Design and Content Validity of a Growth Mindset in Mathematics Scale for High School Students

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ABSTRACT

The lack of standardized instrument for measuring students' growth mindset led to the development and content validation of the Growth Mindset Relationship Model (GMRM). GMRM was anchored on the Social Cognitive Theory, Self-Determination Theory and Self-System Model of Motivational Development. The scale was categorized into five dimensions; relationship with oneself, relationship with mathematics, relationship with peers, relationship with non-peers and relationship with environment, which was subjected to content validation. A total of six experts validated the instrument based on clarity, pertinence and relevance. Data collected were analysed using the Aiken V coefficient. Items with Aiken V index ≥ 0.83 and a corresponding lower limit of ≥ 0.6 at a 95% confidence interval were accepted. A total of 71 out of 97 items met the threshold and were ascertained as a good measurement tool. The construct validity and test-retest reliability were suggested to be included in the future research.

Keywords: growth mindset, content validity, mathematics, high school

INTRODUCTION

The educational landscape is evolving in line with the worlds continued advancement. The current academic environment requires students to possess a distinctive set of skill and ability to navigate and thrive (Imam et al., 2023; Metu et al. (2025); Ngo & Thuy 2024; Mohamoud, 2024), as a result of the rapid technological innovation, evolving standard of the society and the complex global challenges. In order to meet these expectations, researchers and educators are realizing how significant it is to foster traits that will go beyond academic success. A fundamental shift in mindset is evidently needed given the necessity for students to acquire vital life skills to meet the demands of the dynamic society. Hence, students ought to possess the willingness for new ideas and creative solutions by having a growth mindset perspective.

A growth mindset is an important attribute required of any student. This construct has been described as the belief that a students' ability can be developed through effort and practice (Beard, 2023; Dweck & Yeager, 2021; Metu et al., 2025; 2026; Zhang & He, 2025). Other experts added that this ability can also be developed through persistence, learning and dedication (Zurawski & Mancini, 2016; Dong & Kang, 2022; Macnamara & Burgoyne, 2023; Ayoola & Ibrahim, 2024). The growth mindset has been found to be crucial to students' holistic development (Limeri et al., 2020; Stohlmann, 2022). Students with a growth mindset are inclined to adopt a mastery approach, welcome challenges, and exert effort in their learning endeavours (Ng, 2018; Miller & Srougi, 2021). This is in line with the data from the Organisation for Economic Co-operation and Development (2013) which revealed that students with a growth mindset and mathematical problem-solving skills are among the most successful in terms of their overall mathematical achievement.

The importance of a growth mindset in achieving personal and professional success cannot be overstated.

However, its application in academic contexts, notably in mathematics learning, remains largely unexplored. Mathematics as a subject is frequently connected with high levels of anxiety and frustration, which may negatively impact students' learning outcomes and overall performance (Mehmet & Hulya, 2021; Budhathoki et al. 2022). Assessing growth mindset in mathematics can provide valuable insights into students' relationships in the mathematics classroom, thus providing measures which could be used to improve the students' mathematical learning outcomes and overall educational well-being. As the significance of growth mindset in academic environment particularly in relation to mathematics continues to grow, so does the necessity for a reliable assessment tool. Having a good assessment tool plays an important role in obtaining reliable results (Mahapatra et al., 2020). A study by Chen et al. (2023) on assessment tool for growth mindset explored only the variables from the cognitive and affective point of view such as attitude, grit, adversity and motivation, not considering that there may be other variables that could have an effect on the growth mindset of the student. The instruments by Dweck (2006) and Yilmaz (2022) on growth mindset included items with fixed mindset characteristics and it dwelled more on how individuals view their intelligence. While the work of Dweck (1999) and Blackwell et al. (2007) on implicit theory of intelligence captured some traits on growth mindset, the scale has only six items, thus excluding some important constructs which are considered vital in this present study. This limitation was also observed in the study of Dweck et al. (1995) as the scale has only three items. While the reviewed scales share some similarities with this present study, they also differ to a large extent, with some variables, traits and characteristics of growth mindset not covered, thus, highlighting the several weaknesses and limitations of the existing scales on growth mindset.

To better understand the construct, identify the key issues and to ensure that the study is built on a solid foundation, the various theories related to growth mindset were reviewed. This study was anchored on the Social Cognitive Theory (Albert Bandura, 1986), Self-Determination Theory (Ryan & Deci, 2000) and Self-System Model of Motivational Development (Skinner et al. 2008). The Social Cognitive Theory posits that learning occurs in a social context with a dynamic and reciprocal interaction of the person, environment, and behaviour. The theory emphasises how social influence and external and internal social reinforcement play huge roles in helping an individual reach their potentials. The Self-Determination Theory suggests that all humans have three basic psychological needs namely; autonomy, competence, and relatedness, that underlie growth and development. The proponents stated that people are dynamic in nature, possessing the ability to get through difficult challenges and integrating new experiences into personal development. The Self-System Model of Motivational Development assumes that students innately come with a wellspring of intrinsic motivation and the desire and capacity to take responsibility for their learning.

The proponents of these theories emphasized the role of motivation, individual-environmental interaction and self-regulation in human behaviour and development. It also highlighted how personal beliefs, such as self-concept, self-efficacy, and environmental factors, like supportive social contexts interact in shaping learning and behaviour. Finally, the tenets point towards the importance of fostering individual development through creating supportive environments and practices that will empower one with the right mindset for growth, which will ultimately lead to enhanced learning, personal development, and successful outcomes in mathematics related contexts. A study on mindset by Dweck and Yeager (2019) revealed that individuals with a growth mindset are more likely to improve and overcome challenges that would have been avoided by those with a fixed mindset. This shows that the growth mindset plays an important role in many aspects of human development, encompassing behaviour, performance and well-being, thus, in line with the tenets of the reviewed theories.

The development of the scale for this present study was inspired by the PHD thesis of Rafael Méndez (Méndez Romero, 2015). In the study, the model for the dynamics of teaching excellence in the field of education was categorized into different groups, namely; relationship with oneself, relationship with epistemology, relationship with practice, relationship with students, relationship with community and relationship with educational system. By examining this model, the most appropriate dimensions to measure the construct of growth mindset in mathematics was deduced. To this end, the "Growth Mindset in Mathematics Model" has been developed from a relationship point of view by categorizing the model into five dimensions; relationship with oneself, relationship with mathematics, relationship with peers, relationship with non-peers and relationship with environment.

The relationship with oneself emphasises belief in one's ability to improve through effort, tenacity, and resilience in difficult periods. This dimension entails viewing mistakes as learning opportunities, and maintaining a positive viewpoint on personal development. Relationship with mathematics refers to students' attitudes and feelings towards mathematics. It represents the students' confidence, enthusiasm, and desire to take on new challenges, emphasizing the belief that hard work and strategic thinking can help one progress (Akaneme & Metu, 2024; Li & Li, 2021; Sulaiman et al., 2024). The relationship with peers emphasises that positive interactions promote collaboration and idea exchange in mathematics, while the relationship with non-peers illustrates how supportive guidance and constructive feedback from parents and teachers can cultivate a growth mindset in students with respect to mathematics (Metu et al, 2023; Metu & Ugwuanyi, 2024). The relationship with the environment refers to the impact of family, school, and social contexts in providing a supportive space and resources for the students which will bring about a positive attitude towards learning mathematics.

MATERIALS AND METHODS

The instrument was designed based on the outcome of the reviewed literatures, the theoretical framework, while also considering the model of Rafael Méndez. Through these investigations, the scale for the study was developed and termed "Growth Mindset Relationship Model (GMRM)". This model is categorized into five dimensions; Relationship with Oneself; Relationship with Mathematics; Relationship with Peers; Relationship with Non-peers; and Relationship with the Environment. By further examination, the dimensions were segmented into sub-dimensions.

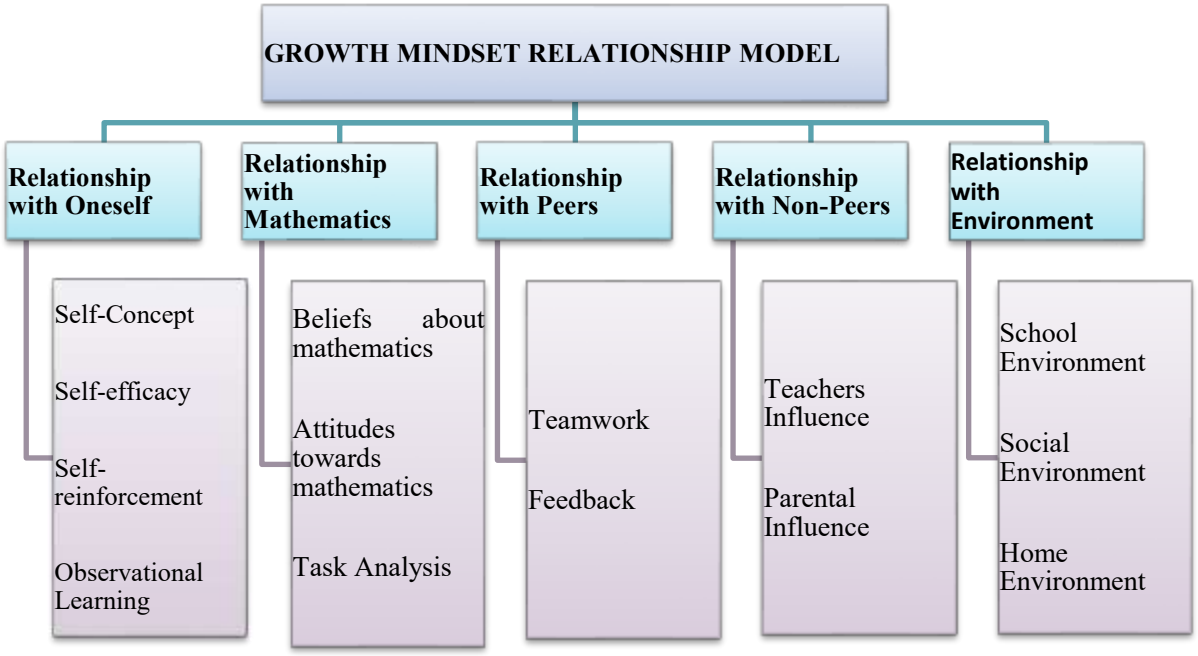

Figure 1. Growth Mindset Relationship Model (GMRM)

Source: Authors

The scale was first subjected to a content validation. This is the degree to which a measurement instrument accurately represents the construct it intends to assess, and it is seen as crucial evidence for substantiating the validity of a scale (Yusoff, 2019; Bull et al., 2022; Kaur et al., 2023). This scale was validated by six experts spread across various specializations in mathematics education, educational psychology and measurement and evaluation. All the experts who participated in the scale validation have over 20 years of teaching experience in high schools in Nigeria. Expert1 is a professor and specialist in science education, Expert2 is a professor and a specialist in mathematics education, Expert3 is a senior lecturer in mathematics education unit, Expert4 is professor of psychology of education and specializes in students attitudes towards learning, Expert5 specializes in psychology of education and human learning, Expert6 interest involves scale development, data analysis and

evaluation of tests and measures. A total of 97 items were subjected to validation. The experts were instructed to validate the instrument based on clarity, pertinence and relevance. Clarity refers to the ease with which an item's semantics and syntax may be understood. Pertinence refers to the amount to which the item is related to the theoretical framework, while relevance determines whether an item is essential and measures the growth mindset construct. The experts rated the items in categories of 1 (does not meet the criterion), 2 (low level), 3 (moderate level) and 4 (highest level).

Table 1. Criteria used by experts for measuring content validity

Clarity	Pertinence	Relevance
1 = does not meet the criterion	1 = does not meet the criterion	1 = does not meet the criterion
2 = low level	2 = low level	2 = low level
3 = moderate level	3 = moderate level	3 = moderate level
4 = highest level	4 = highest level	4 = highest level

Source: Compiled by the authors

The experts provided explanation for items that did not meet the criterion and suggested improvements to ensure full compliance. Feedback was also based on material, language, and item structure. The suggestions and recommendations by the experts were used to improve the scale. Following the suggestions, eight items found to be repeated or similar to each other were discarded while a total of 89 items which comprised "Relationship with Oneself (28 items), Relationship with Mathematics (21 items), Relationship with Peers (11 items), Relationship with Non-peers (15), and Relationship with the Environment (14 items)" were subjected to data analysis. The Aiken V coefficient (Aiken, 1985) was used to calculate the collected data from the experts. This coefficient according to (Ventura-León, 2022) is an effective way of evaluating response of experts and it is also easy to interpret the result. The Aiken V coefficient is given as (i),

$$\frac{\sum s_j}{p(r-1)} \qquad \text{(i)}$$

where 's_j' is the rating of the experts, 'p' represents the total number of experts and 'r' is the maximum assigned weight. A criterion for determining the suitable items was set at a 95% confidence interval, which is an interval estimation of a population parameter (Buenestado & Acho, 2018; Bracke, 2024). The formulas (ii) and (iii) as recommended by Penfield and Giacobbi (2004) was used to estimate the CI of the validity index (U = Upper limit, V = Lower limit).

$$U = \frac{2nkV+Z^2+z\sqrt{4nkV(1-V)+Z^2}}{2(nk+Z^2)} \qquad \text{(ii)}$$

$$L = \frac{2nkV+Z^2-z\sqrt{4nkV(1-V)+Z^2}}{2(nk+Z^2)} \qquad \text{(iii)}$$

Items with Aiken V index ≥ 0.83 and a corresponding lower limit of ≥ 0.6, implies an agreement among the experts. Items < 0.83 with a corresponding lower limit of < 0.60 imply a disagreement among the experts. According to Munisamy et al. (2021), items with content validity index (CVI) ranging from 0.60 – 1.00 are rated highly and are acceptable for measuring a construct.

RESULT

This section presents the findings of the content validation of the Growth Mindset Relationship Model (GMRM) across its five dimensions: Relationship with Oneself, Relationship with Mathematics, Relationship with Peers, Relationship with Non-Peers, and Relationship with Environment. The Aiken V coefficient was used to analyse the ratings of six experts based on three criteria namely clarity, pertinence, and relevance at a 95% confidence interval.

Dimension 1: Relationship with oneself

The analysis of the items as presented in Table 2 was based on clarity, pertinence and relevance. Items 3, 6, 8-22, 25, 26 and 28 (representing 71.4% of the total items) met the threshold for clarity, pertinence and relevance, thus, indicating significant standard. Some of these items such as "I do not give up on a math task until I find a solution; I accept that making mistakes is a natural part of the learning process; I acknowledge my efforts and improvements, regardless of the outcome; I encourage myself to keep going, even when tasks seem difficult; I continue to work on difficult tasks even when I face setbacks" have Aiken V coefficient ≥ 0.83 which is the criterion for determining the most appropriate item. Items 1, 2, 4, 5, 7, 19, 20, and 23 did not meet all the conditions for clarity, pertinence and relevance, hence were discarded. In total, eight items were discarded and 20 items passed the content validity assessment and ascertained as a good measurement tool.

Table 2. Aiken V coefficient of the 28 items at 95% confidence level

	CLARITY			PERTINENCE			RELEVANCE		
Item	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**
1.	0.83	0.61	0.94	**0.72***	0.49	0.88	0.94	0.74	0.99
2.	**0.78***	0.55	0.91	0.94	0.74	0.99	1.00	0.82	1.00
3.	0.94	0.74	0.99	0.94	0.74	0.99	1.00	0.82	1.00
4.	0.83	0.61	0.94	**0.78***	0.55	0.91	0.89	0.67	0.97
5.	**0.78***	0.55	0.91	**0.72***	0.49	0.88	**0.78***	0.55	0.91
6.	0.83	0.61	0.94	1.00	0.82	1.00	1.00	0.82	1.00
7.	**0.78***	0.55	0.91	**0.78***	0.55	0.91	0.94	0.74	0.99
8.	0.83	0.61	0.94	0.94	0.74	0.99	0.94	0.74	0.99
9.	0.94	0.74	0.99	0.94	0.74	0.99	1.00	0.82	1.00
10.	0.94	0.74	0.99	0.89	0.67	0.97	0.94	0.74	0.99
11.	0.83	0.61	0.94	0.94	0.74	0.99	0.89	0.67	0.97
12.	0.83	0.61	0.94	0.94	0.74	0.99	0.94	0.74	0.99
13.	0.94	0.74	0.99	0.94	0.74	0.99	1.00	0.82	1.00
14.	0.94	0.74	0.99	0.89	0.67	0.97	0.94	0.74	0.99
15.	0.89	0.67	0.97	0.94	0.74	0.99	0.94	0.74	0.99
16.	0.89	0.67	0.97	0.83	0.61	0.94	0.94	0.74	0.99
17.	0.83	0.61	0.94	0.89	0.67	0.97	0.94	0.74	0.99
18.	0.83	0.61	0.94	0.83	0.61	0.94	0.89	0.67	0.97
19.	0.89	0.67	0.97	0.89	0.67	0.97	1.00	0.82	1.00
20.	0.89	0.67	0.97	0.89	0.67	0.97	1.00	0.82	1.00
21.	0.89	0.67	0.97	0.89	0.67	0.97	0.83	0.61	0.94
22.	0.94	0.74	0.99	0.94	0.74	0.99	0.94	0.74	0.99
23.	**0.78***	0.55	0.91	1.00	0.82	1.00	1.00	0.82	1.00
24.	**0.72***	0.49	0.88	0.89	0.67	0.97	1.00	0.82	1.00
25.	0.94	0.74	0.99	0.94	0.74	0.99	1.00	0.82	1.00
26.	0.83	0.61	0.94	0.89	0.67	0.97	1.00	0.82	1.00
27.	**0.78***	0.55	0.91	0.83	0.61	0.94	0.83	0.61	0.94
28.	0.83	0.61	0.94	0.89	0.67	0.97	0.89	0.67	0.97

Source: Authors

Dimension 2: Relationship with mathematics

The result of the analysis in Table 3 showed that items 2, 4-9, 11, 15, 16, 18-20 (representing 61.9% of the total items) have Aiken V coefficient ≥ 0.83 which is the criterion for determining the most appropriate item.

These items such as "I can apply what I learnt in mathematics to real-world problems; Anyone can become good at mathematics with dedication; Talent in mathematics is not fixed and can grow with hard work; I don't care about the opinion of others" met the threshold for clarity, pertinence and relevance, thus, indicating significant standard.

However, items 1, 3, 10, 12-14, 17 and 21 did not meet all the conditions for clarity, pertinence and relevance, hence were discarded. In total, eight items were discarded and 13 items passed the content validity assessment and ascertained as a good measurement tool.

Table 3. Aiken V coefficient of the 21 items at 95% confidence level

	CLARITY			PERTINENCE			RELEVANCE		
Item	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**
1.	0.83	0.61	0.94	0.83	0.61	0.94	**0.78***	0.55	0.91
2.	0.89	0.67	0.97	1.00	0.82	1.00	1.00	0.82	1.00
3.	**0.67***	0.44	0.84	0.89	0.67	0.97	0.94	0.74	0.99
4.	0.89	0.67	0.97	1.00	0.82	1.00	1.00	0.82	1.00
5.	0.89	0.67	0.97	1.00	0.82	1.00	1.00	0.82	1.00
6.	0.89	0.67	0.97	0.89	0.67	0.97	0.83	0.61	0.94
7.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00
8.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00
9.	0.89	0.67	0.97	1.00	0.82	1.00	1.00	0.82	1.00
10.	**0.72***	0.49	0.88	**0.78***	0.55	0.91	0.89	0.67	0.97
11.	0.89	0.67	0.97	1.00	0.82	1.00	1.00	0.82	1.00
12.	0.89	0.67	0.97	**0.78***	0.55	0.91	**0.78***	0.55	0.91
13.	**0.78***	0.55	0.91	0.94	0.74	0.99	0.94	0.74	0.99
14.	**0.78***	0.55	0.91	0.94	0.74	0.99	0.94	0.74	0.99
15.	0.89	0.67	0.97	0.89	0.67	0.97	0.89	0.67	0.97
16.	0.89	0.67	0.97	0.94	0.74	0.99	0.94	0.74	0.99
17.	**0.72***	0.49	0.88	0.94	0.74	0.99	0.94	0.74	0.99
18.	0.89	0.67	0.97	0.94	0.74	0.99	0.94	0.74	0.99
19.	0.83	0.61	0.94	0.94	0.74	0.99	0.94	0.74	0.99
20.	0.89	0.67	0.97	0.94	0.74	0.99	0.94	0.74	0.99
21.	**0.78***	0.55	0.91	0.83	0.61	0.94	0.83	0.61	0.94

Source: Authors

Dimension 3: Relationship with peers

The result of the analysis in Table 4 showed that all the items which includes "I am open to my peers' critique because I know it can help me grow; I feel jealous if my peer found the solution in a group task; I actively share my ideas with others; I often get angry when I get negative feedback about my performance" met the criterion for determining the most appropriate item which is Aiken V coefficient ≥ 0.83.

This implies that all the items (1-11) are suitable to the respondents, related to the reviewed theories and relevant to the present study. The threshold for clarity, pertinence and relevance being met shows that the items are of significant standard.

Table 4. Aiken V coefficient of the 11 items at 95% confidence level

	CLARITY			PERTINENCE			RELEVANCE		
Item	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**
1.	0.89	0.67	0.97	0.89	0.67	0.97	0.94	0.74	0.99
2.	0.83	0.61	0.94	0.89	0.67	0.97	0.94	0.74	0.99
3.	0.94	0.74	0.99	0.83	0.61	0.94	0.89	0.67	0.97
4.	0.89	0.67	0.97	0.89	0.67	0.97	1.00	0.82	1.00
5.	0.89	0.67	0.97	0.89	0.67	0.97	0.89	0.67	0.97
6.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00
7.	0.89	0.67	0.97	1.00	0.82	1.00	1.00	0.82	1.00
8.	0.89	0.67	0.97	1.00	0.82	1.00	1.00	0.82	1.00
9.	0.94	0.74	0.99	0.89	0.67	0.97	1.00	0.82	1.00
10.	0.89	0.67	0.97	1.00	0.82	1.00	1.00	0.82	1.00
11.	0.94	0.74	0.99	0.83	0.61	0.94	1.00	0.82	1.00

Source: Authors

Dimension 4: Relationship with non-peers

The result in Table 5 showed the analysis of the items using the Aiken V coefficient ≥ 0.83 criterion for determining the most appropriate item. Items 1-6, 8-12, 14 and 15 (representing 80% of the total items) met the threshold for clarity, pertinence and relevance, thus, indicating significant standard. Some of these items include "My teachers are willing to provide extra help when I need it; I feel comfortable asking my teachers for help when I encounter challenges; When I make progress, my parents celebrate my effort, not just the end result; My parents emphasize the importance of persistence over immediate success." The Aiken V coefficient for items 7 and 14 is 0.78 and this value did not meet the relevance criterion. Therefore, these items were discarded as they have been found not essential to measure the growth mindset construct. In total, two items were discarded and 13 items passed the content validity assessment and ascertained as a good measurement tool.

Table 5. Aiken V coefficient of the 15 items at 95% confidence level

	CLARITY			PERTINENCE			RELEVANCE		
Item	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**
1.	0.94	0.74	0.99	0.89	0.67	0.97	1.00	0.82	1.00
2.	0.94	0.74	0.99	1.00	0.82	1.00	0.94	0.74	0.99
3.	0.94	0.74	0.99	0.89	0.67	0.97	0.83	0.61	0.94
4.	0.94	0.74	0.99	0.94	0.74	0.99	1.00	0.82	1.00
5.	0.94	0.74	0.99	0.89	0.67	0.97	1.00	0.82	1.00
6.	0.94	0.74	0.99	0.94	0.74	0.99	0.94	0.74	0.99
7.	**0.78***	0.55	0.91	0.83	0.61	0.94	**0.78***	0.55	0.91
8.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00
9.	0.89	0.67	0.97	0.94	0.74	0.99	0.94	0.74	0.99
10.	0.94	0.74	0.99	0.89	0.67	0.97	0.89	0.67	0.97
11.	0.94	0.74	0.99	0.94	0.74	0.99	0.94	0.74	0.99
12.	0.94	0.74	0.99	1.00	0.82	1.00	0.94	0.74	0.99
13.	0.94	0.74	0.99	1.00	0.82	1.00	**0.78***	0.55	0.91
14.	0.94	0.74	0.99	0.94	0.74	0.99	0.83	0.61	0.94
15.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00

Source: Authors

Dimension 5: Relationship with environment

The result of the analysis in Table 6 showed that all the items met the criterion for determining the most appropriate item which is Aiken V coefficient ≥ 0.83. Some of these items include "My school values the effort of the students; My school provides resources and support that help me learn; I enjoy interacting with people who have different viewpoints; My home provides a conducive space where I can work towards improving myself; Tasks at home help me develop problem-solving skills". This implies that the item's semantics and syntax are clear, related to the theoretical framework and measures the growth mindset construct. The threshold for clarity, pertinence and relevance being met shows that the items are of significant standard, thus, ascertained as a good measurement tool.

Table 6. Aiken V coefficient of the 14 items at 95% confidence level

	CLARITY			PERTINENCE			RELEVANCE		
Item	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**	**Aiken V**	**Lower Limit**	**Upper Limit**
1.	0.89	0.67	0.97	0.89	0.67	0.97	0.89	0.67	0.97
2.	0.83	0.61	0.94	0.94	0.74	0.99	1.00	0.82	1.00
3.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00
4.	0.94	0.74	0.99	0.94	0.74	0.99	0.94	0.74	0.99
5.	0.94	0.74	0.99	0.89	0.67	0.97	0.89	0.67	0.97
6.	0.94	0.74	0.99	0.94	0.74	0.99	1.00	0.82	1.00
7.	0.94	0.74	0.99	0.83	0.61	0.94	0.83	0.61	0.94
8.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00
9.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00
10.	0.89	0.67	0.97	1.00	0.82	1.00	1.00	0.82	1.00
11.	0.89	0.67	0.97	0.94	0.74	0.99	0.94	0.74	0.99
12.	0.94	0.74	0.99	0.89	0.67	0.97	0.94	0.74	0.99
13.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00
14.	0.94	0.74	0.99	1.00	0.82	1.00	1.00	0.82	1.00

Source: Authors

DISCUSSION

The content validation results of the GMRM demonstrate that 71 out of 97 initial items met the established threshold of Aiken V ≥ 0.83 with a lower confidence limit of ≥ 0.60, confirming that the retained items are clear, pertinent to the theoretical framework, and relevant to the growth mindset construct as it applies to high school mathematics learners. These findings carry several important implications for the measurement of growth mindset and for advancing the existing body of psychometric literature in this domain.

The dimension-level results offer nuanced insights into the measurability of growth mindset from a relational perspective. Dimension 1 (Relationship with Oneself) retained 20 of 28 items (71.4%), with discarded items largely reflecting ambiguity in language or insufficient distinctiveness from one another, suggesting that self-referential constructs such as self-concept and self-efficacy, while theoretically rich, require particular precision in item construction to avoid conceptual overlap. This is consistent with the Social Cognitive Theory (Bandura, 1986), which emphasises the dynamic interplay between personal beliefs and behavioural outcomes, a relationship that is inherently complex and therefore demands carefully differentiated items to capture its breadth without redundancy.

Dimension 2 (Relationship with Mathematics) retained 13 of 21 items (61.9%), the lowest retention rate across all dimensions. The comparatively higher rate of item rejection in this dimension may be attributed to the difficulty of disentangling general mathematical attitudes from growth mindset-specific orientations. Items that

conflated subject-matter anxiety or academic preference with mindset disposition were more likely to fall below the validity threshold. This finding reinforces the argument made in this study that existing scales including those by Dweck (2006) and Yilmaz (2022), have inadequately addressed the domain-specific application of growth mindset in mathematics, often defaulting to general intelligence-related framing rather than capturing students' evolving beliefs about mathematical ability and their practical engagement with mathematical tasks.

In contrast, Dimension 3 (Relationship with Peers) and Dimension 5 (Relationship with Environment) achieved full retention of all items, with Aiken V values consistently at or above the threshold across clarity, pertinence, and relevance. This near-unanimous expert agreement is particularly noteworthy, as it validates the theoretical argument that growth mindset is not a purely individualistic construct but is substantially shaped by social and contextual influences. The Self-Determination Theory (Ryan & Deci, 2000) and the Self-System Model of Motivational Development (Skinner et al., 2008) both underscore the centrality of relatedness and environmental support in sustaining intrinsic motivation and growth-oriented behaviour, a perspective that existing instruments have largely overlooked. By achieving strong expert consensus on these dimensions, the GMRM provides empirical support for extending the conceptualization of growth mindset beyond the individual to encompass the social ecology within which students operate.

Dimension 4 (Relationship with Non-Peers) retained 13 of 15 items (80%), with only two items discarded due to failure to meet the relevance criterion. The high retention rate in this dimension reflects the theoretical salience of teacher and parental influence in cultivating growth-oriented dispositions among students, a relationship well-documented in the literature (Zhang & He, 2025; Macnamara & Burgoyne, 2023). The inclusion of this dimension is a meaningful departure from prior instruments, which have predominantly focused on students' internal cognitive states while paying minimal attention to the scaffolding role of significant adults in shaping mindset development.

Advancement over Existing Scales

The GMRM represents an advancement over existing growth mindset instruments in at least three important respects. First, whereas foundational scales such as those developed by Dweck et al. (1995) and Blackwell et al. (2007) were limited to three and six items respectively, and were designed primarily to measure implicit theories of intelligence, the GMRM offers a multidimensional, 71-item instrument that captures growth mindset across five theoretically grounded relational domains. This breadth allows for a far more comprehensive profile of a student's mindset orientation, accommodating the complexity acknowledged in contemporary mindset research (Dweck & Yeager, 2021). Additionally, while Chen et al.'s (2023) scale examined growth mindset only through cognitive and affective lenses such as attitude, grit, and motivation, the GMRM incorporates relational and environmental dimensions that acknowledge the sociocultural context of learning. This is especially pertinent in mathematics education, where factors such as peer collaboration, parental expectations, teacher feedback practices, and school climate have been identified as significant moderators of mindset and achievement outcomes (Mehmet & Hulya, 2021; Zhang & He, 2025). The GMRM's structural design thus aligns more closely with the ecological realities of students' mathematical learning experiences.

Lastly, the GMRM is the first growth mindset scale to be explicitly anchored in a multi-theoretical framework combining Social Cognitive Theory, Self-Determination Theory, and the Self-System Model of Motivational Development, with each dimension directly traceable to one or more of these theoretical positions. This theoretical triangulation enhances the construct coherence of the instrument and provides a principled basis for future construct validity testing. It also signals a move toward theory-integrated scale development in mathematics education research, which has been called for in the broader psychometric literature (Yusoff, 2019; Bull et al., 2022).

CONCLUSION

A good assessment instrument is essential for obtaining reliable results. The continuous growth in literature on growth mindset in mathematics along with the weaknesses and limitations observed in the previous scales

necessitated this present study. The instruments were designed from the relationship point of view by examining the relationships with oneself, mathematics, peers, non-experts and environment. The content validity guarantees that the measurement tools accurately and comprehensively cover the specified field of study. The result of the study revealed that 71 out of 97 items passed the face validity and content validity assessment, and were included in the measurement tool. All the experts involved in the validation of the scale are from the Nigerian educational system, hence, it was considered a limitation to this study. Future researchers should involve experts from other backgrounds for diversity. This study was limited to content validation; hence, it lacks psychometric validation. Therefore, further studies should involve other testing such as construct validity, criterion validity and test-retest reliability.

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Appendix

Growth Mindset Relationship Model (Gmrm)

Dimension 1: Relationship with Oneself

	Self-concept
1	I like attempting mathematical problems.
2	It bothers me when I fail to solve a particular math problem.
3	I view academic setbacks as opportunities to learn
4	I do not give up on a math task until I find a solution
	Self-efficacy
5	I trust my ability to understand new mathematical concepts, even if they seem complex at first.
6	I am confident that I can overcome any difficulty I face in math with persistence.
7	I receive feedback that reinforces the idea that my mathematics abilities can develop through practice.
8	I accept that making mistakes is a natural part of the learning process.
9	I am motivated to persist in difficult tasks because I know I can develop my abilities.
	Self-reinforcement
10	I acknowledge my efforts and improvements, regardless of the outcome.
11	When I succeed, I take time to celebrate my achievements.
12	I actively look for ways to motivate myself when I feel discouraged.
13	I encourage myself to keep going, even when tasks seem difficult.
14	Efforts result to positive outcomes
15	If I succeed, it is mainly the consequence of hard working.
	Observational Learning
16	I can focus on tasks even when they become difficult or frustrating.
17	When I make a mistake, I am able to quickly regain my focus and continue.
18	I find it easier to concentrate when I remind myself of my long-term goals.
19	I can stay focused on a challenging task for an extended period of time.
20	I continue to work on difficult tasks even when I face setbacks.

Dimension 2: Relationship with Mathematics

	Beliefs about Mathematics
1	Anyone can become good at mathematics with dedication
2	Understanding mathematics requires persistence.
3	Talent in mathematics is not fixed and can grow with hard work.
4	Confidence in solving math problems comes from continual practice
	Attitudes towards Mathematics
5	I will avoid mathematics once I leave school.
6	I can apply what I learnt in mathematics to real-world problems.
7	I will like to have a job that involves mathematical thinking.
8	I can transfer my math knowledge to other subject areas.
9	I like to solve math problems because it allows me to learn new things.
	Task Analysis
10	I reflect on the strategies I use when solving math problems to identify what works and what doesn't.
11	I create a plan of action when preparing for a mathematics test or project.
12	I set short-term and long-term goals for mastering different areas of mathematics.
13	I analyze my mistakes in mathematics to understand why they happened and how to correct them.
14	I believe that with strategic practice and effort, I can improve my mathematical reasoning skills.

Dimension 3: Relationship with Peers

	Teamwork
1	I am open to changing my ideas when my peers present a better approach
2	I don't care about the opinion of others.
3	I feel jealous if my peer found the solution in a group task
4	I believe that my success and my peers' success can both grow when we collaborate
5	I actively share my ideas with others
	Feedback
6	Receiving feedback from my peers motivates me to put more effort into learning
7	I am open to my peers' critique because I know it can help me grow
8	I use feedback from my peers as a tool to improve my performance
9	My peers' suggestions help me to see challenges as opportunities for growth
10	I believe that feedback from my peers can help me develop my abilities
11	I often get angry when I get negative feedback about my performance

Dimension 4: Relationship with Non-Peers

	Teachers Influence
1	My teachers are willing to provide extra help when I need it
2	My teachers create a positive environment where mistakes are seen as part of the learning process
3	I believe that my teachers genuinely care about my success
4	I feel comfortable asking my teachers for help when I encounter challenges.
5	I see my teachers as partners in my learning process
6	My teachers encourage me to keep trying even when I make mistakes
7	I am motivated to do my best because my teachers show belief in my abilities.
	Parental Influence
8	My parents regularly praise my effort and determination, not just my success
9	When I face challenges, my parents help me see them as opportunities to grow
10	When I make progress, my parents celebrate my effort, not just the end result.
11	My parents help me set goals and encourage me to reach for them, no matter how difficult
12	My parents believe that I can develop my abilities through hard work.

Dimension 5: Relationship with Environment

	School Environment
1	The school environment encourages me to keep trying, even when I face challenges
2	The school culture makes me feel confident in my ability to learn from mistakes.
3	My school values persistence and effort of the students
4	The school environment inspires me to set goals and work steadily toward achieving them
5	My school provides resources and support that help me learn.
	Social Environment
6	My surroundings inspire me to push myself and try new things
7	I enjoy interacting with people who have different viewpoints, as it helps to expand my thinking
8	I feel motivated to improve when I am surrounded by positivity
9	In my social environment, mistakes are seen as opportunities to learn
10	I am surrounded by people who value effort and persistence over natural talent
	Home Environment
11	I often find it difficult to focus on my goals because of distractions in my home environment
12	I struggle to balance household responsibilities and academic activities
13	My home provides a conducive space where I can work towards improving myself
14	The people around me at home encourage me to keep trying, even when things get difficult