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Development of VARK Learning Styles Assessment Instrument for Secondary School Students

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A B S T R A C T

This study developed and validated the VARK Learning Style Inventory for Secondary School Students (VARK-LSI-SS) to assess learning preferences across Visual (V), Auditory (A), Read/Write (R), and Kinesthetic (K) modalities. Using a research and development (R&D) approach, the study adapted 4-D model integrated with the Oriondo and Dallo-Antonio framework. The instrument was administered to 278 secondary school students. The participants were selected through multistage sampling across various school types and performance levels. Content validity was confirmed via Aiken's V analysis (V = 0.87). Exploratory Factor Analysis supported the four-factor structure, retaining factors with eigenvalues ≥1, explaining 65.6% of the variance. Reliability analyses showed high internal consistency, with Composite Reliability ranging from 0.75 to 0.85 and AVE values between 0.53 and 0.71. Fleiss' Kappa (κ = 0.18–0.32) indicated fair to moderate inter-rater reliability. The findings support VARK-LSI-SS as a valid, reliable tool for assessing VARK learning styles in secondary education. The study recommends its adoption in experimental and longitudinal research to explore its impact on academic performance, retention, and instructional effectiveness.

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INTRODUCTION

Understanding the learning styles of students is fundamental for improving academic performance and engagement (Akinnawonu et al., 2025; Asiyanbi & Ajagbe, 2022; Pashler et al., 2008; Matazu & Isma'il, 2023). The VARK model, introduced by Neil Fleming in the late 1980s, remains one of the most widely adopted frameworks (Matazu & Isma'il, 2024). It categorizes learners into Visual (V), Auditory (A), Read/Write (R), and Kinesthetic (K) (VARK) groups based on sensory preferences. Teachers and researchers often use this model to adapt instruction, improving knowledge and retention (Fleming & Baume, 2006).

Research have pointed out the benefits of aligning teaching methods with students' learning preferences (Akinnawonu et al., 2025; Liew et al., 2015; Matazu & Isma'il, 2023; Romanelli et al., 2009). Almigbal (2015), Hussain (2019), and Padmalatha et al. (2022) found that students taught using their preferred styles performed better. Kharb et al. (2013) also noted significant benefits of multimodal instruction in medical education.

However, despite its relevance, a major challenge remains the lack of validated learning style assessment tools for secondary schools in Africa, especially Nigeria (Akinnawonu et al., 2025; Olurinola & Tayo, 2015). Most existing instruments were developed mostly in Western settings or for higher education (Husmann & O'Loughlin, 2018). This study aims to develop a psychometrically effective VARK assessment tool for Nigerian secondary schools.

Objective of the Study

The objective of this study is to develop a valid and reliable research instrument for measuring VARK learning styles among secondary school students.

LITERATURE REVIEW

The idea that students have different learning styles has been widely explored in educational psychology (Weiguo, 2024). Learning styles are defined as consistent preferences for processing and interacting with information in specific ways (Matazu & Isma'il, 2023; Pei, 2024). They represent the preferred approach individuals adopt when acquiring and processing knowledge, shaped by their unique traits and cognitive tendencies (Schunk, 2012). Various models have been developed to classify learning styles, including Kolb's Experiential Learning Theory (1984), Honey and Mumford's Learning Styles Questionnaire (1986), and Felder-Silverman's Learning Styles Model (1988) (Matazu & Isma'il, 2024). However, one of the most widely applied models in educational settings is Fleming's VARK model (1995), known for its simplicity and practical relevance in classroom instruction (Fleming & Mills, 1992; Hussain, 2019; Weiguo, 2024).

The VARK model categorizes learners into four primary learning styles; visual, auditory, read/write, and kinesthetic (Fleming, 1995; Husmann & O'Loughlin, 2018; Marcy, 2001; Matazu & Isma'il, 2023). Visual learners prefer diagrams, charts, and spatial representations to process information effectively, while auditory learners benefit from verbal explanations, discussions, and lectures. Read/write learners engage best with texts, reading materials, and note-

taking, whereas kinesthetic learners excel through hands-on experiences, practical activities, and real-world applications (Fleming, 1995). Some individuals exhibit a dominant learning style, whereas others are multimodal learners, integrating multiple learning preferences for more effective understanding and retention (Leite et al., 2010).

Most VARK related research has been conducted in higher education, particularly in medical, engineering, and teacher education programs (Agu et al., 2021; Almigbal, 2015; Baykan & Nacar, 2007; Lujan & DiCarlo, 2006; Moayyeri, 2015; Mozaffari et al., 2020; Padmalatha et al., 2022; Syazwani et al., 2021). However, secondary school students have distinct cognitive and sensory preferences that require tailored learning style assessments (Hussain, 2019; Matazu & Isma'il, 2024). Studies indicate that when teachers recognize and incorporate students' learning styles into instructional methods, it enhances engagement, retention, and academic achievement (Marcy, 2001; Kharb et al., 2013). In Nigeria, secondary school classrooms often have large student populations and limited resources, making it essential to implement learning style-based instruction to improve teaching effectiveness and learning outcomes (Akinnawonu et al., 2025; Gidado et al., 2023; Modebelu & Igwebuike, 2013). However, there is a scarcity of validated learning style instruments specifically designed for the Nigerian educational context, particularly at the secondary school level.

Despite the popularity of learning styles, critics argue that the concept lacks strong empirical support (Pashler et al., 2008; Rohrer & Pashler, 2012). Some researchers contend that adapting instruction to specific learning styles does not always lead to significant learning gains (Husmann & O'Loughlin, 2018). Nevertheless, recent studies suggest that using learning styles as a flexible instructional tool—rather than a rigid classification—can enhance personalized learning and student motivation (Nancekivell et al., 2020; Matazu & Isma'il, 2024). The effectiveness of any learning style inventory depends on its psychometric properties, including content validity, construct validity, and reliability (Aiken, 1980; Costello & Osborne, 2005). Content validity ensures that the instrument accurately assesses learning styles, while construct validity verifies its alignment with the theoretical framework, often evaluated through Exploratory Factor Analysis (EFA) (Costello & Osborne, 2005). Reliability measures, such as Cronbach's alpha and Composite Reliability (CR), assess the internal consistency and dependability of the instrument (Taber, 2018).

Existing learning style assessments have faced criticism regarding their validity and reliability, emphasizing the need for rigorous psychometric evaluation (DeVellis, 2017; Hair et al., 2014). To address these challenges, this study adopts a Research and Development (R&D) approach, incorporating the 4-D model (Define, Design, Develop, Disseminate) (Thiagarajan et al., 1974) and the Oriondo & Dallo-Antonio (1984) framework. These models facilitate the systematic development, validation, and psychometric testing of the VARK Learning Style Inventory for Secondary School Students (VARK-LSI-SS) before its implementation. EFA plays an important role in validating the instrument by confirming its underlying factor structure (Field, 2013). Furthermore, reliability

tests, including CR and Average Variance Extracted (AVE), help establish the instrument's internal consistency and convergent validity (Fornell & Larcker, 1981).

Developing a culturally relevant learning style assessment tool has significant implications for education in Nigerian secondary schools. First, it provides teachers with an evidence-based tool to assess students' learning preferences, enabling more effective and inclusive instruction (Tomlinson, 2014; Onyishi & Sefotho, 2020). Second, it informs educational policies and teacher training programs by promoting differentiated instructional strategies that align with students' cognitive strengths (Adeyemo, 2010). By understanding students' learning styles, teachers can design interventions that optimize academic performance, motivation, and knowledge retention.

Although learning styles continue to be a subject of debate in educational psychology, their practical implementation can improve personalized learning experiences. The VARK-LSI-SS aims to bridge the gap in existing learning style assessments by providing a validated and reliable tool for measuring VARK learning preferences. This study contributes to the field by ensuring that the instrument undergoes rigorous psychometric evaluation, eventually promoting improved teaching and learning outcomes.

METHODOLOGY

Design

This research follows a research and development (R&D) approach. According to Rampean and Rohaeti (2025), the R&D domain involves the creation of a product, in this case, a set of instrument designed to address specific educational needs or problems. The main product, VARK-LSI-SS (Table 5), was developed by adapting the 4-D model and incorporating elements from Oriondo & Dallo-Antonio (1984) framework.

Instrument Development

The VARK-LSI-SS (Table 5) was developed using the 4-D model and Oriondo & Dallo-Antonio's framework as used by Tumanggor and Supahar (2020) and Rampean and Rohaeti (2025). This is to ensure validity and reliability of the instrument. The process involved defining content, pilot testing, expert validation using Aiken's V, and reliability analysis. The 30-item inventory presents learning scenarios with VARK-based responses. A panel of five experts, including two measurement and evaluation specialists, a science education expert, a psychologist, and an experienced secondary school teacher, assessed the instrument's content validity and clarity using Aiken's V formula. Their suggestions refined the instrument, enhancing clarity and alignment with VARK learning styles. The process is shown in Figure 1.

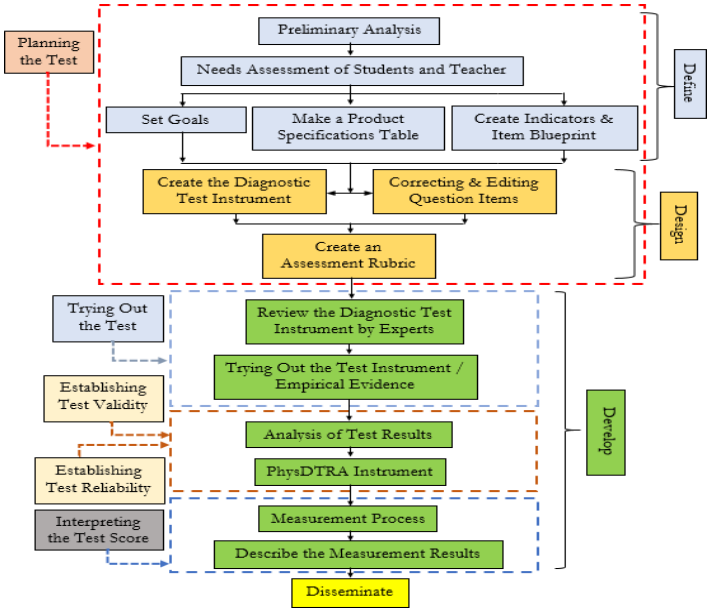

Figure 1. Test Instrument Development Process
Source: Tumanggor and Supahar (2020)

Participants and Sampling Techniques

The study employed a multi-stage sampling technique to select participants. The study employed a multi-stage sampling technique to select 278 secondary school students from eight schools in Sabon Gari Local Government Area, Kaduna State, Nigeria. Schools were purposively chosen to represent varying academic performance levels (low, medium, and high) as applied by Rampean and Rohaeti (2025). Within the selected schools, stratified random sampling was utilized to ensure that key demographic variables were adequately represented. The strata included school type (private and public), school location (rural and Urban) and gender (Male and Female). Following the stratification, simple random sampling was employed within each stratum.

Data Collection

The VARK-LSI-SS was administered to the participants in a classroom setting under controlled conditions to minimize distractions and guarantee standardized administration. Participants were given ample time to complete the inventory to allow for thoughtful and accurate responses. The administration was conducted in November, 2024.

Data Analysis

A series of statistical analyses were conducted to assess the validity and reliability of the VARK-LSI-SS. Aiken's V analysis (Aiken, 1985) was used to evaluate content validity based on expert ratings, with each item rated on a Likert scale and the coefficient calculated to determine expert agreement. The validity thresholds were classified (Azwar, 2019) as follows; $0.8 \leq V \leq 1.0$: Very Good, $0.6 \leq V < 0.8$: Good, $0.4 \leq V < 0.6$: Acceptable, $0.2 \leq V < 0.4$: Weak and $V < 0.2$: Poor.

EFA (Fabrigar et al., 1999) was conducted to identify the underlying factor structure of the instrument and confirm whether it effectively distinguishes the four VARK learning styles. Eigenvalues and total variance explained were examined to determine factor retention, following the guidelines recommended

by Kaiser (1960), who suggested retaining factors with eigenvalues with eigenvalues ≥ 1. To assess reliability, Fleiss' Kappa Coefficient (Fleiss, 1971) was used to measure inter-rater reliability, ensuring consistency across multiple expert raters. CR and AVE (Fornell & Larcker, 1981) were calculated to assess internal consistency and convergent validity, where CR measured the overall reliability of the instrument, and AVE determined the proportion of variance explained by each learning style factor. Additionally, item-total correlations (Nunnally & Bernstein, 1994) were computed to evaluate how well individual items aligned with their respective learning style constructs, with higher correlations indicating greater measurement effectiveness.

Ethical Considerations

Approval was obtained from relevant authorities, and informed consent of the participants was secured. Confidentiality and anonymity were guaranteed.

RESULTS AND DISCUSSION

In developing the VARK-LSI-SS, several psychometric analyses were conducted to establish its validity and reliability. These analyses aimed to ensure the instrument's content and construct validity, internal consistency, and inter-rater reliability, guaranteeing its accuracy in identifying VARK learning styles among secondary school students.

Validity of VARK-LSI-SS

1. Content Validity

To assess the content validity of the VARK-LSI-SS, Aiken's V analysis was conducted. This analysis quantified the level of agreement among experts regarding the alignment of the instrument's items with the intended learning styles.

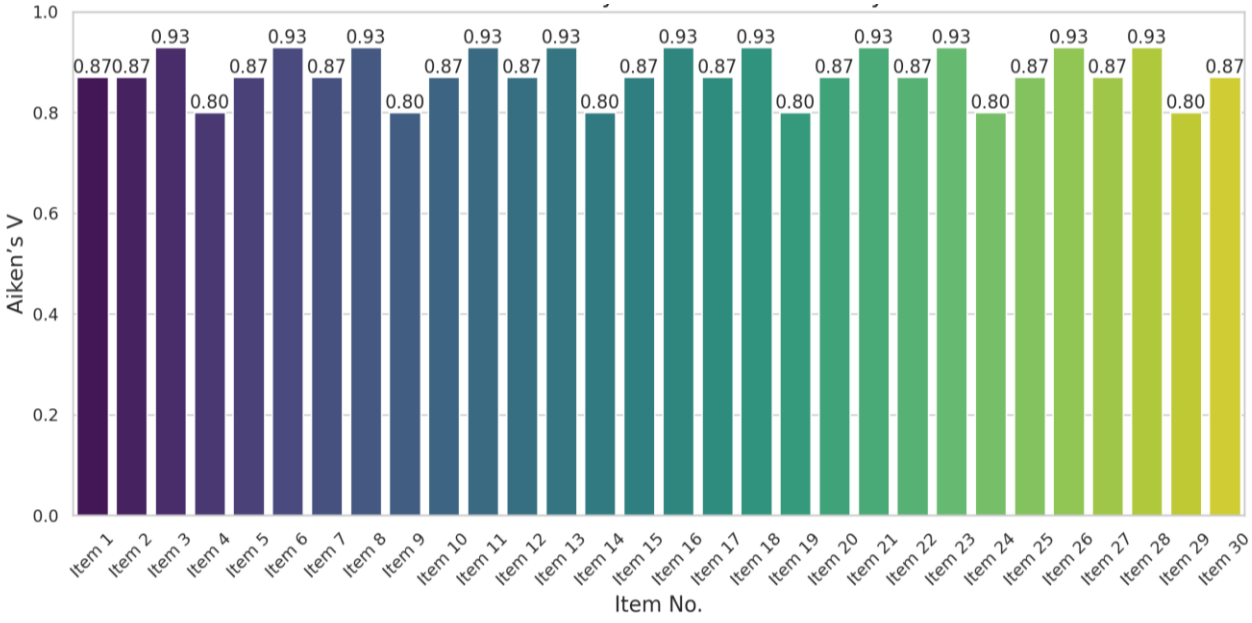

Figure 2. Summary of Aiken's V Content Validity Results
Source. Authors' Computation from Study Data (2025)

Figure 2 shows Aiken's V validity analysis, with 83% of items (V ≥ 0.80) rated highly valid, indicating strong expert agreement. The remaining 17% show moderate validity (V= 0.80), with no item below 0.60, confirming the instrument's overall soundness in assessing VARK learning styles.

2. Construct Validity

Construct validity of VARK-LSI-SS was determined to ensure that the instrument truly measured learning styles and not unrelated constructs. Exploratory Factor Analysis (EFA) was carried out, identifying the underlying factors that defined the students' learning styles.

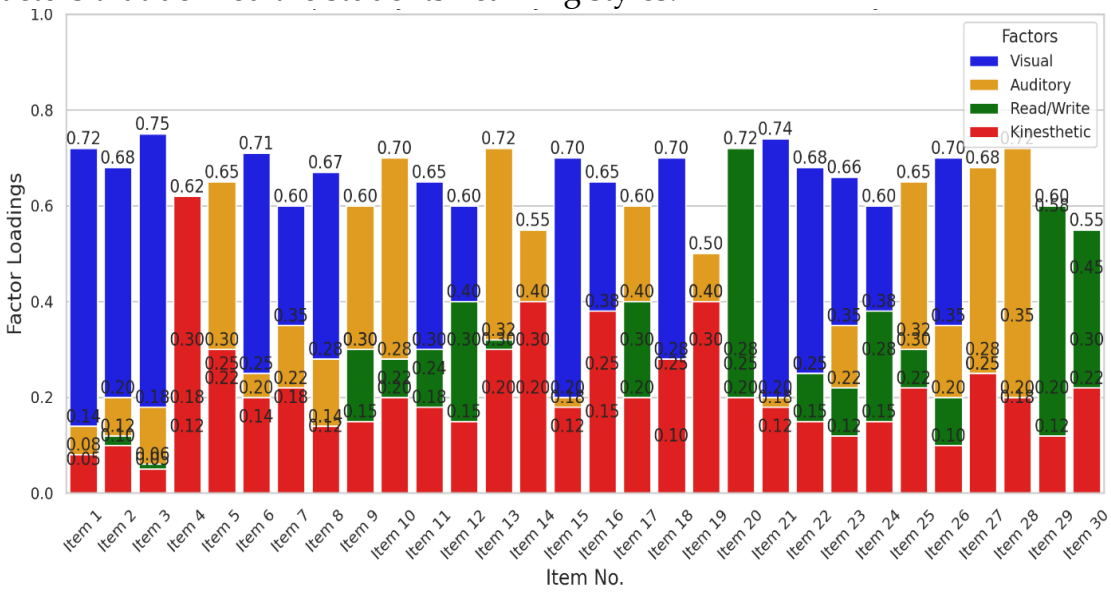

Figure 3. Summary of Exploratory Factor Analysis Results
Source. Authors' Computation from Study Data (2025)

Figure 3 presents the exploratory factor analysis results, highlighting factor loadings for each VARK learning style. Factor 1 (Visual) loads highly on items 1, 2, and 3, indicating a strong visual preference. Factor 2 (Auditory) aligns with items 5, 9, and 10, reflecting auditory dominance. Factor 3 (Read/Write) is linked to items 20, 24, and 29, showing a preference for reading and writing. Factor 4 (Kinesthetic) is best represented by items 4, 18, and 19, suggesting a kinesthetic inclination.

Table 1. Summary of Eigenvalues and Percentage of Variance Explained by Each Factor in the Learning Styles Analysis

Factor	**Eigenvalue**	**% of Variance Explained**
Factor 1 (Visual Learning)	5.8	24.2
Factor 2 (Auditory Learning)	4.5	18.7
Factor 3 (Read/Write Learning)	3.2	12.9
Factor 4 (Kinesthetic Learning)	2.8	9.8
Total Variance Explained	-	**65.6**

Source: Authors' Computation from Study Data (2025)

Table 1 presents eigenvalues and variance explained by each factor. Visual Learning (5.8) accounts for 24.2%, Auditory Learning (4.5) for 18.7%, Read/Write Learning (3.2) for 12.9%, and Kinesthetic Learning (2.8) for 9.8%. The model explains 65.6% of the total variance, indicating a good fit.

Reliability of VARK-LSI-SS

1. Inter-rater Reliability

The inter-rater reliability was assessed to evaluate the consistency of ratings across different raters. Fleiss' Kappa was calculated to measure the degree of agreement between raters in determining VARK learning styles of the students.

Table 2. Summary of Fleiss' Kappa Reliability Coefficient for Rater Agreement

Item No.	Prop. Votes per Category (pV)	Prop. Agreement (pA)	Exp. Agreement (pR)	Fleiss' Kappa Coefficient (pK)	Observed Agreement (Pi)
Item 1	0.3058	0.2158	0.1799	0.2986	0.2616
Item 2	0.2806	0.2590	0.1978	0.2626	0.2539
Item 3	0.3237	0.2086	0.1691	0.2986	0.2661
Item 4	0.2338	0.2482	0.1978	0.3201	0.2579
Item 5	0.2518	0.3165	0.1906	0.2410	0.2580
Item 6	0.3058	0.2698	0.1978	0.2266	0.2568
Item 7	0.2986	0.2878	0.1799	0.2338	0.2590
Item 8	0.3165	0.2662	0.1978	0.2194	0.2583
Item 9	0.2770	0.2842	0.2266	0.2122	0.2539
Item 10	0.2338	0.3058	0.1906	0.2698	0.2573
Item 11	0.2986	0.2698	0.2338	0.1978	0.2557
Item 12	0.2878	0.2806	0.2518	0.1799	0.2573
Item 13	0.1978	0.3237	0.2158	0.2626	0.2595
Item 14	0.2518	0.2770	0.1978	0.2734	0.2540
Item 15	0.3237	0.2662	0.1978	0.2122	0.2598
Item 16	0.2986	0.2338	0.2266	0.2410	0.2532
Item 17	0.2806	0.2878	0.2266	0.2050	0.2549
Item 18	0.3058	0.2482	0.1978	0.2482	0.2558
Item 19	0.2626	0.2518	0.2338	0.2518	0.2504
Item 20	0.2410	0.2590	0.2878	0.2122	0.2530
Item 21	0.3165	0.2698	0.1978	0.2158	0.2587
Item 22	0.2878	0.2662	0.2410	0.2050	0.2538
Item 23	0.2986	0.2842	0.2158	0.2014	0.2571
Item 24	0.2806	0.2698	0.2518	0.1978	0.2540
Item 25	0.2482	0.2986	0.2338	0.2194	0.2536
Item 26	0.3058	0.2842	0.2158	0.1942	0.2586
Item 27	0.2518	0.2878	0.2338	0.2266	0.2522
Item 28	0.2698	0.3058	0.2158	0.2086	0.2564
Item 29	0.2986	0.2482	0.2590	0.1942	0.2556
Item 30	0.2770	0.2698	0.2446	0.2086	0.2529

Source**:** Authors' Computation from Study Data (2025)

Table 2 shows the inter-rater reliability analysis using Fleiss' Kappa assessed the level of agreement among multiple raters in categorizing students' learning styles based on the VARK model. The Kappa values across the 30 items ranged from 0.1799 to 0.3201, indicating varying degrees of agreement. A majority of the items fell within the fair to moderate agreement range, suggesting that while raters showed consistency, some variability existed. The observed agreement (*Pi*) values ranged between 0.2504 and 0.2616, reinforcing the findings. These results highlight that the instrument provides reasonable but improvable inter-rater consistency, supporting its reliability in learning style classification.

2. Internal Consistency

The internal consistency analysis was conducted to determine how well the items in VARK-LSI-SS measured the same underlying construct. Thus, CR and AVE were calculated to ensure that the instrument consistently measured the intended learning styles.

Table 3. Summary of Composite Reliability (CR) for the 30 Items by Factor

Factor No.	**Sum of Loadings (Σλ)**	**Sum of Error Variance (Σθ)**	**Composite Reliability (CR)**
Factor 1 (Visual)	8.20	1.50	0.85
Factor 2 (Auditory)	6.75	1.80	0.82
Factor 3 (Read/Write)	5.10	2.00	0.78
Factor 4 (Kinesthetic)	4.30	1.90	0.75
Total Composite Reliability	-	-	**0.80**

Source**:** Authors' Computation from Study Data (2025)

Table 3 reveals the CR values for all factors exceeded 0.70, which is the acceptable threshold for good reliability. The Visual factor showed the highest CR (0.85), indicating strong consistency among its items, while Auditory (0.82) and Read/Write (0.78) also indicated good reliability. The Kinesthetic factor had the lowest CR (0.75) but remained within an acceptable range. The overall CR of 0.80 reveals that the instrument effectively measures its intended constructs. These values confirm that the items within each factor work well together to measure the specific learning style dimensions.

Table 4. Average Variance Extracted (AVE) for the 30 Items by Factor

Factor No.	**Sum of Squared Loadings ($\Sigma\lambda^2$)**	**Number of Items (n)**	**AVE**
Factor 1 (Visual)	5.68	8	0.71
Factor 2 (Auditory)	4.50	8	0.56
Factor 3 (Read/Write)	3.80	7	0.54
Factor 4 (Kinesthetic)	3.20	7	0.53
Total AVE	-	-	**0.68**

Source**:** Authors' Computation from Study Data (2025)

The AVE values in Table 4 indicate that all four factors demonstrate acceptable convergent validity, with AVE values exceeding the 0.50 threshold. The Visual factor (0.71) shows the strongest variance explanation, signifying that its items are highly representative of the construct. The Auditory (0.56), Read/Write (0.54), and Kinesthetic (0.53) factors also indicate adequate AVE. This confirms that a substantial portion of item variance is attributed to their respective constructs. The overall AVE of 0.68 further supports the reliability of the instrument in measuring VARK learning styles effectively.

3. Item-Total Correlation

To further assess the reliability of VARK-LSI-SS, item-total correlations were computed. This process examined how well each item contributed to the overall measurement of the learning styles.

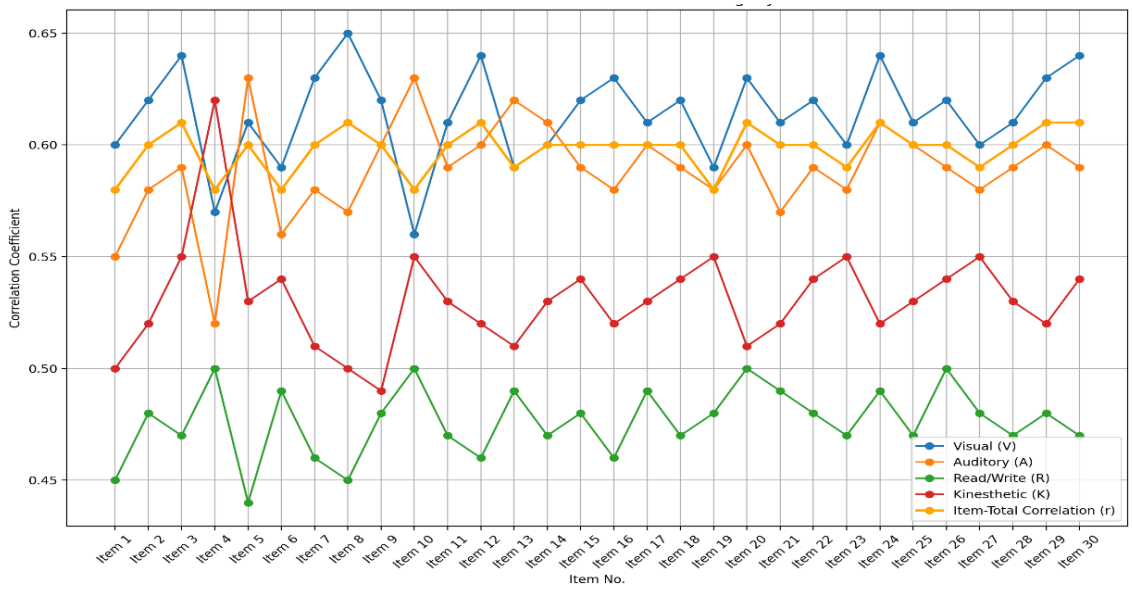

Figure 3: Item-Total Correlation for the 30 Items across VARK Learning Styles
Source: Authors' Computation from Study Data (2025)

The item-total correlation (rr) values in Figure 3 generally range between 0.58 and 0.61, indicating a moderate to strong relationship between individual items and the total test score. Particularly, Item 8 (r=0.61r = 0.61) and Item 24 (r=0.61r = 0.61) show high correlations, signifying they are well-aligned with the overall assessment. Conversely, Item 19 (r=0.58r = 0.58) shows a lower correlation, particularly for the Read/Write learning style (0.48), indicating a weaker association with text-based learners. Additionally, Item 10 demonstrates a relatively strong correlation for auditory learners (0.63), implying its effectiveness in assessing students who learn through listening. The consistency of the correlations across learning styles indicates that the test items are balanced.

The final version of the developed VARK Learning Style Inventory for Secondary School Students (VARK-LSI-SS), after all psychometric analyses, is presented in Table 5.

Table 5. The developed VARK Learning Style Inventory for Secondary School Students (VARK-LSI-SS)

SN	Statement	Options (Tick one)	SN	Statement	Options (Tick one)
1	**When preparing for an exam, I prefer to:**	a) Read my notes and textbooks b) Listen to recorded lessons c) Practice past questions d) Write summaries	**16**	**If I have to remember historical events, I:**	a) Look at timelines and maps b) Listen to the teacher's narration c) Act out or discuss key events d) Write a summary of the events
2	**In science practical, I understand better when I:**	a) Watch a demonstration b) Listen to instructions carefully c) Perform the experiment myself d) Write down the steps	**17**	**When studying a science topic, I understand best when:**	a) I use labeled diagrams b) I listen to explanations carefully c) I carry out practical activities d) I write detailed notes
3	**When my teacher is explaining a topic, I like to:**	a) Look at the board or diagrams b) Listen attentively c) Try out examples d) Take detailed notes	**18**	**When watching an educationa l video, I:**	a) Pay attention to the visuals b) Focus on what is being said c) Practice exercises after watching d) Take notes while watching
4	**If I don't understand a topic, I:**	a) Check my textbook or online b) Ask my teacher or friends c) Practice related exercises d) Rewrite my notes for clarity	**19**	**In literature class, I remember poems better when:**	a) I see them structured b) I hear them read aloud c) I act them out/relate to real life d) I write my own analysis
5	**When learning a new subject, I prefer to:**	a) Read explanations and visuals b) Listen to discussions or talks c) Do related activities myself d) Write down key points	**20**	**In geography, I understand maps better when:**	a) I look at different map examples b) The teacher explains them aloud c) I practice drawing maps myself d) I take notes on different features
6	**To remember what I learned in class, I:**	a) Use diagrams and charts b) Repeat it out loud c) Apply it in exercises d) Write it down multiple times	**21**	**If I don't understand a math concept, I:**	a) Look at examples in my book b) Ask my teacher or a classmate c) Solve problems independently d) Repeatedly write formulas

7	**When solving mathematics problems, I:**	a) Look at solved examples b) Listen to the teacher's talks c) Try solving different problems d) Write down the steps carefully	**22**	**When taking notes in class, I:**	a) Use bullet points and diagrams b) Write key phrases while listening c) Focus on practical applications d) Write everything in full sentences
8	**If I am given a project, I prefer to:**	a) Organize information visually b) Discuss with my classmates c) Handle practical tasks d) Write a detailed report	**23**	**When a teacher gives instructions, I:**	a) Read them myself b) Listen carefully c) Watch a demonstration d) Write them down
9	**In group discussions, I:**	a) Take visual notes b) Listen carefully to others c) Engage in practical tasks d) Write down key points	**24**	**When I need to study a new topic, I prefer to:**	a) Look at pictures and examples b) Listen to an explanation first c) Practice related exercises d) Summarize key points in writing
10	**When reading a novel or story in English class, I:**	a) Visualize scenes or characters b) Pay attention to dialogue c) Act out or summarize events d) Write a short summary	**25**	**When I review my homework, I:**	a) Study diagrams and charts closely b) Read the instructions aloud c) Try solving extra questions d) Rewrite difficult parts
11	**When preparing for a school presentation, I prefer to:**	a) Explain using visuals b) Speak clearly and confidently c) Demonstrate with examples d) Prepare handouts or notes	**26**	**When I hear a new word in English class, I:**	a) Picture how it looks b) Listen to how it is pronounced c) Use it in a sentence d) Write it down and spell it
12	**When studying a difficult subject, I:**	a) Look at charts and pictures b) Listen to someone explain it c) Work on practice questions d) Organize and rewrite notes	**27**	**If I am asked to explain a science concept, I:**	a) Draw diagrams to illustrate b) Describe it verbally c) Demonstrate with an example d) Write a detailed explanation
13	**When I need to recall important information, I:**	a) Visualize the material b) Repeat it out loud c) Practice using the information d) Write it down repeatedly	**28**	**When working on a science experiment, I:**	a) Observe carefully before trying b) Listen to instructions first c) Start working on it immediately d) Take notes throughout

14	**If I get confused in a lesson, I:**	a) Look at visual explanations b) Ask teacher for more explain c) Try solving examples myself d) Rewrite and organize my notes	**29**	**When recalling lessons from last term, I:**	a) Remember the images and charts used b) Recall teacher's explanation c) Think of the activities I did d) Check my written notes
15	**During school debates, I:**	a) Use charts or images to explain b) Speak clearly to argue points c) Use real-life examples d) Write my arguments first	**30**	**To prepare for a test, I:**	a) Review diagrams and notes b) Listen to recorded explanations c) Practice similar questions d) Write key points in my own words

Scoring Guide for VARK-LSI-SS

To determine the dominant learning preference, count the number of responses for each category:

i. A responses – Visual learning preference
ii. B responses – Auditory learning preference
iii. C responses – Kinesthetic learning preference
iv. D responses – Writing learning preference

Interpreting VARK-LSI-SS Results:

i. A dominant category (e.g., mostly A responses) indicates the strongest learning preference.
ii. Multiple high scores suggest a multi-modal learning approach, meaning learning preferences can shift based on the context.
iii. Balanced scores across all categories indicate an ability to adapt learning strategies flexibly depending on the subject or learning environment.

To evaluate the validity and reliability of the VARK-LSI-SS, a series of psychometric analyses were conducted. Content validity assesses the degree to which the items of an instrument reflect the full range of the concept being measured (Haynes et al., 1995). In this study, content validity of the VARK-LSI-SS was evaluated by expert judgment on the alignment of the items with the domain of learning styles. The use of Aiken's V Analysis provided a statistical measure for expert agreement, with values above 0.80 indicating high validity and values below 0.80 suggesting moderate validity (Aiken, 1985). The results indicated that 83% of the items were highly valid ($V \geq 0.80$), while 17% showed moderate validity ($V = 0.80$). This finding suggests that the majority of the items adequately represent the concept of learning styles, but the moderately valid items could be refined to improve clarity or alignment with the construct. The overall content validity of the instrument was considered strong, as no items fell below a validity score of 0.60, as recommended by Polit and Beck (2006).

Construct validity ensures that the instrument measures the theoretical construct it is designed to measure, rather than unrelated variables (Messick, 1995). In this study, construct validity was assessed through EFA, which is

commonly used to identify the underlying factors or dimensions of a construct (Fabrigar et al., 1999). The EFA revealed that the VARK-LSI-SS measures four distinct learning styles (visual, auditory, read/write, and kinesthetic). Factor loadings for each item were consistent with the learning style dimensions, indicating that the instrument effectively captures the learning styles it is meant to assess. Furthermore, the total variance explained by the factors was 65.6%, which is considered a good fit for the data (Kaiser, 1960). This suggests that the instrument accurately measures the constructs of learning styles as intended.

Reliability refers to the consistency of an instrument's measurements over time, across raters, and across items (Cronbach, 1951). Several methods were used to assess the reliability of the VARK-LSI-SS. They are inter-rater reliability, internal consistency, and composite reliability. Inter-rater reliability is important to assess whether different raters produce consistent results when evaluating the same data (Fleiss, 1971). The Fleiss' Kappa coefficient, a measure of agreement for categorical ratings, was used to assess the level of agreement between raters. A Kappa value closer to 1 indicates strong agreement, while values closer to 0 suggest poor agreement (Fleiss, 1971). The results from the analysis showed moderate agreement across raters, with values varying from 0.18 to 0.33. While not perfect, these results indicate that raters were generally consistent in their evaluations of students' learning styles.

Internal consistency refers to the degree to which items within a scale measure the same underlying construct (Cronbach, 1951). The CR and AVE were calculated to assess internal consistency. A CR value above 0.70 is typically considered acceptable (Fornell & Larcker, 1981). The results indicated that the Visual learning factor (CR = 0.85) showed the highest internal consistency, while the Kinesthetic factor (CR = 0.75) had the lowest, but still within an acceptable range. The overall CR of 0.80 suggests that the instrument has good internal consistency, meaning that the items within each learning style dimension reliably measure the same underlying construct (Nunnally & Bernstein, 1994). The AVE is another measure of internal consistency, indicating how much of the variance in the items is explained by the underlying factor (Fornell & Larcker, 1981). The results showed that the Visual factor had the highest AVE (0.71), suggesting that it explained a substantial portion of the variance. The Kinesthetic factor had the lowest AVE (0.53), but still fell within an acceptable range for convergent validity as recommended by Hair et al. (2010). These findings suggest that, while the VARK-LSI-SS performs well overall in terms of internal consistency, slight refinements may be necessary to improve the convergent validity of the kinesthetic factor. This corresponds with DeVellis (2017), who emphasized iterative refinement in instrument development to ensure continuous improvement.

CONCLUSIONS AND RECOMMENDATIONS

This study concluded that the VARK-LSI-SS demonstrates strong content validity, as verified by expert evaluations and Aiken's V analysis. Its construct validity was supported by exploratory factor analysis (EFA), which confirmed the presence of four distinct learning styles, aligning with the theoretical model proposed by Fleming and Mills (1992). Reliability analyses indicated good

internal consistency, with CR and AVE values meeting established psychometric standards. However, the inter-rater reliability analysis revealed areas for improvement, suggesting better rater training and refined guidelines.

Based on these findings, the VARK-LSI-SS is recommended for adoption or adaptation by researchers in experimental and longitudinal studies to assess its impact on academic performance, retention, and instructional effectiveness across diverse student populations.

FURTHER STUDY

Future studies should focus on improving the psychometric properties of the VARK-LSI-SS to contribute to more measurement precision and personalized educational practices.

REFERENCES

Adeyemo, S. A. (2010). The relationship between students' participation in school-based extracurricular activities and their achievement in physics. *International Journal of Science and Technology Education Research, 1*, 111–117. https://academicjournals.org/article/article1379502528_Adeyemo2222.pdf

Agu, A. U., Esom, E. A., Anyanwu, E. G., & Obikil, E. N. (2021). Learning style preference: impact on academic performance of preclinical medical students, a Nigerian survey. *Nigerian Journal of Medicine*, *30*(2), 199–204. https://doi.org/10.4103/NJM.NJM

Aiken, L. R. (1980). Content validity and reliability of single items or questionnaires. *Educational and Psychological Measurement, 40*(4), 955–959. https://doi.org/10.1177/001316448004000419

Aiken, L. R. (1985). *Psychological testing and assessment* (5th ed.). Allyn & Bacon.

Akinnawonu, M. O., Emeke, A., Anyama, S. C., Bolaji, S. D., Kuteyi-Imonitie, O., & Ibilola, O. G. (2025). Learning style differences between high and low achievers in public and independent secondary schools in Lagos State, Nigeria. *European Journal of Education and Pedagogy, 6*(1), 77–82. https://doi.org/10.24018/ejedu.2025.6.1.898

Almigbal, T. H. (2015). Relationship between the learning style preferences of medical students and academic achievement. *Saudi Medical Journal, 36*(3), 349–355. https://doi.org/10.15537/smj.2015.3.10320

Asiyanbi, M. S., & Ajagbe, S. W. (2022). Learning styles and teaching strategies as influence on pupils' performance in basic science in Ife East Local Government. *Journal of Specialised and Professional Education, 6*(1), 43–49.

Baykan, Z., & Nacar, M. (2007). Learning styles of first-year medical students attending Erciyes University in Turkey. *Advances in Physiology Education, 31*(2), 158–160. https://doi.org/10.1152/advan.00043.2006

Costello, A. B., & Osborne, J. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research, and Evaluation, 10*(1), 7. https://doi.org/10.7275/jyj1-4868

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*, 297–334. https://doi.org/10.1007/BF02310555

DeVellis, R. F. (2017). *Scale development: Theory and applications* (4th ed.). Sage Publications.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods, 4*(3), 272–299. https://doi.org/10.1037/1082-989X.4.3.272

Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4th ed.). Sage Publications.

Fleming, N. D., & Mills, C. (1992). Not another inventory, rather a catalyst for reflection. *To Improve the Academy, 11*, 137–155.

Fleming, N., & Baume, D. (2006). Learning styles again: VARKing up the right tree! *Educational Developments, 7*, 4–7.

Flemming, N. D. (1995). I'm different; not dumb: Modes of presentation (VARK) in the tertiary classroom. In A. Zelmer (Ed.), *Research and development in higher education: Proceedings of the 1995 Annual Conference of the Higher Education and Research Development Society of Australia (HERDSA)* (pp. 308–313).

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50. https://doi.org/10.2307/3151312

Gidado, B. K., Apeh, H. A., & Akinwande, A. O. (2023). Learning environment as correlates of academic achievements of senior secondary school students in North Central, Nigeria. *GPH-International Journal of Educational Research, 06*(04), 34–44. https://doi.org/10.5281/zenodo.7881430

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate data analysis* (7th ed.). Pearson New International Edition.

Haynes, S. N., Richard, D. C. S., & Kubany, E. S. (1995). Content validity in psychological assessment: A functional approach to concepts and methods. *Psychological Assessment, 7*(3), 238–247. https://doi.org/10.1037/1040-3590.7.3.238

Husmann, P. R., & O'Loughlin, V. D. (2018). Another nail in the coffin for learning styles? Disparities among undergraduate anatomy students' study strategies, class performance, and reported VARK learning styles. *Anatomical Sciences Education, 12*(1), 6–19. https://doi.org/10.1002/ase.1777

Hussain, I. (2019). Pedagogical implications of VARK model of learning pedagogical implications of VARK model of learning. *Journal of Literature, Languages and Linguistics*, *38*, 33–37.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement, 20*, 141–151.

Kharb, P., Samanta, P. P., Jindal, M., & Singh, V. (2013). The learning styles and the preferred teaching–learning strategies of first-year medical students. *Journal of Clinical and Diagnostic Research, 7*(6), 1089–1092.

Leite, W. L., Svinicki, M., & Shi, Y. (2009). Attempted validation of the scores of the VARK: Learning Styles Inventory with multitrait–multimethod confirmatory factor analysis models. *Educational and Psychological Measurement, 70*(2), 323–339. https://doi.org/10.1177/0013164409344507

Liew, S. C., Sidhu, J., & Barua, A. (2015). The relationship between learning preferences (styles and approaches) and learning outcomes among pre-clinical undergraduate medical students. *BMC Medical Education, 15*, 44. https://doi.org/10.1186/s12909-015-0327-0

Lujan, H. L., & DiCarlo, S. E. (2006). First-year medical students prefer multiple learning styles. *Advances in Physiology Education, 30*(1), 13–16. https://doi.org/10.1152/advan.00045.2005

Marcy, V. (2001). Adult learning styles: How the VARK learning style inventory can be used to improve student learning. *The Journal of Physician Assistant Education, 12*(2), 117–120. http://dx.doi.org/10.1097/01367895-200107000-00007

Matazu, S. S., & Isma'il, A. (2024). Theoretical frameworks and empirical evidences of tactile learning style as a veritable tool for improving biology performance among secondary school students. *Journal of Learning and Educational Policy, 4*(4), 10-20. https://doi.org/10.55529/jlep.44.10.20

Matazu, S. S., & Isma'il, A. (2023). Effect of Flipped Classroom Instruction and Enhanced Lecture Method on Academic Performance in Genetics Among Students with Visual-Auditory-Kinesthetic (VAK) Learning Styles in Gusau, Zamfara State. *Journal of Science, Technology and Mathematics Pedagogy (special edition), 1*(2), 1-20.

Messick, S. (1995). Validity of psychological assessment: Validation of inferences from persons' responses and performances as scientific inquiry into score meaning. *American Psychologist, 50*(9), 741–749.

Moayyeri, H. (2015). The impact of undergraduate students' learning preferences (VARK model) on their language achievement. *Journal of Language Teaching and Research*, *6*(1), 132–139. https://doi.org/10.17507/jltr.0601.16

Modebelu, M. N., & Igwebuike, F. K. (2013). Nigerian child learning styles: A teaching strategy for achieving effective education in Nigeria. *Journal of Educational and Social Research, 3*(6), 9–16.

Mozaffari, H. R., Janatolmakan, M., Ghandinejad, F., Andayeshgar, B., & Khatony, A. (2020). The relationship between the VARK learning styles and academic achievement in dental students. *Advances in Medical Education and Practice*, *11*, 15–19.

Nancekivell, S. E., Shah, P., & Gelman, S. A. (2020). Maybe they're born with it, or maybe it's experience: Toward a deeper understanding of the learning style myth. *Journal of Educational Psychology, 112*(2), 221–235. https://doi.org/10.1037/edu0000366

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

Olurinola, O., & Tayo, O. (2015). Colour in learning: Its effect on the retention rate of graduate students. *Journal of Education and Practice, 6*(14), 1–5. Retrieved

from https://www.iiste.org/Journals/index.php/JEP/article/view/22451

Onyishi, C. N., & Sefotho, M. M. (2020). Teachers' perspectives on the use of differentiated instruction in inclusive classrooms: Implication for teacher education. *International Journal of Higher Education, 9*(6), 136–150. https://doi.org/10.5430/ijhe.v9n6p136

Oriondo, L. L., & Dallo-Antonio, E. M. (1984). *Evaluating educational outcomes (test, measurement, and evaluation)* (5th ed.). REX Printing Company, Inc.

Padmalatha, K., J, P. K., & Shamanewadi, A. N. (2022). Do learning styles influence learning outcomes in anatomy in first-year medical students? *Journal of Family Medicine and Primary Care*, *11*(6), 2971–2976.

Pashler, H., McDaniel, M. D., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and evidence. *Psychological Science in the Public Interest, 9*(3), 105–119. https://doi.org/10.1111/j.1539-6053.2009.01038.x

Pei, W. (2024). Learning style. In Z. Kan (Ed.), *The ECPH encyclopedia of psychology*. Springer. https://doi.org/10.1007/978-981-97-7874-4_1114

Polit, D. F., & Beck, C. T. (2006). The content validity index: Are you sure you know what's being reported? Critique and recommendations. *Research in Nursing & Health, 29*, 489–497. https://doi.org/10.1002/nur.20147

Rampean, B. A. O., & Rohaeti, E. (2025). The development of an integrated instrument to measure higher-order thinking skills and scientific attitudes. *Journal of Turkish Science Education, 22*(1), 48–62.

Rohrer, D., & Pashler, H. (2012). Learning styles: Where's the evidence? *Medical Education, 46*(7), 634–635. https://doi.org/10.1111/j.1365-2923.2012.04273.x

Romanelli, F., Bird, E., & Ryan, M. (2009). Learning styles: A review of theory, application, and best practices. *American Journal of Pharmaceutical Education, 73*(1), 9. https://doi.org/10.5688/aj730109

Schunk, D. H. (2012). *Learning theories: An educational perspective* (6th ed.). Pearson Education.

Syazwani, N., Fadzillah, M., Azmi, M., Ahmad, N., Jamaluddin, J., Din, N. M., & Jabar, F. A. (2021). Relationship between learning style and academic performance of accounting undergraduates in online classes. *GADING (Online) Journal for Social Sciences, Universiti Teknologi MARA*, *24*(December), 64–68.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education, 48*, 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). *Instructional development for training teachers of exceptional children: A sourcebook.* Indiana University.

Tomlinson, C. A. (2014). *The differentiated classroom: Responding to the needs of all learners* (2nd ed.). ASCD.