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Original Article

Transformation Geometry Attitude Scale (TGAS): Development and Validation for Secondary School Learners in Uganda

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ABSTRACT

Transformation geometry, a core topic in secondary school mathematics, strengthens students' spatial reasoning and problem-solving skills. Students' attitudes toward transformation geometry significantly influence their engagement, motivation, and achievement in mathematics. However, existing attitude scales either focus on general mathematics/geometry, are designed for other educational levels or were developed outside Uganda, limiting their contextual relevance. This study aimed to develop and validate the Transformation Geometry Attitude Scale (TGAS) for assessing Ugandan secondary school learners' attitudes. The scale was developed through expert consultations and piloted among 132 secondary students. Validation involved Exploratory Factor Analysis (EFA) and reliability testing. The initial 36-item scale ($\alpha = 0.85$) was refined to 22 items across three dimensions: Interest & Confidence ($\alpha = 0.80$), Engagement & Metacognition ($\alpha = 0.77$), and Relevance & Applications ($\alpha = 0.85$). The validated TGAS provides a reliable tool for evaluating students' attitudes and informing instructional strategies in transformation geometry. Future research should apply Confirmatory Factor Analysis (CFA) across diverse educational settings to further validate its structure.

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INTRODUCTION

Attitudes toward mathematics have long been recognized as crucial determinants of students' motivation, engagement, and academic performance (Ma & Xu, 2004). Research has consistently shown that positive attitudes foster persistence and higher achievement, whereas negative attitudes can lead to avoidance and anxiety (Gülburnu & Yildirim, 2021). Given the significant impact of attitudes on learning outcomes, the development and validation of reliable attitude measurement tools have become a major focus in mathematics education research. Over the years, various models have been employed to conceptualize attitudes, with the Affective, Behavioral, and Cognitive (ABC) framework emerging as one of the most widely accepted (Frenk et al., 2015). This framework posits that attitudes comprise three interrelated components: affective (emotions and feelings toward mathematics), behavioural (engagement and effort), and cognitive (beliefs about the subject's importance and utility).

One of the earliest and most influential tools for measuring attitudes toward mathematics was the Fennema-Sherman Mathematics Attitude Scale (FSMAS), which assessed multiple dimensions, including confidence, motivation, and perceived usefulness (Ren et al., 2016). While FSMAS provided valuable insights, its broad focus on mathematics limited its applicability to specific mathematical domains such as transformation geometry. Similar to this, Tapia and Marsh (2004) developed the Attitudes Toward Mathematics Inventory (ATMI), which measured enjoyment, motivation, and self-confidence. All these remained generalized mathematics attitude scales, failing to capture the unique cognitive and affective dimensions of mathematics like transformation geometry.

As mathematics education evolved, researchers emphasized the importance of domain-specific attitude scales. For instance, Lim & Chapman (2013) refined ATMI into a shorter, more focused version, demonstrating that attitude scales must align with students' specific learning experiences. Similarly, Palacios et al. (2014) developed a psychometrically validated mathematics attitude scale, emphasizing the importance of construct validity through rigorous Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). These studies reinforced the notion that attitudes toward different branches of mathematics vary significantly and should be measured with precision.

In addition, Utley (2007), constructed a Geometry Attitude Scale measuring students' confidence, perceived usefulness, and enjoyment of geometry for undergraduate students. This work highlighted the cognitive and emotional dimensions of learning geometry, reinforcing the importance of tailored attitude assessments. Meanwhile, Hidayat et al. (2021) took this a step further by developing and validating the Mathematical Modeling Attitude Scale (MMAS) among Malaysian mathematics teachers. Their study demonstrated that constructivist approaches, real-world relevance, and motivation play a crucial role in shaping teachers' attitudes toward mathematical modelling.

In recent years, the intersection of education and technological advancements has further transformed attitude scale research. Suh and Ahn (2022) contributed to this discourse by designing the

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Student Attitude toward Artificial Intelligence (SATAI) Scale, capturing how the increasing integration of artificial intelligence (AI) in education influences students' cognitive, affective, and behavioural responses. Their work highlights an ongoing shift in educational research, where attitude scales are increasingly being adapted to emerging technological domains, ensuring that learners' perspectives on digital tools and AI-driven learning environments are adequately captured.

While the development of attitude scales has gained prominence globally, it has also taken distinct regional forms, reflecting context-specific educational needs and challenges. In Asia and Africa, scholars have been proactive in adapting and validating attitude scales for different student populations. In the Philippines, for example, Facultad and Sebial (2019) developed the Mathematics Attitude Scale (MAS) for high school students. Their study demonstrated that motivation, self-efficacy, and parental influence significantly shape students' engagement with mathematics. Similarly, in Nigeria, Kolawole and Kojigili (2015) constructed a Self-Concept and Attitude Scale for secondary school students, identifying key psychological components such as mathematical self-confidence, anxiety, and motivation. These studies highlight the critical role of contextual factors, including socioeconomic backgrounds, parental support, and school environments, in shaping students' attitudes toward mathematics.

Despite these advancements, Uganda has seen limited research on attitude scales specifically tailored to transformation geometry. Given the pedagogical challenges associated with teaching transformation geometry, Ndungo et al. (2024), the absence of validated instruments for assessing students' attitudes toward this topic presents a significant research gap. Since transformation geometry requires strong spatial reasoning skills, students often struggle with conceptualizing transformations such as reflections, rotations, translations, and enlargements. This highlights the need for a specialized attitude scale that not only assesses students' confidence and engagement but also explores their cognitive and affective responses to this sub-discipline of mathematics.

Recognizing this gap, the present study aims to develop and validate an Attitude Scale for Transformation Geometry Learners in Uganda. The study drew from global research on attitude scale development and validation, incorporating best practices such as the ABC framework, expert review, pilot testing, and factor analysis. This research contributes to a deeper understanding of students' attitudes toward transformation geometry, providing valuable insights for educators, curriculum designers, and policymakers in Uganda.

Objectives of the Study

The objective of this study is to develop and validate the Transformation Geometry Attitude Scale (TGAS) for assessing secondary school learners' attitudes toward transformation geometry in Uganda. Specifically, the study aims to:

- Develop and refine TGAS items through expert review to ensure clarity, relevance, and alignment with the transformation geometry curriculum.
- Pilot-test the TGAS with secondary school learners to assess comprehensibility and response patterns before full-scale analysis.
- Determine the factor structure and reliability of the TGAS through Exploratory Factor Analysis (EFA) and Cronbach's Alpha to validate its psychometric properties.

Significant of the Study

This study is significant in developing a validated tool (TGAS) to assess secondary school learners' attitudes toward transformation geometry in Uganda. It aids educators, policymakers, and

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researchers in improving instructional strategies, curriculum development, and student engagement, addressing a critical gap in domain-specific mathematics attitude assessment within the Ugandan education system.

METHODOLOGY

Research Design

This study employed a quantitative survey research design to develop and validate the Transformation Geometry Attitude Scale (TGAS) for secondary school learners in Uganda. The validation process followed a systematic approach, incorporating expert review, pilot testing, exploratory factor analysis (EFA), and reliability testing to ensure that the instrument was psychometrically sound and contextually relevant. The study aimed to create a reliable and valid tool to assess students' attitudes toward transformation geometry.

Participants

The study sampled 132 Senior Three students randomly selected from secondary schools in mid-western Uganda. The choice of Senior Three was guided by the National Curriculum Development Centre, curriculum framework, NCDC (2019), which explicitly includes transformation geometry in the Senior Three mathematics syllabus. Random sampling was used to ensure that students from diverse learning environments were represented, improving the generalizability of the findings.

Instrument Development

The Transformation Geometry Attitude Scale (TGAS) was developed as a 5-Likert-type questionnaire designed to measure students' affective, behavioural, and cognitive attitudes toward transformation geometry. The item pool was generated from a comprehensive review of existing mathematics attitude scales, ensuring that the selected items were contextually appropriate and aligned with the Ugandan mathematics curriculum. The scale aimed to assess students' attitudes regarding their confidence in performing transformations, motivation to learn the topic, perceived usefulness of transformation geometry, and anxiety associated with solving transformation geometry problems.

Validation Process

To ensure content validity, the initial version of TGAS was reviewed by five experts; 3 were secondary school teachers and 2 were university mathematics lecturers. The experts assessed the scale for clarity, relevance, and alignment with the transformation geometry curriculum. Their feedback was used to refine item wording, remove redundant items, and improve the overall structure of the questionnaire, ensuring that it effectively measured students' attitudes toward transformation geometry.

The final revised Transformation Geometry Attitude Scale (TGAS) comprised 36 items, each rated on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The items captured various aspects of students' attitudes toward transformation geometry, including interest, enjoyment, and confidence in learning, as well as engagement, effort, metacognition, and attitudes of relevance, applications, and importance of transformation geometry. The scale was structured as a single instrument without predefined subscales, allowing factor analysis to identify any underlying dimensions.

The revised scale was pilot-tested with 132 students to evaluate its comprehensibility and response patterns. This process helped identify any ambiguities or difficulties students encountered while answering the questionnaire. Based on student feedback, minor adjustments were made to improve clarity while maintaining the intended meaning of each item.

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To examine the factor structure of TGAS and establish its construct validity, Exploratory Factor Analysis (EFA) was conducted. Principal Component Analysis (PCA) with varimax rotation was used to determine how items grouped into factors, ensuring that each retained item contributed meaningfully to a specific dimension of attitude toward transformation geometry.

The internal consistency of TGAS was assessed using Cronbach's Alpha (α) to ensure the reliability of the instrument. Reliability testing was necessary to confirm that the scale consistently measured students' attitudes across different dimensions.

Data Collection Procedures

Before data collection, approvals were obtained from school administrators and relevant educational authorities. Informed consent was sought from participants, and students were assured of confidentiality and anonymity to encourage honest responses. The questionnaire was administered during regular class sessions to provide a familiar environment for students, minimizing external distractions. The first author was present to offer clarification where needed, ensuring that all participants fully understood the questionnaire items before responding.

Data Analysis

Data were entered and stored in CSV Excel format and analyzed using Python. The analysis was conducted by the first author and independently verified by the co-authors to ensure accuracy and consistency.

RESULTS

Before statistical validation, the scale underwent expert review for content validity, ensuring that items were theoretically sound and aligned with the construct of attitude toward transformation geometry. Following this, pilot testing was conducted, and quantitative analyses were performed to assess the scale's reliability and factor structure; beginning with an assessment of internal consistency using item-total correlations and Cronbach's Alpha, followed by an evaluation of sampling adequacy through Bartlett's test and KMO measure. Finally, Exploratory Factor Analysis (EFA) was conducted to identify the underlying factor structure and refine the scale.

Reliability Analysis (Internal Consistency)

To evaluate the internal consistency of the attitude scale, item-total correlations, and Cronbach's Alpha were computed. Item-total correlations assess the strength of each item's relationship with the total scale score, ensuring that individual items contribute meaningfully to the measured construct. The results revealed that most items demonstrated acceptable correlations above 0.3, confirming their relevance to the overall scale. However, five items; $A4, A13, A22, A27, and\ A28$ showed weak correlations below 0.3, suggesting potential misalignment with the scale's construct. Notably, item $A13$ exhibited a negative correlation (-0.29), which raises concerns about its wording or scoring direction.

A preliminary Cronbach's Alpha was calculated to measure the internal reliability of the scale. The results indicated a strong reliability coefficient exceeding the acceptable threshold of 0.7. This suggests that the scale is internally consistent and can reliably measure students' attitudes toward transformation geometry. However, further refinement through factor analysis may enhance the scale's reliability by eliminating weak or redundant items. While item-total correlation analysis provides an initial assessment of item performance, the final decision regarding item retention or removal will be made after conducting an Exploratory Factor Analysis (EFA).

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Data Suitability for Factor Analysis

Before proceeding with Exploratory Factor Analysis, Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy were performed to determine whether the dataset met the necessary conditions for factor extraction. Bartlett's test assesses whether the correlation matrix significantly differs from an identity matrix, indicating whether factor analysis is appropriate. The results of Bartlett's test were statistically significant, $\chi^2(630) = 1492.70, p < .001$, suggesting that the items were sufficiently correlated to justify factor analysis.

The Kaiser-Meyer-Olkin (KMO) test, which evaluates the adequacy of sampling for factor analysis, yielded an overall measure of 0.778. According to Kaiser's criteria, this value falls within the "good" range (0.7–0.79), confirming that the dataset is well-suited for factor analysis. A higher KMO value indicates that a greater proportion of variance can be explained by common factors, making factor extraction more reliable.

Given that Bartlett's test was significant and the KMO value exceeded the recommended threshold of 0.6, the dataset met the necessary assumptions for factor analysis. Consequently, the next step involves conducting Exploratory Factor Analysis (EFA) to determine the underlying factor structure of the scale. The results from EFA will help refine the instrument by identifying strong, weak, and redundant items, ensuring that only the most robust indicators of students' attitudes toward transformation geometry are retained.

Factor Retention and Scree Plot Analysis

An eigenvalue analysis was conducted to determine the number of factors to retain in the Transformation Geometry Attitude Scale (TGAS). The 36-item scale was subjected to factor extraction, and the corresponding eigenvalues were obtained. The Kaiser's Criterion (retain factors with eigenvalues ≥ 1) and a scree plot analysis were applied to guide factor retention decisions.

The eigenvalues revealed that the first factor had a dominant eigenvalue of 8.56, explaining the largest proportion of variance. The next few factors also had eigenvalues greater than 1.0, indicating they contributed meaningfully to the structure of the scale. The first 12 factors had eigenvalues ≥ 1.0, suggesting they could be retained based on Kaiser's Criterion. However, eigenvalue-based retention alone may overestimate the number of meaningful factors, necessitating a scree plot analysis. The scree plot for TGAS is presented in Figure 1.

Figure 1: Scree Plot of Eigenvalues for the Transformation Geometry Attitude Scale (TGAS).

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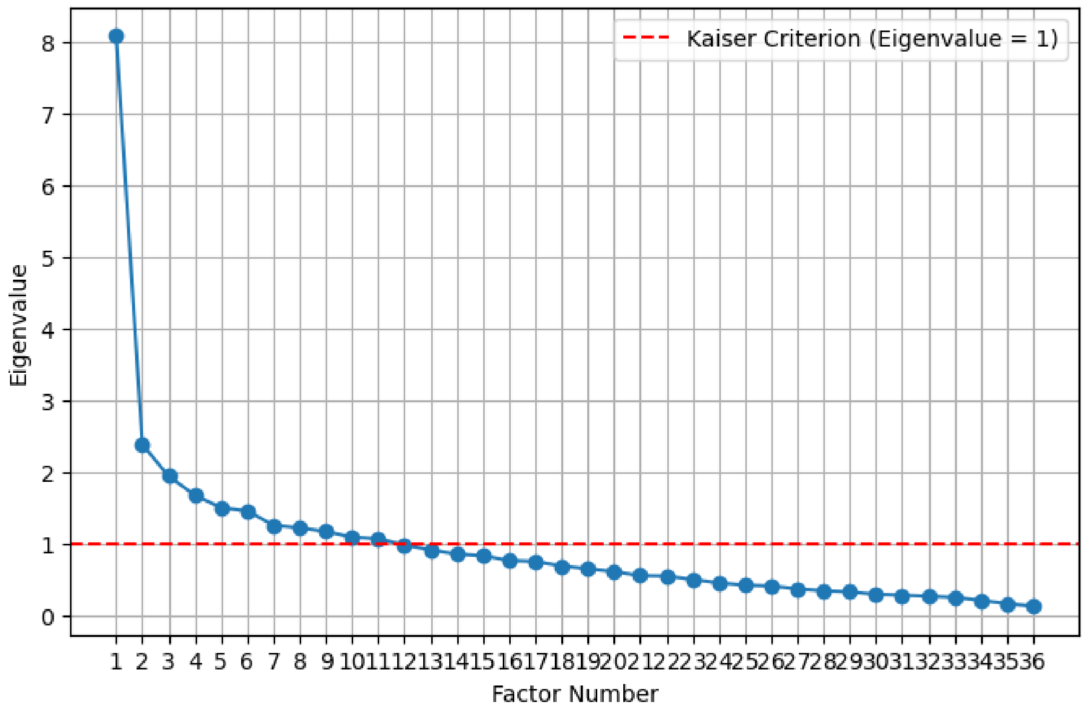

As illustrated in Figure 1, the scree plot reveals a sharp decline in eigenvalues for the first two factors, followed by a more gradual decrease from the 3rd factor onward. This elbow point suggests that the first two to four factors capture the most meaningful variance, while additional factors contribute minimal unique information. Based on this, we proceeded with Exploratory Factor Analysis (EFA) using 2, 3, and 4 factors to determine the most interpretable and theoretically coherent solution.

Factor Retention and Reliability Analysis

Following the exploratory factor analysis (EFA), a three-factor solution was selected based on theoretical interpretability, eigenvalues greater than 1, and the scree plot, which indicated a clear break after three factors. The three retained factors captured distinct but related dimensions of students' attitudes toward transformation geometry: Interest & Confidence, Engagement & Metacognition, and Relevance & Applications.

To improve the coherence of the scale, items with low factor loadings (< 0.40) or weak contributions were removed in phases. Initially, 10 items (A3, A8, A10, A11, A12, A18, A20, A23, A24, and A25) were eliminated due to factor loadings below the acceptable threshold. In the second phase, items A27 and A31 were removed because they exhibited weak loadings across all three factors. Finally, items A13 and A28 were eliminated due to poor item-total correlations and weak contributions to the overall factor structure. This refinement resulted in a final 22-item scale that retained strong conceptual clarity while ensuring statistical rigour.

The final Transformation Geometry Attitude Scale (TGAS) is structured across three distinct factors. The Interest & Confidence factor (7 items) measures intrinsic motivation, enjoyment, and self-assurance in learning transformation geometry. The Engagement & Metacognition factor (8 items) captures students' participation, effort, and reflective learning strategies. Lastly, the Relevance & Applications factor (7 items) assesses students' attitudes toward how transformation geometry connects to real-world applications and broader mathematical understanding.

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After finalizing the items, Cronbach's Alpha was computed for each factor to assess internal consistency. The results demonstrated strong reliability across all three subscales: Interest & Confidence (α = 0.80), Engagement & Metacognition (α = 0.77), and Relevance & Applications (α = 0.85). These values indicate a high degree of internal consistency, confirming that the items within each factor were well-correlated and effectively measured distinct dimensions of students' attitudes toward transformation geometry.

This refined version of the TGAS provides a reliable and valid tool for measuring students' attitudes toward transformation geometry. The strong psychometric properties support its application in future research and educational settings to assess how students engage with and perceive transformation geometry concepts. The final validated scale consisted of 22 well-structured items, categorized as shown in Table 1.

Table 1: Final Attitude Scale for Transformation Geometry

Interest, Enjoyment & Confidence (Affective Component) (α = 0.80)
A1: I find transformation geometry interesting.
A2: Exploring geometric transformations attracts my attention.
A4: The concept of transformations in geometry excites me.
A9: I find joy in discovering the connections between shapes in transformation.
A14: I feel motivated to complete transformation geometry classwork thoroughly.
A19: I am confident in my ability to understand transformation geometry concepts.
A21: I feel sure of myself when working on transformation geometry problems.
Learning Engagement, Effort & Metacognition (Behavioral Component) (α = 0.77)
A5: I actively seek additional information about transformation geometry.
A6: I feel curious about the different types of transformations in geometry.
A7: I look forward to transformation geometry lessons.
A15: I seek opportunities to apply transformation geometry concepts in real-world scenarios.
A16: The variety of transformation geometry activities improves my learning experience.
A17: I take the initiative in discovering advanced transformation concepts beyond class requirements.
A22: I am confident that I can explain transformation geometry concepts to others.
A26: I feel capable of exploring new transformation geometry topics on my own.
Relevance, Applications & Importance of Transformation Geometry (Cognitive Component) (α = 0.85)
A29: Understanding transformation geometry is important for my future.
A30: I can connect transformation geometry concepts to real-world situations.
A32: Transformation geometry is useful in fields outside of mathematics.
A33: I believe transformation geometry has applications beyond the classroom.
A34: Exploring transformation geometry enhances my critical thinking skills.
A35: The knowledge of transformation geometry contributes to my overall education.
A36: I find value in understanding how transformations are used in various disciplines.

DISCUSSION

The development and validation of the Transformation Geometry Attitude Scale (TGAS) provide a significant contribution to the assessment of students' attitudes toward transformation geometry in Ugandan secondary schools. The final scale, structured across three factors; Interest & Confidence (Affective), Engagement & Metacognition (Behavioral), and Relevance & Applications (Cognitive) demonstrate strong internal consistency, aligning with established frameworks in attitude research (Frenk et al., 2015). The high-reliability coefficients (α = 0.80, 0.77, and 0.85) indicate that TGAS is a robust and psychometrically sound instrument suitable for

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assessing students' attitudes toward transformation geometry.

The three-factor model of TGAS aligns with the Affective, Behavioral, and Cognitive (ABC) framework (Frenk et al., 2015), which has been widely used in attitude measurement. Previous studies, such as the Fennema-Sherman Mathematics Attitude Scale (FSMAS) by Ren et al. (2016) and the Attitudes Toward Mathematics Inventory (ATMI) by Tapia & Marsh (2004), have demonstrated that student attitudes toward mathematics are multidimensional, incorporating confidence, motivation, and perceived usefulness. However, these scales were broad and not designed for specific branches of mathematics. The refinement of TGAS ensures that students' attitudes toward transformation geometry, a sub-domain requiring spatial reasoning and visualization skills, are assessed with precision. This finding is consistent with Utley, (2007) who emphasized the need for domain-specific attitude scales in geometry.

The affective factor (Interest & Confidence), which reflects students' intrinsic motivation and enjoyment in learning transformation geometry, resonates with findings by Palacios et al. (2014) who argued that interest and enjoyment play a crucial role in mathematics engagement. The behavioural component (Engagement & Metacognition), which includes effort, persistence, and self-directed learning, aligns with previous research demonstrating that students' active engagement with learning materials enhances comprehension and retention of mathematical concepts (Lim & Chapman, 2013). The cognitive factor (Relevance & Applications) is particularly relevant given the increasing emphasis on real-world applications of mathematics in modern curricula (Pierce et al., 2007).

The validated TGAS addresses a critical gap in the assessment of students' attitudes toward transformation geometry, a topic known to be challenging for many learners (Ndungo et al., 2024). Given the importance of positive attitudes in improving mathematical performance Ma & Xu, (2004), TGAS provides a practical tool for educators and policymakers to identify students who may struggle with motivation, engagement, or perceived relevance of transformation geometry.

A key strength of TGAS is its local adaptation to Ugandan secondary school learners. Prior scales were predominantly developed in Western or Asian contexts (Hidayat et al., 2021; Kolawole & Kojigili, 2015), which may not fully align with African educational experiences. The development process incorporated expert reviews from Ugandan educators, ensuring that cultural and curriculum-specific factors were considered. This enhances content validity, making TGAS a more context-sensitive tool. Additionally, Uganda's national education reforms emphasize competency-based learning, which aligns well with TGAS's ability to measure students' cognitive, affective, and behavioural engagement in mathematics.

While the current study established the validity of TGAS through EFA, future research should conduct Confirmatory Factor Analysis (CFA) across different school contexts to further validate the scale's structure (Palacios et al., 2014). Additionally, researchers could explore how student attitudes toward transformation geometry change over time or in response to innovative teaching strategies such as GeoGebra-based instruction (Ndungo et al., 2024). Longitudinal studies would provide valuable insights into how pedagogical interventions influence students' affective, behavioural, and cognitive engagement with transformation geometry.

CONCLUSION AND RECOMMENDATIONS

The development and validation of the Transformation Geometry Attitude Scale (TGAS) provide a reliable and psychometrically sound tool

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for assessing secondary school learners' attitudes toward transformation geometry in Uganda. By aligning with the ABC framework and established best practices in attitude scale development, TGAS offers a comprehensive measure of students' interest, engagement, and relevance of transformation geometry. The strong internal consistency and clear factor structure make it a valuable tool for educators, policymakers, and researchers aiming to enhance students' motivation and learning outcomes in mathematics. Future studies should focus on CFA validation, cross-context applications, and the impact of instructional strategies on students' attitudes toward transformation geometry.

- **Data Availability:** The data that support the findings of this study are openly available and can be accessed on request.
- **Conflict of Interest:** On behalf of all authors, the corresponding author states that there is no conflict of interest.
- **Funding Statement**: The study did not receive any funding
- **Doctoral Research Attribution**: This article is part of the first author's doctoral study, approved under clearance numbers SS2857ES and MUST-2024-1519. The study focuses on the interplay among instructional strategies, learners' geometry attitudes, and Van Hiele's geometric reasoning levels in selected Mid-Western Uganda secondary schools.

REFERENCES

Facultad, E. B., & Sebial, S. C. L. (2019). Development and validation of a mathematics attitude scale (MAS) for high school students in Southern Philippines. *International Journal of Innovation, Creativity and Change*, *8*(7), 147–162. https://doi.org/10.2139/ssrn.3503680

Frenk, V.-H., Nohlen, H. U., & Schneider, I. K. (2015). The ABC of Ambivalence: Affective, Behavioral, and Cognitive Consequences of Attitudinal Conflict. In *Advances in Experimental Social Psychology* (1st ed., Vol. 52, Issue December). Elsevier Inc. https://doi.org/10.1016/bs.aesp.2015.01.002

Gülburnu, M., & Yildirim, K. (2021). Development and implementation of mathematics attitudes scale for the primary and secondary students. *Pegem Egitim ve Ogretim Dergisi*, *11*(4), 177–184. https://doi.org/10.47750/pegegog.11.04.17

Hidayat, R., Idris, W. I. W., Qudratuddarsi, H., & Rahman, M. N. A. (2021). Validation of the Mathematical Modeling Attitude Scale for Malaysian Mathematics Teachers. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(12). https://doi.org/10.29333/EJMSTE/11375

Kolawole, E., & Kojigili, S. (2015). Development and Validation of a Self-concept and Attitude Scale for Senior Secondary School Students in Nigeria. *British Journal of Education, Society & Behavioural Science*, *7*(1), 42–49. https://doi.org/10.9734/bjesbs/2015/14635

Lim, S. Y., & Chapman, E. (2013). Development of a short form of the attitudes toward mathematics inventory. *Educational Studies in Mathematics*, *82*(1), 145– 164. https://doi.org/10.1007/s10649-012-9414-x

Ma, X., & Xu, J. (2004). Determining the Causal Ordering between Attitude toward Mathematics and Achievement in Mathematics. *American Journal of Education*, *110*(3), 256–280. https://doi.org/10.1086/383074

NCDC. (2019). New Lower Secondary School Curriculum Framework. In *National Curriculum Development Centre, Uganda*.

Ndungo, I., Akugizibwe, E., & Balimuttajjo, S. (2024). Analyzing trends and suggested

Article DOI: https://doi.org/10.37284/ijar.8.1.2861

instructional strategies for Geometry education: Insights from Uganda Certificate of Education-Mathematics Examinations, 2016-2022. *African Journal of Teacher Education*, *13*(2), 153–186. https://journal.lib.uoguelph.ca/index.php/ajote/article/view/8106

Palacios, A., Arias, V., & Arias, B. (2014). Attitudes towards mathematics: Construction and validation of a measurement instrument. *Revista de Psicodidactica*, *19*(1), 67– 91. https://doi.org/10.1387/RevPsicodidact.8961

Perry, L. R., Moorhouse, T. P., Jacobsen, K., Loveridge, A. J., & Macdonald, D. W. (2022). More than a feeling: Cognitive beliefs and positive—but not negative—affect predict overall attitudes toward predators. *Conservation Science and Practice*, *4*(2), 1–10. https://doi.org/10.1111/csp2.584

Pierce, R., Stacey, K., & Barkatsas, A. (2007). A scale for monitoring students' attitudes to learning mathematics with technology. *Computers and Education*, *48*(2), 285–300. https://doi.org/10.1016/j.compedu.2005.01.006

Ren, L., Green, J. L., & Smith, W. M. (2016). Using the Fennema-Sherman Mathematics Attitude Scales with lower-primary teachers. *Mathematics Education Research Journal*, *28*(2), 303– 326. https://doi.org/10.1007/s13394-016-0168-0

Suh, W., & Ahn, S. (2022). Development and Validation of a Scale Measuring Student Attitudes Toward Artificial Intelligence. *SAGE Open*, *12*(2). https://doi.org/10.1177/21582440221100463

Tapia, M., & Marsh, G. E. (2004). An Instrument to Measure Mathematics Attitudes. *Academic Exchange Quarterly*, *8*, 16– 22. https://api.semanticscholar.org/CorpusID:141284071

Utley, J. (2007). Construction and validation of Geometry Attitude scale. *School Science and Mathematics*, *107*(3), 89– 93. https://doi.org/https://doi.org/10.1111/j.1949-8594.2007.tb17774.x.