



Grit Instrument Development on High School Students: Rasch Model Analysis

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Abstract: This study aimed to develop an instrument that will be used to measure the grit of senior high school students. This quantitative study involved 601 senior high school students in Bangka Belitung. Based on an analysis of the relevant literature, this study developed 24 items that collectively described grit. Data was collected using a grit scale and analyzed using the Rasch model. The results show that 1) Cronbach's alpha value is 0.91 which means the interaction between item and person is in the very good category, 2) the item reliability coefficient is 0.97 where the item belongs to the special category, and 3) the person reliability coefficient is 0.87 which means that students respond consistently to each item. Based on the results above, we can see that 23 valid items and the other is invalid. Overall, it can be concluded that the grit scale has good psychometric properties, and it can be used by counselors or counseling guidance teachers to measure students' grit.

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Introduction

Grit is a necessity in realizing individual career success to have competence and competitiveness in a competitive global era, especially in the 4.0 revolution era. Equipping oneself with competencies relevant to the industrial revolution 4.0 is one of the keys to individual success in meeting the demands and challenges of 21st-century competencies such as problem-solving skills, developing ideas, and skills to work collaboratively (Griffin & Care, 2014). Fullan (2018) also identified 21st-century competencies into "The Six Cs", one of which is character education, including honest character, self-regulation, and grit, responsibility, empathy to provide a sense of security and meaning for others. This has implications for the need for educational readiness, especially to the quality of education, so that individuals can grow grit and participate fully in their lives.

Duckworth (2016) described grit as the ability to maintain consistency of interest and persistence of effort to achieve goals in the long term even when faced with challenges, obstacles, and failures. This construct was concluded by Duckworth from his findings which showed that despite having high scores in each subject and ranking at the top of the military academy, cadets with low grit had a greater chance of dropping out than cadets with high grit. Individuals who have high grit can maintain their determination and motivation at all times, even though they often experience failure and difficulties. Although the findings of Abuhassan & Bates, (2015) showed that grit represents persistence rather than consistency of interest. This finding is reinforced by a study (Wolters & Hussain, 2015) showed that the interest consistency aspect of grit only relates to the last two aspects of SRL. Meanwhile, grit, the persistence of effort, was a consistent and adaptive predictor for all SRL indicators including scores, self-efficacy, cognitive, metacognitive, motivation, time and environmental management strategy studies, and procrastination.

Based on literature analysis of 44 studies on grit, 13 were published in the 2015-2018 range and 31 studies were published in the 2019-2021 range. 3 studies are longitudinal (Buzzetto-Hollywood, 2019; Jiang et al., 2019; Light & Nencka, 2019), 4 meta-analytical studies (Christopoulou *et al.*, 2018; M Credé *et al.*, 2017; Marcus Credé, 2018; Loftus *et al.*, 2020), and 37 studies were cross-sectional studies. All studies used a quantitative approach except for 1 study that used mixed methods (Rutberg et al., 2020) and as many as 35 studies used correlation and regression analysis as data analysis techniques.

Of the 44 studies, the majority of research objectives tested and validated the grit construct (consistency of interest and perseverance of effort) and its relationship to other psychological attributes. 3 of them focused on developing grit measuring tools (Clark & Malecki, 2019; Schmidt *et al.*, 2019; Ting & Datu, 2020), and 6 studies focused on intervention strategies (Andrian & Ilfiandra, 2020; L Eskreis-Winkler, 2015; Kalia *et al.*, 2019; Felipe Mercado, 2017; Rhodes *et al.*, 2018; Tang *et al.*, 2019). The measuring instrument for diagnosing student grit still raises various questions because it relates to the validity and consistency of grit size in cross-cultural contexts.

Research on grit has been introduced by Duckworth since 2007. Existing research shows that grit predicts academic success, but research on how the grit scale was developed to assess grit performance in all situations is still an interesting study, despite its widespread use today. Grit construction consists of components of the level of effort of perseverance and passion for long-term goals (Duckworth & Perkins-gough, 2016; Duckworth *et al.*, 2007; Duckworth & Quinn, 2009). Perseverance of effort and consistency of interest produces grit. From that concept, Duckworth developed two versions of the scale (12-item and 8-item).

The Short Grit Scale has also been tested by (Priyohadi et al., 2019) to 200 millennials in Indonesia using the Analysis of Structural Moment (AMOS) showing a reliability value of 0.82, proven reliable because it exceeds the minimum value of 0.60. However, the test was carried out based on classical theory and the number of respondents was quite small so they were not able to measure the interaction between items and persons. For this reason, the researchers tried to develop their grit indicator using Rasch modeling analysis. According to Sumintono & Widhiarso (2014) the advantages of Rasch modeling compared to other methods, especially classical test theory, are the ability to predict missing data based on individual response patterns. This advantage makes the results of the statistical analysis of the Rasch model more accurate in the research carried out, and more importantly, the Rasch model can produce standard error measurement values for the instruments used which can increase the accuracy of calculations. Calibration is carried out in the Rasch model simultaneously in three ways, namely the measurement scale, the respondent (person), and the item (item). An instrument that is not calibrated has the possibility of producing invalid data and can cause the research activities carried out to experience errors.

The review above confirms that grit plays a significant role as a special domain construct in achieving different domains (personal, social, academic, and career). The strength between grit and academic performance makes grit a valuable factor in developing students' competencies as a way to achieve success. Grit is important for individuals, both at school and in life, so it is necessary to develop and test grit instruments for further research purposes.

This need is the reason why it is important to develop a grit scale, especially for high school students in Indonesia, which is used to measure their grit. The measurement results can be considered in providing appropriate guidance and counseling services regarding the importance of strengthening grit in the context of education to maintain character and increase student potential.

Research Method

This research method uses a survey method. This quantitative study involved 601 high school students in Bangka Belitung with details of 231 male respondents and 370 female respondents. The grit data disclosure tool is in the form of a Google form-based Likert-scale self-report that has been examined by experts. This scale consists of a set of statements that are opinions about the attitude of the subject. The measurement scale used is a Likert scale with 5 answer choices, namely: not at all like me, not like me, somewhat like me, generally like me, and like me.

This instrument consists of favorable and unfavorable statements. For favorable statements, the answer really like I was given a weight of 5, generally like I was given a weight of 4, somewhat similar to I was given a weight of 3, unlike I was given a weight of 2, and the answer was not at all like I was given a weight of 1. As for the statement unfavorable, each respondent's answer is given the opposite score of the favorable statement. Data collection was carried out in April-May 2021 by involving guidance and counseling teachers from each school to maintain the purity of the data obtained by researchers. The data analysis technique used Rasch modeling analysis with the help of the winstep program application version 3.73.

Results and Discussion

Based on the results of the analysis using Rasch modeling, various information was obtained regarding the items and respondents who were participants in the scale trial (person). The results of the analysis shown are rating scale, validity, reliability, and unidimensionality analysis.

1) Rating Scale

The rating scale analysis aims to verify whether the choice ratings used confuse the respondents or not. The results can be seen in Table 1.

Table 1. Rasch Rating Scale

Category	Observed Average
1	-26
2	-13
3	0.14
4	0.42
5	0.81

The results of Rasch's analysis in Table 1 Rating Scale show the average value of observations starting from logit -0.26 for the choice of score 1 (not at all like me), then the choice with a score of 2 (not like me) of -0.13, and increasing to logit 0.14 for choice score 3 (similar to mine), increase again to logit 0.42 for score 4 (generally like me) and increase to logit 0.81 for score 5 (really like me). The increase in the average value of this observation indicates the validity of the scale used on the grit instrument can be said to be very good and does not confuse the respondents. The absence of a decrease in the value of these five answer choices indicates that respondents can clearly distinguish between the answer choices from not at all like me to like me.

2) Validity

The grit instrument validity test used the Rasch modeling approach (Rasch model) with the help of the Winstep application version 3.73. Some of the validity testing criteria based on Rasch modeling are as follows.

- Outfit MNSQ value: $0.5 < \text{MNSQ} < 1.5$ to test the consistency of respondents' answers with the level of difficulty of the statement items;
- Outfit ZSTD value: $-2.0 < \text{ZSTD} < +2.0$ to describe how much (measure result column) is an outlier item, does not measure, or is too easy or difficult;
- Point Measure Correlation (Pt Measure Corr.): $0.4 < \text{Pt Measure Corr} < 0.85$ to describe how good (SE), the statement items are not understood, responded differently, or confused with other items;
- Unidimensionality, to evaluate whether the developed instrument can measure what it should measure with the requirement that the unidimensionality is at least 20% (Sumintono & Widhiarso, 2014). With the following criteria.

Construct Validity

- >60% Very great
- 40-60% Good
- 20-40% Sufficient
- <20% Poor
- <15% Unexpected variance

Table 2. Recapitulation and Interpretation of Instrument Test Results Using Rasch Model Analysis
N<300, All Criteria Must Be Meet (1),
If N>=300, Then ZSTD Ignore (2)

No. ITEM	OUTFIT		Pt. Mean Corr (0,4 <Pt. Corr <0,85)	INTERPRETATION			DECISION		
	MNSQ (0,5<MNSQ<1,5)	ZSTD (-2,0<ZSTD<2,0)		MNSQ	ZSTD	Pt. Corr.	Use	Revision	Discard
11	1.80	9.9	0.20	×	×	×			✓
8	1.59	9.3	0.33	✓	×	×		✓	
20	1.53	8.3	0.30	✓	×	×		✓	
6	1.49	7.6	0.29	✓	×	×		✓	
15	1.38	6.1	0.53	✓	×	✓	✓		
3	1.40	6.5	0.42	✓	×	✓	✓		
18	1.08	1.1	0.40	✓	×	✓	✓		
24	1.23	3.9	0.45	✓	×	✓	✓		
10	1.23	3.8	0.46	✓	×	✓	✓		
17	1.11	1.5	0.42	✓	✓	✓	✓		
16	1.11	1.9	0.53	✓	✓	✓	✓		
13	1.05	0.9	0.56	✓	✓	✓	✓		
4	0.93	-1.3	0.56	✓	✓	✓	✓		
9	0.82	-3.4	0.60	✓	×	✓	✓		
5	0.77	-4.1	0.69	✓	×	✓	✓		
7	0.81	-3.6	0.68	✓	×	✓	✓		
14	0.76	-4.4	0.73	✓	×	✓	✓		
2	0.74	-5.0	0.64	✓	×	✓	✓		
23	0.69	-5.8	0.73	✓	×	✓	✓		
19	0.69	-5.8	0.72	✓	×	✓	✓		
21	0.72	-5.5	0.70	✓	×	✓	✓		
1	0.71	-5.8	0.64	✓	×	✓	✓		
12	0.69	-6.3	0.69	✓	×	✓	✓		
22	0.65	-6.9	0.70	✓	×	✓	✓		

Referring to the criteria for testing the validity of the instrument using Rasch modeling, from the 24 statements that were tested on 601 respondents, 23 statements were adequate. Meanwhile, 1 statement item was discarded, because the Outfit MNSQ, ZTSD, and PT Mean Corr scores did not meet the criteria and 3 statement items were revised.

Table 3. Explained and Unexplained Variance Criteria

Criteria	Value
Raw variance explained by measure	33.3%
Unexplned variance in 1st contrast of residuals	11.9%

Undimensionality results are also important to know in the development of this measuring tool. It is useful to know whether the developed instrument can measure what it is supposed to measure. In the context of this research the grit constructs (consistency of interest and persistence of effort). According to Sumintono & Widhiarso (2014), the minimum requirement for undimensionality is 20%, and the variance that cannot be explained by the instrument ideally does not exceed 15%. From table 3, it is known that the raw variance of the data obtained is 33.3%. which means that the minimum 20% undimensionality requirement can be met, and the raw variance that cannot be explained by the instrument also meets the criteria, namely 11.9%.

3) Reliability

Reliability as a data collection tool explains how far measurements made repeatedly will produce the same information (Sumintono & Widhiarso, 2014). The reliability test aims to determine the consistency of the grit instrument used in the study. A reliable instrument will produce objective and reliable data because its provisions have been tested so that the results remain consistent. The reliability test of this grit instrument was carried out using Rasch modeling (Rasch model).

Referring to the criteria for testing the reliability of the instrument with Rasch modeling that the reliability of person and item as well as Cronbach's alpha (item-person interaction) must be greater than (0.67). Meanwhile, item-person separation must be greater than 3.0 (Sumintono & Widhiarso, 2014). More detailed reliability test results can be seen in the following table.

Table 4. Summary of Reliability Test Results

	Mean Measure	Separation	Reliabilit y	alpha Cronbach
Person	0.29	2.56	0.87	0.91
Item	0.00	5.53	0.97	

Table 4 shows that the person reliability value of 0.87 is at a good consistency level, with a separation value of 2.56. while the item reliability value of 0.97 indicates that the level of item consistency is in a special category, with a separation value of 5.53. As Cronbach's alpha value of 0.91 indicates that the interaction between items and persons is in the very good category.

Researchers have also tested the level of difficulty, discriminating power, and homogeneity of items with the conclusion that first, item P11 does not meet any of the validity criteria, be it Outfit MNSQ, ZSTD, and Pt Corr. Analysis of Table 1. The Maps variable also shows that the most difficult item for respondents to agree on is P11. This result strengthens the researcher to discard item P11 and not use it in data collection. Second, statements P8, P6, and P20 were revised because they did not meet the Pt Mean Corr. Third, although P3 is an item that is difficult to agree on, the researcher still uses the P3 item because it still meets the MNSQ Outfit and Pt Mean Corr validity criteria. Fourth, the researcher continued to use items P17 and P18 even though they were classified as the easiest items to approve because they met all the validity criteria, be it Outfit MNSQ, ZSTD, and Pt Mean Corr.

Discussion

Based on the results of the analysis using Rasch modeling, it is known that the grit scale for high school students gives consistent results and is proven to reveal one psychological construct, namely grit in the sample of high school students. The results of this grit scale test seem to be very adequate because the reliability and validity coefficients obtained have met the standards set in the analysis of the Rasch model. Of the 24 items analyzed, 23 items fit the model, with a reliability coefficient of $\alpha = 0.91$. This alpha value is a standard measure of reliability in its measurement practice interpreted as an interaction between respondents and the item as a whole. These results indicate that the grit scale has a very good reliability coefficient. This means that this scale produces a consistent and reliable measurement score and is good at measuring the diversity of respondents' abilities and can measure one variable comprehensively. The item and person reliability coefficients are also quite good, namely 0.87 and 0.97, which means that these 23 items are quality items and high school students have the same perception and the instrument itself is correct in formulating each dimension of the grit scale so that this instrument is reliable. These two results further strengthen and confirm that the grit scale is said to be a quality measuring instrument because not only the measurement results are reliable, but also the 23 quality items.

The results of calculations using Rasch modeling can be concluded to be accurate because the respondent's data used have been selected and free from outliers that/who may not be proven by classical test theory. The classical test does not consider the presence of these outliers and analyzes the data as a whole as the criticism made by Alagumalai, S., Curtis, D. D., & Hungi (2005) that the level of difficulty and discriminatory power depends on the sample size and the assumption of an equivalent measurement error for all respondents. Meanwhile, the analysis of Rasch modeling can provide information about the suitability and accuracy index of respondents' answers with the model. The use of the Rasch model in instrument validation will result in more holistic (comprehensive) information about the instrument and the level of accuracy that better meets the definition of measurement (Bond & Fox, 2015). By this information, researchers can find inconsistent and inappropriate response patterns in a group of respondents. This indicates that the respondent is not serious (carelessly) in answering the item.

Based on the results, an item was identified as inappropriate with the model, so it needed to be dropped. In the aspect of difficulty level, one of the items that fell out was item P11 because it did not meet any of the validity criteria, whether it was Outfit MNSQ, ZSTD, and Pt Corr. Analysis of Table 1. The Maps variable also shows that the most difficult item for respondents to agree on is P11. This result strengthened the researcher to discard item P11, namely "I find it difficult to maintain focus on activities that take longer to complete". This item has the highest logit value compared to other items, which is 0.25 logit. While item P18 is the item that is the easiest for respondents to agree with, namely "I am determined to give my best effort in school assignments". This item has the lowest logit value, which is -0.58. This item is not too difficult to be approved by the respondent because the respondent can interpret it according to their respective conditions. However, the researcher still uses this item because it meets all the validity criteria, be it Outfit MNSQ, ZSTD, and Pt Mean Corr.

Meanwhile, the respondent's separation index is 2.56 and the item separation index is 5.53. The greater the value of separation, the quality of the instrument in terms of overall respondents and items is better because it can identify groups of respondents and items (Sumintono & Widhiarso, 2014). When viewed in more detail using the strata separation formula (H), with a person separation value of 2.56, then $H=3.74$ (rounded to 4) and for item

separation value of 5.53, $H=7.70$ (rounded to 8). These results indicate that respondents can be divided into four major groups, namely groups with very high, high, medium, and low grit. While the items can be divided into seven levels based on the level of difficulty for respondents to agree, namely very easy, easy, somewhat easy, moderate, difficult, somewhat difficult, and very difficult. The results of this analysis can be interpreted that all of the items used carefully can assess respondents' answers related to the grit construct of students. The value of the separation response and item separation which is quite large indicates that this grit scale has good quality because it can identify groups of respondents and items very carefully and thoroughly.

Another advantage of the analysis of the Rasch model is in terms of verifying the rating used, whether it is clear or confusing to the respondents. This monotonic increase indicates that the measurement has been going well. Respondents did not experience confusion in ascertaining the difference between the answer response choices. Thus, the choice option on the grit scale is appropriate.

It can be concluded from the analysis that this grit scale can be used as an instrument in needs assessment and research because it is proven to have good psychometric properties. The number of respondents is quite large, making one of the advantages of this research. The limitations of this research are, firstly, the information is not complete and complete because the sample is taken from one city from several selected schools. Second, trial reliability, concurrent coefficients, and group validity among groups of secondary school students have not been refined by context dimensions, age, and grade. Third, the validity of the grit has not been assessed or compared to other scales. Fourth, filling in the grit instrument requires strict assistance to minimize the occurrence of social desire (outlier) data.

Conclusion

Based on the results of the grit scale analysis, it can be concluded that:

- 1) Person reliability value of 0.87 is at a good consistency level, with a separation value of 2.56. Meanwhile, the item reliability value of 0.97 indicates that the level of item consistency is in a special category, with a separation value of 5.53. As Cronbach's alpha value of 0.91 indicates that the interaction between items and persons is in the very good category.
- 2) The analysis of the level of difficulty, discriminating power, and homogeneity of the items showed that the P11 item did not meet any of the validity criteria, whether it was Outfit MNSQ, ZSTD, and Pt Corr. Analysis of Table 1. The Maps variable also shows that the most difficult item for respondents to agree on is P11. This result strengthens the researcher to discard item P11.
- 3) The results of instrument testing through Rasch modeling analysis showed that of the 24 items tested, 23 items were suitable for use with a note that 3 items (P8, P6, and P20) were revised and 1 item (P11) was discarded.
- 4) An assessment of grit can be used to support persistence in learning, development, and student well-being in various dimensions. Thus, the grit instrument can be used by counselors or BK teachers to measure students' grit.

Recommendation

The Grit scale can be used by school counselors or guidance and counseling teachers as a measuring tool for assessing student needs. The results of the grit measurement are used as the basis for providing appropriate guidance and counseling services, regarding the

importance of strengthening grit in the context of education to maintain character and increase student potential.

The Grit scale can also be used as a reference for other researchers in developing instruments related to grit to develop scales with more diverse samples. The analysis of the detection of measurement bias has also not been carried out in this study. Therefore, an analysis of the detection of measurement bias based on gender, age, education level, and cultural background (ethnicity) can be carried out for further researchers to validate and evaluate whether the formulated items can benefit or favor respondents with certain characteristics or not.

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