaching (e.g., computers, projectors, smartphones, tablets etc.).
5	LE5	Natural science teachers use the application in assigning assignments, collecting assignments, interacting with students (Zalo, Azota, Google Classroom, etc.).
6	LE6	The school has a full system of computers and the Internet for learning.
7	LE7	She often uses her phone to search for knowledge content to support solving natural science exercises at home.
Learning methods		
1	LM1	I prepare my lesson before going to class.
2	LM2	I plan my studies;
3	LM3	I take notes according to what the teacher reads.
4	LM4	I take notes selectively according to my own understanding.
5	LM5	She spends a lot of time studying natural sciences on her own.
Academic outcomes		
1	LO1	I have learnt a lot of knowledge from natural sciences.
2	LO2	I have developed many skills such as observation skills, explanation proposals, and experimental skills from natural sciences.
3	LO3	I can apply a lot of knowledge I have learnt from natural science to practice.
4	LO4	I have learnt a lot of knowledge and skills in natural sciences.

3.2. Methods of Data Collection, Processing and Evaluation

We collect data using a random sample selection method to ensure representativeness. Each questionnaire is handed out to a student and instructs students to answer directly on the questionnaire, wait and collect the questionnaire immediately after the student has finished answering.

During the data collection phase conducted in April of the 2023–2024 academic year, 315 survey instruments were administered, yielding 300 usable responses for statistical analysis. The study adopted a quantitative research design, targeting 300 eighth-grade students from 16 lower secondary schools in Nam Tu Liem District, Hanoi. This district is notable for its dynamic educational development and diverse school system, comprising both public and private institutions. The participating schools (public and private secondary schools) included Nam Tu Liem, Phuong Canh, My Dinh 1, My Dinh 2, Tay Mo, Dai Mo, Tay Mo 3, Phu Do, Me Tri, Ly Nam De, Tran Quoc Tuan, Nguyen Du, Cau Dien, Vietnam Australia, Lomonoxop, and Marie Curie Secondary Schools. The school selection ensured a balanced representation across different residential areas within the district. All student participants were enrolled in the newly implemented general education curriculum with an average age ranging from 13 to 14 years. The sample included 51.4% female and 48.6% male students. A probabilistic sampling strategy was adopted. Informed consent was obtained from both school authorities and student participants before data collection.

We used SPSS 20 software to evaluate and benchmark the measurement scale assessing the predictive validity of motivation on students' educational attainment in the field of natural sciences. We tested the scale's scale reliability using two indicators: Cronbach's alpha and the correlation coefficient for each question. The criteria for evaluating the scale's reliability include observed variables exhibiting low item-total correlation coefficients (i.e., values below 0.3) and the retention of scale constructs demonstrating a Cronbach's alpha coefficient exceeding 0.6. The questions were then examined using EFA coefficient analysis. The Bartlett test was used to determine which observed variables correlated with one another. The Bartlett's test of Sphericity was deemed statistically significant at a significant level of $p < 0.05$. Additionally, the observed variables were correlated with one another. Additionally, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was used, where a value above 0.5 suggests that the data are suitable for factor extraction. Observed variables with factor loadings below 0.50 were excluded from further analysis due to insufficient contribution to the underlying constructs to ensure the methodological rigor of the EFA. Factor extraction followed the Eigenvalue-greater-than-one rule (Kaiser criterion), whereby only components explaining a meaningful proportion of variance were retained. Additionally, a minimum threshold of 50% cumulative variance explained was applied to confirm that the retained factors captured a substantial portion of the total variability among the observed indicators.

4. RESEARCH RESULTS

4.1. Evaluate Scale Reliability

The study used SPSS software to analyze the reliability of the whole scale and 5 components and analyze the correlation coefficient (Cronbach's alpha) with the sum variable of the questions in 29 observation variables. Eliminate questions have a coefficient correlation with the sum variable, which has a value < 0.3. Eliminate variables iteratively, prioritizing the removal of observed items with the lowest item-total correlation coefficients. The Cronbach's alpha coefficient is recalculated to reassess the internal consistency of the revised scale after eliminating an observed variable. Until all the questions on the scale have a correlation coefficient with the sum variable ≥ 0.3 and the confidence coefficient value of both scales > 0.6, the elimination of the variable is stopped.

Table 2. Reliability analysis of the independent variable using Cronbach's alpha coefficient

Latent variables	Encryption	Variable correlation coefficient sum	Cronbach's alpha coefficient when eliminating variables
1. External motivation (EM) Cronbach's alpha = 0.916	EM1	0.675	0.911
	EM2	0.708	0.907
	EM3	0.728	0.904
	EM4	0.769	0.900
	EM5	0.816	0.895
	EM6	0.695	0.908
	EM7	0.814	0.895
2. Internal motivation (IE) Cronbach's alpha = 0.850	IE1	0.553	0.840
	IE2	0.699	0.812
	IE3	0.685	0.815
	IE4	0.509	0.847
	IE5	0.719	0.808
	IE6	0.638	0.825
3. Learning environment (LE) Cronbach's alpha = 0.886	LE1	0.711	0.865
	LE2	0.664	0.871
	LE3	0.743	0.861
	LE4	0.641	0.875
	LE5	0.796	0.856
	LE6	0.552	0.884
	LE7	0.653	0.873
4. Learning methods (LM) Cronbach's alpha = 0.836	LM1	0.614	0.812
	LM2	0.709	0.783
	LM3	0.640	0.803
	LM4	0.524	0.836
	LM5	0.719	0.780
5. Learning outcomes (LO) Cronbach's alpha = 0.810	LO1	0.581	0.785
	LO2	0.738	0.706
	LO3	0.593	0.778
	LO4	0.618	0.766

Table 2 indicates that all measurement scales satisfy the reliability threshold with Cronbach's alpha coefficients exceeding 0.6 and item-total correlations surpassing 0.3. These results confirm the internal consistency of the scales, justifying their retention for subsequent analytical procedures.

Thus, we obtain the following results after verifying the dependability of the scale:

1. The model's Cronbach's alpha coefficient exceeds 0.6.
2. All observed variables exhibit item-total correlation coefficients greater than 0.3.

3. The EFA discovery factor is analyzed using 5 scales and 29 observational variables that meet the reliability standard.

4.2. Assessment of Scale Validity

EFA was conducted on 29 observed variables to further evaluate the construct validity of the scale following the reliability analysis using Cronbach's Alpha. Table 3 presents the results of the Kaiser–Meyer–Olkin (KMO) and Bartlett's Test of Sphericity for the independent variables. The KMO value is 0.830 which exceeds the acceptable threshold of 0.5, indicating that the sample is adequate for factor analysis. Additionally, Bartlett's Test of Sphericity yields an approximate chi-square of 5219.911 with 300 degrees of freedom and a significance level of 0.000. This suggests that the correlation matrix is not an identity matrix, confirming sufficient correlations among variables.

Table 3. KMO and Bartlett test results for independent variables

KMO and Bartlett's test		
Kaiser-Meyer-Olkin measure of sampling adequacy.		0.830
Bartlett's test of sphericity	Approx. chi-square	5219.911
	Df	300
	Sig.	0.000

Table 4 presents the KMO and Bartlett's test results for the dependent variables. The KMO value of 0.737 indicates an acceptable level of sampling adequacy while the significance level of 0.000 in Bartlett's Test of Sphericity confirms that the observed variables are sufficiently correlated.

Table 4. KMO and Bartlett test results for dependent variables

KMO and bartlett's test		
Kaiser-Meyer-Olkin measure of sampling adequacy.		0.737
Bartlett's test of sphericity	Approx. chi-square	420.215
	Df	6
	Sig.	0.000

Table 5 presents the rotated component matrix for the independent variables, revealing a clear four-factor structure. Each item loads strongly onto its respective component with no significant cross-loadings, indicating good discriminant validity. The variables grouped under each factor are consistent with their theoretical constructs, supporting the construct validity of the measurement model.

Table 5. Factor rotation matrix table for independent variable

Independent variables	**Components**			
	1	**2**	**3**	**4**
EM5	0.868			
EM7	0.866			
EM4	0.830			
EM3	0.802			
EM2	0.790			
EM6	0.773			
EM1	0.750			
LE5		0.861		
LE3		0.816		
LE1		0.771		
LE7		0.744		
LE2		0.729		
LE4		0.727		
LE6		0.601		

Independent variables	Components			
	1	2	3	4
IE2			0.802	
IE5			0.779	
IE3			0.771	
IE6			0.766	
IE1			0.696	
IE4			0.651	
LM5				0.843
LM2				0.830
LM3				0.798
LM1				0.658
LM4				0.538

Table 6 presents the unrotated component matrix for the dependent variable. All four observed variables (LO1 to LO4) load strongly onto a single factor with loadings ranging from 0.758 to 0.876. This indicates a unidimensional structure, suggesting that the dependent variable exhibits good internal consistency and can be treated as a single latent construct in further analysis.

Table 6. Factor matrix of the dependent variable (unrotated)

Component matrix[a]	
Dependent variables	**Component**
	1
LO4	0.786
LO3	0.770
LO1	0.758
LO2	0.876

Note: a. Predictors: (constant), LM, OM, IE, LE.

Table 7 presents the variance extraction results for the independent variable factors. The initial eigenvalues and corresponding percentage of variance indicate that the first four components account for a cumulative 62.9% of the total variance. The extraction sums of squared loadings confirm the retention of these four factors as they explain a substantial portion of the variability in the data.

Table 7. Table of variance extracted when analyzing independent variable factors

Components	Initial eigenvalues			Extraction sums of squared loadings		
	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %
1	6.503	26.011	26.011	6.503	26.011	26.011
2	4.115	16.459	42.470	4.115	16.459	42.470
3	2.920	11.680	54.150	2.920	11.680	54.150
4	2.187	8.750	62.900	2.187	8.750	62.900

Table 8 indicates that the first component has an eigenvalue of 2.554, explaining 63.857% of the total variance. This suggests that the first factor accounts for the majority of the variation in the data, making it a primary contributor to the overall structure of the dependent variables.

Table 8. Table of variance extracted when analyzing dependent variables

Components	Initial eigenvalues		
	Total	Variance%	Cumulative %
1	2.554	63.857	63.857
2	0.663	16.570	80.427
3	0.491	12.267	92.694
4	0.292	7.306	100.000

4.3. Accreditation of Research Models

Five factors were integrated into the model for evaluation after conducting a reliability assessment of the scales using Cronbach's Alpha and performing factor analysis to identify the underlying components. The Pearson correlation analysis was employed to assess the relevance of these components in the regression framework. The outcomes from the multivariate regression will be utilized to test the proposed hypotheses.

4.4. Pearson Correlation Coefficient Test

The Pearson correlation test assesses the strength of the linear association between independent and dependent variables. If a strong relationship is found, the potential for multicollinearity must be addressed during regression analysis.

Table 9. Correlation matrix between variables

Correlations						
Variables		**THE**	**TO**	**IE**	**THE**	**LM**
THE	Pearson correlation	1	0.326**	0.372**	0.599**	0.537**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
	N	300	300	300	300	300
TO	Pearson correlation	0.326**	1	0.071	0.203**	0.134*
	Sig. (2-tailed)	0.000		0.220	0.000	0.020
	N	300	300	300	300	300
IE	Pearson correlation	0.372**	0.071	1	0.232**	0.220**
	Sig. (2-tailed)	0.000	0.220		0.000	0.000
	N	300	300	300	300	300
THE	Pearson correlation	0.599**	0.203**	0.232**	1	0.428**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000
	N	300	300	300	300	300
LM	Pearson correlation	0.537**	0.134*	0.220**	0.428**	1
	Sig. (2-tailed)	0.000	0.020	0.000	0.000	
	N	300	300	300	300	300

Note: ** indicates a significant correlation at the 0.01 level (2-tailed).
* indicates a significant correlation at the 0.05 level (2-tailed).

Table 9 shows a significant relationship between the independent and dependent variables with a two-tailed significance value of 0.000, which is less than 0.05. Environmental factors and learning methods exhibit Pearson correlation coefficients ranging from 0.5 to 1, suggesting a strong relationship with the dependent variable. In contrast, the internal motivation variable shows a moderate correlation with Pearson values between 0.3 and 0.49. Consequently, the independent variables—external motivation, internal motivation, environment, and learning methods are all significantly correlated with the dependent variable, learning outcomes. These factors are suitable for inclusion in a regression analysis aimed at explaining variations in students' learning outcomes in natural sciences.

4.5. Linear Regression Analysis

Regression analysis is employed to determine the specific weights of each factor influencing learning outcomes. The analysis incorporates four independent variables—external motivation, internal motivation, learning environment, and learning methods with the dependent variable, learning outcomes. The analysis was conducted using SPSS 20 software, utilizing the enter method for full regression. The results of the regression analysis are as follows:

Table 10. Model summary

Model summary[b]					
Model	**R**	**R- square**	**Adjusted R square**	**Std. error of the estimate**	**Durbin-Watson**
1	0.728a	0.530	0.524	0.378	1.858

Note: a. Predictors: (constant), LM, OM, IE, LE.
b. Dependent variable LO.

Table 10 shows that the coefficient R^2 adjustment = 0.524, signifying that 52.4% of the variance in the dependent variable is explained by the independent variables. This works well as a regression correction. Furthermore, Table 10 shows that the Durbin-Watson index of 1.858 is between 1.5 and 2.5. As a result, the topic concludes that no first-order chain autocorrelation exists.

Table 11. ANOVA inspection table

ANOVA[a]						
Model		**Sum of squares**	**df**	**Mean square**	**F**	**Mr.**
1	Regression	47.609	4	11.902	83.198	0.000b
	Residual	42.203	295	0.143		
	Total	89.812	299			

Note: a. Dependent variable: LO.
b. Predictors: (Constant), LM, OM, IE, LE.

Table 11 presents the results of the ANOVA test for the regression model. The regression model explains a significant portion of the variance, with an F-value of 83.198 and a p-value of 0.000, indicating that the model is statistically significant.

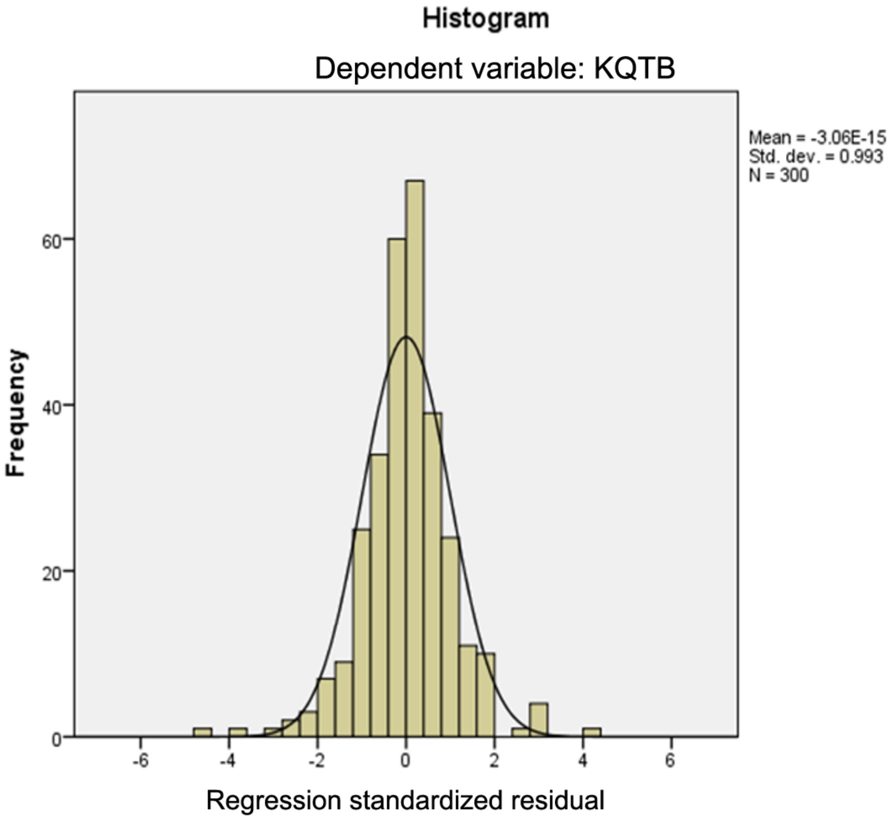

Figure 2. Histogram chart.

Figure 2's histogram shows that the mean value of MEAN = -3.06E-15 (= 0.0000...) is approximately 0, while the standard deviation is 0.993, which is close to one. As a result, it is possible to conclude that the model's standard approximation residual and standard residual distributions are not violated.

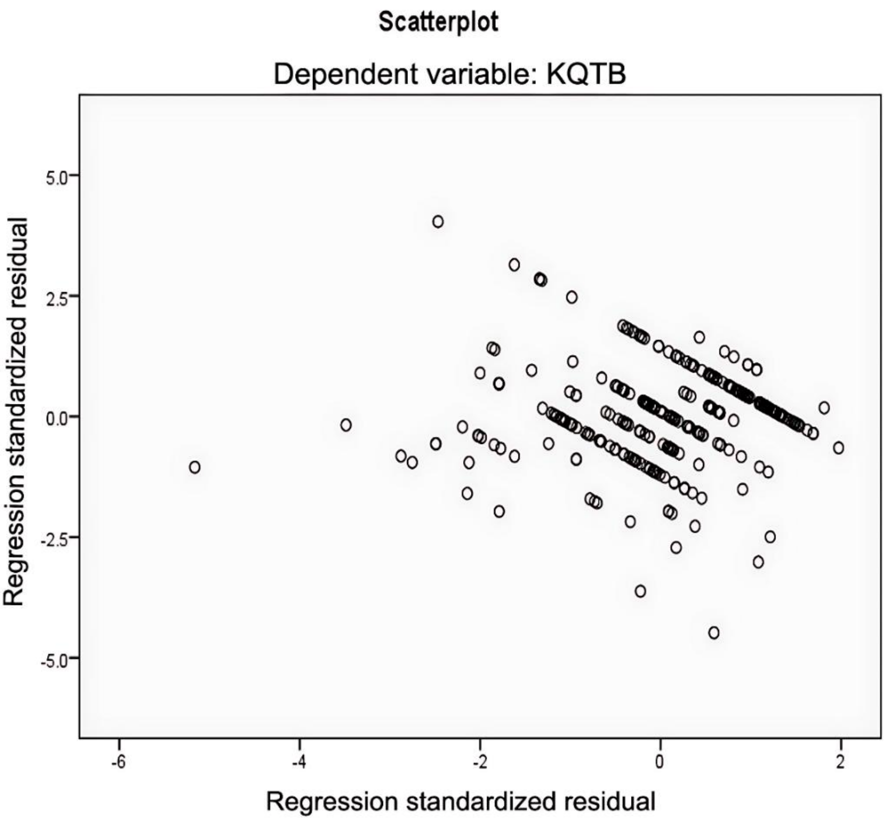

Figure 3. Scatter plot scatter chart.

The author used the ScCNter Plot scatter chart to investigate the linear relationship between dependent and independent variables in addition to the histogram. The author obtains the result depicted in Figure 3 with the data points clustered around the zero degree, ranging from -2 to 2, and tending to form straight lines after running the SPSS software. This confirms that the assumption of a linear relationship holds, allowing the regression model results to be considered valid.

Table 12. Unstandardized and standardized regression coefficients.

Coefficients[a]								
Model		**Unstandardized coefficients**		**Standardized coefficients**	**t**	**Sig.**	**Collinearity statistics**	
		B	**Std. error**	**Beta**			**Tolerance**	**VIF**
1	(Constant)	0.591	0.199		2.966	0.003		
	TO	0.142	0.030	0.193	4.723	0.000	0.956	1.046
	IE	0.173	0.035	0.202	4.884	0.000	0.928	1.078
	THE	0.283	0.033	0.384	8.473	0.000	0.777	1.286
	LM	0.251	0.037	0.302	6.777	0.000	0.800	1.251

Note: a. Dependent variable: LO, LM, OM, IE, LE.

Table 12 presents the unstandardized and standardized regression coefficients for the model. Regression results show that

- The VIF statistical coefficients of all variables are < 2, so the correction model is not likely to occur multi-contour phenomenon between independent variables.
- Most sig. values correspond to variables with values less than 0.05. Specifically, the sig. values of the external motivation, the internal motivation, learning environment and methods are 000; 0.000, 0.000, 0.000 respectively and have a meaning in the model. They all have an impact on the variable depending on the learning outcomes of natural sciences. From there, we have the regression equation as follows:

Through the above results, I have built a general regression model as follows:

$$LO = \beta 0 + \beta 1OM + \beta 2IE + \beta 3LE + \beta 4LM + \varepsilon$$

- With the unstandardized regression model, we have the following formula.

$$LO = 0.591 + 0.142 * OM + 0.173 * IE + 0.283 * LA + 0.251 * LM + \varepsilon$$

Through the formula, we find the following:

- External motivation (EM) has the same relationship with the learning outcomes (LO) of natural sciences. A one-unit increase in the EM factor results in a 0.142-unit increase in LO.
- The internal motivation (IE) has a relationship in the same direction as the learning outcomes (LO) of natural sciences . An increase of 1 unit in the IE factor leads to a 0.173-unit rise in LO.

+ The learning environment (LE) has the same relationship with the learning outcomes (LO) of natural sciences . When the LE factor increases by 1 unit, the LO increases by 0.283 units.

+ Learning methods (LM) have the same relationship with learning outcomes (LO) in natural sciences. A 1-unit increase in the LM factor results in a 0.251-unit increase in LO.

- The model with the normalized regression coefficient has the formula.

OM is the external motivation and $\beta = 0.192$.

IE is the internal motor, and $\beta = 0.202$.

LE is the learning environment, and $\beta = 0.384$.

LM is the learning method, and $\beta = 0.302$.

The normalized regression equations are arranged in the following order:

$$Academic\ Outcomes = 0.193 * OM + 0.202 * IE + 0.384 * LE + 0.302 * LM + \varepsilon$$

Thus, the following conclusions are made after analyzing the topic regression:

- The linear regression model in the project has identified 4 factors that significantly affect the learning results of natural sciences.
- 52.4% of the variance in the dependent variable is accounted for by the changes in the independent variables within the model.
- Regression models not only do not arise autocorrelation, but they also do not have multi-collinear problems.
- The majority of regression coefficients (β) are statistically significant with a confidence level of 95%.

Table 13. Hypothesis testing and impact statistics of variables independent of the dependent variable

Research hypothesis	Conclude	Extent of impact
Question 1: External motivation positively influences the learning outcomes in natural sciences.	Accept	At least
Question 2: Internal motivation positively affects the learning outcomes in natural sciences.	Accept	3rd Most
Question 3: The learning environment positively influences the learning outcomes in natural sciences.	Accept	Most
Question 4: The learning method positively affects the learning outcomes in natural sciences.	Accept	Most 2nd

4.6. Testing the Hypothesis of the Model

Table 13 presents the hypothesis testing results and the impact statistics for the independent variables on the dependent variable. All coefficients in the regression model have positive signs (+), suggesting that the independent variables are positively correlated with the dependent variable based on the linear regression analysis results. Consequently, the hypotheses from questions 1, 2, 3, and 4 are all accepted.

5. ANALYSIS AND INTERPRETATION OF RESULTS

The study identified four key factors affecting the middle school students' learning outcomes in natural sciences in Nam Tu Liem District, Hanoi City, Vietnam: external motivation, internal motivation, learning environment and learning methods. The regression analysis results confirmed the positive relationship between these factors and learning outcomes and clarified the extent of the influence of each factor.

The influence of the learning environment: The most important finding of the study was that the learning environment had the strongest impact on student learning outcomes ($\beta = 0.384$). This result aligns with previous research. Hanrahan (1998) and Harefa et al. (2023) emphasized the role of the learning environment in enhancing academic motivation and performance. A conducive learning environment, including support from teachers, the integration of technology in instruction, and classroom interaction can facilitate students acquiring knowledge more effectively.

The influence of learning methods: The learning method also had a significant effect on learning outcomes ($\beta = 0.302$). Students with good learning methods, such as study planning, selective note-taking, and self-study, achieve higher results. This finding aligns with previous work on the role of learning methods in improving learning performance (Pintrich & De Groot, 1990). Developing active learning skills can help students improve their ability to think scientifically and apply knowledge to practice.

Effects of internal motor and external motivation: Both the internal motor ($\beta = 0.202$) and the external motivation ($\beta = 0.193$) have a positive impact on learning outcomes although their impact is less significant compared to the learning environment and learning methods. This reflects that although personal motivation is important, the learning environment and instructional methods play a more decisive role in promoting learning outcomes. Internal motivation is expressed through interest in the subject, awareness of the value of natural sciences and future career goals. This is consistent with the learning motivation model (Ryan & Deci, 2000) in which intrinsic motivation can sustain long-term and effective learning. However, external motivations, such as expectations from parents and teachers also have a significant impact but are often short-term in nature (Ryan & Deci, 2020).

The findings suggest that teachers and education administrators should focus on improving the learning environment and supporting students to develop effective learning methods.

Increase support from teachers: Teachers need to use interactive teaching methods, ask questions, and encourage students to participate in the learning process.

Application of technology in teaching: The use of online platforms, such as Google Classroom, Zalo, and Azota can help students easily access learning materials and communicate with teachers.

Orientation of learning methods: Students need to be instructed on how to organize learning, take effective notes and self-study to improve their ability to acquire knowledge.

Create learning motivation: Schools and parents can work together to build engaging learning programs that promote students' inner motivation.

There are still some limitations that need to be overcome in subsequent studies although the study has highlighted the main factors influencing the learning outcomes of natural sciences.

The study focused on only one district in Hanoi. It was not possible to generalize the results for all middle school students in Vietnam. Other variables, such as family influence and social factors have not been fully considered. The research method is mainly based on self-reported data, which may be affected by errors from survey participants.

In the future, studies may expand the geographical scope, incorporating qualitative methods to better understand the influence of each factor on student learning outcomes.

6. CONCLUSION

This study examines the effects of key factors—learning motivation, learning methods, and learning environments—on the academic outcomes of middle school students in natural sciences in Nam Tu Liem District, Hanoi, Vietnam. The findings indicated that the learning environment had the strongest impact on learning outcomes ($\beta = 0.384$) followed by the learning method ($\beta = 0.302$), while internal motivation, although significant had the weakest influence ($\beta = 0.192$). These findings underscore the critical importance of the learning environment in shaping student achievement, emphasizing the need for targeted interventions to optimize the educational environment. This is a profound finding, especially in the context that developing countries, such as Vietnam are making efforts to reform the general education program in the direction of capacity development, interdisciplinary integration and strengthening practicality. The learning environment with factors, such as active support from teachers, modern facilities, classroom interaction, and the application of digital technology has proven to be the foundation for students to learn more effectively. In education systems that are facing pressure to innovate, prioritizing building a conducive learning environment is not only a material requirement but also a strategy to develop the quality of education in a comprehensive way.

In addition, students' learning methods also have a great influence on learning outcomes. The results of the study confirm that students who know how to plan their studies have the habit of self-study and take notes selectively will have higher results. This is the key point that many new educational programs aim for but have not really invested properly in teaching practice. The improvement of self-learning capacity, the development of active learning skills, and critical thinking should be focused not only on the content of the program but also on pedagogical methods and student assessment. This requires teachers not only to be imparters of knowledge but also to act as learning coaches – guiding, motivating and developing lifelong learning capacity for students.

Although the two factors of internal and external motivations have a lower influence, their roles cannot be underestimated. Internal motivation, such as interest in the subject, perception of practical values, and career goals is what sustains persistence and joy in learning, particularly at the middle school level when students start developing a sense of identity and future goals. Conversely, external motivation coming from parents, teachers and friends, has an impact and motivate students to make efforts in the short- term. Research shows that the harmonious coordination between the two types of motivation will help improve more sustainable learning performance.

From the perspective of commentary, the study has provided valuable empirical data, contributing to clarifying the multidimensional nature of learning outcomes which is not only a product of individual competence but also the result of the interaction between individuals and the surrounding educational ecosystem. The analytical model offered by the study can become a reference model for countries with similar conditions, especially in education policymaking, improving the learning environment and teacher training. This study also emphasizes that for education reform to be successful in the context of globalization and the transformation of education towards individualization. It is necessary to focus on understanding students, improving the learning environment, developing self-learning capacity, and evoking intrinsic learning motivation factors that any education develops sustainably also cannot be ignored.

Funding: This study received no specific financial support.
Institutional Review Board Statement: The Ethical Committee of the Vinh University, Vietnam has officially approved this research on 15 April 2025.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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