International Journal of Learning, Teaching and Educational Research
Vol. 24, No. 3, pp. 349-365, March 2025
https://doi.org/10.26803/ijlter.24.3.17
Received Feb 5, 2025; Revised Mar 10, 2025; Accepted Mar 16, 2025

Adaptation and Validation of the Academic Interest Scale for Vietnamese High School Students: Application in Chemistry Education

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Abstract. The decline in student enrollment and engagement in Chemistry education has become a pressing concern, necessitating reliable tools to measure academic interest. However, validated instruments tailored to this subject remain limited. This study aimed to adapt and validate the Academic Interest Scale for Adolescents for Vietnamese high school students in Chemistry education. Using a cross-sectional survey design, data were collected from 380 students across three regions of Vietnam via a structured questionnaire. Confirmatory factor analysis was performed to examine the factor structure, and measurement invariance was tested across sex and grade levels. The results of the confirmatory factor analysis supported the four-factor structure with 29 items, demonstrating strong model fit indices and high reliability. Invariance testing confirmed sex-based equivalence at all levels (configural, metric, and scalar), ensuring unbiased comparisons. While metric invariance across grade levels was established, scalar invariance was initially unsupported, indicating variations in item intercepts. Allowing covariance between two items significantly improved model fit, validating the modification. These findings provide empirical support for the validity and reliability of the Academic Interest Scale for Adolescents in Chemistry education, offering a robust tool to assess academic interest and inform future interventions to enhance student engagement.

Keywords: AISA; Chemistry education; confirmatory factor analysis; measurement invariance; high school students

1. Introduction

Student interest in learning is recognized as a critical determinant of engagement and motivation in educational settings. Numerous studies have conceptualized interest as a positive emotional state emerging from the learning process that plays a pivotal role in enhancing academic performance (Dewey, 1913; Svensson et al., 2022; Trautwein et al., 2015). Interest in learning alleviates fatigue and stress, increases focus, promotes creativity, and fosters higher cognitive efficiency.

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Students with high levels of interest tend to achieve better academic outcomes, exert more effort, and actively participate in learning activities (Isaak et al., 2022; Mappadang et al., 2022). Interest is essential for learning, as it boosts cognitive engagement, deepens understanding, and supports long-term knowledge retention. Without interest, students struggle to process and absorb new information effectively (Krapp, 2002).

However, research has consistently shown that students' interest in most school subjects, particularly Mathematics, Physics, and Chemistry, declines over time (Dotterer et al., 2009; Frenzel et al., 2010; Svensson et al., 2022). In Vietnam, the Ministry of Education and Training highlights Chemistry as a key subject because of its role in science, technology, and industry (Ministry of Education and Training, 2018). However, it is often perceived as abstract and challenging due to its reliance on microscopic and symbolic representations that require high cognitive processing. With the introduction of the new general education curriculum in 2018 and its full implementation by 2024, Chemistry became an elective at high school level. Since then, student enrollment has declined, as many find the subject abstract and difficult (Gräber, 2011). This disengagement underscores the need to foster interest in Chemistry to enhance student participation and learning outcomes (Renninger & Hidi, 2016).

To design effective interventions that enhance learning interest, precise measurement of this construct is imperative. Accurate assessment not only helps researchers and educators understand students' psychological states but also provides a scientific basis for developing targeted solutions (Schiefele, 2009; Wigfield & Eccles, 2000). In particular, well-validated measurement tools allow educators to identify specific factors that affect student interest, thereby facilitating tailored pedagogical strategies to enhance engagement and academic performance (Ainley & Ainley, 2011). In Vietnam, while prior studies have emphasized the importance of learning interest in improving academic achievement (Danh et al., 2021; Nam et al., 2014; Nhân, 2016; Thái, 2016; Thọ, 2014; Thủy, 2011; Trung et al., 2022; Vân, 2014), most research has been conducted on university students, with little attention given to high school students or specific measurement tools tailored to their context.

To address this gap, Luo et al. (2019) developed the Academic Interest Scale for Adolescents (AISA), which is grounded in the Four-Phase Model of Interest Development of Hidi and Renninger (2006). The AISA encompasses four dimensions: Emotion, Value, Knowledge, and Engagement and has demonstrated its effectiveness across diverse academic contexts, including Mathematics, English, and Chinese (Luo et al., 2019). Recognizing its potential, this study adapted the AISA for Vietnamese high school students by carefully translating and contextualizing the items to align with local cultural and cognitive characteristics while preserving the original scale's core content. The AISA is not only valuable for measuring students' psychological states but also for identifying the specific factors that are influencing their interest, thereby guiding the design of effective interventions. This study examined measurement invariance across sex and grade level, as these are fundamental in educational research and are

widely used in studies on learning interest. While factors such as parental support, economic status, and school quality also matter, sex and grade level were prioritized to ensure reliable subgroup comparisons. This foundation allows future research to explore additional variables with confidence. This study sought to answer the following research questions: (1) To what extent is the AISA a valid and reliable instrument for measuring academic interest in Chemistry among Vietnamese high school students? (2) Does the AISA demonstrate measurement invariance across sex and grade levels?

2. Literature Review

Interest as a research topic has been studied ever since Johann Friedrich Herbart (1776–1841) saw it as both a motivational force and an educational goal (Krapp & Prenzel, 2011). Scholars such as Baldwin, Dewey, James, Piaget, and Thorndike explored interest in the late 19th and early 20th centuries, although less systematically. Systematic research on interest has emerged over the past three decades (Renninger & Hidi, 2011), with contributions from Renninger & Hidi, 2006; Krapp, 2002; Ainley, 2011; Eccles and Wigfield, 2020. Interest, a key motivational variable, refers to engagement with specific content over time (Hidi & Renninger, 2006). Krapp (2002) and Krapp and Prenzel (2011) categorized interest into situational and individual types, proposing a three-phase development model: (1) situational interest triggered by external stimuli, (2) its maintenance over time, and (3) the transition to enduring individual interest.

Hidi and Renninger (2006), expanding on Krapp's (2002) framework, introduced the Four-Phase Model of Interest Development, distinguishing between situational and individual interest. Situational interest includes triggered situational interest, a temporary state that is driven by external stimuli, and maintained situational interest, which is marked by sustained attention. Individual interest consists of emerging individual interest, an initial tendency to reengage, and well-developed individual interest, a lasting inclination. This model outlines early-stage interest (focusing on attention and emotions) and later-stage interest (integrating emotions, value, and knowledge). Developing interest requires both external support and personal effort, with knowledge playing a key role (Hidi & Renninger, 2006).

According to Renninger and Hidi (2011), most scholars acknowledge the role of emotions as a core component of interest. However, other studies suggest that interest should also encompasses cognitive and value-based dimensions. Specifically, (1) the cognitive aspect relates to knowledge stored in the domain of interest, (2) the emotional aspect involves positive feelings such as enjoyment and enthusiasm, and (3) the value aspect reflects the perceived importance or utility of the subject matter to the individual (Renninger & Hidi, 2011). Consequently, academic interest can be divided into four components: Emotion, Value, Knowledge, and Engagement. The component Emotion captures positive experiences such as joy and excitement; Value refers to the personal significance or perceived usefulness of the subject; Knowledge pertains to the understanding of domain-specific content; and Engagement reflects the tendency to participate

actively in academic activities (Alexander, 2004; Luo et al., 2019; Mazer, 2013a; Mazer, 2013b; Renninger & Hidi, 2006; Schiefele, 2009).

Several tools have been developed to measure academic interest and its relationship with learning outcomes, particularly among adolescents in Western contexts. However, these scales often focus on single components such as emotions or value or are tailored to specific subjects such as Mathematics or Sports (Dotterer et al., 2009; Kalender & Berberoglu, 2009; Lin & Chai, 2017; Linnenbrink-Garcia et al., 2010; Rotgans, 2015). For instance, single-component measures use emotional or value-based indicators, while dual-component scales incorporate both aspects (Høgheim & Reber, 2015; Jõgi et al., 2015; Viljaranta et al., 2014; Von Maurice et al., 2014). Some three-component scales include Emotion, Value, and either Knowledge or Engagement (Kleespies et al., 2024; Rotgans, 2015; Tang & Toyama, 2016). Despite their contributions, these tools lack generalizability, as they are often narrowly designed for specific educational settings and fail to encompass all four components of interest as proposed in the Four-Phase Model (Rotgans, 2015).

Hidi and Renninger's (2006) Four-Phase Model of Interest Development offers a key framework for understanding and assessing academic interest. It has guided the creation of multidimensional scales such as the AISA by Luo et al. (2019) that measures four components: Emotion, Value, Knowledge, and Engagement. These elements reflect students' positive emotions (e.g., enjoyment), perceived subject relevance, domain knowledge, and active participation in learning. The AISA has been validated across various subjects (e.g., Mathematics, English, and Chinese) and demographic groups, demonstrating strong internal consistency (Cronbach's α = .86–.93) and measurement invariance across subjects, sexs, and grade levels (Luo et al., 2019). The four-component scale based on this model, including Emotion, Value, Knowledge, and Engagement, has also been constructed and developed in several studies. However, it has only been applied to specific subjects such as Mathematics (Wininger et al., 2014) or Sports (Lin & Chai, 2017) rather than being applied to address multiple subjects, as does the AISA. Widely adopted in research (Kaluge & Halimi, 2023; Li et al., 2024; Morales-Castillo, 2022; Rahman et al., 2023; Rost & Feng, 2024; Valenzuela, 2023), the AISA serves as a robust tool for evaluating academic interest and its multidimensional components in diverse educational contexts. By reflecting the theoretical foundations of the Four-Phase Model, the AISA enables accurate measurement of key variables and offers practical implications for enhancing learning engagement.

3. Methodology

3.1 Research Design

- ***Measures***

This study employed the Vietnamese version of the AISA by Luo et al. (2019), which includes four subscales with 29 items: Emotion (7 items), Value (8 items), Knowledge (7 items), and Engagement (7 items). Each item was rated on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Originally designed for Mathematics, English, and Chinese, the scale allows subject-specific adaptation by replacing ". . ." with the relevant subject name.

The original scale exhibited strong psychometric properties, including good model fit and high internal consistency across all subscales and subjects. Factor loadings exceeded .3, while composite reliability (CR) and Cronbach's alpha (α) values consistently supported the scale's reliability. For instance, in Mathematics, *CR = .98, a* = .80, and in English, *CR = .98, a = .83*. Across all three subjects, the subscales for Emotion, Value, Knowledge, and Engagement demonstrated CR and α values above .80. Furthermore, configural, metric, and scalar invariance were supported across sex and grade levels, with minimal changes in model fit ($\Delta CFI > -.01$ or $\Delta CFI \leq .01$).

- ***Translation procedure***

The AISA was translated into Vietnamese using a rigorous process to ensure linguistic and cultural appropriateness, following the guidelines of Sousa and Rojjanasrirat (2011). Two independent translators conducted the translation. The first translator, a psychology lecturer, had expertise in the construct and relevant terminology. The second translator, an educational scientist fluent in English and colloquial Vietnamese, was intentionally blinded to the construct being measured.

The two translations were compared, and discrepancies were resolved through discussion to produce a consensus version. Certain items were adapted and reworded to reflect the cultural and cognitive perspectives of Vietnamese adolescents better while maintaining the original meaning. Further feedback was gathered from two psychology lecturers and six high school students from three different schools. Their insights helped to refine wording and clarify ambiguous items, thus ensuring greater clarity and contextual relevance.

3.2 Sample and Data Collection

Data were collected using a stratified random sampling approach to ensure representation across the different geographical regions of Vietnam (Northern Vietnam, Central Vietnam, and Southern Vietnam), including both mountainous and rural areas. First, high schools were purposively selected based on their geographical location and educational diversity. Within the selected schools, a random sampling method was employed to invite students from different grade levels to participate in the survey, thus ensuring a diverse and representative sample. Those who agreed to participate completed a self-reported questionnaire during school hours. Students were given 15 minutes to complete the questionnaire in its entirety.

The survey was administered by trained proctors, with researchers present during the survey session to address any questions raised by the respondents. Informed consent was obtained from all the respondents before the survey began. Participation was entirely voluntary and anonymous. Students could withdraw from the survey at any time without providing a reason or facing any consequences. All responses were kept strictly confidential.

In total, data from 380 students were analyzed, with the following demographic breakdown: Sex: Males (n = 187, 49.21%), Females (n = 193, 50.79%); and Grade

Levels: Grade 10 (n = 149, 39.21%), Grade 11 (n = 124, 32.63%), and Grade 12 (n = 107, 28.16%).

3.3 Data Analysis

- ***Validity of the adapted scale***

Following Kline's (2011) recommendations, CFA was used to assess the structural validity of the adapted scale. Unlike exploratory factor analysis (EFA), CFA requires researchers to specify a theoretical model based on prior research to determine the number of factors and their associated observed variables (Kline, 2011). This study evaluated the four-factor model (Emotion, Value, Knowledge, and Engagement) proposed by Luo et al. (2019).

A stepwise approach was adopted; CFA was first conducted on individual subscales, followed by a combined CFA for all four factors. Items with factor loadings below .3 were removed, and error covariances were modified based on model modification indices. If the four-factor model showed good fit, further analyses tested its invariance across sex and grade levels (Kline, 2011).

Model fit was evaluated using AMOS software, with the following criteria: Chi-square/$df \leq 3.0$ (good), ≤ 5.0 (acceptable) (Kline, 2005); Comparative Fit Index (CFI) $\geq .95$ (excellent), $\geq .90$ (good), $\geq .80$ (acceptable) (Hu & Bentler, 1999); Tucker-Lewis Index (TLI) $\geq .90$ (good) (Hu & Bentler, 1999); Root Mean Square Error of Approximation (RMSEA) $\leq .06$ (excellent), $\leq .08$ (acceptable) (McDonald & Ho, 2002); and Standardized Root Mean Square Residual (SRMR) $\leq .08$ (Hu & Bentler, 1999; Kline, 2011).

- ***Reliability of the scale***

Internal consistency was assessed using CR and α, with values above .70 indicating acceptable reliability (Cronbach, 1951; Nunnally & Bernstein, 1994). The SPSS was used for reliability analysis.

- ***Measurement invariance***

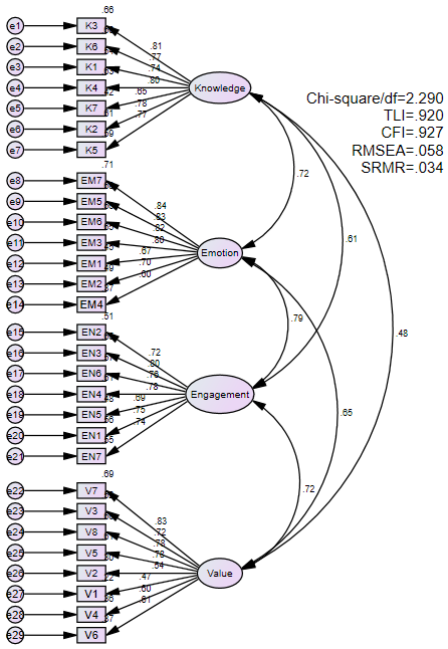
Measurement invariance was tested using Mplus version 8.8 across sex and grade levels. A stepwise framework (Byrne, 2016; Chen, 2007) was applied, testing configural, metric, and scalar invariance. Three models were sequentially tested: Configural invariance—This model tested the baseline structure without imposing any equality constraints; Metric invariance—Factor loadings were constrained to be equal across groups; and Scalar invariance—Factor loadings and item intercepts were constrained to equality across groups. Model comparisons were based on the change in χ^2 values. Non-significant differences in χ^2 (relative to degrees of freedom) or changes in CFI ($\Delta CFI > -.01$) indicated support for invariance. The ΔCFI criterion was preferred over $\Delta\chi^2$ due to its reduced sensitivity to sample size (Cheung & Rensvold, 2002). The following definitions of invariance guided the interpretation: Configural invariance—The pattern of factors is equivalent across groups (Horn & Mcardle, 1992); Metric invariance—Factor loadings are equal across groups, indicating consistent scaling (Cole & Maxwell, 1985; Marsh, 1994); and Scalar invariance—Item intercepts are equal across groups, implying consistent item regression on factors (Meredith, 1993).

4. Results

4.1 Construct Validity of the AISA

The construct validity of the AISA was evaluated using a stepwise CFA approach. The analysis demonstrated a good fit for each individual factor in the scale. The fit indices for the four factors were as follows: Emotion: normed χ^2 = 1.781, CFI = .992, TLI = .989, RMSEA = .045, SRMR = .014; Engagement: normed χ^2 = 2.359, CFI = .988, TLI = .980, RMSEA = .060, SRMR = .016; Value: normed χ^2 = 2.568, CFI = .985, TLI = .974, RMSEA = .064, SRMR = .017; and Knowledge: normed χ^2 = 1.964, CFI = .993, TLI = .988, RMSEA = .050, SRMR = .014.

After confirming the fit of individual factors, a CFA was conducted on the combined four-factor model, which included 29 items. The results indicated that the four-factor model provided a good fit to the data, with the following fit indices: normed χ^2 = 2.290, CFI = .927, TLI = .920, RMSEA = .058, SRMR = .034. Detailed results are presented in Figure 1.



Note: K = Knowledge, EM = Emotion, EN = Engagement, V = Value

Figure 1: Structural Equation Modeling of the Four Factors in the AISA

Alternative three-factor models were examined to evaluate the impact of the high correlations between certain factors (e.g., Emotion and Engagement, r = .79; Knowledge and Emotion, r = .72; and Engagement and Value, r = .72). However, the results indicated that these models did not fit the data well. Specifically, the three-factor model combining Engagement and Value, while retaining Knowledge and Emotion as separate factors, yielded the following fit indices: normed χ^2 = 3.548, CFI = .854, TLI = .841, RMSEA = .082, SRMR = .047.

Thus, the four-factor model demonstrated the best fit to the data, aligning with the original study by Luo et al. (2019) on the AISA. Furthermore, CFA on the four-factor model was conducted across stratified subgroups based on sex and

grade levels. As presented in Table 1, the model exhibited a good fit for male and female groups and for grade levels 10, 11, and 12.

- ***Reliability of the scale***

All factor loadings exceeded the threshold of .3, ranging from .47 to .84 (Figure 1). As presented in Table 1, the scale demonstrated strong internal consistency, with α values exceeding .70 across all subscales. The CR values ranged from .852 (Value) to .903 (Emotion), indicating high reliability. Convergent validity was also confirmed, with average variance extracted (AVE) values meeting the threshold of .5 for all subscales (Emotion = .573, Knowledge = .605, Engagement = .561, Value = .500).

These results suggest that the AISA exhibits robust reliability and validity, making it suitable for use in the Vietnamese cultural and educational context.

Table 1: Internal consistencies and descriptives of the AISA subscales

	Items	α	CR	AVE	*M*	*SD*
Emotion	7	.902	.903	.573	3.794	.661
Knowledge	7	.900	.906	.605	3.141	.719
Value	8	.848	.868	.500	4.130	.597
Engagement	7	.897	.899	.561	3.885	.657

Note: α = Cronbach's α; CR = composite reliability; AVE = average variance extracted; *M* = mean; *SD* = standard deviation

4.2 Measurement Invariance

Measurement invariance analysis was performed to evaluate the comparability of the measurement structure across sex (Males: n = 187, Females: n = 193) and grade levels (Grade 10: n = 149, Grade 11: n = 124, Grade 12: n = 107). The results are summarized in Table 2.

Table 2: Model fit statistics for models representing different degrees of invariance across sexs and grades

Models	χ^2	*df*	$\Delta\chi^2$	CFI	SRMR	RMSEA (90% CI)	ΔCFI
Sex							
Males (n = 187)	645.077	371	-	.915	.043	.063	
Females (n = 193)	688.333	371	-	.906	.036	.067	
Configural invariance	1184.236	742	-	.921	.055	.056 (.050, .062)	
Metric invariance	1209.816	767	25.58, p = .4420	.920	.064	.055 (.049, .061)	-.001
Scalar invariance	1237.120	792	27.304, p = .4288	.920	.066	.054 (.048, .060)	.000
Grade							
10 (n = 149)	573.968	371	-	.920	.042	.061	
11 (n = 124)	586.160	371	-	.893	.041	.069	
12 (n = 107)	703.778	371	-	.851	.050	.092	
Configural invariance	1755.878	1113		.893	.064	.068 (.061, .073)	
Metric invariance	1811.854	1163	55.751, p = .2675	.892	.056	.066 (.060, .072)	-.001
Scalar invariance	1885.101	1213	72.887, p = .0190	.888	.056	.048	-.040
Grade (After Correlating V4 and V6)							
Configural invariance	1702.493	1110		.901	.064	.065 (.059, .071)	
Metric invariance	1761.247	1160	58.470, p =.1923	.900	.080	.064 (.058, .070)	-.001
Scalar invariance	1829.543	1210	67.734, p =.0481	.897	.085	.064 (.058, .069)	-.003

- ***Tests of measurement invariance across sexs***

The configural model demonstrated a good fit with the data (CFI = .921, TLI = .913, RMSEA = .056, SRMR = .055), indicating that the factor structure was equivalent across sex groups. In comparison to the configural model, metric invariance examined whether the factor loadings were consistent between the sex groups. The results showed that the fit indices remained satisfactory (CFI = .920, TLI = .916, RMSEA = .055, SRMR = .064). The comparison between the configural and metric models revealed a ΔCFI of -.001, which met the acceptance criterion (ΔCFI ≤ .01), with a *p*-value of .4420 (no statistically significant difference). This suggests that the factor loadings were similar across the male and female groups. The scalar invariance tested whether the intercepts were equivalent across the sex groups, and the results showed that the fit indices remained stable (CFI = .920, TLI = .918, RMSEA = .054, SRMR = .066). The comparison between the scalar and metric models yielded a ΔCFI of .000, satisfying the acceptance criterion (ΔCFI ≤ .01), with a *p*-value of .4288 (no statistically significant difference). This indicated that the intercepts did not differ between sexs (scalar invariance).

- ***Tests of measurement invariance across grades***

The fit indices for each grade level indicated a gradual decrease in model fit as the grade level increased. The CFI values declined from .920 in Grade 10 to .851 in Grade 12, while the RMSEA increased from .061 to .092, suggesting a reduction in model fit for the higher grade levels. The SRMR remained relatively stable across the grades, ranging from .041 to .050. For measurement invariance across grades, the configural invariance model demonstrated an acceptable model fit (CFI = .893, SRMR = .064, RMSEA = .068, 90% CI [.061, .073]), indicating that the factorial structure was comparable across grades. The metric invariance model resulted in a non-significant chi-square difference test ($\Delta\chi^2$ = 55.751, p = .2675), with a minimal ΔCFI = -.001, thus meeting the recommended threshold (ΔCFI ≤ .01). This suggested that the factor loadings were equivalent across the grade levels.

The scalar invariance model showed a significant chi-square difference ($\Delta\chi^2$ = 72.887, p = .0190) and a ΔCFI of -.040, exceeding the acceptable cutoff and indicating that full scalar invariance was not supported.

After correlating V4 and V6, the model fit improved: The configural model showed better fit (CFI = .901, RMSEA = .065, 90% CI [.059, .071]). The metric invariance model still met the invariance criteria ($\Delta\chi^2$ = 58.470, p = .1923, ΔCFI = -.001), confirming equivalent factor loadings. The scalar model, however, still showed a significant chi-square difference ($\Delta\chi^2$ = 67.734, p = .0481) and ΔCFI = -.003, although the decrement in CFI was smaller than before.

5. Discussion

The findings of this study confirm that the four-factor model of the AISA—Emotion, Engagement, Knowledge, and Value—demonstrates strong construct validity and reliability within the Vietnamese educational and cultural context. The CFA results indicated excellent model fit indices for each factor, with CFI, TLI, RMSEA, and SRMR values surpassing recommended thresholds for all subdimensions. Specifically, all four factors exhibited good model fit, and the

combined four-factor model (29 items) also showed strong fit with the data, reinforcing the structural integrity of the AISA. These results align with the original study and prior validations in different cultural contexts, supporting its stability and adaptability across diverse settings (Luo et al., 2019; Schiefele, 2009).

The reliability of the scale was well established, with all factor loadings exceeding the acceptable threshold of .3 and α values being above .70 for all subdimensions, thus indicating strong internal consistency. Furthermore, the CR values ranged from .852 to .903, further reinforcing the robustness of the AISA. Convergent validity was also well supported, as the AVE values for all subdimensions met the required threshold of .5, indicating that the items effectively measured the intended theoretical constructs. These results are consistent with those of the original study, which also reported high reliability and internal consistency across different academic domains such as Mathematics and English (Luo et al., 2019). The findings of the current study also align with previous research on interest measurement, which emphasizes the multidimensional nature of academic interest and its role in fostering student motivation and engagement (Renninger & Hidi, 2016).

When comparing these results with prior studies, the findings of this study corroborate the psychometric properties established in previous validations of the AISA. The consistency in factor structure and reliability across different cultural contexts suggests that the scale is a robust tool for measuring academic interest. Studies in Western contexts such as those by Schiefele (2009) and Hidi and Renninger (2006) have demonstrated that academic interest comprises emotional, cognitive, and behavioral components, all of which are reflected in the AISA model. The strong structural validity observed in this study further supports the theoretical underpinnings of the Four-Phase Model of Interest Development (Hidi & Renninger, 2006).

Measurement invariance analysis provided additional insights into the applicability of the AISA across groups. The configural invariance model confirmed that the factor structure remained consistent across sex groups, validating that the scale assesses the same latent constructs for both male and female students. Similarly, metric invariance, which examined the consistency of factor loadings between the sex groups, was also supported, with minimal variation in fit indices, indicating that factor loadings were equivalent across males and females. These results suggest strong sex invariance, which is consistent with previous studies that have emphasized the importance of measurement invariance for valid cross-group comparisons (Byrne, 2016; Chen, 2007).

Interestingly, while full scalar invariance was initially not achieved across grade levels, modifications improved the model fit, suggesting potential differences in item interpretation based on grade level. This aligns with prior research indicating that academic interest evolves over time, particularly as students advance through different stages of schooling (Eccles & Wigfield, 2020). Future studies could explore how developmental and contextual factors contribute to these

variations, further refining the applicability of the AISA in diverse educational settings.

The findings of this study have important implications for both research and educational practice. First, by validating the AISA in the Vietnamese high school context, this study provides educators and policymakers with a reliable tool for assessing student interest in Chemistry. Second, the measurement invariance results highlight the need for tailored interventions that account for potential sex and grade-level differences. These findings contribute to the broader literature on student motivation by reinforcing the role of interest in academic engagement and performance (Ainley, 2012; Linnenbrink-Garcia et al., 2016).

Overall, this study demonstrates that the AISA is a valid and reliable instrument for measuring student engagement and motivation within the Vietnamese educational context. Its strong psychometric properties, including structural validity, internal reliability, and convergent validity, affirm its applicability in Vietnam. Additionally, the findings on measurement invariance highlight considerations for future research and scale refinement, particularly regarding sex and grade-level differences. The AISA represents a valuable tool for advancing research on student engagement and motivation in Vietnam and demonstrates the potential for adaptation and application in other cultural contexts.

6. Conclusion

This study focused on adapting and validating the AISA to assess students' interest in learning Chemistry in Vietnam. The CFA results confirmed that the four-factor model of the AISA—Emotion, Engagement, Knowledge, and Value—demonstrated strong validity and reliability within the Vietnamese educational context. This validation provides a robust and reliable tool for measuring students' interest in Chemistry learning.

Measurement invariance across sex groups was established, ensuring the scale's applicability for comparing male and female students accurately. Regarding grade levels, the model's fit improved significantly after correlating items V4 and V6, indicating the feasibility of using the AISA across different grade levels; however, minor differences in scalar invariance persisted.

Beyond validating the scale, this study provides critical insights into enhancing students' interest in Chemistry. Based on these findings, educators can implement flexible teaching methods, incorporate practical applications, and foster interactive learning environments to improve student engagement and motivation. Additionally, educational policymakers can use this validated scale to assess the effectiveness of teaching strategies and curriculum designs, leading to more student-centered educational approaches in Vietnam.

In summary, this study confirms that the adapted AISA is a valuable tool for assessing and fostering students' interest in Chemistry learning in Vietnam. Its application not only supports future educational research but also holds practical

significance in designing and implementing effective instructional strategies, ultimately contributing to the overall quality of Chemistry education in schools.

7. Limitations and Recommendations

Although the AISA is a valuable tool, this study has certain limitations that should be acknowledged. First, the findings may not be fully generalizable across different cultural or educational contexts, as the validation process was conducted within a specific population. Second, while the scale provides insights into academic interest, it does not account for external influences such as socioeconomic background or individual learning styles, which may also shape student motivation. Finally, ongoing refinement is necessary to ensure the scale remains relevant across diverse educational settings.

To address these limitations, future research should focus on cross-cultural validation to confirm the applicability of the AISA in different contexts. Additionally, incorporating factors such as socioeconomic background and learning styles would provide a more comprehensive understanding of student motivation. Expanding the scale's use in various educational systems and refining its items based on longitudinal data could further enhance its effectiveness.

8. Fundings

This research is funded by Hue University under grant DHH2024-03-192.

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Appendix: The 29-item Academic Interest Scale for High School Students in Chemistry—Vietnam

Emotion	
E1	I understand the fun of chemistry
E2	I am interested in chemistry
E3	Studying chemistry makes me feel happy
E4	The content I learn from chemistry courses is interesting
E5	I enjoy studying chemistry
E6	I really like chemistry courses
E7	I enjoy it when I study chemistry
Value	
V1	Knowledge of chemistry is important
V2	A good mark in chemistry courses means a lot to me
V3	I think that chemistry is helpful for my career in the future
V4	Knowledge of chemistry makes my daily life easier

V5	Knowledge of chemistry promotes my growth
V6	I find that knowledge of chemistry is useful in daily life
V7	Knowledge of chemistry is valuable for my future development
V8	I think that learning chemistry is significant for my growth
Knowledge	
K1	I know all kinds of things about chemistry
K2	I do well in chemistry lessons
K3	I have a great deal of knowledge in chemistry
K4	I am familiar with the knowledge and skills required in chemistry
K5	I have much to say about chemistry topics
K6	I can answer all types of questions that teachers ask in the chemistry class
K7	I am an expert in chemistry
Engagement	
EN1	I want to know more facts about the field of chemistry
EN2	I want to learn details that are not included in chemistry textbooks
EN3	I hope to explore aspects of chemistry
EN4	I will read more books about chemistry if I have the chance
EN5	I will take part in an extracurricular training class for chemistry if I have the opportunity
EN6	I want to find various ways to complete the chemistry assignment
EN7	I am willing to spend time on the skills or methods learned from chemistry lessons