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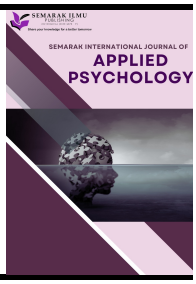

The Psychometric Assessment of GRIT using Rasch Measurement Model for Vernacular Students Setting

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ABSTRACT

In facing a competitive global landscape and an uncertain future, fostering a national character rooted in grit emerges as a critical necessity. Grit stands out as a multifaceted trait encompassing perseverance of effort and consistency of interest over an extended period. The innovative and groundbreaking research that contributes new insights to the field by improving the validity and reliability on quality of items in assessing grit for vernacular setting among Tamil students who rarely explored. Hence, this study will focus on the setting of vernacular students consist of Tamil National Type Primary School (SJKT) in Negeri Sembilan. The study aimed to test whether grit measurement items have good psychometric properties in the context of SJKT students based on Rasch analysis. Two grit constructs have been applied in this study such as perseverance and interest. The survey with quantitative approach was applied. Cluster sampling technique was used to select a total of 93 SJKT students studying in Year 6 from two districts in Negeri Sembilan. The total of 11 from 12 items met the requirements of Rasch's statistical modelling using WINSTEPS 3.68.2 software. This psychometrics properties also reports on the strength of items through graphical analysis such as Wright Map. Person reliability shows the reading of 0.78 and item reliability shows of 0.84. Meanwhile, person separation is at 1.88 and item separation at 2.32 proved that items and persons can be categorized by the difficulty and ability. Cronbach Alpha shows the reading of 0.89 for internal consistency evidence. An implication of this is the possibility to generate more difficult items for SJKT students to measure grit and expand the impact of grit measurement that only focus on psychology part, but also the psychometric field. It is recommended that future studies can be conducted to examine the suitability of items using few other new settings such as Sekolah Kebangsaan (SK), Sekolah Jenis Kebangsaan Cina (SJKC) and private primary schools in Negeri Sembilan with larger samples. Future study for these items could be used as a self and peers -assessment for the self-improvement purpose in grit.

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1. Introduction

In contemporary educational research, the exploration of non-cognitive factors has become increasingly vital in understanding and enhancing students' academic performance [1]. In the interconnected world of today, it is critical to develop resilience among students and upcoming knowledge workers. Resilience can be defined as the ability to adapt and rebound from adversity. It does not comprise solely of academic skill but includes emotional well-being, adaptability and perseverance. Resilience gives people the skills they need to thrive in a time of uncertainty, diversity and fast change. It supports people in overcoming setbacks, embracing diversity, navigating difficult situations, and effectively managing stress. Educational institutions are essential for building resilience.

They employ comprehensive strategies that give equal weight to non-cognitive and cognitive elements. In the end, this readiness makes it possible for people to have happy lives and prosper in the fast-paced global economy. In the context of Malaysia, to thrive in the competitive world of today and steer through the future's unexplored regions, we must cultivate a national character imbued with grit. Grit is essential for everything from businesses innovating in a new economy to citizens working together for a more equal society. By remodelling education to focus on perseverance, encouraging entrepreneurs to bounce back from setbacks and encouraging open discussions about challenges, Malaysia can cultivate this national grit and drive itself towards a prosperous future.

Among these factors, grit, as defined by Duckworth [2], stands out as a multifaceted trait encompassing perseverance of effort and consistency of interest over an extended period. This study delves into the multifaceted dimensions of grit which will focus on its impact on the mathematics achievement of vernacular students. Vernacular students in this study consist of Tamil National Type Primary School (SJKT) who learn mathematics in Tamil, their mother tongue. They add cultural and linguistic diversity to the academic landscape in Malaysia. SJKT students encounter challenges in mathematics [3].

Mathematics can be perceived as a difficult subject leading to lower confidence and impacting motivation to learn but by developing grit they can overcome these obstacles and achieve success. With grit students are more likely to stick with challenging problems and not give up easily. This is crucial in mathematics where practice and overcoming hurdles are essential for understanding. Grit can fuel a student's internal drive to learn and improve in mathematics even when faced with challenges or setbacks. Gritty students are better at setting achievable goals and developing strategies to reach them. This can be particularly helpful in mathematics where breaking down complex problems into smaller steps is key.

The originality emphasizes on (a) clarifying the originality of the research by took the inisiative to test grit items that develop in western countries to local context in vernacular Tamil school in facing Mathematics challenges; (b) apply the modern theory of analysis using Rasch model rather than only focusing on conventional testing that limiting to internal consistency only; (c) sparks the ideas to interpret the grit results in different way of understanding students grit in facing Mathematics challenges by testing in vernacular Tamil school students. Besides, this research discusses possible implications in the level of items measurement specifically.

2. Literature Review

Many studies on grit have been conducted in Malaysia such as those by Farok *et al*., [4], Effendi *et al*., [5], Hassan *et al*., [6], Mustaza *et al*., [7] and Shariff *et al*., [8] which only focused on university and polytechnic students. Similarly, studies abroad also focused on these groups of students' [9-13].

In the context of SJKT, most of its students are of Indian descent. They come from various socio-economic backgrounds. The difference in socio-economic backgrounds has a varied impact on academic achievement, especially in the subject of mathematics among SJKT students. There is a significant gap between SJKT students and students from other schools in mathematics achievement [14]. In addition, through the 2019 Primary School Assessment Report by the Malaysian Ministry of Education (KPM), it can be observed that only 36.27 percent of students are at an excellent level, 46.86 percent are at a satisfactory level, and 16.87 percent of students have not reached the minimum level. Based on this data, we can see that only 25 percent of students are at an excellent level.

Although factors influencing the excellence of SJKT students in Mathematics can be attributed to various reasons, the attitude of perseverance among students in solving mathematical problems is crucial as it involves intrinsic motivation. If students easily give up and lack resilience, they will become bored and no longer want to continue solving mathematical problems, especially during thier years in primary school. The resilience of a student is characterized by an optimistic reaction to failure and demonstrates grit to face difficulties and rejection. Similarly, many studies have been conducted in various countries around the world, and most of the research has been conducted in United States of America (USA) [15-19], Europe [20-24] and Asia [25-29]. Although research on grit is conducted in various sectors, a large number of them are in the medical, educational, professional, and personal development fields.

There are several instruments used to measure grit around the world. These instruments vary in their design and complexity, but they all aim to assess an individual's perseverance and passion for long-term goals. One such instrument is the Duckworth Grit Scale, which is a self-report questionnaire that measures an individual's level of grit based on their own perceptions. There are several versions of Duckworth's Grit Scale such as the Grit Original or Grit-O with 12 items [30] and the short version Short Grit Scale or Grit-S with 8 items [31]. These instruments often adapted according to their usage around the world such as the 3-D Grit Scale [32], PE-Grit [33], L2-Teacher Grit Scale (L2TGS) [34], The Triarchic Model of Grit Scale (TMGS) [35], Grit-K [36], Teacher Grit Scale (TGS) [37], Clinical Nurse Grit Scale (CN-Grit) [38] and Oviedo Grit Scale [39]. In Malaysia, there are several studies that uses the Grit-S instrument including [40-43]. All these studies involve higher education students as samples.

In order to unleash the full potential of SJKT students, it is essential to implement focused assessments that measure grit for these targeted samples. The objective of this study is to employ Rasch analysis for evaluating the psychometric characteristics of grit related items within the context of SJKT students. Grit, a personal quality encompassing persistence and intense dedication toward long term objectives, has garnered substantial recognition as a pivotal element in attaining success. Individuals with high grit possess the ability to maintain their determination and motivation in the face of challenges and setbacks [22]. Studies on grit have focused on evaluating its psychometric characteristics including those [43-45]. These studies use the Grit-S, a short version of the full Grit-O which was developed by Duckworth [30].

Meanwhile, this study uses the Original Grit Scale (Grit-O). Grit-O consists of two components with 6 items each, in total of 12 items. Consistency of Interests (Passion) and Perseverance of Effort (Perseverance) are the main two components of this scale [30]. These 12 items are measured on a five-point Likert scale such as 1- Not like me at all, 2- Not much like me, 3- Somewhat like me, 4- Mostly like me and 5- Very much like me. The items of this study were adapted and translated from the Grit-O scale to suit local use. The Table 1 shows the adapted 12 Grit-O items.

Table 1
List of adapted Original Grit Scale (Grit-O) items

No	Item
1	I am able to overcome challenges in solving mathematical problems.
2	I will not be discouraged by the decline in maths scores.
3	I work hard to learn maths.
4	I am able to solve maths problems from start to finish.
5	I can easily master maths skills that took years to master.
6	I am a diligent student of mathematics.
7	Ideas from new projects in mathematics do not distract me from previous projects.
8	My interest in mathematics improves year by year.
9	I remaine interested in maths projects for a long period of time.
10	I set goals in learning mathematics.
11	I maintain focus on maths projects that take longer to complete.
12	I am interested in solving maths problems.

There are several issues and concerns with the psychometric evaluation of grit, particularly within the unique cultural and educational context of Malaysia. A major concern with measuring grit in Malaysia is its cultural fit. The original concept of grit, developed by Duckworth [30] might be based on western values. This raises questions about whether it accurately reflects perseverance and passion in other cultures [46,47]. To ensure the measure captures these qualities accurately in a Malaysian context, adaptations that consider local cultural values are necessary. While studies have investigated grit in Malaysia, the focus has primarily been on the psychometric properties of existing scales, such as the Short Grit Scale (Grit-S) which has largely focused on higher education students [40-42]. The Grit-S has shown some promise in Malaysian contexts.

However, recent studies suggest that certain items within the scale might not function optimally for technical students in Malaysia [43]. This highlights the need for either refining existing scales or developing new ones that better capture the implications of grit specific to the Malaysian cultural context, including the vernacular educational setting. Existing measures might not fully capture the complexities of grit within the Malaysian context. Cultural values may influence how individuals approach challenges and long-term goals. Developing culturally sensitive measures that consider these factors is essential for accurate grit assessment.

In conclusion, research on grit in Malaysia particularly concerning psychometric properties is in its promising stages. While existing scales offer a starting point, further research is necessary to develop reliable and culturally-sensitive measures of grit specific to the Malaysian population, including vernacular student settings. The application of the Rasch Measurement Model, as explored in this study has the potential to address these limitations and provide a more accurate assessment of grit within this unique educational context.

3. Methodology

This study used the survey research design with quantitative research approach. Survey research design produces valid, accurate and trustworthy data on the behavior, experiences and characteristics of respondents in the past and present [48]. The sample of this study consisted of 93 SJKT students from 2 districts in Negeri Sembilan, Malaysia. Cluster sampling was used to randomly select the samples from the population. This technique offers more diversity (heterogeneity) within cluster groups and more similarity (homogeneity) between cluster groups [49]. All the samples are

12 years old students. Males comprise 51 students (55%) and females comprise 42 students (45%). 67% of the samples were from city schools and the rest 33% of the samples were from rural schools.

The psychometric properties of this study's were assessed using The Rasch Model which included item fit, unidimensionality, local independence, Wright map, reliability index and separation index. Item fit assessed whether individual items fit the Rasch model fit statistics [50]. Meanwhile, unidimensionality is the number of latent traits determining item responses, which is one of the key assumptions. It indicates the reproducibility or reliability of a test [51]. Local independence on the other hand, is often considered as evidence of a test's validity. Different items in a test should not be closely related to each other [52]. Wright map or item-person map places the items of the instrument and persons responses on the same logit scale based on the item difficulty and person ability levels [53]. Reliability index and separation index will be analyzed for both item and person. The Cronbach's alpha of 0.71 – 0.99 is accepted reliability index for both item and person [54]. The separation index shows the difficulty level of items and persons, where the instrument can separate persons and items into different groups and the suggested value is more than 2 [54].

WINSTEPS version 3.68.2 was used to perform this analysis. The Rasch model assumes that every item has the same discriminating index and has a single difficulty parameter [55]. Besides that, Rasch model may evaluate and investigate an instrument's psychometric qualities in terms of validity and reliability [56]. A good internal consistency value (Cronbach's alpha), which is regarded as acceptable when it exceeds 0.7, may be used to determine the reliability factor [57]. Items which did not fit and contribute to the psychometric features of the instrument were submitted for revision or eliminated [58].

4. Result

This section discusses the findings of Rasch model for this instrument which consists of 11 items out of 12. The psychometric properties discussed in this study include item fit, unidimensionality, local independence, Wright map, reliability index and separation index.

4.1 Item Fit

Item fit in the Rasch model refers to the degree to which individual test items conform to the model's expectations regarding item difficulty and discrimination as assessed through statistical measures such as outfit and infit statistics [59]. Table 2 shows the 11 out 12 items which were fit and contribute to the psychometric features of this instrument. It illustrates the MNSQ values for infit and outfit which range from 0.65 logits to 1.28 logits. Meanwhile the ZSTD values for infit and outfit also fits the model by being in the range with the reading of -1.9 to 1.4. Apart from that, the PTMEA values are between 0.53 logits and 0.72 logits. These reading fit the range fixed by Bond et al. [60] for MNSQ value within 0.6 logits and 1.4 logits, for ZSTD values ±2.0 and for PTMEA values should be positive and greater than 0.4.

Table 2
Summary statistic for item fit (N = 11)

Item	Total Score	Measure	Standard Error	MNSQ		ZSTD		PTMEA	
				Infit	Outfit	Infit	Outfit	Corr.	Exp.
12	367	0.03	0.12	1.10	1.28	0.7	1.4	0.58	0.62
10	397	-0.46	0.14	1.03	1.26	0.2	1.2	0.53	0.57
11	375	-0.09	0.12	1.03	1.25	0.2	1.3	0.54	0.61
5	378	-0.21	0.13	1.06	1.20	0.4	1.0	0.57	0.60

3	393	-0.47	0.14	1.16	1.07	0.9	0.4	0.58	0.57
7	341	0.33	0.11	1.11	1.15	0.8	0.9	0.60	0.64
9	337	0.44	0.11	1.05	0.98	0.4	0.0	0.59	0.65
4	348	0.24	0.12	0.98	0.90	-0.1	-0.5	0.66	0.64
1	330	0.47	0.11	0.95	0.95	-0.3	-0.3	0.65	0.66
6	369	-0.06	0.12	0.88	0.72	-0.7	-1.5	0.72	0.61
8	379	-0.22	0.13	0.73	0.65	-1.8	-1.9	0.70	0.60

4.2 Unidimensionality

Unidimensionality is used to determine the construct validity of an instrument, ensuring that each of its elements evaluates just one dimension as opposed to several [61]. Table 3 shows that 46.4% of the raw variance explained by measures meets the criteria of at least 40% [60]. The result proves that all eleven items reflected 46.4% to measure grit. It means that there is room for improvement in generating more items on grit that reflects grits better. This value is equal to the principal component analysis (PCA) which explains the proportion of variance explained by each principal component and how much of the total variance in the dataset is captured by that component of grit. In this context of research, 46.4% is simply the amount of variance in the data that can be attributed to the specific measure or variable of grit.

In the initial comparison, the unexplained variation stood at 9.1%, falling below the criterion of 15%, with an Eigenvalue of 1.9, which meet the accepted value requirement of 2 [60]. Eigenvalues are important in Rasch analysis because they indicate the amount of variability in the data that is accounted for by each underlying dimension or factor. A small eigenvalue shows that it has no probability of having another dimension. In this research, it proves that there are no other dimensions besides grit.

Table 3
Summary statistic for unidimensionality

	Eigenvalue	Empirical		Modeled
Total raw variance in observations	20.5	100.0%		100.0%
Raw variance explained by measures	9.5	46.4%		46.5%
Raw variance explained by persons	4.9	24.0%		24.1%
Raw variance explained by items	4.6	22.4%		22.5%
Raw unexplained variance (total)	11.0	53.6%	100.0%	53.5%
Unexplained variance in 1st contrast	1.9	9.1%	17..0%	

4.3 Local Independence

Local independence is performed to determine that the items are not significantly correlated with other items within the same construct. Even if a correlation exists, its strength should fall within the accepted range which is less than 0.5. Table 4 demonstrates the range of correlation of the items is between -0.39 to 0.24. The largest combination is (r=0.24) for two pairs of items namely (B3-B10) and (B6-B8).

These results suggest that the items in this instrument largely comply to the principle of local independence. This compliance is crucial as it indicates that the items are functioning independently as intended. This establishes the robustness of the measurement model employed. The fact that the correlation values fall within the specified range further strengthen confidence in the reliability of the data collected from this instrument.

Table 4
Summary statistic for local independence

Correlation	Item Number	Item Number
0.24	B3	B10
0.24	B6	B8
-0.39	B6	B9
-0.35	B1	B11
-0.32	B1	B8
-0.26	B5	B12
-0.25	B3	B4
-0.23	B4	B10
-0.22	B5	B11
-0.21	B10	B12

4.4 Wright Map

The distribution of item difficulty in relation to the range of student abilities along a measuring continuum is graphically represented by the Wright map in Figure 1. In a way that links item complexity to student aptitude, this graphic shows the range of levels from the simplest to the most difficult. Item B1 “I am able to overcome challenges in solving mathematical problems” is the most difficult item with the logit value of 0.47.

The reason respondents believe this item is hard to endorse is a fear of failure or lack of confidence. Some students may feel anxious or lack confidence when faced with challenging mathematical problems, which can hinder their ability to think clearly and solve problems effectively. Building students' confidence in their mathematical abilities and providing a supportive learning environment can help alleviate these issues. This confidence issues are related to grit that refers to the combination of passion and perseverance towards long-term goals, especially in the face of obstacles and setbacks in solving mathematics problem. It's the ability to maintain effort and interest over time, even when faced with challenges, failures, or adversity.

Meanwhile, item B3 “I can work hard to learn math” is the simplest with -0.47 logits. This item is close to students because they know that they really put in effort to study mathematics. Therefore, this item well known among respondents and easy for them to endorse. For some students, mathematics is more than just a requirement; it's a subject they genuinely enjoy and find intellectually stimulating. These students may be drawn to the logical reasoning, problem-solving challenges, and patterns inherent in mathematics. Hence, they need to work hard to learn every essential skill in learning mathematics.

The mean score for the item is 0.00 while the mean score for student is 1.05. This explains that the ability of students from this sample is higher than the items difficulty. There are no difficult items to cater to the higher capability students, which suggest more difficult items should be developed to satisfy this group of students. It shows that more difficult items are needed (more than 0.47 logits) to cater to the higher ability of students. The instrument also needs several easier items (less than -0.47 logit) to cater to lower ability students.

Ensuring a balanced range of item difficulties is essential for accurately measuring the abilities of all students. The Wright map in Figure 1 shows a mismatch between the highest student abilities and the most challenging items, highlighting the need for more difficult items for higher-performing students. Adding easier items is also crucial for assessing lower-ability students. This balanced

approach will improve the validity and reliability of this instrument, making it a more effective tool for evaluating grit among the students.

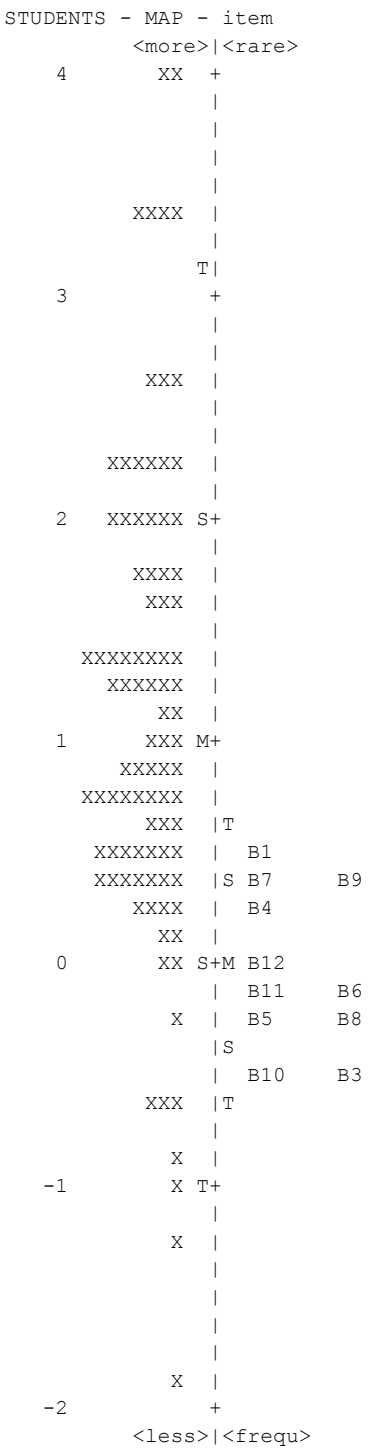

Fig. 1. Wright map

4.5 Reliability and Separation Index

Person and item reliabilities are the two categories of reliability that the Rasch model discusses. Person reliability refers to calculating the degree to which a score may distinguish between person

for a certain variable under study and item reliability describes the degree of consistency an item maintains in its level across the scale, even when another sample with the same ability is given the same collection of items [43]. Table 5 displays the person reliability at 0.78 and person separation at 1.88. If the separation index is greater than 1.5, it may still be considered appropriate even if the person separation index is less than 2. Cronbach's alpha shows the reading of 0.89 which is a good value [57]. Table 6 explains the item reliability which scored 0.84 and item separation at 2.32. Both readings could be regarded as satisfactory.

Table 5
Summary statistic for the person (N = 91; extreme score 2)

	Total Score	Count	Measure	Model Error	Infit		Outfit	
					MNSQ	ZSTD	MNSQ	ZSTD
Mean	42.9	10.9	1.05	0.41	1.00	0.00	1.03	0.00
S.D.	8.7	0.7	1.01	0.17	0.65	1.20	0.78	1.20
Max	54.0	11.0	3.37	1.00	4.26	4.10	5.95	5.20
Min	15.0	4.0	-1.91	0.28	0.28	-2.60	0.30	-2.40
Real RMSE	0.47	True SD	0.81	Separation	1.88	Student Reliability		0.78
Model RMSE	0.44	True SD	0.91	Separation	2.08	Student Reliability		0.81

Students Raw Score-To-Measure Correlation = 0.87
Cronbach Alpha (KR-20) Student Raw Score Reliability = 0.89

Table 6
Summary statistic for the item (11 items)

	Total Score	Count	Measure	Model Error	Infit		Outfit	
					MNSQ	ZSTD	MNSQ	ZSTD
Mean	364.9	92.4	0.00	0.12	1.01	0.10	1.04	0.20
S.D.	21.7	0.5	0.32	0.01	0.12	0.70	0.21	1.10
Max	397.0	93.0	0.47	0.14	1.16	0.90	1.28	1.40
Min	330.0	92.0	-0.47	0.11	0.73	-1.80	0.65	-1.90
Real RMSE	0.13	True SD	0.29	Separation	2.32	Item Reliability		0.84
Model RMSE	0.12	True SD	0.29	Separation	2.38	Item Reliability		0.85

UMean = 0.000 Uscale = 1.000
Item Raw Score-To-Measure Correlation = -0.99

5. Research Significant and Impact

This research has two main significances. Firstly, to expand theoretical meaningful contribution in behavioral changes into grit in facing Mathematics challenges by Tamil students. The result can increase the understanding an individual's level of grit that able to help therapists assist clients among Tamil students in setting realistic objectives and developing ways to overcome obstacles in Mathematics learning. It offers a paradigm for developing resilience and commitment in the face of adversity in SJKT, which are critical for behavior change and personal growth in Mathematics. Secondly, the sustainability of the items in measurement and evaluation context especially in validity and reliability aspect that provide empirical modern theory using Rasch model, rather than just rely on limitation of classical test theory only.

According to the research impact, it has three main impacts that covers this research. First is on the health psychology impact by demonstrating the potential for substantial contributions towards academic community and beyond. Grit is an important factor in educational psychology because it affects student motivation and academic accomplishment in Mathematics learning. Educators can employ grit to inspire students to adopt a growth attitude, take on difficulties, and persevere in their

learning in Mathematics. It aids in the formation of circumstances that promote tenacity and grit among students.

Second impact is on the sustainability of item psychometric empowerness in Mathematics among Tamil students. The analysis can strengthen the items of grit by combining different style of item assessment of multivariate analysis and beyond. For instance, by considering external factors that influenced the accuracy of items quality such as social and environment cultural context, biases and different type of school settings.

Third research impact is policy impact. Grit research item assessment contribute to the policy makers act and how policies are developed especially when it comes to Tamil in vernacular schools. Recipients of this impact may include Malaysian government, non-governmental organisations (NGOs) of Tamil students, charities and public sector organisations and society, either as a whole or groups of individuals in society. All of them can apply this instrument to identify potential students that weak in grit in Mathematics to be guided by the expertise of grit.

Besides, this paper highly relevance to the applied psychology by align closely with the transformation paradigm in this study by understanding Tamil students' motivation in Mathematics, perseverance, and performance in numerous Mathematics disciplines of applied psychology. The vital strategies for assessing psychometric item help to measure accurately the students individually in order to empower building resilience, improving performance, and promoting well-being in individuals and communities especially in Tamil vernacular schools in SJKT.

6. Conclusion

Overall, these results indicate that a total of 11 out of the 12 items from the instrument met the Rasch model assumptions except item B2 "I will not be discouraged by the decline in math scores" and was removed from the instrument. These findings are rather promising because having 11 out of 12 items conform to the Rasch model suggests the instrument has good internal consistency. Examining item B2 further can help identify potential issues and improve the overall instrument. Due to practical constraints, this paper cannot provide a comprehensive review of samples involved. This study was only conducted in SJKT environment and could be carried out in other new settings such as Sekolah Kebangsaan (SK), Sekolah Jenis Kebangsaan Cina (SJKC) and private primary schools in Negeri Sembilan. By including samples from SK, SJKC and private schools, the study applies to a broader range of primary school settings in Negeri Sembilan. This allows the determination of wheter the findings hold true for students across different educational backgrounds and socio-economic demographics. If the results remain consistent, the study's conclusions become more generalizable to the wider primary school population in the region.

This finding has important implications for developing instruments that measure the same construct across diverse school settings. The remaining 11 items can be a strong foundation for instruments applicable to SK, SJKC, and private schools. Besides that, this finding could help in developing interventions to address discouragement in students facing declining maths scores. By understanding why item B2 deviated, we can identify aspects that might be causing discouragement and tailor interventions accordingly. Future studies on the current topic are therefore recommended. A further study could extend to different subjects and at secondary level of education to explore the potential of grit to foster improvement in student achievement.

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