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The development of an instrument to measure the grit of junior high school students using rasch analysis model

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Abstract: This study aims to obtain a valid and reliable Student Grit Scale and to analyze the feasibility of a measurement instrument using the Rasch Model. This study employed a quantitative research method with a descriptive approach and involved 75 junior high school students. The grit scale developed by Datu, called the Triarchic Model of Grit (TMG), was used in this study. The results of the reliability test showed that Cronbach's Alpha was greater than 0.60 ($\alpha = 0955$), indicating that the measurement instrument was reliable. The unidimensional analysis showed that the instrument was feasible because the variance observed in the contrast of 1 to 5 residues contained only values above 15%. Thus, the entire construct of the grit has measured one appropriate variable. This study provides recommendations for the development of a grit measurement instrument to investigate he balance between the topics contained in the questions and the level of ability of students as respondents.

Keywords: grit; triarchic model of grit; students.

Abstrak: Penelitian ini bertujuan untuk memperoleh skala *Grit* siswa yang valid dan reliabel serta menganalisis kelayakan alat ukur dengan menggunakan *Rasch Model* serta sesuai dengan budaya kolektvitas di Indonesia, khususnya di bidang akademik. Penelitian ini menggunakan metode penelitian kuantitatif dengan pendekatan deskriptif yang melibatkan 75 orang siswa SMP. Skala *grit* yang diambil dalam penelitian ini adalah diadaptasi dari pengembangan skala *grit* sebelumnya yaitu Datu yang diambil dari teori *Triarchic Model of Grit* (TMG). Hasil pengujian reliabilitas diperoleh bahwa *cronbach's Alpha* lebih besar dari 0,60 ($\alpha = 0955$) sehingga instrumen memiliki reliabilitas yang baik selain itu alat ukur yang dikembangkan juga layak karena dari analisis unidimensional diperoleh bahwa *observed variance in* 1^{st} ke 5th contrast of residuals tidak terdapat satupun nilai yang lebih besar dari 15%. Sehingga, seluruh konstruk dari *grit* telah mengukur satu variable yang sesuai. Penelitian ini memberikan rekomendasi agar pengembangan alat ukur *grit* lebih memperhatikan keseimbangan antara topik yang terkandung dalam soal dengan tingkat kemampuan siswa sebagai responden.

Kata kunci: grit; triarchic model of grit; peserta didik.

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INTRODUCTION

Students' academic success is often associated with their academic achievements, academic adjustments, and academic retention. Previous research suggests that intelligence plays a crucial role in creating an objective instrument to measure a school's success (Gottfredson, 1997; Kuncel, Credé, & Thomas, 2007). However, over the last few decades, many have argued that student success does not solely depend on cognitive abilities and intelligence. Research has shown that student success is not always correlated with IQ, cognitive abilities, or talents (Duckworth et al, 2007; Duckworth & Quinn, 2009; Eskreis-Winkler, Duckworth, Shulman, & Beal, 2014). In fact, a person who successfully achieved their dreams is often influenced by their non-cognitive psychological characteristics, such as creativity, growth mindset, self-confidence, and emotional stability (Duckworth et al, 2007). One of the noncognitive factors that have received considerable attention recently is grit. Grit is a person's ability to overcome challenges to reach their full potential (Soutter & Seider, 2013).

The study of grit was first conducted by Angela Duckworth at the University of Pennsylvania. Grit is defined as perseverance and passion for long-term goals (Angela L. Duckworth et al., 2007) People with high grit tend to be consistent in achieving goals. On the other hand, people with low grit often feel boredom and disappointment that they give up on their work or choose to take an alternative solution (Duckworth et al, 2007). Bazelais et al., (2018) and Eskreiss-Winkler et al., (2014) found that grit is closely linked with student retention. According to Saunders-Scott, Braley, & Stennes-Spidahl (2018), students with high levels of grit are more likely to graduate from high school or university with good grades. Credé et al (2017) argued that students with higher levels of grit tend to achieve higher GPAs than those with lower levels of grit. More importantly, students with high levels of grit are more likely to form stronger commitments to accomplish their goals. As a result, they are not

distracted by their short-term goals and not fearful of failures.

Grit has been pyschometrically measured using Grit-S and Grit-O. Grit was measured for the first time using Grit-Original (Grit-O). It consisted of 12 items (Duckworth et al., 2007), but was reconstructed into Grit-Short (Grit-S), consisting of 8 items (Duckworth & Quinn, 2009). The reconstruction was conducted to improve the factor results by removing two items from each sub-scale due to their lower correlation with the latent construct. The Grit-S measurement was initially developed into two dimensions: perseverance of effort and consistency of interest.

The first group of grit factors is correlated with learning, such as mastery orientation goals (Akin & Arslan, 2014) or the self-transcendent learning model (Yeager et al., 2014). The second group of grit factors is related to the relationship among positive psychological variables, connection, and goals, such as hopes, life goals and commitments, and positive influences (Hill et al., 2016; Vela, Lu, Lenz, & Hinojosa, 2015), and family perceptions are conceptualized as social and psychological supports (Lin & Chang, 2017). Grit was later expanded into three dimensions, with adaptability as an additional aspect and the Triarchic Model of Grit (TMG) as the foundational model. However, this version of grit was found to be more relevant for regions with a collectivist culture, such as Asian countries, and it could only be used to identify the perseverance of effort that has strong latent criteria (Datu et al., 2017).

Research shows that the levels of grit among students in Indonesia vary. A study involving 214 student athletes found that 72.6% of them had a moderate level of grit, while 27.4% had a high level of grit. None of the participants (0,0%) had a low level of grit (Oktaviasari & Widyastuti, 2021). Meanwhile, a study conducted on elementary school students in Indonesia discovered that 76 students had adequate grit with the mean value of 3.52 (Safitri, Thee, & Sitasari, 2020). Another study revealed that among 312 junior high school students, the majority of them (85.8%) had a moderate level of grit and 14.4% had a low level of grit; no students had a high level of grit (Kusumawardhani, Safitri, & Zwagery, 2018). All these results suggest that the grit levels among Indonesian students are adequate and moderate, and some claimed that no students have low grit.

No surveys about grit in Indonesia have described the inconsistent interest and perseverance of Indonesian students in attending school. Ideally, students with moderate or adequate grit would show interest in school activities, such as practicing regularly, adhering to specific practice schedules, committing to study plans to accomplish goals, and paying close attention to lessons (Oktaviasari & Widyastuti, 2021). In reality, however, the student drop-out rate remains high in Indonesia, posing a national problem. Based on the 2021 school dropout data, 38,176 students dropped out of elementary school, 15,042 from middle school, 10,022 from high school, and 12,063 from vocational school (Kemendikbudristek, 2022). Riau Province had the third highest dropout rate in the country, with a rate of 88.91% across all levels of elementary, middle, and high school. Muhibbin & Wulandari (2021) explained that students who dropped out of schools due to poor determination and perseverance exhibited low levels of grit.

The study conducted by (Kamsihyati, Sutomo, & Suwarno, 2016) revealed that the most prominent factor contributing to student dropouts is interests. Another contributing factor is the technology and information advancement, inducing indolence and procrastination among students. Some students are not capable of being independent in their exploration of subject matter due to a lack of available materials and heavy reliance on search engines (Viviekanda, 2017). This phenomenon is not aligned with the competence expected of 21stcentury students, who are expected to possess life skills and create things, including flexibility and adaptability, social and cultural interactions, productivity, accountability, initiative, self-control, and independence (Trilling and Fadel, 2009). In fact,

independence in learning, such as motivation, can have positive impacts on students' grit (Zhao, 2018). This problem potentially suggests that grit has not been extensively studied in Indonesia.

Research on the development of grit in Indonesia was first conducted by (Indraswari, 2020), measuring the grit of 100 postgraduate students through two dimensions. The study found that the 15 items were valid and reliable, as determined the AIken's V and Cronbach's Alpha tests. However, no previous studies have developed a tool to measure grit using the Triarchic Model of Grit, which is claimed to be relevant for Asian cultures. The development of the grit scale in Indonesia has remained poor, and hence a measurement tool is necessarily developed. Previous measurements of grit in foreign countries are still debatable and have limitations in being directly applied to measuring grit across cultures.

The development of the grit scale in Indonesia has remained poor, and hence a measurement tool is necessarily developed. Previous measurements of grit in foreign countries are still debated and have limitations in being directly applied to measuring grit across cultures. Indonesia is a country with a tendency of having collectivist culture like the Philippines, as suggested by Datu, et al. (2007), but the Philippines is not multicultural like Indonesia. Moreover, the measuring instrument in Duckworth's (2007) research was not intended for academic contexts as the items were geared towards everyday life situations. This allows for a bias and multiinterpretation about the measurement of grit among students in Indonesia. This construction can become a reference for school counselors, especially at middle school, when conducting an assessment in addressing students' poor academic performance.

The findings of this study contribute to the development of a grit measurement instrument, including the novel factor of student grit in Indonesia.

This study aims to develop 1) a valid and reliable student grit scale and 2) a testing

unidimensional analysis of the grit scale with the Rasch model.

METHODS

This study employed a quantitative approach with a descriptive design. A descriptive design aims to obtain the description of typical characteristics of a certain group (Gravetter & Forzano, 2018). The population in this study was all 8th grade students at SMPN 8 Pekanbaru. The sample of this study was taken using non-probability sampling technique. Non-probability sampling is a technique where members of the population do not have an equal chance of being selected (Sugiyono, 2019). The sample size used in the Rasch model for stable item measurement calibration had to meet the requirements of the logit scale $(\pm 0,3)$. A minimum sample size of 50 is required in the Rasch model to meet the criterion of logit > 0.3 at the 95% confidence level. (Sumintono & Widhiarso, 2015). The study utilized a sample size of 75 students, which is the maximum number of analyses allowed in the MINISTEP Rash model.

The study was conducted in the following stages: 1) compiling, writing, and reviewing items related to grit construct, 2) carrying out expert judgment, 3) analyzing test results using SPSS and Rasch models, 4) interpreting the results of analysis, and 5) drawing conclusions.

RESULTS AND DISCUSSION

This study used the grit scale developed by Datu, called the Triarchic Model of Grit (TMG). The scale developed by Duckworth, et al. (2006) only had two dimensions, which is not appropriate for a collectivist society in Indonesia. Datu, et al. (2017), however, developed a grit scale involving students in the Philippines.

Analysis of the Development of an Instrument Measuring Student Grit

Datu et al. (2017) conducted a validity test on the instrument and found that each item had a factor loading value as follows: POE2 (0.35), POE3 (0.80), POE4 (0.54), COI1 (0.57), COI2 (0>73), COI3 (0.77), ATS1 (0.66), ATS3 (0.79), ATS4 (0.84), ATS5 (0.84), and ATS6 (0.67). These results showed that all of the items had a factor value greater than 30, suggesting a valid instrument. The reliability test was conducted, and the alpha coefficient indicated consistency of interests (alpha = 0.60), perseverance of effort (alpha = 0.78), and adaptability to situations (alpha = 0.88). These results showed that the reliability was greater than or equal 0.60, indicating a reliable instrument. In this study, the validity and reliability of the grit measuring instrument were tested. The scale was modified and expanded based on previous research. The results are as follows:

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation ^x	Cronbach's Alpha if Item Deleted
POE1	88.653	292,851	0.677	0.930
POE2	88.227	292.880	0.642	0.930
POE3	88.653	297.284	0.651	0.930
POE4	88.520	293.334	0.673	0.930
POE5	88.533	294.063	0.614	0,930
POE6	88.587	304.111	0.296^{*}	0.934
POE7	88.427	296.843	0.609	0.930
POE8	88.627	296,291	0,584	0,931
POE9	88.520	298.145	0.593	0.931
COI1	89.373	310.102	0.149*	0.935
COI2	89.213	294.927	0.615	0.930

Table 1. Results of the Validity Test of the Instrument

Itoms	Scale Mean if	Scale Variance if	Corrected Item-Total	Cronbach's Alpha if		
Items	Item Deleted	Item Deleted	Correlation ^x	Item Deleted		
COI3	89.187	313.748	0.035^{*}	0.936		
COI4	88.147	292.073	0.733	0.929		
COI5	88.560	295.709	0.637	0.930		
ATS1	88.467	292.468	0.679	0.930		
ATS2	88.693	293.486	0.617	0.930		
ATS3	89.280	308.258	0.187^*	0.935		
ATS4	88.973	306.161	0.229^{*}	0.935		
ATS5	88.640	297.477	0.607	0.931		
ATS6	89.173	295.470	0.564	0.931		
ATS7	88.733	295.306	0.581	0.931		
ATS8	88.693	291.053	0.712	0.929		
ATS9	89.440	312.277	0.093*	0.935		
ATS10	88.760	293.698	0.591	0.931		
ATS11	89.213	311.981	0.071^{*}	0.937		
COI6	88.653	308.257	0.195*	0,935		
COI7	88.573	289,545	0.673	0.929		
COI8	88.587	290.543	0.726	0.929		
COI9	88.480	290.172	0.693	0.929		
COI10	88.440	290.385	0.713	0.929		
POE10	88.680	289.166	0.752	0.929		
ATS12	88.413	294.246	0.681	0.930		
ATS13	88.667	292.279	0.607	0.930		

*item <0.30 were omitted, *p > 0.05

Based on the results of analysis, four items are not valid since their values were below 0.30. On the other hand, 25 items are considered valid since their values were greater than 0.30. The results of the reliability test on 25 items are as follows:

Table 2. Results of Reliability Test

Reliability Statistics						
Cronbach's Alpha	N of Items					
	.955	25				

The results of reliability test showed that the Cronbach's Alpha was greater than 0.60 ($\alpha = 0.955$), meaning that the instrument is reliable.

Unidimensionality Analysis of the Development of an Instrument for Measuring Student Grit Using the Rasch Model Unidimensionality is a tool for testing the reliability level of a research model and demonstrating its dimensional suitability (Wijayanto, 2007). Based on the *Dimensionality table*, *Raw variance explained by measures* and *Unexplained variance in 1st to 5st contrast* are the elements that require attention in analyzing the instrument used to assess student grit.

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Assessment	Eigenvalue	Observed	Expected
Raw variance explained by measures	15.567	38.4%	38.5%
Unexplained variance in 1st contrast	4.593	11.3%	18.4%
Unexplained variance in 2 nd contrast	2.518	6.2%	10.1%
Unexplained variance in 3 rd contrast	1.968	4.9%	7.9%
Unexplained variance in 4 th contrast	1.724	4.3%	6.9%
Unexplained variance in 5 th contrast	1.526	3.8%	6.1%

Table 3. Results of the Unidimensionality Analysis

It can be seen from Table 3 that none of the observed variances in the 1st to the 5th contrast of residuals were greater than 15%. These results

indicate that the construct of the grit instrument measured an appropriate variable. The Wright Map analysis was then conducted.



Figure 1. Analysis of the Wright Map on the Student Grit Instrument

The logit of the student grit instrument ranged between -3 and 3, with the difficulty levels of all the items ranging between -2 and 1. The logit of student competence ranged between -3SD and +3SD with the majority falling between -1SD and 1SD. The student with highest competence had the code 50L (a male student number 50) and the student with lowest competence had the code 14P. Regarding the difficulty level of the instrument, all of the items ranged between +1SD and -1SD. The most difficult item was ATS9, while the easiest was CO14. These results indicate that the question items of the creativity instrument are not higher than students' levels of grit, meaning that all the question items in the grit instrument are understandable and acceptable for students. This is in line with the results of analysis of the student grit items as follow.

 Table 4. Results of Analysis of the Items of the Student Grit Instrument

 INPUT: 75 PERSON 25 ITEM REPORTED: 75 PERSON 25 ITEM 4 CATS MINISTEP 4.8.2.0

PERSON: REAL SEP.: 2.72 REL.: .88 ... ITEM: REAL SEP.: 3.41 REL.: .92

ENTRY NUMBER	T0TAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	IN MNSQ	NFIT ZSTD	OU MNSQ	TFIT ZSTD	PTMEAS	UR-AL EXP.	EXACT 0BS%	MATCH EXP%	ITEM
23	154	75	1.05	.15	1.30	1.90	1.73	3.81	.16	.54	44.0	44.2	ATS9
10	159	75	.94	.15	1.32	2.04	1.56	3.11	.26	.54	50.7	43.9	C0I1
17	166	75	.79	.14	1.31	2.05	1.58	3.28	.35	.55	46.7	44.0	ATS3
11	171	75	.69	.14	.69	-2.40	.70	-2.17	.69	.55	53.3	43.4	C0I2
25	171	75	.69	.14	1.79	4.56	2.07	5.51	.16	.55	42.7	43.4	ATS11
12	173	75	.65	.14	1.36	2.33	1.75	4.18	.17	.55	44.0	43.3	C0I3
20	174	75	.63	.14	.82	-1.28	.79	-1.46	.67	.55	48.0	43.2	ATS6
18	189	75	.33	.14	1.46	2.90	1.50	3.00	.37	.55	29.3	43.9	ATS4
24	205	75	.00	.14	1.01	.13	1.04	.30	.61	.55	45.3	45.4	ATS10
21	207	75	04	.14	.89	70	.86	91	.63	.54	50.7	45.7	ATS7
16	210	75	10	.15	.90	66	.88	75	.65	.54	48.0	45.6	ATS2
22	210	75	10	.15	.76	-1.76	.74	-1.81	.71	.54	46.7	45.6	ATS8
1	213	75	17	.15	.77	-1.64	.74	-1.81	.67	.54	56.0	45.8	P0E1
3	213	75	17	.15	.54	-3.72	.54	-3.51	.66	.54	66.7	45.8	P0E3
19	214	75	19	.15	.69	-2.32	.75	-1.69	.61	.54	61.3	45.8	ATS5
8	215	75	21	.15	.79	-1.48	.79	-1.37	.64	.54	44.0	46.0	P0E8
6	218	75	28	.15	1.46	2.72	1.48	2.69	.40	.54	42.7	46.5	P0E6
14	220	75	32	.15	.77	-1.61	.75	-1.66	.61	.54	53.3	47.0	C0I5
5	222	75	36	.15	1.01	.09	.96	23	.60	.53	53.3	47.1	P0E5
4	223	75	39	.15	.74	-1.84	.71	-1.91	.70	.53	56.0	47.2	P0E4
9	223	75	39	.15	.66	-2.52	.63	-2.59	.65	.53	56.0	47.2	P0E9
15	227	75	48	.15	.93	39	.91	49	.63	.53	46.7	48.5	ATS1
7	230	75	55	.15	.80	-1.32	.80	-1.21	.62	.53	60.0	48.6	P0E7
2	245	75	93	.17	1.24	1.37	1.08	.47	.62	.50	50.7	50.4	P0E2
13	251	75	-1.10	.17	.98	07	.85	77	.68	.49	57.3	52.5	C0I4
MEAN	204.1	75.0	.00	.15	1.00	1	1.05	.1	 		50.1	46.0	
P.SD	26.3	.0	.56	.01	.31	2.1	.41	2.4	İ		7.5	2.2	i

Item fit and item outlier or misfit can be seen from the level of item fit which are: a) OUTFIT MNSQ value > 0.5 and < 1.5, the closer to 1, the better the question item is, b) OUTFIT ZSTD value > -2.0 and < +2.0, the closer to 0, the better the question item is, and c) PT MEASURE CORR is considered as good if question item is in between > 0.4 and < 0.85. A question item is considered fit if it can meet at least one criterion. Outlier is defined as the observation data that is not consistent with its series (L. Budiarti, Tarno, & Warsito, 2013).

The table shows that there are six misfit items for OUTFIT MNSQ, which are the question items number 23, 10, 17, 11, 25, and 12. There are ten misfit items for OUTFIT ZSTD, which are items number 23, 10, 17, 11, 25, 12, 18, 3, 6, and 9. The table shows that there are six misfit items for PT OUTFIT MNSQ, which are the question items

number 10, 17, 11, 25, and 12. The items mentioned previously can be reconsidered before incorporating them into a measurement instrument for student grit.

CONCLUSION AND SUGGESTIONS

Based on the results, it can be concluded that the measuring scale is valid and reliable. Besides, the unidimensional analysis shows that the students' grit instrument development is in a good category. It means that the items of question in the instrument are able to do the intended measurement and accepted by the students as the respondents. Furthermore, all of the items of question in the grit measuring instrument can be done easily by almost all of the students and only a few of them are in a difficult category. Moreover, the strength of instrument's question items are lower than the students' grit ability, so that the students were able to answer the questions well and were encouraged to improve the grit within them. In order to refine the grit measurement instrument, the balance between the topics contained in the questions and the level of ability of students as respondents needs to be more considered.

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