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Factors Underlying Student Academic Grit: Development and Validation of the Scale

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Abstract

Academic grit can be a student's rock-solid confidence to maintain focus and go on learning despite obstacles in the way of achieving their long-term goals. This investigation into points to develop an academic grit scale and determine the variables that underlie students' academic grit will help to construct a significant and reliable tool for measuring academic grit. Twelve questions that measure students' intellectual grit when thinking about chemistry make up the intended survey. 817 understudies were randomly selected from 13 different state-tall schools to participate in the test. Calculations for reliability, confirmatory factor analysis, exploratory factor analysis, and Cronbach alpha internal consistency coefficient were done in the process of constructing the scale. It has been shown that academic grit assessments are reliable and significant tools that can be used with high school students studying chemistry. The encouraging results demonstrate Three essential elements: diligence, constancy in studying, and learning focus. These findings also suggest that female students have greater perseverance in their studies than male students.

Introduction

Education is the most important pillar in building a better life through the process of learning knowledge, skills, and habits, which can influence students` personal development. Recent research discusses that students face many challenges during their studies, including Examples: workload, learning helplessness, learning difficulties, study pressure, etc. (Posamak et al., 2023). One reason is that although they know they are capable, they are not motivated to complete tasks and believe that their performance is not good enough (Bozgün et al., 2022). Much science education research has investigated factors influencing academic success. Although most of this research focuses on cognitive factors, recent research is starting to address the importance of non-cognitive factors in academic success (Al-Mutawah & Fateel, 2018).

Success in learning is not only measured by cognitive factors, but non-cognitive factors also play an important role. Courage is an important factor in understanding students' academic learning, especially in improving students who are at high risk of not overcoming challenges in school. In recent years, grit has received increased attention from educational psychologists and has emerged as an important non-cognitive predictor of students' academic performance (Duckworth et al., 2007; Duckworth & Quinn, 2009; Duckworth & Yeager, 2015). At the same time,

(Paat et al., 2020) show that educational success depends on many interrelated factors and cannot be linked to just one factor alone.

Research on grit was introduced in 2007 by Angela Lee Duckworth, an expert in educational psychology. Grit is defined as the perseverance and enthusiasm a person must possess to achieve long-term goals (Duckworth et al., 2007). In a behavioral context, grit is defined as strength of character and tenacity. Grit can be interpreted as an aspect of personality that is characterized by efforts to achieve goals despite obstacles and failures in achieving them (Rusadi & Sugara, 2021). Grit, a relatively new concept in education, includes theories of passion and perseverance (Mattick et al., 2021) and is considered a non-cognitive skill known to predict success (Alan et al., 2019).

Three important elements of grit have been identified: (1) a clear goal to be achieved, (2) continuous effort to achieve the goal, and (3) commitment and enthusiasm for the goal. Clear goals emphasize the direction of the goal, and continuous hard work shows “persistence for effort,” which relates to the mental strength to continue working under pressure, but to achieve goals, commitment and passion relate to “consistency” interest"(Duckworth et al., 2007). Grit is not a simple combination of perseverance and interest, but rather an element of purposeful direction, distinct from persistence, interest, and a combination of both (Lam & Zhou, 2019). As a response, (Duckworth & Gross, 2014) found that the concept of grit strongly emphasizes the role of personal gain, and that courageous people are more likely to focus their interests on achieving future goals. Grit can be measured in a variety of ways, including forms of self-assessment and questions about everyday situations (Posamak et al., 2023).

Academic grit is a term used to describe grit in the academic realm. Academic grit is defined by (Dweck et al., 2014) as a mindset and skills that enable students to go beyond short-term goals and achieve long-term goals. Working hard and smart over long periods of time is the essence of resilience (Singh & Chukkali, 2021). Academic grit is a personality factor that explains differences in individual abilities in achieving academic success (Christopoulou et al., 2018). Academic grit is a personal characteristic or ability that includes determination, resilience, and focus in pursuing challenging long-term goals in education (Clark & Malecki, 2019). Academic grit is a character demonstrated through actions aimed at maintaining persistence and enthusiasm to achieve desired long-term goals (Sturman & Zappala-piemme, 2017).

Individuals with a high level of grit can use their skills to increase their efforts to achieve their vision (Credé et al., 2017). As a result, you become less focused on short-term goals and less afraid of the possibility of failure. Students with higher ambitions demonstrate higher engagement, which leads to higher academic productivity (Hodge et al., 2018). Students with high-grade scores have higher academic achievement than students with lower grit scores (Mason, 2018). Students with high grit scores are students who are hardworking and productive, able to persevere through difficult times, complete many difficult tasks, and overcome learning obstacles more easily. A review of relevant literature shows that academic ability positively predicts students' academic success (Clark & Malecki, 2019), academic performance (Pate et al., 2017), students GPA (Fong & Kim, 2021). career predictors (Lee & Sohn, 2017), self-efficacy (Alhadabi & Karpinski, 2019), gender (Shah, 2021; Sigmundsson et al., 2020;

Hwang & Lim, 2017) , increasing positive emotions (Datu et al., 2017), while negative levels are associated with levels of stress, depression, and anxiety (Mosanya, 2019; Musumari et al., 2018) dan test anxiety (Sturman & Zappala-piemme, 2017).

For the last 15 years, researchers studying grit have relied on two instruments to measure the construct. One of them is the Grit Scale which contains 12 items (Grit-O; Duckworth et al., 2007), and the other is the Short Grit Scale containing 8 items (Grit-S; Duckworth & Quinn, 2009). Both tools cover two subscales called Persistence of Effort (PE) and Consistency of Interest (CI). However, there are differences of opinion regarding the poor predictive power, subdimensions, and measurement performance of the grit scale (Datu et al., 2017; Tang et al., 2021).

One of the current debates regarding grit is that research on grit in adolescents is limited, with most research conducted on college students, and that this group needs to be more diverse. This is what underlies the idea (Tang et al., 2019). According to (Credé et al., 2017), most of the existing grit research was conducted in college-age samples using measures that were psychometrically tested in recent meta-analyses. Therefore, research on adolescents is needed to increase our understanding of grit. This is important for achieving outcomes and response to interventions. Developing a psychometrically rigorous measure of grit will not only help elucidate the relationship between grit and important youth outcomes in basic research, but also to assess the effectiveness of grit interventions in future applied research.

Similarly (Kardaş et al., 2022), Although the concept of grit has become a widespread research topic in the fields of mental health and education in recent years, ways to measure traits such as grit, tenacity, and perseverance are still limited, and existing measurement instruments are tools developed and adapted in other cultures. Although the validity and reliability of measurement instruments in adaptation research are calculated using statistical methods, developing measurement instruments directly for each culture versus adaptation, especially when measuring culturally sensitive personal characteristics, is important. This is considered important to do. Result of (Datu et al., 2017) also suggest that cultural differences in the conceptualization of grit are needed to improve the psychometric quality of grit measures.

The study of grit development in Indonesia was first carried out by (Indraswari, 2020) which measured the grit of 100 graduate students in two dimensions. The results obtained indicate that the grit scale measures grit structure consistently and satisfactorily. However, the development of grit measurement in Indonesia is still lacking, so it is necessary to develop measurement instruments (Nur & Al, 2023). Therefore, these findings will contribute to the development of appropriate academic grit measurement tools that focus on secondary school student performance and incorporate new elements of Indonesian student performance. The development of this device is something new in terms of teaching chemistry to high school students. From the various problems mentioned above, the research questions are as follows.

a. How good is the tool used to measure students' academic grit?
b. What factors underlie students' academic grit?
c. What is students' academic grit when studying chemistry?

d. Does gender significantly affect students' intellectual grit scores in chemistry classes?

Method

Research Design

This research is quantitative research conducted to develop valid and reliable measures of student academic grit. This research uses a development instrument (Retnawati, 2016: 3-6). This study will (1) determine the objectives of the equipment preparation; (2) Look for related theories. (3) Develop instrument/questionnaire indicators. (4) Develop equipment elements. (5) Content verification (expert assessment). (6) Revision Based on Validator Input. (7) Conduct experiments with appropriate respondents to obtain participant response data. (8) Perform analysis. (9) Assemble equipment.

This research process includes:

1. When planning competency measurements, researchers carry out activities to prepare an initial design for developing student academic retention tools. The preparation is as follows.

A. The purpose of this preparation is to understand equipment construction theory, equipment geometry, evaluation, and the meaning of equipment evaluation results. In this study, this instrument was used to measure academic persistence. The purpose of this test is to measure students' academic persistence in chemistry courses

B. In determining academic continuity, in this step the researcher determines the basic abilities and skills that students must have when studying chemistry.

C. Determining the constituent indicators. This stage is the configuration of the indicator configuration used to test the test equipment. The arrangement of indicator constructs in Table 1 is as follows:

Table 1. Construct Indicators

Dimension	No	Indicators
Consistency	1	Although I found it difficult, I tried to complete the group internship.
of study	2	I don't like chemistry problems, but I find ways to solve them.
	3	I am working intensively on chemistry problems.
	4	I studied chemistry seriously during my studies.
	5	I will try to maintain good grades even after passing the chemistry exam.
	6	If I fail the chemistry exam, I will practice more and try harder.
Working	7	I have doubts about my ability to complete a group internship.
hard	8	I am having difficulty solving the chemistry assignment given by my teacher.
	9	I'm interested in classes that don't involve chemistry.
	10	Chemistry is difficult for me, so I will study other subjects.
Focus study	11	I tend to relax when working on chemistry problems.
	12	I am satisfied with the results of my chemistry test.

D. As part of the preparation of the `"Academic grit" tool, the next step is to develop the tool based on the

evaluation of the indicator configuration. An inquiry item will be created

1. Content Validation: This step is carried out to test aspects and indicators of academic sustainability through experts. The goal of this activity is to achieve content performance that meets content, organizational, and language requirements.
2. Equipment is repaired and the equipment is rebuilt in accordance with the law. The goal is to improve the quality of the devices produced.
3. Tool testing: this stage tests whether the academic persistence tool developed is based on sufficient empirical evidence and limited testing of the tool developed is to obtain the required empirical data. Validity and reliability criteria for data and product parameters are met. The aim of this experiment is to obtain an estimate of students' academic persistence in learning chemistry, to determine the application of the model, to evaluate the problem parameters and to determine possible obstacles in carrying out the experiment.
4. Measurement The final step in developing this research tool is measurement. This is the step that determines a student's academic grit. This measurement was carried out in Pekanbaru, Indonesia.

Participants and Measurements

This research was carried out in 13 different state high schools. Research students were randomly selected as research samples from first and second year high school students using simple random sampling techniques. The sample consisted of 817 students, 275 male students and 542 female students. Data obtained from the selected sample was used to investigate how respondents reported their academic persistence in studying chemistry.
Questionnaires are used to collect data about test subjects and measurements. A survey is a series of questions asked of individuals to obtain statistically useful information about a specific topic (Roopa, 2012). The academic grit questionnaire consists of 12 Likert scale items with five point answers ranging from 1 (disagree) to 5 (strongly agree) using Google Forms. The data collection instrument was developed by the researcher to develop a measure of academic persistence in chemistry research. Definition of grit according to (Duckworth & Quinn, 2009) and (Clark et al., 2019) has been modified to say that academic grit consists of study consistency, working hard, and study focus. The three academic grit factors are defined as follows:

- The first dimension is study consistency, related to students' efforts to maintain interest in learning chemistry in order to achieve their goals.
- The second dimension is working hard, namely behavior that shows seriousness in chemistry teaching and learning activities.
- The third dimension is the study focus, to achieve academic goals and keep everything clear and put aside things that are not related to academic activities

Data Analysis

Content Validity

Content validity was determined based on expert consensus. The consensus of experts in the field, or what is often called the measurement domain, determines the degree of content validity (content-related). Measurement

instruments, for example in the form of tests or questionnaires, are used if experts assume that the instrument measures proficiency in a skill specified in the psychological domain or domain that is to be measured, and is proven to be valid. To determine suitability, validity indices are used, including the index proposed by Aiken (1985).

Construct Validity

Construct validity in this research is used to test the extent to which the instrument can measure a particular construct. There are two types of construct validity, namely EFA (exploratory factor analysis) and CFA (confirmatory factor analysis). The analysis tool used for the EFA and CFA constructs uses JASP 0.16.2.0.

EFA

EFA aims to determine the latent composition of item sets in a variable and determine the composition of factors or dimensions (Hu & Li, 2015). At the initial factor analysis (EFA) stage, the data was filtered using the Kaiser-Meyer Olkin (KMO) Measure of Sampling Adequacy (> 0.5) and Bartlett's Test of Sphericity (< 0.05) (Taherdoost et al., 2020). Parallel analysis with Principal Component Analysis was conducted to identify the number of factors to be retained in the model, twelve items and a sample size of 817 were calculated, and factors with Eigenvalues > 1 were considered (Wood et al., 2016).

CFA

The next analysis is factor analysis using confirmatory factor analysis (CFA). The goal of CFA is to provide confirmatory evidence of the validity of the theorized model (Lottero-Perdue, P.S. & Lachapelle, 2019). CFA in this research was conducted to test the suitability of the construct model used to measure academic grit. The accuracy of the model can be seen using chi-square criteria (χ^2 /df ≤ 3, perfect fit; Hooper et al., 2008, Kline, 2016), other goodness-of-fits indices such as Normed Fit Index (NFI ≥ .90, acceptable; Bentler & Bonett, 2014), Comparative Fit Index (CFI ≥ .90, acceptable; Hooper et al., 2008) and Root Mean Square Error of Approximation (RMSEA ≤ .08, good; Hooper et al., 2008).

Result

Instrument Content Validity

The content validity of this instrument is carried out by reaching a master judgment to survey the scholarly coarseness of the instrument and the things that will be utilized in creating the instrument. There were five specialists included in the appraisal. The questions surveyed for substance legitimacy consisted of 12 things employing a Likert scale (scale 1-5).

Based on Table 2, it can be concluded that the 12 things surveyed utilizing master judgment are within the tall category. This implies that the extent of V numbers from the investigation comes about ranges from 1.00, so all

the V comes about over have great coefficient values. So that the things have great substance legitimacy and back the substance validity of the test as an entire. Total points of interest can be seen within the taking after table.

Table 2. Instrument Content Validity Results

No	Rater													
	1	2	3	4	5	S1	S2	S3	S4	S5	Σs	n(c-1)	V	Information
1	4	4	4	4	4	3	3	3	3	3	15	15	1	Valid
2	4	4	4	4	4	3	3	3	3	3	15	15	1	Valid
3	4	4	3	4	4	3	3	3	3	3	15	15	1	Valid
4	4	3	3	4	4	3	2	3	3	3	14	15	0.93	Valid
5	4	4	4	4	4	3	3	3	3	3	15	15	1	Valid
6	4	4	4	4	4	3	3	3	3	3	15	15	1	Valid
7	4	4	4	4	4	3	3	3	3	3	15	15	1	Valid
8	4	4	4	4	4	3	3	3	3	3	15	15	1	Valid
9	4	4	4	4	4	3	3	3	3	3	15	15	1	Valid
10	4	3	4	4	4	3	2	3	3	3	14	15	0.93	Valid
11	4	3	4	3	4	3	2	3	2	3	13	15	0.87	Valid
12	4	4	4	4	4	3	3	3	3	3	15	15	1	Valid
Average Aiken V Index													0.9775	Valid

Construct Validity

EFA

EFA in this think was to test the ampleness of the test utilized within the examination of academic grit. The test was 817 understudies with 12 test things. The taking after are the comes about of the EFA investigation that has been carried out:

Table 3. KMO and Bartlett's test

KMO and Bartlett’s Test		
Kaiser-Meyer-Olkin Measure of Sampling	Adequacy	0.855
Bartlett's Test of Sphericity	Approx. Chi-Square	3469.729
	df	66
	Sig.	0.000

The result of the examination over can be concluded that the KMO esteem is 0.855 > 0.05. This implies that the instrument utilized has a satisfactory demonstration. So, it can be proceeded for examination. In expansion, the comes about of Bartlett's test of sphericity was calculated as χ^2= 3469.729, and looks significant at the <0.001 level.

These comes about illustrate appropriateness for calculate examination. When performing EFA in academic grit,

the promax revolution operation is connected. Based on this examination, three variables were gotten whose eigenvalues were over 1 for 12 things. A figure develop is considered steady on the off chance that its eigenvalue is 1 or more.

The result of the other investigation is to see how numerous components contained within the instrument can be seen from the scree-plot. The taking after are the comes about of the scree plot investigation (Figure 1):

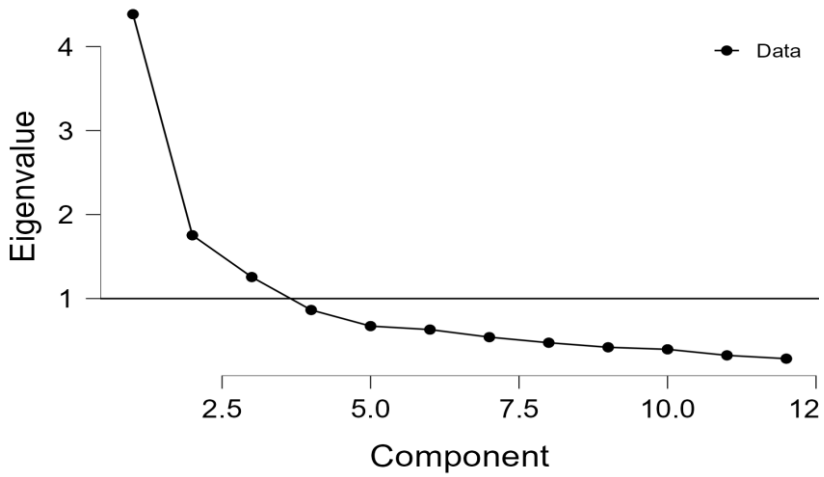

Figure 1. Scree Plot Academic Grit

Based on the picture (Fig. 1), it can be concluded that the eigenvalue starts to incline at the 3rd figure. The change of the primary measurement is 36.542%, the moment is 14.613%, and the final is 10.466%. The biggest eigenvalue is 4.385 for the primary measurement, whereas the consequent eigenvalues are 1.754 and 1.256 separately as seen in Table 4.

Table 4. Total Variance Explained by the Research Instruments

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.385	36.542	36.542	4.385	36.542	36.542
2	1.754	14.613	51.155	1.754	14.613	51.155
3	1.256	10.466	61.621	1.256	10.466	61.621

Within the handle of naming scholastic coarseness subfactors, both the thing substance and significant writing were considered. In this manner, components 1, 2, and 3 were named as “study consistency” (6 things), “working hard” (4 things), and “study focus” (2 things), separately.

CFA

The CFA test for the scholastic coarseness estimation instrument was created to degree the instrument develop

which comprises of three variables, to be specific (1) study consistency; (2) work hard; and (3) study focus. These three components were tried through CFA. This build legitimacy test was carried out to reply investigate questions related to the quality of the instrument that meets legitimacy and unwavering quality.

Table 5. EFA Results of the 12 Academic Grit Items

Factor	No	Item	Factor loading		
			F1	F2	F3
		Study consistency			
	1	Although I found it difficult, I tried to complete the group internship.	0.724		
	2	I don't like chemistry problems, but I find ways to solve them.	0.546		
	3	I am working intensively on chemistry problems.	0.722		
	4	I studied chemistry seriously during my studies.	0.735		
	5	I will try to maintain good grades even after passing the chemistry exam.	0.808		
	6	If I fail the chemistry exam, I will practice more and try harder.	0.772		
Academic		**Working hard**			
grit	7	I have doubts about my ability to complete a group internship.		0.531	
	8	I am having difficulty solving the chemistry assignment given by my teacher.		0.807	
	9	I'm interested in classes that don't involve chemistry.		0.480	
	10	Chemistry is difficult for me, so I will study other subjects.		0.482	
		Study focus			
	11	I tend to relax when working on chemistry problems.			0.564
	12	I am satisfied with the results of my chemistry test.			0.627
% Of variance			F1=36.542	F2= 14.613	F3= 10.466
Eigenvalue			4.385	1.754	1.256

The CFA test for the academic grit instrument was created to the degree the instrument developed which comprises three variables, specific (1) study consistency; (2) working hard; and (3) study focus. These three components

were tried through CFA. This construct validity test was carried out to reply to investigate questions related to the quality of the instrument that meets validity and reliability.

The CFA on the grit academic instrument that was created consisted of 12 items. Here's what the test took place:

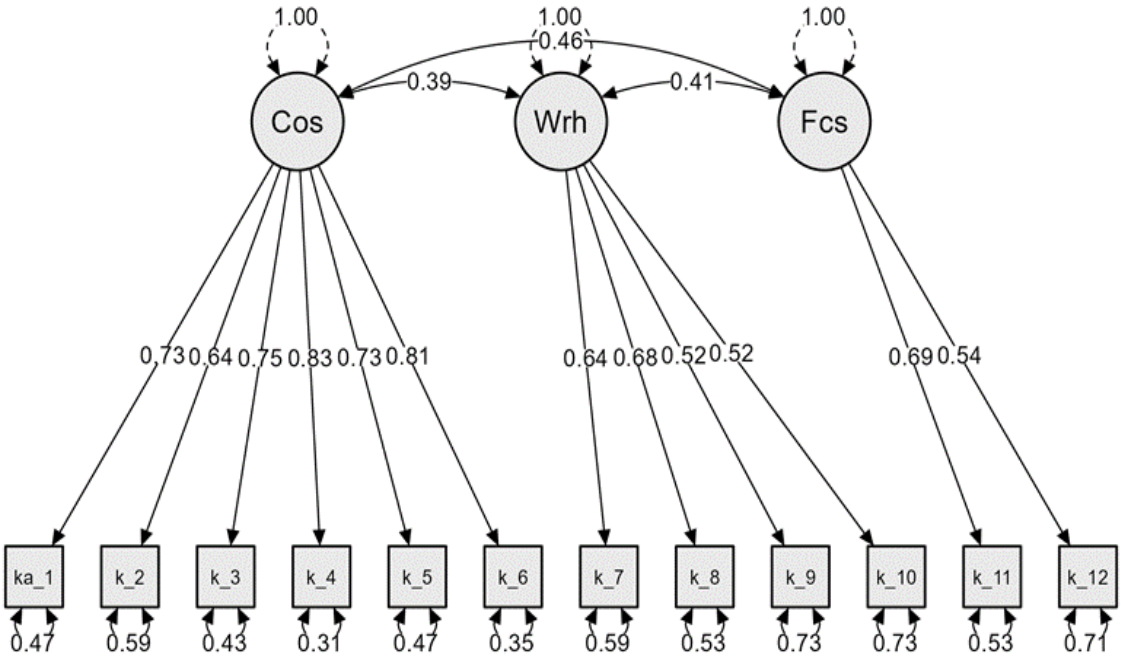

Figure 2. Model Plot CFA

Based on the comes about of the examination in Figure 2 over, the results of the suitability test for the student academic grit measurement instrument meet the model suitability test criteria (good of fit) using the following commonly used suitability index ($\chi 2$ /df = 2.48, perfect fit, $\chi 2$ = 126.452, df = 51, $p < 0.05$), NFI 0.974 (NFI≥0.90), CFI 0.984 (CFI≥0.90), RMSEA 0.043 (RMSEA≤0.08). Hence, the instrument for measuring academic grit is based on hypothetical ponders in agreement with observational information within the field.

Instrument Reliability

Reliability refers to whether an appraisal instrument is nice giving the same comes about every time it is utilized within the same circumstance with the same sort of subject. reliability fundamentally implies reliability or solid comes about. Reliability quality is a portion of validity evaluation (Sullivan, 2011). Cronbach's alpha coefficient (which may be a degree of inside consistency) is calculated for each academic grit which comprises three sub-factors, specifically study consistency (SC), working hard (WH), and study focus (SF). The reliability coefficient (alpha) for the three sub-factors was found to be 0.883, 0.681, and 0.541 individually, and the overall alpha was 0.829 in detail. See Table 3. Agreeing with analysts, the reliability quality category based on Cronbach's Alpha esteem is less dependable (0-0 .2), to some degree solid (>0.2-0.4), modestly solid (>0.4-0.6), dependable (>0.6-0.8), and exceptionally solid (>0.8) (Hair et al., 2019).

Results of Pearson's Correlation Analysis between the Academic Grit Sub-Dimensions

These three variables were found to correlated significant (see Table 6). The relationship between study consistency and study focus is the most noteworthy whereas between working hard and study focus is the most reduced, even though all three are significant.

Table 6. Correlation between the Components of Academic Grit

		Study consistency	Working hard	Study focus
Study consistency	Pearson Correlation	1	.301**	0.322**
	Sig. (2-tailed)		.000	.000
	N	817	817	817
Working hard	Pearson Correlation	.301**	1	.253
	Sig. (2-tailed)	.000		.000
	N	817	817	817
Study focus	Pearson Correlation	.322**	.253**	1
	Sig. (2-tailed)	.000	.000	
	N	817	817	817

**. Correlation is significant at the 0.01 level (2-tailed).

Predominance of Academic Grit among Understudies

This reflection uncovered three basic academic grit variables, each indicating different levels of academic grit. In accordance with the answers, the level of study consistency was moderate (M=14.77, SD=4.06), low working hard (M=9.93, SD=3.56), and low focus study (M=20.03; SD=5.02) (see Table 7).

Table 7. The Academic Grit Level of Students in All Dimensions

Variable	N	Min	Max	Mean	SD
Study concistency	817	6	30	20.07	5.931
Working hard	817	4	20	11.81	3.245
Study focus	817	2	10	6.10	1.953

Gender Differences in Academic Grit

The t-test resulting from this study revealed that women demonstrated factual critical differences and the highest level of academic grit in studying chemistry with three basic components (study consistency: women M = 20.32, men M = 19.58), (working hard: female M = 11.95, male M = 11.53) and (study focus: female M = 6.29, male M = 5.74) (see Table 8).

Table 8. t-test on Academic Grit between Women and Men

Variable	Gender	N	M	SD	t	df	Sig.
Study	Male	275	19.58	6.569	-1.605	478.078	0.091
consistency	Female	542	20.32	5.569			
Working hard	Male	275	11.53	3.587	-1.658	479.227	0.081
	Female	542	11.95	3.050			
Study focus	Male	275	5.74	1.770	-3.807	617.803	0.000
	Female	542	6.29	2.016			

Discussion

This research aims to develop a measure of academic grit and identify the factors underlying students' academic grit in learning chemistry. As part of scale improvement, 12 items were created based on a writing audit, and their content validity and construct validity were measured. Because the content validity test results of the instrument are >0.7, the content validity test results are declared valid. From the results of the analysis, it can be seen that the instrument for measuring the sustainability of academic grit as a whole has fulfilled the rules of item construction and has proven its suitability for measuring students' academic grit.

The results of this research show that there are three factors that influence students` academic grit. This means study consistency, working hard and study focus. There are many standardized grit measures such as findings (Duckworth et al., 2007) developed the Grit-O scale consisting of 12 items, which was later revised into the Grit-S scale consisting of 8 items (Duckworth & Quinn, 2009). The structure of grit consists of two important aspects: consistency of interest and persistence. The first dimension involves a long-term focus on clear long-term goals, while the second dimension emphasizes overcoming adversity and perseverance to overcome challenges along the way (Duckworth et al., 2007).

The study (Kardaş et al., 2022) developed a tool to measure grit for students and tested the measurement invariance of the developed scale in two different groups. The results of exploratory factor analysis show that the grit scale consists of 14 items with three subdimensions. The dimensions of this scale are persistence of interest, determination, and consistency. Other than that, (Kuruveettissery et al., 2023) reported that three psychometric components consisting of 17 items were developed: Perseverance-Commitment (PC), Interest-Passion (IP), and Goal-Oriented Resilience (GR).Then, (Clark et al., 2019) said in 2019 that grit assessments commonly used today may not be appropriate for young people. The Academic Grit Scale aims to measure the academic grit of the younger generation, especially in the academic field and correct potential weaknesses in the existing scale. The dimensions of academic grit are the dimensions of determination, resilience, and factors consisting of 30 items. The findings (Datu et al., 2017) found that the three-dimensional grit model may be more suitable for measuring Filipino students' grit through the dimensions of consistency of interests, persistence of effort, and ability to adapt to situations.

As reported in Table 6, academic persistence shows a significant and positive relationship with all three factors

(i.e., study consistency, working hard and study focus) at $p<0.01$. Then, this research found that three factors underlie academic grit, each showing different levels of grit. This is because grit is a trait that changes depending on environmental interventions, such as individual effort and the amount of time spent on the task at hand (Alan et al., 2019). Grit, like all identity characteristics, is affected by hereditary qualities. Moreover, some say there are social contrasts in conceptualizing grit in learning. Based on these discourses, it is anticipated that the improvement of unused estimation apparatuses in completely different societies and age bunches will permit the rise of distinctive measurements and introductions regarding the concept and in this way, it'll contribute to the advancement of writing on the subject with diverse focuses of see (Kardaş et al., 2022).

Other creators such as (Sheldon et al., 2015) compared grit with nine other positive identity characteristics in a consideration of objective fulfilment over a year and found that grit was the foremost dependable indicator of accomplishing by and by significant objectives over that period. These discoveries show that grit is a critical calculation that decides victory, even though not as it were one. From an intercession and instruction viewpoint, the examination of grit as a result turns out to be as imperative and vital as grit as an indicator. The shortage of predictive research on grit is obvious within the writing and this may be because analysts are more inquisitive about considering the prescient execution of different measures than the inverse approach (Fernández-martín et al., 2020). Grit is a vital figure that contributes to a person's victory, characterized by energy, diligence, and a willingness to face dangers. Grit can be measured in different ways, counting shapes of self-assessment and questions around lifestyle circumstances (Posamak et al., 2023). In this manner, future investigations may construct on our starting assessment by looking at other psychometric properties of the instrument such as test–retest unwavering quality and prescient legitimacy. Such work might moreover consider the commitment of grit and its components to victory in accomplishing long-term objectives in Spanish-speaking populaces controlling for mental and instructive factors, as has been drained English-speaking populaces with the initial form of the scale (Arco-tirado et al., 2018)

This study revealed that women's average score showed a higher level of academic persistence than men in all dimensions, although the difference was only slightly higher. However, in the dimensions of study focus, there are significant differences between women and men, while in the dimensions of study consistency and working hard, there are no significant differences. This is because women maintain their speed at the maximum level when we talk about hard work and dedication to achieve long-term goals compared to men. Whenever they are faced with a difficult challenge, they try to overcome it with the same effort and hard work that they usually show in some other situation and they do not stop until they have completed the task completely. Even unfamiliar situations do not dampen their enthusiasm to return to the past and they become very motivated and dedicated to their work, so situations like this can be overcome by trying as hard as possible.

In general, women are more persistent than men (Kumar & Rathee, 2019). Similar research also shows women have higher grit scores than men (Sigmundsson et al., 2021; Kannangara et al., 2018; Christensen & Knezek, 2014). This is different from previous research carried out by (Shariff et al., 2022; Olabode, 2022) found that there was no distinction in scores between women and men. This in a roundabout way demonstrates that studies regarding gender differences in academic grit are still conflicting and require advance consideration.

Conclusion

This research concludes that the development of instruments for measuring student academic grit can be continued well because it produces valid and reliable measurements. Therefore, it is important to examine academic grit in chemistry learning among upper-secondary students. These findings show that there are three factors of student academic grit; namely, study consistency, working hard, and study focus. Although these three factors are correlated, students' abilities on each factor vary. The student's academic grit level on the study consistency factor is moderate, while their scores on the working hard and study focus factors are low. Further findings reveal that women show a higher level of academic grit than men in all fundamental factors, study consistency, working hard, and study focus. In this context, the factors developed can be used to examine the strength of the grit character in learning. On the other hand, grit is an important feature of the student development process as a non-cognitive skill.The literature has benefited greatly from the current study in several ways. First, this study sheds light on the connection between gender disparities in chemistry learning and students' academic grit, which is currently uncommon in the literature on psychology and learning education. Second, the findings of this study lend credence to the notion that a student's academic grit plays a significant role in indicating their level of learning accomplishment. More learning outcomes can be attained by students with high academic grit than by those with lower levels of grit. Third, academic grit is a measurement technique that was created to objectively demonstrate different psychological objectives through science or application in the education sector as well as other broader domains.

Recommendation

This investigation can be suggested to instructors who educate chemistry in high school. Moreover, the components compiled in creating this instrument have to be considered carefully by the educator. This aims to back students' information, demeanors, and abilities within the learning handle so that understudies have long-term objectives in accomplishing their instruction. This research contains several statements that are unique to Indonesian culture and are recommended for use in other related cultures.

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