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Academic Grit Scale in Primary School: Relationship With Attitude Toward Science and School Belonging

Menşure Alkış Küçükaydın

Necmettin Erbakan University, Konya, Turkey

Correspondence: Menşure Alkış Küçükaydın (mensurealkis@hotmail.com)

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ABSTRACT

The Academic Grit Scale (AGS) precisely measures grit in the academic domain. However, the AGS has only been adapted to a limited number of samples, and little evidence of its reliability and validity has been presented. The current study consists of two separate studies addressing the AGS. In Study-1, the 10-item unidimensional structure of the AGS was confirmed by confirmatory factor analysis in a Turkish sample of children aged 8–11 years. Different reliability coefficients supported the high reliability of the AGS. In Study-2, two models addressing the relationship between academic grit, science attitude and school belonging were tested. Structural equation modelling showed that science attitude mediated the relationship between academic grit and school belonging. Adapting AGS to different cultures is valuable in highlighting academic grit's social and cultural structure. In addition, the present study revealed the relationship between academic grit, science attitude and school belonging for the first time. This indicates that academic grit can be addressed in different contexts across disciplines.

1 | Introduction

In educational settings, students' effort and determination to achieve their long-term goals is an important factor affecting their academic success (Lam and Zhou 2022). In particular, academic grit represents the ability of individuals to persevere despite the difficulties they face in their learning processes (Duckworth et al. 2007). However, measuring and assessing academic grit may vary in different cultural contexts (Lin et al. 2024; Kolemba et al. 2024). This necessitates the development of scales that consider the impact of cultural and educational context on individuals' academic perseverance levels (Robertson-Kraft and Duckworth 2014). Particularly in the Turkish context, there is limited evidence of students' perseverance toward their academic goals and how it relates to variables such as attitudes toward science or school engagement (Sağkal et al. 2020; Kaya and Kaya 2022). Considering the unique structures, such as the education system in Turkey, teacher-student interaction structure, and exam orientation, the need for a valid and reliable academic grit scale for this context is increasing. This study aims to develop a measurement tool specific to the Turkish sample and test the psychometric properties of this instrument to fill this gap.

Previous studies have generally addressed academic grit through two dimensions (perseverance of effort and consistency of interests) (Peña and Duckworth 2018) but have not adequately assessed how this concept changes across developmental processes or how it interacts with contextual factors (Postigo et al. 2021; West et al. 2016). Moreover, there is no direct research on how academic grit relates to science attitude and school belonging during the educational process. However, it is important to note how providing students with academic grit at an early age affects their science achievement and school belonging life (Bazelais et al. 2016). Accordingly, this study not only defines the concept of academic grit but also makes a unique contribution to the literature by revealing its dynamic

Summary

- Academic grit scale is a valid and reliable instrument in Turkish sample.
- Academic grit scores are not change between male and female students.
- Science attitude mediated the relationship between academic grit and school belonging.

relationship with science attitude and school belonging. Academic grit, which is generally examined at the secondary and university levels in the literature (Harpaz et al. 2024; Hodge et al. 2018; Lee 2017), is examined at the primary school level in this study, both generating theoretical knowledge about early age groups and providing a new assessment tool for practitioners. Moreover, information about the relationship between academic grit, age, and gender will be presented. Previous studies found that academic grit varied according to gender (Clark and Malecki 2019; Kolemba et al. 2024) and had a negative relationship with age (Lin et al. 2024). Therefore, this study provides a new perspective on academic grit at both cultural and developmental levels.

Therefore, the unique contribution of this study is that it comprehensively examines the relationship between academic grit, science attitude, and school belonging for the first time and presents the validity and reliability analyses of the academic grit scale (AGS) in the Turkish sample. Measuring the concept of academic grit, especially at the primary school level, will bring a new perspective to the literature. Accordingly, the study proceeds in line with two main research questions:

RQ1. *Is the Turkish version of the AGS a psychometrically valid and reliable measurement tool?*

RQ2. *How are the relationships between academic grit, science attitude, and school belonging shaped?*

2 | Theoretical Background

2.1 | Academic Grit

Self-regulation theory is one of the most basic theories underlying the concept of academic grit (Zimmerman 2002). According to this theory, students' ability to manage themselves in academic processes is directly related to their grit and goal-setting mechanisms. Individuals with well-developed self-regulation skills can develop conscious strategies to overcome their learning difficulties and demonstrate academic grit more effectively. Another important theoretical framework is the social cognitive theory (Bandura 1997). According to this theory, individuals' motivation in the learning process is shaped by environmental factors and personal beliefs. Self-efficacy belief plays an important role, especially in developing academic grit. Bandura (2006) states that self-efficacy belief increases individuals' efforts to achieve their academic goals and makes them more strongly committed to the learning process.

Academic grit is a critical variable that describes students' grit and determination to achieve long-term goals (Duckworth et al. 2007). According to Lin et al. (2024), academic grit does not reflect passion for long-term goals. In addition, although there is a change in general grit and academic grit over time in all age groups, the change in academic grit does not exactly parallel the change in general grit (Akos and Kretchmar 2017). Moreover, it provides academic grit, determination, resilience, and focus, offering a more targeted measure of perseverance in long-term educational goals (Lin et al. 2025). According to Clark and Malecki (2019), this concept is defined by the persistence individuals' show in achieving their goals despite obstacles in the learning process. Especially in educational settings, academic grit is a critical factor that strengthens students' motivation and commitment to learning processes (Strayhorn 2014).

Credé et al. (2017), who conducted a meta-analysis review of the relevant literature, stated that a close relationship exists between the mentioned aspects of grit and academic performance. In this context, Kirchgasler (2018) pointed to academic grit in developing many school-based intervention programs to increase academic achievement. Based on these results, academic grit is associated with academic achievement and represents a passion for challenging educational goals (Rusadi et al. 2023). Therefore, academic grit may be related to other school-related variables.

2.2 | Relationship Between Academic Grit, School Belonging, and Science Attitude

School belonging refers to students' social and psychological bonds in the educational environment. Accordingly, students feeling supported and accepted by others and knowing that they are respected is related to school belonging (Juliyabadu Gunathilake et al. 2025). Goodenow (1993) showed that school belonging increases students' motivation to learn and supports their persistence in the educational process. Previous studies reported that school belonging is associated with student engagement in tasks, academic performance, and social development (Watson 2017). Niehaus et al. (2016) found that school belonging was associated with positive academic outcomes, such as student achievement, effort, and enthusiasm. Bowman et al. (2015) reported that individuals with high school belonging will have greater feelings of community, increased participation in extracurricular activities, and increased communication within the school. Liu and Huang (2025), who studied mathematics attitudes among secondary school students, reported that school belonging directly affects mathematics achievement in the United States. Similarly, Baş (2025) emphasized the positive relationship between feelings of belonging and academic achievement. Therefore, there appears to be a relationship between school belonging and positive academic development. However, the relationship between school belonging and academic grit is not clear. Accordingly, addressing academic grit in an educational context may represent a critical point for understanding students' motivational processes.

Science attitude encompasses students' interest, motivation, and learning strategies toward science (Smith et al. 2022). Previous studies have shown that positive attitudes toward science

courses directly impact students' academic efforts and learning strategies (Küçükaydın 2021; Mao et al. 2021). How positive attitudes toward science shape students' commitment to the educational process and school belonging has been previously investigated (Liou 2021). Results showed that science attitude is one of the key factors shaping students' interest in scientific knowledge, motivation to learn, and long-term academic success in STEM fields (Palancıoğlu et al. 2023).

Science education increases students' academic grit as a field supporting problem-solving skills and analytical thinking (Eroğlu 2023). Especially in Bandura (1997) social cognitive theory, science attitude is seen as a fundamental factor that strengthens students' self-efficacy perceptions and academic motivation. For this reason, choosing a science attitude instead of an educational attitude in the study allowed for a more detailed examination of how academic grit is shaped in a disciplinary context. This approach offers a unique contribution to educational psychology.

Developing positive attitudes toward science courses can increase students' academic achievement in science and support their academic grit in learning processes (Hill et al. 2024). Science education is a fundamental process that develops students' ability to understand scientific concepts, inquiry, and problem-solving (Tytler and Ferguson 2023). Research on how academic grit plays a role in this process suggests that the challenges encountered in science lessons can significantly impact students' grit (Küçükaydın 2021). It has been reported that students who develop positive attitudes towards science have higher academic grit, reflecting positively on their learning processes (Mao et al. 2021).

On the other hand, students' sense of belonging to school plays a decisive role in developing academic grit. Bowman et al. (2015) showed that school belonging enables students to be more integrated into the educational process and increases academic motivation. However, no comprehensive studies have examined the impact of academic grit on school belonging through scientific attitudes. Previous studies have generally focused on the direct link between academic grit and achievement but have not assessed how it interacts with factors such as science education and school belonging (Rusadi et al. 2023). Therefore, this study aims to provide a new perspective to the literature by addressing how academic grit interacts with science attitude and school belonging. In particular, science education and school belonging processes are important for understanding the functionality of academic grit in the educational context. For this purpose, the study was structured as Study-1 and Study-2. Study-1 included adapting the academic grit scale into Turkish; Study-2 examined two models testing the relationship between the adapted academic grit scale and science attitude and school belonging.

3 | Study-1

In this phase of the study, the validity and reliability analyses of the Turkish adaptation of the AGS are presented and confirmatory factor analysis (CFA) of the AGS is presented.

3.1 | Method

The study adopted a quantitative research approach. The data collection process was based on the questionnaire method, and the scale's psychometric analysis was carried out using CFA and structural equation modeling (SEM).

3.2 | Participants and Procedure

This study included 668 students from three primary schools in the Central Anatolia Region of Turkey. Schools from different socioeconomic levels were selected during sample selection to ensure diversity in student profiles. This selection method is critical in assessing the scale's validity for different student groups.

The purposive sampling technique was adopted as the sampling method. Since the target group of the study is primary school students in a particular age group, the sample was formed according to specific criteria to evaluate how academic grit is shaped in this age range. Instead of random sampling to represent the general population, selecting students who could provide sufficient information on this topic strengthened the study's validity. In addition, the schools participating in the study were selected from different socioeconomic levels to ensure diversity so that the scale's functionality in different student groups could be evaluated. The choice of this method allowed the study to examine in detail the age-related variations of academic grit and its effects in the educational context.

Participants were recruited voluntarily, and written informed consent was obtained from the parents before their inclusion in the study. The data collection process consisted of the following stages: Ethics committee approval was obtained from the university where the researcher was affiliated, and official permissions were sent to the relevant primary schools. Students were informed by their classroom teachers, and brief explanations were given to help them understand the scale items; however, responses were not directed. The questionnaires were administered to the students face-to-face. It took approximately 40 min for the students to complete the questionnaires.

A total of 668 primary school students participated in the study. Of the students, 384 (57.5%) were female and 284 (42.5%) were male. The mean age of the students was 10.64 years (range = 6, SD = 1.21).

3.3 | Instrument

3.3.1 | Academic Grit Scale (AGS)

The AGS was developed by Clark and Malecki (2019). AGS is a one-factor structure with four items about determination, four about resilience, and two about focus. The one-dimensional scale consists of 10 items rated on a 5-point Likert scale (1 = *Not at all like me* and 5 = *Very much like me*). Higher scores reflect higher academic grit. Researchers have examined the validity and reliability of the scale through intra-item correlation analysis, factor analysis, and Cronbach's alpha coefficients (for more details, see Clark and Malecki 2019). In this study, the single-

TABLE 1 | Descriptive statistics of AGS.

	Min	Max	Mean	SD	Skewness (*S.E.* = 0.09)	Kurtosis (*S.E.* = 0.18)
AGS Total	22.00	50.00	41.23	6.55	−0.87	0.37
Item 1	1	5	3.98	1.09	−1.16	0.95
Item 2	1	5	4.04	1.03	−1.02	0.52
Item3	1	5	4.11	0.99	−1.05	0.48
Item 4	1	5	4.24	0.94	−1.31	1.41
Item 5	1	5	4.26	0.85	−1.22	1.27
Item 6	1	5	3.93	1.08	−0.93	0.22
Item 7	1	5	4.37	0.86	−1.44	1.65
Item 8	1	5	4.18	0.93	−1.01	0.37
Item 9	1	5	3.96	1.05	−0.99	0.51
Item 10	1	5	4.17	0.99	−1.24	1.16

factor structure of the scale was analyzed as proposed by Clark and Malecki (2019) and as in previous Chinese versions (Bei et al. 2024; Lin et al. 2024; Tang et al. 2019) and the Polish version (Kolemba et al. 2024).

After obtaining author approval, the AGS was translated into Turkish for use in the Turkish sample. According to Brislin (1970) translation procedures for cross-cultural studies, two independent bilingual translators first translated English into Turkish. Then, the scale was back-translated into English by two other translators. The process continued until all items were retained in the Turkish version. In the final stage, a mini panel of all translators participated online to review the translations and back-translations and produce a final version (the Turkish version of the AGS is presented in the Appendix A1).

In the final stage, the final Turkish form was sent to a Turkish teacher to assess the clarity and comprehensibility of each item. Before the implementation, 12 primary school teachers were asked to evaluate the fluency and clarity of each item. Thus, the form was made ready for implementation.

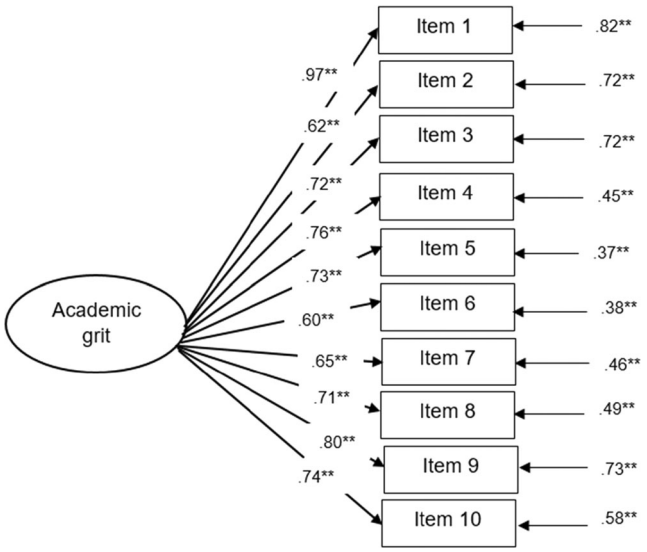

FIGURE 1 | Factor structure for the AGS. *Note*: ***$p < 0.001$.

3.4 | Data Analysis

The 10-item structure of the AGS was analyzed with CFA using maximum likelihood estimation in AMOS Graphics. The main reason for using AMOS software in the study is that it provides a suitable environment for applying CFA and SEM techniques. AMOS can visually represent SEM analyses and facilitate model-building, primarily through its graphical interface. It was also preferred because of its capacity to integrate multivariate statistical techniques and provide a wide range of goodness-of-fit indices for confirmatory analyses.

CB-SEM (Covariance-Based SEM) was preferred in this study because the research aims to test a theoretical model and evaluate the causal structure of the relationships between variables. CB-SEM is a more appropriate method to evaluate the general validity of the model and the accuracy of the measurement structure by providing reliable results, especially in scale adaptation studies and psychometric evaluation processes (Hair et al. 2014). To assess model fit, $\chi^2/df < 3$; AGFI, GFI, NFI, IFI, CFI, and TLI > 0.90; RMSEA and S-RMR < 0.10 (Schermelleh-Engel et al. 2003) were used. In addition, item-total correlations of the scale were examined. In addition, factor loadings and average variance extraction (AVE) values were calculated for validity. For reliability, different reliability coefficients such as Cronbach's alpha (α), McDonald's omega (ω) and composite reliability (CR) were also calculated.

3.5 | Results

Table 1 show the skewness and kurtosis indices, which indicate that the distribution of the AGS results does not deviate from normal.

CFA was used to validate the scale structure. A single-factor model was tested (Figure 1), as in both the original scale by Clark and Malecki (2019) and the Chinese (Lin et al. 2024) and

TABLE 2 | Factor loadings, descriptive statistics, item-total correlations, and α, ω, CR, AVE values.

Item	Factor Loading	Item-total correlations	α	ω	CR	AVE
1. I push myself to do my personal best in school.	0.970	0.531	0.85	0.86	0.92	0.68
2. I work toward my academic goals no matter how long they take to reach.	0.625	0.552				
3. Even when I could do something more fun, I give schoolwork my best effort.	0.728	0.463				
4. I complete my schoolwork no matter how difficult it is.	0.760	0.625				
5. I am determined to give my best effort in schoolwork.	0.733	0.638				
6. Once I set a goal in school, I try to overcome any challenges that arise.	0.600	0.512				
7. I am able to balance working hard in school with my other hobbies and interests.	0.655	0.553				
8. Even if I am struggling in school, I keep trying my best.	0.710	0.616				
9. When it comes to completing work in school, I always try my hardest.	0.800	0.600				
10. In school, I work hard to achieve challenging goals.	0.740	0.581				

Polish (Kolemba et al. 2024) adaptations. Goodness-of-fit indices were obtained for the one-factor model without any error term confounding: $\chi^2 = 102.477$, $p = 0.00$, $df = 35$, $\chi^2/df = 2.92$, GFI = 0.96, CFI = 0.96, NFI = 0.94, IFI = 0.96, TLI = 0.95, RMSEA = 0.05 [95% CI: 0.04/.06], S-RMR = 0.03.

The factor loadings of the AGS ranged between 0.970 and 0.600, and the item-total correlations were between 0.463 and 0.616. The reliability coefficients calculated for AGS were as follows: $\alpha = 0.85$, $\omega = 0.86$, CR = 0.92, AVE = 0.68 (Table 2).

4 | Study-2

4.1 | Method

In Study-2, a quantitative research method was adopted to test the effect of academic courage on science attitude and school belonging. The data collection process was based on the questionnaire method, and SEM was used to verify the scales' factor structure and determine the relationships between the variables.

4.2 | Participants and Procedure

A total of 668 students from three different primary schools in the Central Anatolia Region of Turkey participated in the study. Participants were the students in Study-1 ($M_{age} = 10.64$, SD = 1.21, range = 6). Students were asked to complete scales assessing their science attitude and school belonging, and data were collected face-to-face through classroom teachers.

4.3 | Instruments

In addition to the Turkish scale of the AGS, the following instruments were added in Study-2.

4.4 | Attitude Scale Towards Science

It was developed by Palancıoğlu et al. (2023) to determine primary school students' attitudes towards science. The scale comprises 12 items and three sub-dimensions (love, interest and extracurricular science). The scale, which includes sample statements such as "I look forward to science class" and "I am happy when I have science class", is scored on a 3-point Likert scale (1 = *no*, 2 = *sometimes*, 3 = *yes*). A higher score on the scale is explained as a higher science attitude. Within the scope of this study, Cronbach's alpha coefficient of the scale was 0.93, and it was found to have acceptable fit indices: $\chi^2 = 156.00$, $p = 0.00$, $df = 50$, $\chi^2/df = 3.12$, GFI = 0.95, CFI = 0.90, NFI = 0.94, IFI = 0.96, TLI = 0.95 RMSEA = 0.05 [95% CI: 0.04/.06], S-RMR = 0.03.

4.5 | School Belonging Scale

The scale was used by Canbulat et al. (2020) to determine primary school students' school belonging. In the scale in the form of sentence completion, students use one of the 5-point rating options appropriate to the relevant statement (1 = *Very sad* to 5 = *Very happy*). The scale, consisting of a single dimension and 13 items, included the following statements: "When I come to school....." and "If there was school every day...." A high score on

the scale means a high level of school belonging. Cronbach's alpha coefficient of the scale is 0.83 for this study. The goodness of fit values of the scale are as follows: $\chi^2 = 100.818$, $p = 0.00$, $df = 33$, $\chi^2/df = 3.05$, GFI = 0.96, CFI = 0.93, NFI = 0.91, IFI = 0.93, TLI = 0.91 RMSEA = 0.05 [95% CI: 0.04/.06], S-RMR = 0.04.

4.6 | Data Analysis

Within the scope of the study, descriptive information of the data was first tested with SPSS 26. Then, the relationship between academic grit, science attitude and school belonging was calculated with the correlation coefficient. Then, structural equation modelling (SEM) was performed in AMOS Graphics using maximum likelihood estimation to estimate the parameters. In this context, two separate models were tested (Figure 2). In the first model, the mediating variable was science attitude. In contrast, school belonging was tested as the mediating variable in the second model. In both models, 5000 bootstraps were used to determine whether the indirect effects were significant.

5 | Results

The AGS score did not show a significant difference according to gender ($t = 0.13$ $p = 0.89$). According to the analysis conducted, there was a negative correlation between age and AGS scores ($r = -0.28$, $p < 0.01$). Also, the AGS had a significant and positive relationship with science attitude ($r = 0.42$, $p < 0.01$) and school belonging ($r = 0.55$, $p < 0.01$). There was also a significant and positive relationship between science attitude and school belonging ($r = 0.34$, $p < 0.01$).

The SEM results analyzing the effects of academic grit on school belonging through science attitude (see Panel A) showed that the model had a good fit. The model was accepted: $\chi^2 = 1477.875$, $p = 0.00$, $df = 459$, $\chi^2/df = 3.22$, GFI = 0.97, CFI = 0.91, NFI = 0.94, IFI = 0.91, TLI = 0.91 RMSEA = 0.05 [95% CI: 0.05/.06], S-RMR = 0.05. Science attitude and academic grit explained 54% of the variance in school belonging. According to the bootstrap results, the indirect effect of academic grit on school belonging through science attitude was significant ($\beta = 0.14$, 95% CI: [0.07/0.26], $p < 0.05$).

The model testing the effect of academic grit on science attitude through school belonging also provided an acceptable fit: $\chi^2 = 1495.590$, $p = 0.00$, $df = 459$, $\chi^2/df = 3.25$, GFI = 0.97, CFI = 0.90, NFI = 0.94, IFI = 0.90, TLI = 0.91 RMSEA = 0.05 [95% CI: 0.04/.06], S-RMR = 0.05 (see Panel B, Figure 2). Academic grit and school belonging explained 41% of the variance in science attitude. Bootstrap results showed that the indirect effect of academic grit on science attitude through school belonging was significant ($\beta = 0.22$, 95% CI: [0.12/0.36], $p < 0.05$).

The analyses showed that the models' path coefficients and model fit in both Panel A and Panel B were acceptable. However, changes in the chi-square value ($\Delta\chi^2$) were used to select the model that best explained the relationship between academic grit, science attitude and school belonging. Since the chi-square difference test is sensitive to sample size, the CFI (ΔCFI) change was also considered in the model comparison. The criterion of ΔCFI greater than 0.005 indicated significant differences between the two models examined (Meade et al. 2008). In addition to these criteria, the Akaike information criterion (AIC) and expected cross-validation index (ECVI) were used in model comparison (Brown 2006; Schreiber et al. 2006). Accordingly, the model with low AIC and ECVI values is accepted as the model that best explains the relationship between the variables (Table 3). According to these criteria, the model tested in Panel A is accepted.

6 | Discussion

This study examined the relationship between school belonging and attitudes towards science by first adapting AGS into Turkish and then using the adapted AGS scale. The results in Study-1 showed that the AGS scores did not change between male and female students. This was different from previous literature. In Clark and Malecki's (2019) original scale and its Polish version (Kolemba et al. 2024), girls had higher academic grit. This may be related to the age group of the sample as well as social and cultural characteristics. In Clark and Malecki's (2019) study, the

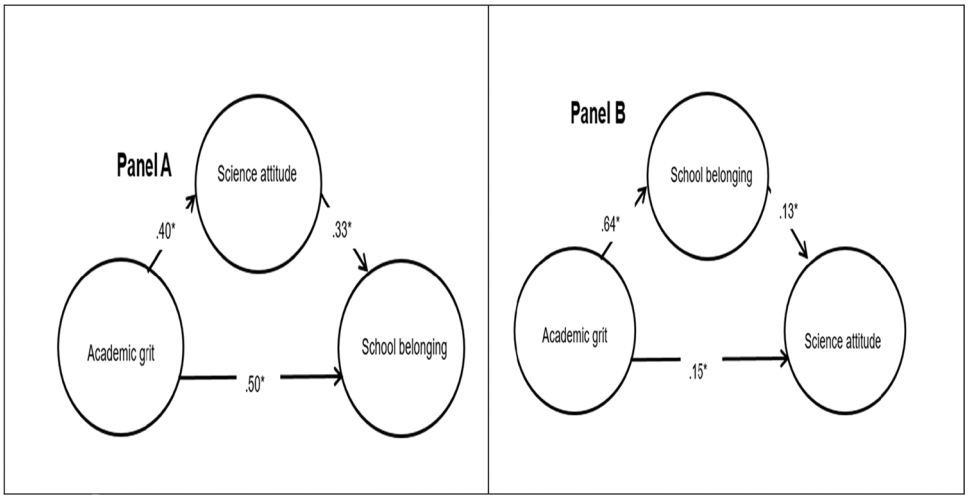

FIGURE 2 | Mediating models for academic grit through science attitude and school belonging. *Note* *$p < 0.05$.

TABLE 3 | Goodness of fit values for models.

Models	χ^2	df	χ^2/df	AIC	ECVI	CFI	RMSEA	S-RMR	Model Comparison		
										$\Delta\chi^2$	ΔCFI
Panel A*	1477.875	459	3.22	1615.875	2.423	0.91	0.05	0.05		—	
Panel B	1495.590	459	3.25	1633.590	2.449	0.90	0.05	0.05	B versusA	0.03	0.01

*Preferred model.

participants were adolescents (6th–8th grades), while in Kolemba et al.'s (2024) study, the participants were adolescents between the ages of 11–15. This study covers the 8–11 age groups. Therefore, the fact that academic grit has not yet been differentiated in this age group may not be defined as a distinct gender characteristic. However, gender equality and children's rights processes have been strengthening in Turkey in recent years. This may have reduced gender-based processes.

Regarding age, a negative relationship was found with AGS. Accordingly, there is a decrease in academic grit with increasing age. Previous studies reported different results on age. While the results of Clark and Malecki (2019) were similar to this study, Kolemba et al. (2024) found that academic grit did not change with age. Credé et al. (2017) reported that overall grit increased with age in their meta-analysis. Lin et al. (2024) reported that academic grit in the 9–14 age group differed according to grade level. The lack of a clear answer regarding age is related to the fact that the participants are not in the same age group (child, early adolescent or adolescent). However, they are close to each other and may be affected by cultural, social and familial factors. Again, Lin et al. (2025) reported diversity in four groups in their study examining the relationship between growth mindset and academic grit in Chinese adolescent groups. This means that more studies are needed on the relationship between age and academic grit.

CFA confirmed the AGS's one-factor model. The scale's reliability was satisfactory ($\alpha = 0.85$, $\omega = 0.86$, $CR = 0.92$) and similar to the original version ($\alpha = 0.92$). Item-total correlation values were quite good. This provides clear and robust evidence to support the AGS's single-factor structure for measuring academic grit in Turkish children.

In Study-2, two models addressing the relationship between academic grit, attitude towards science and school belonging were tested. Academic grit is a cognitive and motivational construct that is critical in helping students achieve their long-term academic goals (Duckworth et al. 2007; Mao et al. 2021). Previous research reveals that academic grit is a skill shaped during learning processes and a fundamental factor that drives students' school belonging and educational attitudes (Baş 2025; Credé et al. 2017; Smith et al. 2022). Therefore, in this study, academic grit was not considered a function of variables such as science attitude and school belonging but a key predictor of learning processes. However, it should be kept in mind that since this study has a cross-sectional design, it is limited to precisely determining the causal relationships between variables.

Comparison criteria showed that science attitude mediated the relationship between academic grit and school belonging. Previous literature suggests that individuals' commitment to school can influence their motivation for the educational process and their grit towards their long-term goals (Han 2021). In addition, encouraging students to have a positive attitude toward any subject by teachers and/or the school can foster a sense of belonging to the school (Juliyabadu Gunathilake et al. 2025). Therefore, the relationship between academic grit and school belonging can be explained by students' effort and determination to achieve their educational goals, which are also related to their participation and sense of belonging in the educational process.

The study also found that attitude towards science was mediating in this relationship. It has been previously reported that individuals who develop positive attitudes towards science courses make more effort in these areas and increase their motivation for academic success (Smith et al. 2022). In this context, a positive attitude towards science appears as a variable related to students' academic grit and school belonging. Science attitude includes individuals' interests and beliefs in science, their expectations of success in these courses, and the impact of this field on future career opportunities (Mao et al. 2021). Therefore, reinforcing students' positive attitudes towards science can be associated with academic grit. Supporting academic grit can be used to improve attitudes towards science.

Similarly, positive attitudes towards science are important for students to develop a sense of belonging to and liking school. Policies, specific institutions and resources, and educational programs can contribute to developing positive attitudes towards science. If improvements in the school climate support this, a charming effect can be created between academic grit, science attitude, and school belonging. This suggests that the development of academic grit should not be limited to this concept alone but should be considered in a more holistic context of the overall school environment.

Recent studies show that academic grit is directly related to students' overall life satisfaction and school belonging (Eroğlu 2023). In particular, academic grit enables students to invest more in their educational processes and increases their belonging to the school environment. In this context, academic grit should be considered not only as an individual characteristic but also as an important factor affecting the overall structure of the education system.

In addition, it has been shown that the effect of academic grit on school belonging is also affected by the environmental factors in which students live (Baş 2025; Özdoğan 2023). Studies conducted especially on students who migrated after disasters reveal that academic grit and school belonging facilitate students' adaptation to educational processes. This result shows that academic grit is not only limited to individual motivation but is also directly related to students' social and environmental conditions.

The effect of academic grit on school belonging through science attitude is critical in understanding how students' motivation toward the educational process is shaped. Bandura (1997) concept of self-efficacy explains how individuals' beliefs about achieving educational goals guide their active participation in learning processes. In the study, the fact that academic grit showed that students were more strongly connected to the educational environment through a science attitude is an important result that confirms the motivational effect of an individual's self-efficacy perception in the learning process.

In addition, in parallel with Zimmerman (2002) self-regulation model, results showed how academic grit contributes to students' structuring of their learning processes. Especially in science, students' high academic grit indicates they are more open to scientific inquiry and more motivated to learn. Academic grit is an individual learning characteristic and an important variable that shapes interest and engagement in science. Methods that support self-regulation and problem-solving skills used in science courses (Mao et al. 2021; Smith et al. 2022) can strengthen students' academic grit by increasing their interest in learning. These results suggest that academic grit is an individual characteristic and a fundamental factor shaping the learning environment. Therefore, these results have important implications for educational policies and practices. Providing appropriate learning environments for students to develop positive attitudes towards science can support their academic grit and school belonging. For example, experimental and discovery-based teaching methods in science courses can increase students' interest in these fields (Liou 2021). Such approaches may not only contribute to science education but also have a positive impact on student's overall academic performance and engagement in the educational process.

Finally, the results of this study highlight the importance of integrating perseverance development techniques into the science curriculum at the primary school level, as they reveal that academic grit is associated with science attitude and school belonging at an early age. In particular, structured activities that support students' effort, grit, and goal-directedness in science classes can strengthen both motivation to learn and a sense of school belonging (Duckworth et al. 2007; Clark and Malecki 2019). Pedagogical approaches such as inquiry-based learning, student-centered tasks, and self-regulation strategies are reported to have the potential to promote academic grit (Kirchgasler 2018; Liou 2021; Liu and Huang 2025). In this regard, the results obtained are guiding the development of curriculum-based intervention programs in primary education settings.

6.1 | Theoretical Implications

The results of this study extend the theoretical knowledge in educational psychology by showing how the relationship between academic grit and science attitude is shaped through school belonging. In particular, based on Bandura (1997) social cognitive theory, science attitude strengthens individuals' self-efficacy beliefs and increases their academic grit. The relationship between academic grit and school belonging provides a more holistic perspective on how students engage in learning processes within the framework of motivational theories.

The fact that academic grit influences attitudes toward science through school belonging highlights the multifaceted nature of motivational processes. Although academic grit is generally considered an individual trait in the literature (Duckworth et al. 2007), this study emphasizes how grit is integrated with the social context, particularly the student-belonging relationship (Clark and Malecki 2019).

Results suggesting that attitudes toward science can support academic grit by increasing students' interest and confidence in their learning processes (Hill et al. 2024; Mao et al. 2021) demonstrate how individual effort intersects with contextual factors. As a result, students' social interactions in the school environment and the academic experiences they gain in science classes affect their levels of grit not only in terms of success but also in emotional and psychosocial contexts. This holistic approach indicates that school-based interventions should encompass not only success but also students' overall learning motivation and academic engagement.

6.2 | Practical Implications

The results of this study highlight the importance of interventions aimed at enhancing students' self-regulation skills and motivation in science education, thereby strengthening academic grit at the primary school level. Practices that enable students to set individual goals, structure their learning process, and track their progress can support the development of grit. For example, practices such as having students create daily goal cards to track their progress in science classes or express experiment results in their own words can develop both academic self-efficacy and the ability to sustain effort. In this process, teachers who frame failure as part of the learning process and encourage students to try again will contribute to creating an atmosphere that promotes grit within the school environment. Additionally, planning experimental learning activities that increase interest and curiosity in science classes allows students to establish a more internal and meaningful connection with science. For example, having students conduct small scientific research projects related to their environment or work in groups to find solutions to problems can increase not only science achievement but also school engagement. In this context, developing academic grit at an early age can provide a critical opportunity not only for individual success but also for strengthening the school climate and enabling students to participate more meaningfully in the educational process.

6.3 | Limitations and Suggestions for Future Research

The study's most important limitation is that the data were collected using self-report scales. Self-report scales at the primary school level may have limitations regarding students' capacity to evaluate their learning processes. It is recommended that multiple assessment methods be used in future data collection processes.

The second limitation is the study's cross-sectional design. This prevents causal inferences in the tested SEM and does not allow for the assessment of test-retest reliability. Future studies

should also be conducted to test how academic grit changes as a malleable skill and the possible effects of belonging and science attitude on academic grit. At the same time, to better capture the developmental nature of academic grit, future research could be expanded to include longitudinal or mixed-methods designs. Finally, the fact that the data were collected only from a specific region of Turkey voluntarily limits the generalizability of the results. Further research on different age groups and cultural contexts is recommended to obtain more comprehensive results on academic grit.

7 | Conclusion

This study presents Turkish validity and reliability evidence of the recently developed AGS. The Turkish AGS showed a similar structure to the original scale with 10 items and a single-factor structure. In addition, academic grit predicted school belonging through science attitude in elementary school children. Academic grit may serve as a lever to increase school belonging. Moreover, attitude towards science is a variable that should be considered when increasing school belonging. This situation reveals the importance of academic grit in changing attitudes towards specific disciplines in primary school children in a positive direction and making them like school.

Author Contributions

Menşure Alkış Küçükaydın: conceptualization, data curation, formal analysis, methodology, software, review and editing.

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Ethics Statement

This study was approved by the ethics committee of the Necmettin Erbakan University (2024/185).

Consent

Informed consent was obtained from all individual participants included in the study.

Conflicts of Interest

The author declares no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.
Appendix.