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From self-regulation to chemistry aspirations: Structural equation modeling of academic resilience as a key mediator

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Abstract

This study investigates the relationship between self-regulation and chemistry aspirations, with academic resilience as a key mediator. The research aims to examine how academic resilience functions as a crucial intermediary between students' chemistry aspirations and their self-regulation. A survey method was employed to collect data from 733 science-major students, utilizing three closed-ended questionnaires. The data were analyzed using Structural Equation Modeling (SEM) to explore latent variable relationships. The findings indicate that chemistry aspirations are directly and significantly influenced by self-regulation, with academic resilience serving as a strong mediating factor. This study highlights the critical role of resilience and self-regulation in shaping students' chemistry aspirations, particularly in STEM subjects like chemistry. Practical implications are provided to enhance these qualities in educational settings.

Keywords: Academic resilience, Chemistry aspirations, Mediation, Self-regulation, STEM education, Structural equation modeling.

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1. Introduction

1.1. Background

Fostering chemical aspirations is crucial in education, particularly in STEM (Science, Technology, Engineering, and Mathematics) programs, as it encourages students to pursue careers and higher education in the scientific fields. According to Lu, et al. [1] one should consider STEM occupations as part of their career aspirations. the strong desire of an individual to succeed in STEM fields [2, 3]. It isn't easy to assist students in creating STEM career goals since knowledge regarding STEM selection procedures is dispersed across several academic fields [4]. In light of this, it is critical for researchers to identify the factors that influence or mediate this relationship and to monitor the mechanisms that are vital in the development of STEM career goals. This can help us better understand how STEM career objectives are developed and offer professional development and teacher education guidance. However, because it necessitates strong conceptual knowledge and sophisticated problem-solving abilities, students frequently view learning chemistry as challenging [5, 6]. These difficulties frequently result in students having limited desire and aspirations to study chemistry or work in the field [7].

The key to overcoming this obstacle is students' capacity for self-regulation during the learning process. According to Suan [8] Self-regulation is essential for academic performance because it allows students to efficiently manage their time, focus, and emotions while maintaining their motivation to learn. Additionally, pupils who possess self-regulation skills are typically more flexible and resilient than those who do not. However, students' capacity to bounce back from setbacks and continue to do well academically in the face of stress or adversity is also a key component of academic resilience [9]. According to earlier research, academic resilience frequently acts as a mediator between many variables, including social support, intrinsic drive, and professional goals, whereas self-regulation has a positive correlation with academic achievement [10, 11]. The connection between student aspirations, academic resilience, and self-regulation in the context of chemistry education is still not well understood.

Chemistry aspirations refer to the objectives and driving forces behind students' decisions to study chemistry in college and pursue it as a potential career. To address this research gap, this study aims to investigate how academic resilience functions as a crucial mediator in the relationship between students' chemistry aspirations and self-regulation. The use of the Structural Equation Modeling (SEM) approach in this study is expected to deepen our understanding of the dynamics of the variables influencing students' goals and provide valuable suggestions for teachers on how to help students enhance their chemistry skills.

1.2. Research Questions

The following research questions served as the basis for this investigation:

1. What impact does self-control have on students' aspirations in chemistry?
2. How far does the connection between self-control and chemistry aspirations get mediated by academic resilience?
3. How does academic resilience function as a mediator in the pathway connecting chemistry aspirations and self-regulation?

2. Literature Review

2.1. Self-Regulation

Self-regulation includes the processes of metacognition (thinking critically about one's thinking), strategic action (planning, tracking, and assessing one's development to a predetermined standard), and motivation to learn. A self-regulated learner actively monitors, guides, and controls their behavior to learn new things, develop their skills, and improve themselves. A key component of successful education is self-regulation. It gives students the ability to take charge of their education, establish objectives, track their development, and modify their methods as necessary [12, 13]. Research on self-regulation learning is very crucial, especially for psychologists and educators [14]. Academic self-regulation is currently considered a key element and one of the main pillars of education in the contemporary global educational system [15]. The conviction in one's ability to organize and carry out significant acts to accomplish particular objectives is known as self-regulation [16]. By encouraging their academic self-regulation, teachers can assist students in developing their self-regulation abilities [17]. Scholars must be conscious of their higher-order self-regulation abilities, identify and highlight the abilities that students require most in a particular situation, and confidently exhibit these abilities to their students to accomplish this [18].

Students' comprehension of the concept of self-regulation has a significant impact on their academic performance. One reason students struggle academically may be that they lack self-control [19]. Students' academic growth is greatly impacted by their self-regulated learning behavior, according to [20]. Acknowledging their strengths and weaknesses in the classroom allows self-managed learners to adjust their behavior accordingly. For this process to take place, students need to plan, oversee, and assess their education autonomously. Self-managed students can therefore plan their educational careers and establish their goals [21].

Metacognitive, motivational, and behavioral traits that demonstrate students actively participating in the learning process are referred to as self-regulation in learning [22]. To accomplish learning objectives entails controlling and guiding one's thoughts, emotions, and behaviors. Students who possess self-regulation can act on their initiative and control their learning. It also includes planning learning techniques and procedures. Students exhibit self-regulation, for instance, when they schedule their time to complete assignments and employ a variety of study techniques to prepare for tests [23]. Students who can organize effective learning strategies, supply learning resources, encourage themselves to learn, and reward themselves when they meet learning objectives are said to be engaging in this type of self-regulated learning [24]. This is explained by

the fact that students who exhibit positive metacognition, initiative, and behavior are also those who have high degrees of self-adjustment in their learning [25].

Aspirations in STEM fields, including chemistry, are significantly enhanced by self-regulation. According to recent studies, self-regulation affects motivation to study and self-efficacy, both of which support the fulfillment of academic goals. A study conducted in 2023, for instance,, found that individual characteristics, including academic self-regulation, significantly impact students' goals for education, particularly those in rural China [26]. Higher self-regulation abilities among adolescents are often associated with similar professional goals and aspirations, or, if different, similar training requirements and/or primary vocational interest areas or categories [27]. These findings imply that adolescents with strong self-regulation skills may also engage in a targeted, goal-oriented form of career development since individuals with strong self-regulation skills concentrate their energies on one or a limited number of goals to give structure and direction to their actions. It is often known that self-regulation improves student achievement [28]. There is evidence that self-regulation improves academic performance [29]. Academic accomplishment is significantly impacted by the environment, time management, and metacognitive activities [30]. The dynamic nature of education and the requirement for student participation make self-regulation a sign of learning and personal growth [31].

2.2. Academic Resilience

Academic resilience is known as the ability to persevere and achieve in the face of difficulties, stress, and academic failure. Resilient students are better able to bounce back from failures and keep working toward their academic objectives [32]. Academic resilience in the context of chemistry helps students overcome obstacles to understanding difficult subjects, completing demanding assignments, and remaining dedicated to their academic goals in the face of failures. A new area of study in positive psychology called resilience examines how individuals can continue to function well in the face of adversity [33]. The ability to adjust to hardship, trauma, tragedy, threats, or even major stress causes is known as resilience [34]. According to Amelasasih et al. [35] resilience is the capacity to adjust and get through challenging circumstances. According to Coronado-Hijón [36] resilience is the capacity to overcome obstacles in pursuing academic, professional, or personal objectives. Social competence, problem-solving abilities, and autonomy are all components of resilience that assist teenagers in overcoming obstacles in life [37]. Student resilience is the capacity to control negative emotions, uphold self-efficacy, think constructively, and draw on social support when faced with challenges [12]. Resilient students can handle challenging circumstances during their education, like math problems, and use them to their advantage to enhance their learning results [38]. Social psychology and public health sciences have defined and approached resilience in ways that improve knowledge of how people cope with stress [39]. According to the several definitions given above, resilience is the capacity of people to endure hardships, adjust, and ultimately overcome them to improve themselves.

A subset of general adaptability, academic resilience refers to an individual's difficulty adjusting to various requirements, courses, and disciplines of study [40]. Given the novelty of the notion, there is still much to learn about the potential influence of students' cognitive characteristics and preferences on academic resilience [9]. According to Aliyev et al. [41] Academic resilience is the ability to function and succeed at high levels in the face of challenging situations brought on by a hostile learning environment. It defines the potential for success in a variety of spheres of life, despite adverse circumstances resulting from prior experiences [42].

Students who are given personal aims or goals will be challenged to overcome peer pressure, self-doubt, and barriers, which can help them become more resilient [43]. The knowledge that academic aptitude is not fixed but can be enhanced through optimal growth is being taught. Resilient pupils can overcome challenges and recover from exam failures, in addition to possessing cognitive abilities. One of the key psychological traits linked to both academic performance and psychological and emotional well-being is resilience [44]. In the classroom, resilience is crucial because it fosters the growth of social, intellectual, and personal abilities that enable students to overcome challenging circumstances[45].

Students' aspirations in chemistry are significantly positively impacted by academic resilience. Perseverance and the ability to overcome academic obstacles, such as failure or excessive stress, enable students to stay focused on their objectives. Students' identities as scientists and their desire to work in science, especially chemistry, are shaped by their tenacity, resilience, and self-efficacy, according to a 2024 study [46]. In addition, supportive elements from the social environment, instructors, and family are crucial for raising children's academic goals and resilience [47]. Academic resilience plays a major role in enhancing academic achievement, especially in challenging circumstances like online learning during the COVID-19 pandemic, according to a study by Annisa et al. [48].

2.3. Chemistry Aspirations

Chemistry students' aspirations to continue their studies and work in a science-related field are referred to as aspirations. According to research, students' academic aspirations have a significant impact on their drive, interest, and perseverance in their studies [49]. High-chemistry-aspiration students are more likely to enroll in related courses, take advantage of academic opportunities, and eventually work in chemistry or other scientific disciplines. Some of these elements are linked to an individual's personality and self-perception, while others are related to their living situation and surroundings.[50]. Furthermore, these elements may interact with the environment and individual cognitive and emotional elements, including self-efficacy, goal-setting, and analytical thinking ability. Two factors influence students' future career choices in science Cleaves [51] research: first, they have a lower awareness of science jobs, scientific jobs, and the abilities needed for them. Second, they think that their scientific skills are inferior to those of students in other subjects. However, the anticipated difficulty of science-related courses and careers should not deter students from choosing them [52].

Globally, sustainable economic development is being hampered by dwindling job prospects in research, especially in chemistry [53]. Chemistry is a less popular major among high school students, and even fewer opt to major in it, according to several studies. to study chemistry in college [54]. The basic subject of chemistry is linked to the development of new materials, medical chemistry, green and environmental chemistry, forensic chemistry, materials engineering and chemistry, nanotechnology, and many other domains [55, 56]. Nonetheless, deciding on a career path is essential to promoting scientific and technical innovation, which will dictate a country's future prosperity.

As a result of fewer high school students majoring in chemistry and fewer post-secondary graduates, there is a serious lack of qualified and experienced chemists and chemical engineers [57]. According to research, high schools have a big influence on teenagers' decisions to pursue careers in chemistry. Chemistry teachers' lack of enthusiasm for their pupils to major in the subject is the main cause of this issue [58]. Teachers, businesspeople, and other stakeholders should concentrate on determining the elements that impact career choices to boost the number of competent applicants and experienced and competent chemistry professionals who decide to pursue a career in chemistry [59]. In a similar Ogunde et al. [49] asserted that there are issues with the retention of scientific degrees in post-secondary education.

The innate drive to study is one of the most crucial lessons that pupils should be taught, claims [60]. This desire will drive them to discover their purpose, which is crucial for their development and the future effects of their choices, accomplishments, and lifestyle. According to Uzzaman and Karim [61], aspiration is a great desire to accomplish something noteworthy or honorable. "Aspiration is a goal that students have for their future in terms of their education and career," [62]. Chemistry is meant to encourage pupils to pursue the subject and pursue careers in chemistry [59].

Analyzing the objectives of undergraduate chemistry students is crucial because it can assist stakeholders and policymakers in putting interventions into place that promote the retention of talented, academically prepared students who aspire to work in science. Furthermore, academic achievement and ambition have been connected [63]. To encourage or inspire students to pursue professions in science, educators can try to alter their attitudes, such as their views on the importance of science, and/or employ creative teaching and learning techniques and activities. Enhancing students' attitudes toward science is the particular goal of numerous projects [64]. Numerous techniques have been employed to boost students' interest in science, including emphasizing the value of research and outlining the experiences and accomplishments of scientists [65]. According to research conducted in the same setting, students' enthusiasm and performance in science, as well as their choice of scientific courses, were found to rise when parents and students were encouraged to recognize the importance and applicability of science [66]. Teachers can use a range of approaches to discuss science work or more general science applications, in addition to or in place of already-existing teaching activities or tactics.

2.4. Mediation Model

This study hypothesizes that the association between self-regulation and chemistry goals is mediated by academic resilience. When the independent variable (self-regulation) and the dependent variable (chemistry aspirations) are explained by the intervening variable (academic resilience), mediation occurs. Although its significance in influencing ambitions, particularly in STEM disciplines, is poorly understood, prior research has demonstrated that academic resilience can moderate the impact of academic habits like self-regulation on academic performance.

3. Methodology

3.1. Participants

This study used a survey method. A total of 733 high school students taking advanced chemistry courses participated in the study, including 500 females and 233 males. Participants were selected from 14 public high schools in urban and suburban Pekanbaru to ensure diversity in socio-economic backgrounds and academic achievement.

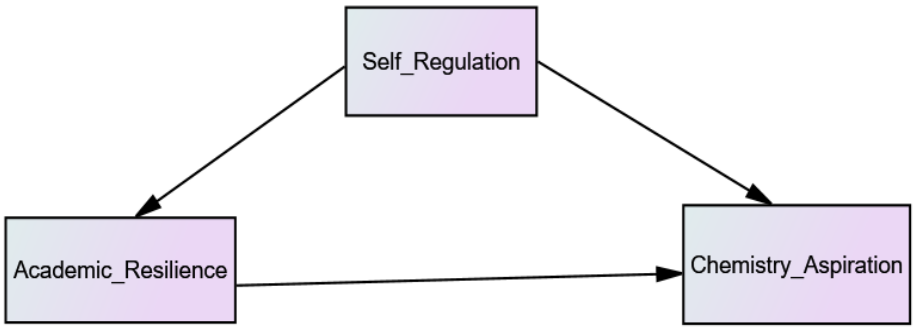

Figure-1.
The hypothesized model

3.2. Instrument

Three tools—self-regulation, academic resilience, and chemical aspirations—were employed in this study and are explained below.

3.2.1. Self-Regulation

Researchers created an eight-item self-regulation scale by synthesizing the opinions of three experts [67-69]. This scale assesses students' self-control, which includes self-planning and motivation. The following five options for answers are presented to students: Five is for highly agree, four is for agree, three is for somewhat disagree, two is for disagree, and one is for strongly disagree.

3.2.2. Academic Resilience

This measure evaluates students' capacity to bounce back from academic setbacks, persevere in the face of difficulty, and stay motivated. Eight items, spirituality, emotional control, and self-reflection, make up this scale, which was developed by three experts [9, 70, 71]. The following five response options are presented to the students: the numbers 1 through 5 represent strongly disagree, disagree, somewhat disagree, agree, and strongly agree, respectively.

3.2.3. Chemistry Aspirations

Six items from the dimensions of attainment, self-confidence, and interest make up the Chemistry Aspiration Scale, which was independently developed by researchers based on the synthesis of several experts, including [72-74]. It is used to evaluate students' aspirations to pursue further studies and careers in chemistry. Students are then presented with the following five options for answers: five for highly agree, four for agree, three for somewhat disagree, two for disagree, and one for strongly disagree. The data were coded into SPSS (version 26) after processing.

The internal reliability of the instrument was evaluated in this study using Cronbach's Alpha. Most people agree that an instrument has satisfactory internal consistency if its Cronbach's Alpha score is greater than 0.5 [75]. To ascertain the questionnaire's range of internal reliability, each scale variable was examined separately. The thorough test findings are displayed in Table 1. The Corrected Item Total Correlation (CITC) between the observed variables and their latent variables indicates the suitability of the instrument's reliability as well as the appropriateness of each latent variable's measurement item [76]. Items with a loading factor and corrected item-total score correlation (CITC) of 0.2 are deemed to be highly satisfactory, while items with a CITC $\geq$0.4 suggest that the item has a reasonably strong connection with the factor or dimension that the instrument is intended to assess. Next, each item is removed once to remove the observed variables. The measurement item for that variable is deemed to have high reliability if, following deletion, the reliability index does not rise [77]. Given that each item's Cronbach's Alpha coefficient stays constant after being deleted, the results in Table 1 demonstrate how well-established each item is.

Table-1.
Reliability of the measures.

Variate	Item	CITC (Corrected Total Item Correlation	Cronbach's Alpha of Item Deleted	Cronbach's Alpha
Self-Regulation			0.746	0.743
- Self-Planning	SR_13	0.471	0.711	0.767
	SR_14	0.417	0.721	
	SR_16	0.449	0.715	
	SR_17	0.658	0.670	
	SR_20	0.427	0.720	
	SR_21	0.510	0.703	
- Motivation	SR_18	0.298	0.743	0.580
	SR_22	0.302	0.744	
Academic Resilience			0.734	0.739
- Spirituality	AR_1	0.578	0.680	0.721
	AR_5	0.517	0.695	
	AR_6	0.469	0.705	
	AR_9	0.452	0.709	
- Emotion Control	AR_4	0.312	0.735	0.579
	AR_7	0.294	0.737	
- Self-reflection	AR_2	0.495	0.700	0.512
	AR_10	0.331	0.730	
Chemistry Aspiration			0.916	0.914
- Attainment	CA_24	0.744	0.901	0.866
	CA_25	0.840	0.887	
- Self-Confidence	CA_32	0.746	0.904	0.768
	CA_33	0.730	0.903	
- Interest	CA_28	0.799	0.893	0.824
	CA_29	0.721	0.905	

3.3. Procedures

Students pursuing science majors in chemistry were given an online survey to complete to gather data. Aspirations in chemistry, academic resilience, and self-regulation were all included in the survey. The hypothesis was tested using structural equation modeling (SEM), where the dependent variable was chemistry goals, the independent variable was self-regulation, and the mediator was academic resilience.

There were two phases to the research and data collection. Following an explanation of the project's goal and intended use to each participant, the researcher secured their informed consent, ensuring that their information would be utilized anonymously and only for scientific purposes. The tool was given to participants in their native Indonesian language and contained all three questions as well as an opening piece asking for biographical information. Using a link to a Google Form, respondents opened the WhatsApp app and started completing the questionnaires. Within the allotted time, the researcher gathered all valid questionnaires and retrieved data.

4. Result

4.1. Confirmatory Factor Analysis (CFA)

The validated CFA model for AMOS version 23, which was used to evaluate the validity of the scale, is shown in Figure 2. The Goodness-of-Fit Index was used in the current study to measure the validated CFA model. Various fit indices are used to assess model fit in mediation analysis, confirmatory factor analysis (CFA), and structural equation modeling (SEM). These include the Ratio of Chi-Square to Degrees of Freedom (χ^2/df), which takes into account model complexity, and the Chi-Square Test (χ^2), which evaluates the difference between the observed and expected covariance matrices [78]. The fit between the observed and implied covariance matrices in the model is measured by the Goodness-of-Fit Index (GFI) and the Adjusted Goodness-of-Fit Index (AGFI), the latter of which takes into account degrees of freedom [79]. The fit of the target model was compared to the independent baseline model using the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI), commonly referred to as the Non-Normed Fit Index (NNFI); higher values indicate better fit [80]. The Root Mean Square Error of Approximation (RMSEA) measures model fit per degree of freedom and the standardized difference between observed and predicted correlations, respectively, while the Normative Fit Index (NFI) also compares the target model to the null model [81].

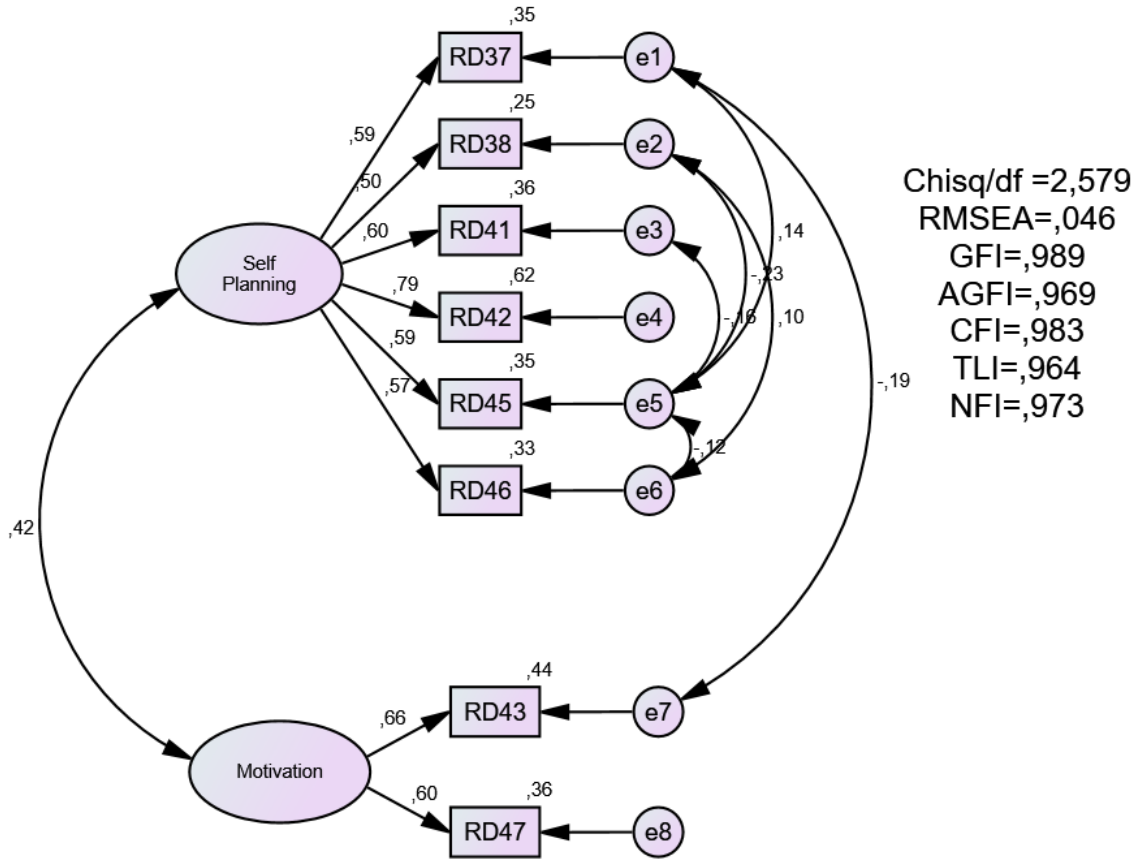

Figure-2.
CFA model of Self-Regulation.

Table-2.
The goodness of fit indices for self-regulation

	CMIN/df	RMSEA	GFI	AGFI	CFI	TLI	NFI
Standard values	≤ 5	≤0.08	≥0.9	≥0.9	≥0.9	≥0.9	≥0.9
Revised model	2.579	0.046	0.989	0.969	0.983	0.964	0.973

The student Self-Regulation Scale indicates that the two-dimensional model (self-planning and motivation) matches the data collected from the respondents, as noted in the data fit index Table 2. The correlation level between the three-dimensional Framework scheme is also shown in Figure 2, where the factor loadings for each spirituality dimension range from 0.55 to 0.80, the factor loadings for each emotional control dimension range from 0.57 to 0.74, and the factor loadings for the self-reflection dimension range from 0.51 to 0.70. Accordingly, the validity of the Academic Resilience Scale is measured using CFA. The results of evaluating the data fit using the same criteria as previously stated are displayed in Table 3. The scale's high degree of acceptance, as well as its good generalization and applicability, are evident from the data. Factor loadings for each attainment dimension range from 0.82 to 0.94, factor loadings for each self-confidence dimension range from 0.77 to 0.83, and factor loadings for the chemistry interest dimension range from 0.80 to 0.88. CFA is used to assess the validity of the Chemistry Aspiration Scale. Figure 4 shows the correlation level between the three-dimensional framework scheme. The outcomes of evaluating the data using the fit index are displayed in Table 4. The fit was assessed using the previously stated criteria. The scale's high degree of acceptance, as well as its good generalization and applicability, are evident from the data.

Lastly, Table 5 reports the convergent validity (AVE) and composite reliability (CR) of the self-regulation, academic resilience, and chemistry aspirations measures. The degree to which each latent variable is consistently explained by all of the measurement items that comprise that latent variable is measured by CR, a discriminant criterion that evaluates the model's basic merit. With a CR greater than 0.60, Table 5 shows that every measurement item in each latent variable consistently describes that latent variable [82]. The percentage of measurement error that explains the variance attributable to the latent variable can be explicitly illustrated using the AVE value, which represents the convergent validity of each construct. As the AVE value rises, the relative measurement error, which is typically needed to be >0.50, decreases [82, 83]. Since every result is higher than the typical value of 0.50, Table 5 shows that the AVE ratings in this investigation exhibit significant convergent validity.

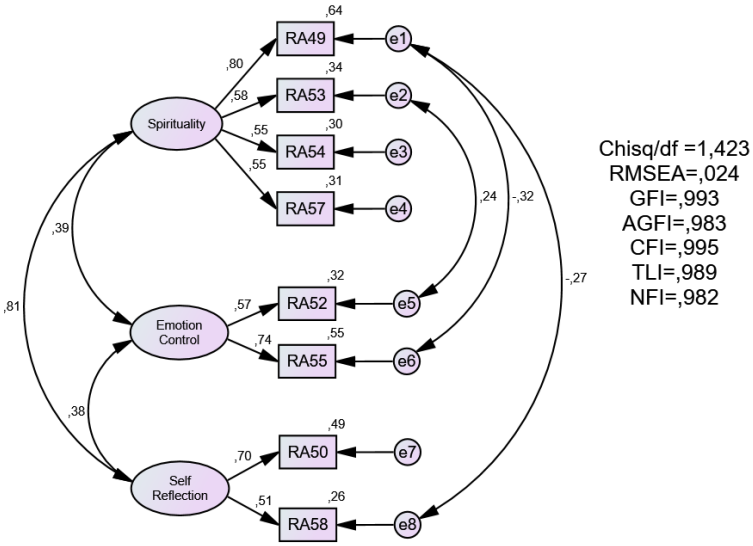

Figure-3.
CFA Model of Academic Resilience.

Table-3.
The goodness of fit indices for academic resilience.

	CMIN/df	RMSEA	GFI	AGFI	CFI	TLI	NFI
Standard values	≤ 5	≤0.08	≥0.9	≥0.9	≥0.9	≥0.9	≥0.9
Revised model	1.423	0.024	0.993	0.983	0.995	0.989	0.982

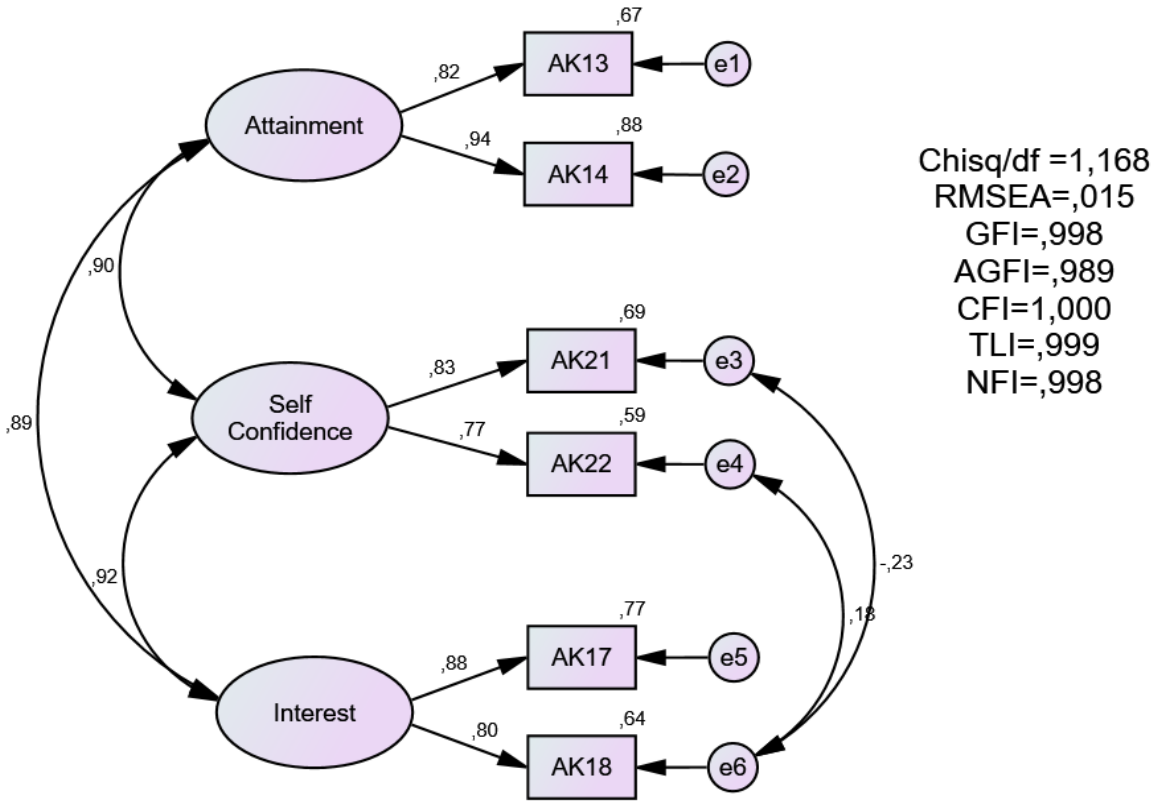

Figure-4.
CFA Model of Chemistry Aspiration.

Table 4.
The goodness of fit indices for chemistry aspiration.

	CMIN/df	RMSEA	GFI	AGFI	CFI	TLI	NFI
Standard values	≤ 5	≤0.08	≥0.9	≥0.9	≥0.9	≥0.9	≥0.9
Revised model	1.168	0.015	0.998	0.989	1.000	0.999	0.998

4.1. SEM Analysis

The compatibility of a certain theoretical model with sample data is assessed using the statistical analysis method known as SEM. Every data set used is used to characterize the validity of the suggested model. SEM (Fig. 4) and the fit index Table 6 are used. With a CMIN/df value of 5.541, the model surpasses the conventional cut-off of ≤5. With an RMSEA of 0.079, which is less than the typical threshold of 0.08, a better match is indicated. GFI = 0.893, AGFI = 0.856, CFI = 0.887, TLI = 0.860, and NFI = 0.866, even though CMIN/df is marginally higher than the standard cut-off of ≤5, which is frequently regarded as being appropriate in structural model analysis. This indicates that, while it must be taken into account, the model's degree of misfit is still within the tolerance limit. All things considered, the model is acceptable and rather good, with many metrics (such as RMSEA) demonstrating a strong fit. Some markers, like GFI, CFI, TLI, and NFI, are near the optimum threshold but not quite there yet. Consequently, further refining could be required to increase the model fit even when the model is usable.

4.2. Correlation between self-regulation, academic resilience, and chemistry aspiration

The route analysis's findings in Table 7 demonstrate that the standardized dependent variable Chemical ambitions and students' self-regulation are significantly positively correlated, as seen by the path coefficient of self-regulation to chemical aspirations (β = 0.28, t = 2.97, p = 0.00 <0.001) reaching a substantial level. Students' chemical goals are evident from the strong standardized learning path coefficient of involvement to academic resilience (β = 0.61, t = 5.89, p = 0.00 <0.001). Academic self-regulation to academic resilience standardized path coefficient (β = 1.16, t = 9.05, p = 0.00 <0.001). Academic resilience and academic self-regulation are positively correlated in a very strong and meaningful way. This demonstrates that academic resilience increases with an individual's level of academic self-regulation. However, β values greater than 1 require additional review to ensure that multicollinearity and data scale issues are absent [79]. Given that the t and p values indicate a substantial association, this model is statistically valid.

4.3. Mediating effect test

Overall, the effect of students' self-regulation on academic resilience is 1.16; the 95% CI's upper and lower bounds are [1.05, 1.30], neither of which includes 0. As seen by the P value Table 7, which is continuously less than 0.01<0.05, self-regulation has a highly significant overall effect on academic resilience. Using 300 repeated samples and 95% confidence

intervals, the bootstrap method for assessing mediation effects was used to assess the robustness of the current analysis. Students' self-regulation has a direct impact of 1.16 on academic resilience, and the 95% CI's upper and lower bounds are [1.05; 1.30], none of which includes 0. The P value that achieves 100% of the total impact is also less than the 0.05 level of statistical significance. intellectual resilience and self-regulation have a strong direct correlation. As the indirect effect value is 0.71 with a 95% confidence level of the upper and lower limit intervals [0.10; 1.01], which excludes 0, and the P value is low from the significance level of 0.01<0.05, the hypothesis is deemed valid. It has been established that academic resilience mediates the relationship between self-regulation and present chemical aspirations, accounting for 71% of the entire effect (see Table 8).

Table-5.
Reliability of all the factors.

Variate	Item	Standardized Estimate	Unstandardized				
			S.E.	t-value	P	CR	AVE
Self-Regulation							
Self-Planning	RD37	0.59				0.92	0.88
	RD38	0.50	0.08	10.26	***		
	RD41	0.60	0.09	12.04	***		
	RD42	0.79	0.11	13.43	***		
	RD45	0.59	0.10	12.38	***		
	RD46	0.57	0.09	11.35	***		
Motivation	RD43	0.66			***	0.85	0.78
	RD47	0.60	0.17	5.83	***		
Academic Resilience							
Spirituality	RA49	0.80				0.89	0.84
	RA53	0.58	0.05	13.52	***		
	RA54	0.55	0.05	12.37	***		
	RA57	0.55	0.04	12.98	***		
Emotion Control	RA52	0.57				0.84	0.78
	RA55	0.74	0.24	5.28	***		
Self-reflection	RA50	0.70			***	0.90	0.84
	RA58	0.51	0.07	8.86	***		
Chemistry Aspiration							
Attainment	AK13	0.82				0.96	0.95
	AK14	0.94	0.04	29.25	***		
Self-Confidence	AK21	0.83				0.93	0.91
	AK22	0.77	0.03	22.61	***		
Interest	AK17	0.88				0.95	0.95
	AK18	0.80	0.03	24.57	***		

Table-6.
The goodness of fit indices for the proposed model.

	CMIN/df	RMSEA	GFI	AGFI	CFI	TLI	NFI
Standard values	≤ 5	≤0.08	≥0.9	≥0.9	≥0.9	≥0.9	≥0.9
Revised model	5.541	0.079	0.893	0.856	0.887	0.860	0.866

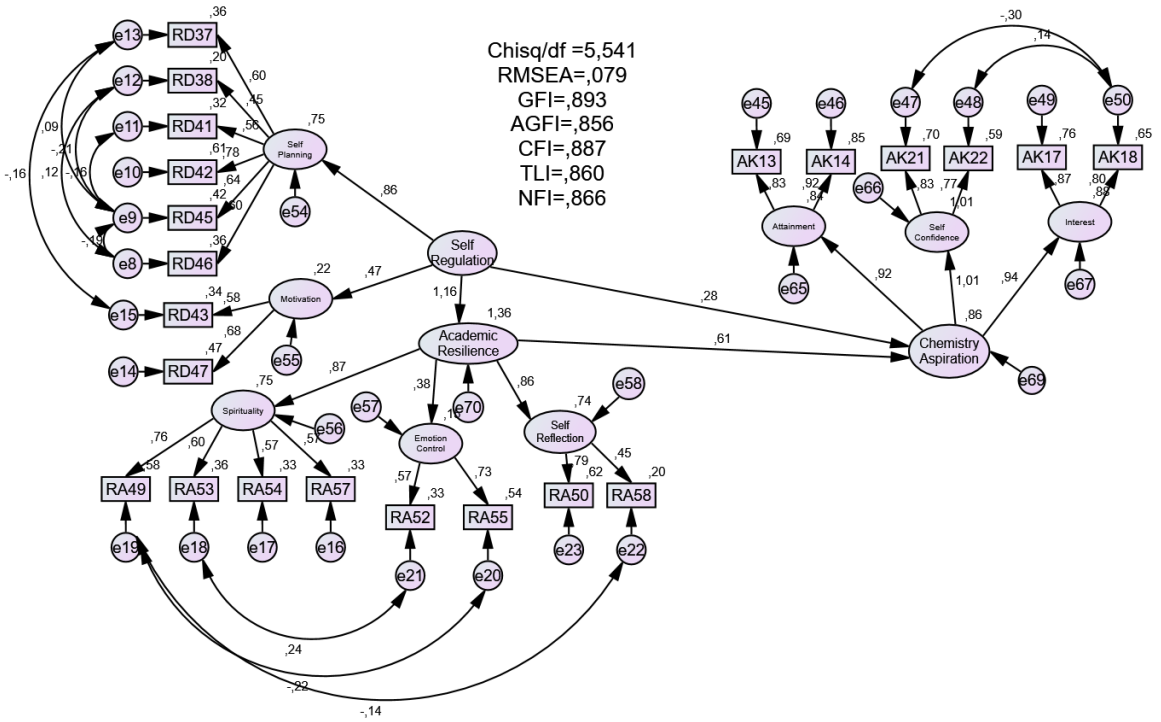

Figure-5.
The finalized SEM Model

Table-7.
Results of multiple linear regression with SEM. ***

Hypothetical path			β	S.E.	T	P
Academic Resilience	<---	Self-Regulation	1.16	0.14	8.63	***
Chemistry Aspiration	<---	Self-Regulation	0.28	0.16	2.97	0.00
Chemistry Aspiration	<---	Academic Resilience	0.61	0.18	5.81	***

Note: * P<0.05,
** P<0.01,
*** P<0.001.

Table 8.
Mediating effect test.

Parameter	Estimate	95 % CI		P	Percent
		Lower	Upper		
(Total) Self-Regulation-Academic Resilience	1.16	1.05	1.30	0.01	
(Total) Self-Regulation-Chemistry Aspirations	1.00	0.90	1.09	0.02	
(Direct) Self-Regulation-Academic Resilience	1.16	1.05	1.30	0.01	
(Direct) Self-Regulation-Chemistry Aspirations	0.28	0.05	0.72	0.02	28%
(Indirect) Self-Regulation-Chemistry Aspiration-Academic Resilience	0.71	0.10	1.01	0.04	71%

5. Discussion

Students in high school are often faced with the decision to attend college or enter the workforce. This is because higher education, which follows high school, aims to develop a workforce capable of addressing future issues and fostering a generation of competent scholars and professionals. The theory of career development has identified several factors that can influence an individual's career choices. Therefore, it is important to clarify how academic resilience mediates self-regulation and chemical desires during chemistry education. The primary goal of the current study is to examine the relationships among students' self-regulation, academic resilience, and chemical ambitions, as well as how academic resilience mediates the interaction between students' self-regulation and chemical desires. To achieve this, the researcher developed a theoretical model, proposed three research questions, and tested the hypotheses using CFA, SEM, path analysis, Pearson correlation analysis, and mediation effect testing.

In the context of educational results, particularly in chemistry education, the connection between self-regulation and chemistry aspirations is significant. According to the study's findings, students' aspirations in chemistry are significantly shaped by their ability to regulate themselves. With a correlation value of R = 0.28, the association between students' desires for chemistry and self-regulation is significant but moderately strong. This implies that pupils are more likely to have higher expectations in chemistry the more self-regulation they possess. Despite the weakness of this link, the R-value shows that self-regulation plays a significant role in chemistry students' motivation and objectives. Chemistry students' aspirations are heavily impacted by their capacity for self-regulation. Goal-setting, self-monitoring, and self-reflection are just a few of the

abilities that make up self-regulation, which helps students effectively regulate their learning process. Strong self-regulation abilities have been linked to increased self-efficacy, which improves motivation and academic achievement in chemistry [84]. Students who successfully employed self-regulated learning strategies, for instance, outperformed their peers who did not use such tactics on chemistry examinations [85].

Additionally, in chemistry classes, specific teaching methods that prioritize goal-setting and self-monitoring can promote the development of self-regulation skills. Students' academic performance is enhanced by this method, which also increases their interest in the subject and helps them match their goals with their aptitudes [23]. Increasing preservice chemistry teachers' motivation and understanding of motivational control techniques greatly enhanced their capacity for self-regulated learning, which in turn led to increased aspirations in the topic [86]. In conclusion, the relationship between self-control and chemistry goals is essential for chemistry students to succeed academically, underscoring the necessity of educational frameworks that encourage the growth of these crucial abilities. For instance, a study by Al-Bahrani et al. [87] revealed that students who possess high levels of self-regulation are more equipped to handle obstacles in their academic path and are therefore more likely to set ambitious professional objectives. Adolescents have higher career goals, yet they are guided to fulfill their parents' expectations. Regular parent-teacher interactions help teachers learn about the interests and dislikes of their pupils and give parents information about their children's school activities. Since sound job decisions result in professional success, fulfillment, and enjoyment, parents and educators should be more cognizant of early adolescents' career goals [88]. In summary, there are several facets to the relationship between self-regulation and career aspirations in chemistry; the development of self-regulation abilities not only enhances academic achievement but also gives students the confidence and resolve to follow their career objectives.

There is a high positive association between students' aspirations in chemistry and their academic resilience, as indicated by the correlation value of $R = 0.61$. This implies that students' aspirations in chemistry increase with their level of academic resilience. This suggests that students with adaptive skills and the capacity to recover from setbacks are more likely to be motivated and to have high hopes of succeeding in chemistry. This relationship is also consistent with research by Cai and Wang [89] which demonstrates the importance of resilience in bridging the gap between personal goals and outside assistance, bolstering optimism and drive by overcoming setbacks. Furthermore, Luu [90] emphasized that improving communication skills fosters resilience, which aids people in achieving their best outcomes in a variety of settings, including the classroom. An essential field of study that emphasizes how students' capacity to overcome academic obstacles influences their career objectives is the connection between academic resilience and vocational aspirations. To navigate the complexity of the educational environment, students must be able to adapt and prosper in the face of adversity. This ability is known as academic resilience. Academically resilient students are more likely to have aspirations for ambitious careers, according to research. According to studies, for instance, professional flexibility and resilience have a positive correlation, which in turn affects how students make career decisions. Because they can effectively handle losses and stay motivated in the face of difficulties, resilient people may be better able to define and pursue significant career goals [91, 92] these findings highlight the value of fostering academic resilience through educational interventions such as adaptive skills training, solution-focused learning strategies, and supportive mentoring. Students' motivation to achieve their goals in chemistry and other subjects may increase as a result.

Additionally, the data were examined using path analysis and mediation effect tests to address the third hypothesis question, which is whether academic resilience can act as a mediator of self-regulation to influence chemistry aspirations. The results were statistically significant. This relationship's primary mediator, academic resilience, has an R-value of 1.16. The association between self-regulation and chemistry aspirations is mediated mostly by academic resilience, as evidenced by its R-value of 1.16. This relationship is significantly strengthened by the combined impacts of the direct and indirect pathways through academic resilience. In other words, pupils who possess strong self-control are better able to overcome obstacles and stay motivated over the long term, which helps them achieve their full potential in chemistry. Perceived competence as a mediator in the relationship between academic resilience, self-regulation, and academic goals is a crucial topic of research in educational psychology. According to research, students' resilience is greatly enhanced by their capacity for self-regulation, or the ability to control their thoughts, feelings, and actions while pursuing academic objectives. To improve their learning experiences and results, self-regulated learners actively employ behavioral, motivational, and metacognitive techniques [93]. According to Bandura's self-efficacy hypothesis, people who establish objectives for themselves and monitor their progress have a higher chance of succeeding academically. Additionally, the results imply that the relationship between resilience and self-regulation is mediated by perceived competence. According to Kılıç et al. [94] Students who have confidence in their skills are more likely to exercise self-regulation effectively, which strengthens their resilience. Additionally, resilience and self-regulation are correlated; greater resilience can lead to improved self-regulation abilities. Students who are dynamic and resilient may also be better equipped to manage their learning process [95, 96]. Students who possess good self-regulation abilities, for instance, are more equipped to adjust to a range of academic obstacles, enhancing their resilience. In conclusion, perceived competence acts as a mediator in the complex interaction between academic resilience and self-regulation of academic goals. Enhancing students' self-regulation abilities fosters a positive feedback loop that supports long-term educational achievement by improving their resilience and academic performance [97, 98]. According to other research, academic resilience protects students from pressures and keeps them motivated and goal-focused [99].

Furthermore, with a correlation coefficient (R) of 0.78, the study discovered that the self-planning dimension specifically, item RD_42, which read, “I think it is important to study chemistry because it will be useful in the future” had a significant impact on the relationship between self-regulation and chemistry aspirations. This substantial link implies that students are more likely to participate in self-regulated activities that support their job aspirations in chemistry if they understand the

relevance of their education to those careers. This idea is supported by research that demonstrates the importance of self-regulated learning techniques like goal-setting and self-monitoring in promoting academic motivation and goals [100]. Additionally, the focus on using chemical knowledge practically inspires students to use efficient self-planning techniques, which can raise their expectations and enhance their academic success. Students who successfully employed self-regulation strategies showed increased resilience and adaptability during their learning process, which reinforced their dedication to academic objectives, according to a study by Artuch-Garde et al. [101]. According to the results, students are more inclined to work hard and stay focused on their academic goals when they understand how important their academics are to their success in the future. The relationship between self-regulation and chemistry goals is greatly influenced by self-planning connected to projected future rewards, as item RD_42 demonstrates. Teachers may improve students' self-regulation abilities and goals by encouraging an awareness of the value of chemistry education, which will ultimately result in increased success in their academic and professional pursuits.

The spirituality dimension's item RA_49, which read, "I believe that I will achieve good and successful results if I surrender to God," had the strongest effect on academic resilience toward chemistry objectives, with a correlation coefficient (R) of 0.76. Given this high R-value, it appears that students' aspirations in chemistry and academic resilience are strongly correlated with their spiritual beliefs. By giving people a sense of direction and support, spirituality can improve resilience, according to research. This is especially helpful in demanding academic settings [102]. Strongly spiritual students frequently exhibit more self-assurance in their capacity to overcome challenges because they see their work as a component of a greater whole. This viewpoint might boost their academic enthusiasm and perseverance, particularly in challenging courses like chemistry. According to a study by Hatami and Shekarchizadeh [103] More spiritual students tend to have higher levels of resilience, indicating that spiritual beliefs may have a beneficial impact on academic results. Additionally, studies reveal that spiritually inclined children possess superior coping strategies and can handle stressful situations more effectively [104]. All things considered, item RA_49 demonstrates how spirituality has a substantial impact on academic resilience and how it affects students' goals in chemistry. By acknowledging how spiritual beliefs contribute to resilience, teachers can better assist students in reaching their learning objectives and negotiating the challenges of their academic paths.

5.1. Conclusion

The results show that academic resilience functions as a mediator in the strong association between self-regulation of chemical aspirations and academic resilience. This indicates that individuals who successfully control their actions and desires are better able to cope with difficulties in school, adapt to failures, and persist toward their objectives. The observed correlation further supports the idea that self-regulation directly influences academic achievement by fostering resilience. These findings suggest that helping students demonstrate resilience and self-regulation may enhance their success and goals in chemistry, which in turn may inspire more children to pursue STEM professions. Additionally, this supports theories emphasizing the need for targeted interventions and programs to foster self-regulation and resilience in educational settings, viewing resilience as a dynamic process influenced by behavioral and cognitive components.

5.2. Implication for Education

The results have many significant ramifications for student development and education. To promote academic resilience, they first emphasize the necessity for schools and teachers to put in place initiatives and plans targeted at improving self-regulation abilities. Teachers may give students the skills they need to overcome academic obstacles and persevere in their learning by teaching them how to effectively manage their goals, feelings, and behaviors. Additionally, because academic resilience acts as a mediator, self-regulation-focused therapies may indirectly enhance chemical aspirations by enhancing students' capacity to adjust and flourish in the face of hardship. Finally, our observations underscore the importance of including social-emotional learning (SEL) in the curriculum, stressing the connection between academic resilience, self-regulation, and chemical ambitions, all of which can support long-term learning and individual development.

5.3. Limitations and Future Research

Although the study provides insightful information about the connection between academic resilience and self-regulation of chemical aspirations, it is essential to acknowledge certain limitations. Initially, the research might have depended on self-reported information, which is prone to errors in participant responses and social desirability bias. Secondly, the cross-sectional approach emphasizes the necessity for longitudinal research to examine these processes over time by limiting the capacity to establish causal links between academic resilience and self-regulation. Furthermore, contextual factors, including socioeconomic position, cultural differences, and educational contexts, may not have been adequately considered in the research, which could have impacted the results. Extending the scope to include interventions that target self-regulation and resilience development would also provide useful insights for educators and policymakers. Future research should concentrate on addressing these limitations by using diverse samples, experimental designs, and longitudinal methods. To further enhance our understanding of how self-regulation impacts resilience and chemical aspirations, we should investigate other potential mediators or moderators, such as motivation, peer support, or teacher-student relationships.

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