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Article

An internet-delivered VAK learning style assessment: development, validation, and implications for educational practice in Indonesia

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ABSTRACT

This study aimed to develop and validate the Internet-Administered Learning Style VAK Inventory for Junior High School students in Indonesia, addressing the need for culturally relevant, technology-driven assessments. Existing learning style inventories often lack adaptation to specific educational contexts, and there is a growing demand for accessible, internet-based evaluation tools. This study seeks to fill this gap by examining the inventory's construct validity, reliability, and effectiveness in classifying students' learning preferences. The inventory, consisting of 15 items measuring visual, auditory, and tactile learning styles, was tested on a sample of 1,400 students using online data collection. Confirmatory Factor Analysis (CFA) was conducted to assess the factor structure, yielding good model fit indices (CFI = 0.946, RMSEA = 0.024, SRMR = 0.027), supporting the inventory's validity. However, internal consistency was moderate (Cronbach's Alpha = 0.580), highlighting the need for further refinement. Item discrimination indices ranged from 0.132 to 0.328, suggesting revisions for clarity and relevance. Descriptive findings indicated that tactile learners scored slightly higher (Mean = 21.187) than visual (Mean = 20.872) and auditory learners (Mean = 19.119), reflecting individual differences in learning preferences. While the study confirms the instrument's structural validity, limitations include moderate reliability and potential biases due to online administration. Future research should focus on improving reliability, refining weak items, and ensuring broader population representation. The findings suggest that this inventory could assist educators in tailoring instructional strategies to students' learning preferences, supporting adaptive curriculum planning and personalized learning approaches in digital education settings.

Keywords:

Internet-administered assessment
VAK learning styles
Psychometric validation
Junior high school students
Educational assessments

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Introduction

In recent years, the push toward personalized learning has intensified, particularly with the rapid integration of digital technologies in educational environments. One foundational element of personalized education is understanding students individual learning preferences, which can help educators tailor instruction to better meet diverse learner needs (Ph ng, 2018; Awla, 2014). Among various learning style frameworks, the Visual-Auditory-Kinesthetic (VAK) model remains one of the

most widely recognized and applied due to its conceptual simplicity and practical relevance in classroom settings (DePorter, et al., 2002; Akçay r et al., 2023).

The VAK model categorizes learners into three primary modalities: visual learners, who prefer seeing and spatial information; auditory learners, who learn best through listening and verbal instruction; and kinesthetic learners, who benefit most from hands-on activities and physical movement. The intuitive and accessible nature of this model makes it particularly suitable for younger students and for application in various educational systems, including developing countries like Indonesia. However, despite its widespread adoption, many VAK learning style assessments remain paper-based, lacking scalability, interactivity, and accessibility features that are critical in today s increasingly digital learning landscape.

Based on Cabual s (2021) research, Chinese university students tend to prefer group and auditory learning modes, while the less popular modes are individual and kinesthetic learning. His study did not provide explanations about students language learning styles. A study by Hu et al. (2021) showed that students majoring in Language and Humanities are more likely to prefer kinesthetic learning compared to students in Science/Medicine and Business in ESP classrooms. Tertiary education, according to Gong, Gao, and Lyu (2020), has a significant impact on learners learning styles. According to Lethaby and Mayne (2020), students who study English for a longer period tend to prefer kinesthetic learning. A kinesthetic learner is more likely to take risks, which is a crucial element in successful language acquisition. Additionally, their research indicated that students are more likely to prefer kinesthetic learning if they have attended classes taught by native English speakers.

Most learning style studies (Hu et al., 2021; Nge & Eamoraphan, 2020; Sengsouliya et al., 2021; Lethaby & Mayne, 2020) show that Chinese ESL students primarily prefer certain learning styles, such as group and tactile learning. However, in Yao et al. s (2025) study, a significant number of students chose minor learning modes rather than primary learning modes. As Reid (1987) noted, some participants, like Japanese students in her research, might feel more comfortable responding moderately in surveys rather than choosing strongly agree or strongly disagree. Students in this study seemed to prefer moderate options. There were some students with negative learning modes, and no general preference for negative learning styles was observed, unlike in some studies on Mandarin learners (Feng, Iriarte & Valencia, 2020; Hu et al., 2021).

Findings from several learning style studies (Lethaby & Mayne, 2020; Sun & Zhang, 2020; Li, Zhang & Parr, 2020) indicate that Chinese ESL students are more likely to prefer visual learning compared to other styles. Thus, these researchers label Chinese students as visual learners. However, it is noteworthy that these studies investigated Chinese ESL students at universities studying general English rather than ESP students at vocational institutions. Research findings suggest that compared to other learning styles, ESP students have a lower preference for visual aids such as PowerPoint presentations, handouts, and notes on the board.

In Indonesia, the integration of ICT (Information and Communication Technology) into education has become a national priority (Kementerian Pendidikan dan Kebudayaan, 2023). This is reflected in major curricular reforms such as the Kurikulum Merdeka, which emphasizes student-centered, active, and experiential learning principles that align well with the VAK framework. However, the tools currently available for assessing students' learning styles have notable limitations. Most instruments used are adaptations of international tools like Kolb s Learning Style Inventory (Kolb, 1976), the Myers-Briggs Type Indicator (Myers, 1962), and the Index of Learning Styles (Felder & Spurlin, 2005), which were originally designed for adult learners in Western contexts. These instruments often lack psychometric validation for younger age groups and cultural alignment with Indonesian learners.

The need for localized learning style assessment tools in Indonesia is pressing. Existing studies suggest that while teachers often attempt to implement learning style-based strategies, they do so without access to reliable or validated instruments, especially for junior high school students

(Rahmawati et al., 2022). Furthermore, many tools remain paper-based, limiting their feasibility for broad implementation across Indonesia s geographically diverse and often resource-constrained school systems. This is especially problematic for students in rural or underserved regions, where digital platforms could offer more equitable access.

Internet-administered assessments provide several advantages in this context. They offer greater accessibility to students across regions, streamlined data collection, instant feedback, and the potential to reduce manual errors or biases (Cohen & Richardson, 2020; Zhou et al., 2022). Properly designed online tools can also improve response accuracy and enhance students' engagement, making them well-suited for large-scale educational settings.

Against this backdrop, this study proposes the development and validation of an Internet-Administered VAK Learning Style Inventory tailored for Indonesian junior high school students. This initiative is driven not only by the country s growing digital capacity but also by the urgent need for culturally relevant, psychometrically sound, and pedagogically useful instruments that support differentiated instruction. The VAK framework is particularly appropriate in this context due to its alignment with the Kurikulum Merdeka and its suitability for early adolescents.

Although previous studies such as Suyata and Pujiati (2015) have highlighted the effectiveness of VAK-based teaching strategies in Indonesian classrooms, there remains a critical gap in the availability of reliable and validated instruments for assessing students learning preferences. This study seeks to address that gap by designing and validating a tool that is not only accessible via the internet but also rooted in the cultural and educational realities of Indonesia.

To ensure the quality of the developed instrument, the study will employ a comprehensive validation process, including Confirmatory Factor Analysis (CFA), internal consistency reliability testing, and item discrimination analysis. The goal is to produce a robust tool that can be practically used by educators to understand their students better and to implement teaching strategies that reflect their learners' preferred modalities.

This research aims to: (1) Develop an Internet-Administered VAK Learning Style Inventory for Indonesian junior high school students; (2) Validate its psychometric properties to ensure its construct validity, reliability, and practical utility.

Accordingly, the research is guided by the following questions: (1) Does the proposed Internet-Administered VAK Learning Style Inventory demonstrate a valid construct structure, as indicated by CFA?; (2) What is the internal consistency of the inventory?; (3) Which items exhibit sufficient discrimination power among the student sample?; (4) What are the dominant learning style preferences among Indonesian junior high school students?

By addressing these questions, the study contributes to the advancement of personalized learning in Indonesia by providing a validated, culturally appropriate, and digitally accessible tool for understanding and leveraging students learning style preferences in educational practice.

Literature review

Understanding Learning Styles and the VAK Framework

Learning styles refer to students preferred ways of processing and engaging with information across various learning situations, while teaching styles refer to the methods and behaviors instructors use to deliver content (Ph'ng, 2018). Understanding learning styles is considered crucial in facilitating active learning and improving the alignment between how students learn and how teachers teach (Awla, 2014).

According to Reid (1987), learning styles reflect general tendencies such as auditory or visual preferences and are best understood as existing on intersecting continua, not rigid dichotomies. She also introduced the idea of perceptual learning styles, where learners use sensory modalities visual, auditory, and kinesthetic to absorb and recall information. Kolb (2007) emphasized that learning styles are not fixed traits but are flexible preferences influenced by both context and prior

experiences. In this view, learning is a cyclical and experiential process of transformation, with learners adjusting their styles based on situational demands. El-Sabagh (2021) further noted that learning styles may shift depending on the environment, emphasizing the contextual and adaptable nature of style preferences.

The VAK learning style model, originally proposed by Fleming and Mills (1992), is one of the most widely used perceptual learning frameworks. It classifies learners into three dominant sensory modalities: (1) Visual learners, who prefer information through charts, diagrams, and written texts; (2) Auditory learners, who learn best by listening and speaking; (3) Kinesthetic learners, who understand through movement and hands-on experiences.

While the VAK model has been critiqued for oversimplifying the complexities of cognition (Pashler et al., 2008), it remains a practical and accessible model, especially at the primary and secondary levels, due to its ease of application and intuitive structure (Suyata & Pujiati, 2015; DePorter, Reardon, & Nourie, 2002).

Studies across various educational contexts have shown mixed but informative results. For example, Chinese ESL students tend to favor visual and auditory modes, with some studies showing a growing preference for kinesthetic learning among students exposed to native-speaking teachers or longer-term English instruction (Lethaby & Mayne, 2020; Gong et al., 2020). However, learning style preferences are not always consistent. Yao et al. (2025) found that many students selected moderate or minor styles, possibly influenced by cultural tendencies toward neutrality in responses an issue previously observed by Reid (1987). Such findings highlight the importance of cultural factors in interpreting learning style data.

In the Indonesian context, Suyata and Pujiati (2015) emphasized the importance of integrating all three VAK components in teaching. They argue that learners benefit from varied sensory inputs and that teachers should also balance their instructional strategies accordingly. Gholami and Bagheri (2013) reinforce this by describing the unique characteristics of each modality visual learners enjoy reading and visuals, auditory learners thrive in discussions and lectures, and kinesthetic learners excel with tactile experiences and role-playing.

Learning Style Assessment Instruments

A central issue in applying learning style theory is the availability of reliable and valid assessment tools. Learning style assessments help students recognize their learning preferences, allowing them to develop effective strategies and overcome learning barriers (Siddiquei & Khalid, 2021). These instruments also assist teachers in identifying students needs and adjusting instruction accordingly.

Historically, learning style inventories such as the VARK questionnaire (a variant of VAK), Kolb s Learning Style Inventory, and Felder and Silverman s Index of Learning Styles have been widely used. However, most were developed in Western, adult learning contexts and do not always align with the developmental or cultural characteristics of students in other countries (Ramadhani et al., 2020; Herlina et al., 2021). When used without proper localization, these tools can result in inaccurate interpretations or reduced engagement due to linguistic or cultural mismatches.

Moreover, most VAK instruments have traditionally been paper-based, limiting their scalability, interactivity, and efficiency in modern classrooms (Sánchez & Luján-Mora, 2021). This issue is especially relevant in Indonesia, where the need for scalable tools that align with the Kurikulum Merdeka and promote student-centered, active learning is growing.

The Role of Internet-Based Tools in Learning Style Assessment

The increasing adoption of digital tools in education offers opportunities to modernize learning style assessments. Internet-based tools allow for real-time data collection, automated scoring, and broader accessibility, especially for students in rural or remote areas (Zhou et al., 2022). Digital instruments

also increase student motivation and engagement, particularly among digital-native learners (Sreenidhi & Tay Chinyi, 2017).

Several recent studies (Lee et al., 2021; Yusuf & Firdiansyah, 2022) have explored digital implementations of the VAK model and found them effective in enhancing learning experiences. However, these studies primarily focus on teaching strategies, not the development and psychometric validation of the instruments themselves. This gap is especially notable in developing countries like Indonesia, where localized, online learning style assessments remain rare.

Despite the promise of technology, rigorous validation is essential to ensure that internet-based tools are both educationally meaningful and psychometrically robust. According to Gierl and Lai (2020), technology must be accompanied by evidence-based practices in test development, including construct validation, reliability analysis, and item discrimination testing.

Methods

Participants

This study employed a quantitative confirmatory research design aimed at validating an internet-delivered learning style assessment instrument grounded in the VAK (Visual, Auditory, Kinesthetic) model. The participants consisted of 1,400 high school students across various regions of Indonesia. A non-probability purposive sampling technique was used to recruit participants, targeting students aged 15 to 18 years who had access to the internet and were willing to complete the online assessment voluntarily.

Among the 1400 participants, the mean age was 15.9 (SD = 1.63) years. Most participants (78.6%) were aged 15-17 years old and in grade 10 (40.5%). The number of female participants (63.9%) was greater than male participants (36.1%), with diverse socio-economic backgrounds representative of urban and semi-urban school populations. These demographic details were collected to examine potential variation in learning style preferences across different student profiles and enhance the generalizability of the findings. A detailed breakdown of participant characteristics is presented in Table 1.

Tabel 1 Participants demographic characteristics

Variables	Total n (%)	Visual		Auditory		Tactile	
		Mean	SD	Mean	SD	Mean	SD
Sex							
Male	506 (36.1)	20.4	2.80	19.4	3.11	20.9	2.90
Female	894 (63.9)	21.1	2.54	18.8	2.97	21.4	2.88
Age							
12-14	211 (15.1)	21.0	2.53	19.4	3.05	20.9	2.96
15-17	1101 (78.6)	20.9	2.64	19.1	3.00	21.2	2.88
18-20	73 (5.2)	20.5	3.02	19.2	3.40	21.2	3.07
21-23	1 (0.1)	26.0	0	22.0	0	25.0	0
Above 23	14 (1.0)	21.4	3.48	19.1	3.30	21.2	1.85
Grade							
7	119 (8.5)	20.8	2.50	19.2	3.17	20.5	2.89
8	100 (7.1)	21.2	2.57	19.6	2.75	21.2	3.08
9	28 (2.0)	22.1	2.45	19.6	2.75	22.0	2.24
10	567 (40.5)	20.8	2.64	19.4	3.08	21.4	2.85
11	522 (37.3)	20.7	2.62	18.7	2.97	21.1	2.96
12	37 (2.6)	21.4	3.36	19.5	3.00	21.4	2.84
Above 12	27 (1.9)	21.7	3.311	18.3	3.14	20.9	2.09

Method of Analysis

Research Design and Instrument Development

The study utilized a quantitative, confirmatory design to evaluate the psychometric properties of the online VAK learning style inventory. The instrument development was informed by Fleming s VAK model, which classifies learners based on their preferred sensory modalities: visual, auditory, and kinesthetic. The original item pool was designed in consultation with Prof. Gijsbert Stoet (University of Essex), who also provided a computer-coded version of the instrument for web-based deployment.

The development process included an initial trial phase (pilot study) with 100 participants to assess the clarity and functionality of the instrument. Feedback from this phase led to revisions in item wording and interface design to improve comprehensibility and user experience.

The final instrument consisted of 30 items, with 10 items for each learning style category. Each item was rated using a five-point Likert scale ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree"). The item format and distribution were balanced to prevent response pattern bias.

Data Collection Procedures

Data collection was conducted entirely online through a secure platform developed by Prof. Stoet, which ensured data encryption and participant anonymity. Respondents accessed the instrument through a unique link distributed via school networks and educational forums. Before participation, students received clear instructions on how to complete the assessment, including definitions of each response scale and examples.

To ensure data quality and completeness, the platform was programmed to prevent submission of incomplete responses. Additionally, consent forms were included at the beginning of the assessment, and participant data were stored on a secure digital server provided by Stoet (2010), with restricted access limited to the research team.

Bias Control

Several steps were taken to reduce potential biases. The instrument included balanced item phrasing to minimize social desirability and acquiescence bias. Instructions emphasized honest self-reflection rather than choosing socially preferred answers. The platform also included algorithms to detect inconsistent or patterned responses (e.g., always choosing the same response option), and these responses were excluded from the final dataset.

Data Analysis and Psychometric Evaluation

The primary method for construct validation was Confirmatory Factor Analysis (CFA), chosen because the theoretical framework of the VAK model provided a predefined factor structure to be confirmed by empirical data. CFA is particularly suited to this context as it tests whether the collected data fit the hypothesized three-factor model (Visual, Auditory, Kinesthetic).

CFA was conducted using JASP version 0.11.1.0. Goodness-of-fit indices such as CFI, TLI, RMSEA, and SRMR were used to evaluate model adequacy. In addition, convergent validity was assessed using the Average Variance Extracted (AVE) for each factor, while discriminant validity was examined through the Heterotrait-Monotrait (HTMT) ratio.

Reliability testing included both Cronbach s Alpha and Composite Reliability (CR) to ensure internal consistency. Items with corrected item-total correlations below 0.30 were flagged for potential revision in future iterations of the instrument.

Results and Discussion

Alignment with Research Objectives

This study aimed to develop and validate an Internet-Administered VAK Learning Style Inventory for Indonesian high school students. The research focused on (1) assessing the construct validity of the scale using Confirmatory Factor Analysis (CFA), (2) evaluating its internal consistency and item

discrimination, and (3) examining its practical application in the educational context. The findings are discussed in relation to these objectives.

Descriptive Statistics

Table 1 presents descriptive statistics for each learning style model. The mean scores for the Visual (20.872), Auditory (19.119), and Tactile (21.187) models were relatively close, with the auditory group scoring slightly lower. This suggests a slightly stronger preference for visual and tactile modalities among participants. These findings are consistent with prior research in Indonesian secondary education that observed similar trends in learning style preferences (Setiawan & Cahyono, 2021).

Table 2. Descriptive Statistics

Model	Visual Model	Auditory Model	Tactile Model
Mean	20.872	19.119	21.187
Std. Deviation	2.658	3.029	2.892

Internal Consistency

Internal consistency was assessed using Cronbach's Alpha, which resulted in a value of 0.580. While this value demonstrates a moderate level of reliability, it falls below the standard threshold of 0.70 commonly recommended in psychometric studies (Azwar, 2021). This suggests the inventory may require item refinement to improve measurement consistency. Additional reliability indices such as Composite Reliability (CR) and McDonald's Omega are recommended for future studies to provide a more nuanced understanding of internal consistency.

Item Discrimination Index

Item discrimination, measured through item-rest correlations, ranged from 0.132 to 0.328. Items with discrimination indices below 0.20 (e.g., MV3, MT8) showed weak differentiation between respondents and may reflect ambiguity, lack of relevance, or limited respondent comprehension. These items should be qualitatively reviewed, potentially rewritten for clarity, or removed altogether. The review process should consider whether the low-performing items align well with the theoretical constructs they aim to measure.

Confirmatory Factor Analysis

CFA was employed to test the theoretical structure of the inventory comprising three latent variables: Visual, Auditory, and Tactile. CFA was chosen over Exploratory Factor Analysis (EFA) due to the existence of a well-defined theoretical framework (VAK model) guiding the item construction. The CFA diagram for the inventory consisting of three (3) subscales is shown in Figure 1.

Table 3. Analysis Results of the Fit Confirmatory Factor Analysis Model

Index	Value	Interpretation
Comparative Fit Index (CFI)	0.946	Good (>0.90)
Tucker-Lewis Index (TLI)	0.935	Good (>0.90)
Bentler-Bonett Normed Fit Index (NFI)	0.889	Acceptable (=0.90)
Bollen's Relative Fit Index (RFI)	0.866	Acceptable (=0.90)
Root mean square error of approximation (RMSEA)	0.024	Excellent (<0.05)
Standardized root mean square residual (SRMR)	0.027	Excellent (<0.08)
Goodness of fit index (GFI)	0.999	Excellent (>0.90)

Based on the results in Table 2, it can be said that the Internet-Administered VAK Learning Style Inventory model demonstrates excellent accuracy with the hypothetical model.

The purpose of this study was to develop a learning style inventory and assess its validity and reliability. We tested the Internet-Administered VAK Learning Style Inventory on 1,400 high school students in Indonesia.

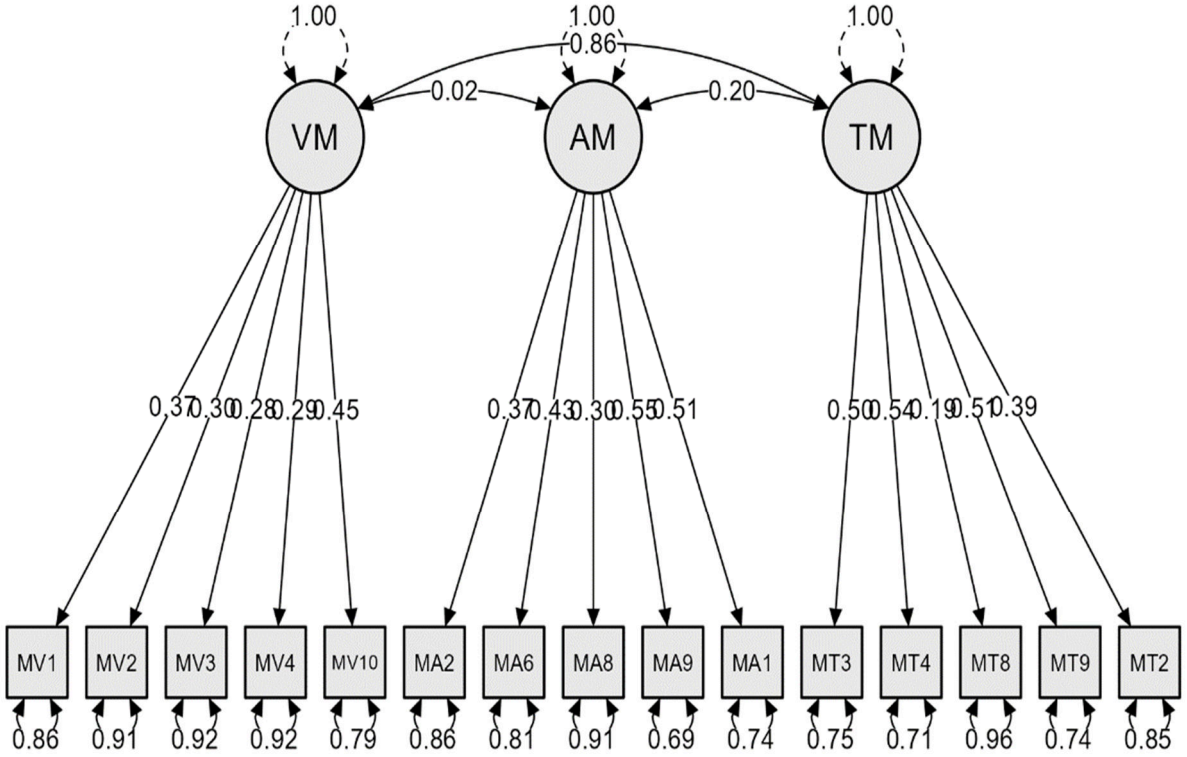

Figure 1. Internet-Administered Learning Style VAK Inventory Plot Model. (Source : processed data with JASP 0.11.1.0)>

Information: VM = Visual Model, AM = Auditory Model, TM =Tactile Model. The goodness-of-fit results of the CFA for the Internet-Administered VAK Learning Style Inventory indicate the following outcomes from the confirmatory factor analysis model fit analysis:

Table 4. Passed Items, Parameter Estimates, and Factor Loadings

Factor	Item	Estimate	95% Confidence Interval		p
			Lower	Upper	
Visual Model	MV1	0.206	0.166	0.247	< .001
	MV2	0.203	0.156	0.249	< .001
	MV3	0.160	0.114	0.206	< .001
	MV4	0.182	0.136	0.228	< .001
	MV10	0.294	0.248	0.341	< .001
Auditory Model	MA2	0.266	0.212	0.319	< .001
	MA6	0.280	0.230	0.330	< .001
	MA8	0.185	0.137	0.233	< .001
	MA9	0.384	0.332	0.437	< .001
	MA10	0.367	0.314	0.419	< .001
Tactile Model	MT2	0.251	0.266	0.349	< .001
	MT3	0.308	0.293	0.374	< .001
	MT4	0.333	0.086	0.177	< .001
	MT8	0.132	0.290	0.374	< .001
	MT9	0.332	0.209	0.293	< .001

Based on the Table 4 Descriptive statistics revealed that the average scores for the three learning style models (Visual, Auditory, and Tactile) were close but slightly different. Specifically, the auditory

model group had a mean score of 19.119, slightly lower than the visual model group (20.872) and the tactile model group (21.187). This suggests that, on average, participants in the visual and tactile groups reported a higher preference for their respective learning styles compared to those in the auditory group. These differences in means might reflect inherent differences in learning preferences, with students possibly exhibiting stronger inclinations toward visual or tactile learning materials. However, these differences are relatively small, and further studies with larger samples could help validate this trend.

The internal consistency of the inventory was assessed using Cronbach's Alpha, which yielded a value of 0.580. While this value indicates some level of consistency, it falls below the commonly accepted threshold of 0.70, which is considered indicative of good reliability (Azwar, 2021). This suggests that while the inventory measures the intended constructs to some extent, it may still require refinement to enhance consistency. Items with low discrimination indices (below 0.20) should be carefully reviewed and possibly removed to improve the scale s reliability. The current Cronbach's Alpha coefficient highlights the need for further work to achieve the desired level of reliability.

The item discrimination index, calculated using item-rest correlations, ranged from 0.132 to 0.328. According to Azwar (2021), items with indices below 0.20 exhibit poor discriminative power and should be reevaluated. In this study, six items had discrimination indices lower than 0.20, indicating that these items might not effectively differentiate between individuals with varying learning style preferences. These items should be examined for clarity, relevance, and how well they reflect the intended constructs.

The CFA results indicated that the Internet-Administered VAK Learning Style Inventory demonstrated an excellent fit to the hypothesized model, as shown by the fit indices in Table 2. The Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Bentler-Bonett Normed Fit Index (NFI) all exceeded the 0.90 threshold, which is considered indicative of good fit (Arbuckle, 2013). Additionally, the Root Mean Square Error of Approximation (RMSEA) value of 0.024 and Standardized Root Mean Square Residual (SRMR) value of 0.027 further confirmed the model s excellent fit to the data. These findings suggest that the model fits the data well and that the VAK Inventory is a reliable tool for assessing learning styles.

Table 3 provides the factor loadings for each item within the three subscales (Visual, Auditory, and Tactile models). Results indicated that most items had high factor loadings (greater than 0.2), signifying that they significantly contributed to their respective latent variables. However, certain items, such as MA9 and MA10 from the auditory model, as well as MT3, MT4, and MT9 from the tactile model, exhibited very strong factor loadings, with estimates exceeding 0.3. These items appear to be particularly influential in defining their respective learning style subscales and should be retained in the final version of the inventory.

Conversely, items with lower factor loadings, particularly those in the visual model (e.g., MV3), should be reviewed for potential refinement or removal. This is consistent with previous research, which suggests that items with weak factor loadings may not adequately measure the intended constructs and could reduce the overall reliability of the inventory (Gaskin & Lim, 2016).

While the confirmatory factor analysis results support the validity of the inventory, issues with internal consistency highlight that further work is needed. It is essential to consider both the statistical and theoretical foundations of the scale. Researchers should review the content validity of each item to ensure it accurately reflects the learning styles it is intended to measure. Additionally, revising problematic items and considering the inclusion of new items could enhance the overall reliability and validity of the inventory.

Comparison with Prior Research

The psychometric findings are generally consistent with prior efforts to develop VAK-based instruments (e.g., Zhang, 2009; Fleming & Baume, 2006), although the internal consistency in this study is slightly lower. This may be due to the cultural and linguistic adaptation required for an

Indonesian high school context or the challenges of online administration. Unlike earlier studies that often used paper-based inventories, this study contributes by validating an internet-delivered format, which has the potential for wider accessibility.

Limitations

Several limitations should be noted. First, the internal consistency of the scale is suboptimal, requiring further refinement of specific items. Second, the sample, although large, was limited to high school students and may not generalize to other educational levels. Third, the online nature of the assessment introduces potential variability in how respondents understood and interacted with the items. The absence of bias control mechanisms (e.g., attention checks, reverse-coded items) also represents a limitation.

Practical Implications

Despite these limitations, the study offers practical value for educators and counselors. The inventory can be used as a preliminary screening tool to understand students' preferred learning modalities, allowing for differentiated instruction. For instance, teachers may integrate more diagrams and visual aids for visual learners, auditory discussion formats for auditory learners, and hands-on activities for tactile learners. Furthermore, the online format makes it adaptable for digital learning environments increasingly common in Indonesian education.

Synthesis and Future Directions

In summary, the Internet-Administered VAK Learning Style Inventory demonstrates promising construct validity and moderate reliability. The CFA results support the theoretical three-factor structure of the instrument, while item analysis suggests specific areas for improvement. Future research should focus on item refinement, conducting validation with diverse populations, and including broader psychometric evaluations such as convergent and discriminant validity (e.g., using AVE and HTMT ratio). This instrument represents a significant step toward modernizing learning style assessments through digital platforms in Indonesia.

Conclusion

This study successfully achieved its primary objectives: developing and validating an Internet-Based VAK (Visual, Auditory, Kinesthetic) Learning Style Inventory for Indonesian high school students. The construct validity of the instrument was supported through Confirmatory Factor Analysis (CFA), which demonstrated a strong model fit with a clear three-factor structure corresponding to the VAK theoretical framework. This confirms that the instrument effectively captures the intended constructs.

Although the overall internal consistency (Cronbach's Alpha = 0.580) fell below the ideal threshold, this moderate reliability level is acceptable for an initial development stage and signals the need for further refinement. In particular, six items were identified with low discrimination indices, indicating areas where item wording or format may be improved to enhance scale precision and consistency.

The results contribute to the field of learning style assessment by introducing a culturally adapted, internet-administered inventory tailored to the Indonesian educational context. Unlike many prior instruments that are paper-based or developed for Western settings, this tool bridges a methodological gap by leveraging digital delivery to increase accessibility and scalability. As such, it offers a valuable resource for educators seeking to identify student learning preferences and adapt instruction accordingly.

In addition to improving the internal consistency and refining low-performing items, future research should validate this instrument across broader demographic groups, including students from different educational levels and regions. Cross-cultural comparisons and concurrent validity testing with existing VAK instruments are also recommended. Moreover, examining the relationship

between identified learning styles and academic outcomes could provide practical insights for classroom application and educational planning.

In conclusion, while the inventory presents some psychometric limitations, it lays a solid foundation for future work in learning style assessment and opens new opportunities for integrating digital tools in educational diagnostics. The findings represent a meaningful step forward in understanding and supporting individualized learning approaches in the digital age.

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