Full research paper

THE ROLE OF ACADEMIC RESILIENCE, SELF-REGULATION, AND PERCEPTIONS OF CHEMISTRY STUDENTS IN ACADEMIC ACHIEVEMENT: A STRUCTURAL EQUATION MODELLING (SEM) APPROACH

Desfi Annisa
Hari Sutrisno✉
Endang Widjajanti

Yogyakarta State University, Indonesia

✉ sutrisnohari@uny.ac.id

ABSTRACT

Improving student achievement is one of the most important components of learning, and it is influenced by several variables, including academic resilience, self-regulation, and students' perceptions. This study examined how high school academic resilience, self-regulation, and students' perceptions affect their academic achievement in chemistry classes. Even though chemistry is regarded as a crucial subject for learning, most students find it complicated, making it challenging to comprehend. This explains why students' academic achievement in chemistry is so low. Using cluster random sampling techniques, 791 students participating in chemistry classes formed the sample. The linear relationship model between academic resilience, self-regulation, student perceptions, and achievement in chemistry is examined in this research using the Structural Equation Modelling (SEM) method. The results indicate that chemical achievement correlates negatively with academic resilience, significantly positively with self-regulation, and negatively and insignificantly with student perception. To ensure that students in chemistry learn at their best, teachers should focus more on the qualities of their students and incorporate learning activities.

KEYWORDS

Academic resilience, achievement, chemistry, perception, self-regulation, structural equation modelling

HOW TO CITE

Annisa D., Sutrisno H., Widjajanti E. (2025) 'The Role of Academic Resilience, Self-Regulation, and Perceptions of Chemistry Students in Academic Achievement: A Structural Equation Modelling (SEM) Approach', *Journal on Efficiency and Responsibility in Education and Science*, vol. 18, no. 2, pp. 129–146. http://dx.doi.org/10.7160/eriesj.2025.180206

Article history
Received
September 5, 2024
Received in revised form
February 18, 2025
Accepted
April 23, 2025
Available on-line
June 30, 2025

Highlights

- *Academic resilience shows a negative relationship with students' achievement in chemistry.*
- *Self-regulation has a significant positive effect on chemistry achievement.*
- *Students' perceptions of chemistry learning have no significant impact on achievement.*
- *Strengthening students' self-regulation skills may enhance cognitive outcomes in chemistry learning.*

INTRODUCTION

Education plays a major role in developing and expanding the human resources needed for nation-building. The reason is that education is an important component of human life and helps foster a morally and socially responsible, inventive, and civilized society (Taheri et al., 2016; Malik and Parveen, 2019). As Oyelekan et al. (2019) noted, students are an integral part of the teaching and learning process. Students' academic achievement is a reflection of the quality of their learning. Any education system aims to improve students' general abilities, especially academic achievement (Lim et al., 2022). Measuring students' academic achievement is very important because it can provide an overview of how students succeed in the learning process (Hussain et al., 2019).

Numerous obstacles to chemistry education in Indonesia impact learners' academic achievement. One of the primary issues is that students frequently struggle to comprehend abstract fundamental chemical ideas (Priliyanti et al., 2021).

This is because chemistry is a challenging subject that takes much practice and dedication to master (Moreno et al., 2021; Siddique et al., 2023). Various factors, such as psychological factors, can affect students' academic achievement in chemistry. Academic resilience, self-regulation, and student perception are some variables that have received attention from researchers.

Academic resilience, self-regulation, and students' perceptions of cognitive achievement are interrelated elements and one of the important factors for success in chemistry learning. Academic resilience enables students to better deal with problems in chemistry studies (Annisa et al., 2023). Meanwhile, self-regulation in chemistry lessons allows students to efficiently and autonomously oversee the learning process (Feldman-Maggor, 2023) studies show that this flexibility also poses a challenge for individual learners who are required to manage their schedules and complete specific tasks independently. Therefore, success in an online learning environment relies heavily on the learner's self-regulated learning (SRL. Students with good self-regulation skills tend to be more confident in understanding chemistry concepts, which ultimately increases their perceptions of cognitive achievement (Ataii et al., 2021). Perceived competence plays a mediating role in the relationship between self-regulation and academic resilience so that students remain motivated to succeed despite facing difficult material (Kiliç et al., 2022). Therefore, problems arise when students cannot face learning challenges, low self-regulation skills, and poor perceptions of their cognitive abilities in chemistry that hinder their overall achievement.

This study provides major contributions. First, research on academic resilience can improve student achievement, considering resilient individuals can overcome obstacles and adapt to new environments. Second, research on self-regulation can improve students' motivation to learn because students have a personal task to learn to achieve positive learning outcomes and improve their quality of life. Third, research on student perception can affect memory, idea generation, and attitude development, all of which affect response activities in the learning process. As a result, if these three contributions function well, it is expected that the academic achievement of chemistry students can increase.

THEORETICAL FRAMEWORK AND HYPOTHESES

Academic Resilience and Academic Achievement

Research on the role of resilience in improving the cognitive achievement of chemistry students in Indonesia is increasingly in demand, given how important resilience is for academic success (Annisa et al., 2024a). This is a key factor in developing academic resilience, as giving students individual targets or goals can help them become more resilient as they will be challenged to overcome obstacles, peer pressure, and self-doubt (Finklestein et al., 2022). Academic resilience is part of general adaptability that relates to how difficult it is for an individual to adjust to various requirements, courses, and fields of study (Deng et al., 2023). This is because chemistry is often considered complicated and abstract in achieving educational goals (Timilsena et al., 2022).

Several studies have shown that student resilience highly depends on their intelligence level (Huang et al., 2022). There are numerous articles on academic resilience. However, the relationship between student learning achievement in chemistry and academic resilience has not been well-researched (Annisa et al., 2023). Theoretically, though, academic resilience may influence students' learning outcomes. A person with a high level of resilience may learn more effectively because they can overcome various obstacles in learning (Peker and Cengiz, 2022). Another study revealed that motivation and academic resilience significantly predicted achievement in chemistry (Chikendu et al., 2021). This is in line with the findings of Oke et al. (2016), which showed a significant correlation between academic resilience and academic achievement across groups. Another study involving high school students in mathematics found that students had varying levels of resilience based on grade level, suggesting that students' perceptions of their academic resilience in mathematics may change as they progress (Ishak et al., 2020). Similarly, Jamaluddin et al. (2023) investigated the resilience of biology students and found a correlation between academic resilience and the development of critical thinking skills.

Spirituality, emotional regulation, and self-reflection are all important components of academic resilience (Cherian and Kumari, 2021). Academic resilience has many subdimensions, such as spirituality, emotional regulation, and self-reflection, which are particularly beneficial. Spirituality is primarily concerned with finding greater meaning and "purpose in life," as well as personal pursuit and progress. Students with high spirituality are better able to cope with stress, adapt, and think positively about difficult circumstances (Gnanaprakash, 2013). According to Saefudin and Sriwiyanti (2023) during the education and rehabilitation process, juveniles experience adverse psychological states and encounter external difficulties. Therefore, the juveniles must have stress resistance or resilience to deal with these issues, as well as spiritual well-being which provides a holistic perspective on an individual's existence and facilitates a more comfortable understanding of life. This broad perspective empowers the individual to manage challenging conditions, including the educational environment. Therefore, this study assumed that spiritual well-being affects student academic resilience. Researchers employed the proportionate stratified random sampling approach. There were 100 juvenile respondents. The enrollment criteria include juveniles aged 12 to 18 who perpetrated various criminal offenses, served their sentences in prisons, and participated in the institution's educational program. The results are categorized into two principal findings discussions. First, the academic resilience of juveniles is found to be 75% high and 25% moderate. Second, spiritual well-being correlates with students' academic resilience, and the regression analysis results depict that spiritual well-being can explain 42.6% of academic resilience. These results indicate that spiritual well-being enhances academic resilience during study in prison.\r \r Abstrak. Lembaga Pembinaan Khusus Anak (LPKA, worship is students' main spiritual method to cope with school-related anxiety. Students can manage their feelings better, resulting in increased resilience and overall well-being. This is a result of emotional regulation, specifically emotional

maturity. Higher distress tolerance results from adaptive emotion regulation strategies, indicating how important these strategies are in dealing with academic challenges (Chen, 2022). In addition, emotional regulation, specifically emotional maturity, helps students manage their feelings well, resulting in better resilience and well-being (Annisa et al., 2024b). Reflective thinking significantly increases academic resilience and well-being, particularly among language learners, highlighting the importance of self-evaluation in fostering persistence (Hammad Al-Rashidi and Aberash, 2024) both self-evaluation (SE). Salem (2024) also found that students who engaged in self-reflection on their technological competencies developed stronger academic resilience, particularly in STEM fields. These subdimensions work together to build a resilient mindset and provide students with the tools they need to thrive in the face of academic challenges.

Self-Regulation and Academic Achievement

Self-regulated learning is still an interesting research topic for psychologists and educators (Khan et al., 2020). Self-regulated learning (SRL) is very important in chemistry education in Indonesia because it affects students' academic outcomes and achievements (Fazriah et al., 2021). Another study emphasized the importance of SRL in a laboratory environment, which showed that SRL significantly affected students' motivation and engagement during practical activities (Purwoko et al., 2024). Web-based learning can significantly improve students' self-regulated learning, leading to enhanced chemistry academic achievements (Indriani et al., 2023). In addition, metacognition and motivation are important components that influence students' success and persistence in chemistry education (Rahmawan et al., 2024). These results indicate that developing self-regulation skills is essential to improving students' performance and engagement in chemistry learning. Self-regulation positively impacts academic achievement (Xiao et al., 2019; Wandler and Imbriale, 2017). Environment, time management, and metacognitive activities significantly impact academic achievement (Lee et al., 2020). These insights suggest that educational approaches that enhance self-regulated learning skills are needed for Indonesian chemistry students to be more resilient and achieve.

In addition to chemistry, other studies have shown that self-regulation is essential for students in physics, biology, mathematics, and science, allowing them to manage their thoughts, behaviors, and emotions to navigate learning (Paz-Baruch and Hazema, 2023). Self-regulated learning involves managing cognitive, behavioral, metacognitive, affective, and motivational aspects to achieve educational goals. In mathematics, self-regulation is associated with improved problem-solving abilities (Říčan et al., 2022). Additionally, studies show that students who practice self-regulation experience decreased procrastination and stress, which positively impacts their academic performance (García-Ros et al., 2023). Students in mathematics show better attitudes toward learning. In addition, self-regulation is related to critical thinking, which is important for processing information in science education (Higgins et al., 2023)whether SRL improves as students gain educational experience in undergraduate science has not been adequately studied. It is also unclear whether traditionally strong predictors of academic performance, such as the Australian Tertiary Admissions Rank (ATAR).

Self-regulation is a fundamental psychological process that allows individuals to control their behavior, emotions, and cognitions to achieve goals. It is closely related to self-planning, impulse control, and motivation. Self-planning, as a component of self-regulation, involves setting structured strategies to guide behavior, such as implementation intentions, which have been shown to reduce impulsive decision-making (Thürmer et al., 2020). Impulse control, another dimension of self-regulation, is critical in reducing automatic behaviors driven by external stimuli, as failures in self-regulation often occur when self-control resources are depleted (Gnanaprakash, 2013). In addition, motivation interacts with self-regulation by influencing the selection and implementation of self-regulation strategies. Research suggests that self-motivational and emotion-regulation strategies can enhance volitional control, thereby improving behavioral outcomes (Forstmeier and Rueddel, 2007). Self-regulated learning involves reflection, goal setting, and self-monitoring, which enhance students' ability to manage their learning (Clayton Bernard and Kermarrec, 2022). In addition, self-regulation includes regulating emotions, motivation, and cognitive control, which enables students to persist in complex learning tasks. Understanding these interrelated dimensions provides insight into how individuals can enhance their self-regulatory capacity to achieve long-term success.

Student's Perception of Chemistry and Academic Achievement

Perception is related to the five senses because it occurs after the object sees, hears, or feels something and organizes and interprets it. In addition, this process occurs in how students view learning in class to achieve achievement (Ansow et al., 2022). Perception is the ability to be aware of things, understand and analyze the surrounding environment, and categorize various types of information (Altundağ et al., 2022). To form a meaningful world perspective, perception must be understood as a job that involves focusing on sensory input and analyzing and interpreting it (Mannopovna, 2019).

In many countries, most students leave chemistry courses in high school and college due to the general opinion that the subject is challenging to understand and teach (Rosly et al., 2021). Many students still view chemistry as an abstract and difficult topic with no relevance to real life, even though it directly relates to it (Karsli Baydere, 2021). Students have difficulty understanding complex chemistry concepts, especially in organic chemistry and thermodynamics, which require a lot of visualization and symbolic representation (Oladejo et al., 2023). In addition, complex organic chemistry reaction mechanisms lead to student frustration and isolation (Salame and Khalil, 2023). Furthermore, Crossdale et al. (2022) found that female students are less likely to continue studying chemistry in high school because they experience difficulties and are not confident in their abilities in the field. Learning chemistry should make understanding the

chemical processes that occur in nature and the environment easier. Students argue that they should be able to apply the chemical information they gain in class to solve the difficulties they face in real life (Habibi et al., 2022; van Vorst and Aydogmus, 2021). To overcome students' lack of interest in chemistry, self-regulation and academic resilience can be effective strategies to increase engagement and understanding. Studies show that resilience, self-regulation, and a supportive learning environment improve students' academic performance. This helps them to deal with difficult chemical concepts (Machmud and Ramadhan, 2022). Self-regulation skills directly influence students' mathematics, chemistry, and physics performance. This suggests incorporating self-regulation strategies into the curriculum can increase students' interest and success in chemistry and physics lessons (Sultanova et al., 2024).

Chemistry students' perceptions are closely related to the dimensions of learning materials, learning attitudes, and learning concepts because these elements collectively shape their educational experience. These dimensions were chosen because they represent important aspects of the learning process that significantly influence chemistry students' engagement and learning outcomes (Masbukhin et al., 2023). For example, how students viewed online chemistry learning during the COVID-19 pandemic revealed that, although some found it easy and flexible, many found it poor due to uninteresting content and lack of readiness to participate online. This suggests that well-designed learning materials and positive learning attitudes are essential when learning online (Dewi et al., 2023). Incorporating ICT in chemistry education improves students' perceptions, making learning materials more interactive and accessible (Hairida et al., 2023). In addition, students introduced to the concept of "Green Chemistry" showed a deeper understanding and appreciation of sustainable practices, indicating how important this concept is in chemistry learning (Jusniar et al., 2023). These aspects cover a wide range of aspects that influence students' understanding and engagement with chemistry lessons, making them important for improving their understanding of chemistry learning.

Current Study

This study uses the Structural Equation Modeling (SEM) method, which is novel compared to commonly used approaches like ANOVA and simple linear regression in earlier research (Ghozali, 2011). This study attempts to provide greater insight into the factors that influence student accomplishment by utilizing SEM and synthesizing findings from prior studies. In essence, research focuses on statistics as a whole, which encompasses theories, procedures, and the analysis of statistical findings. This study investigated the following hypotheses.

H_1: Academic achievement is significantly impacted by the academic resilience of learning chemistry.

H_2: Academic achievement is significantly impacted by the self-regulation of chemistry learning.

H_3: Academic achievement is significantly impacted by students' perceptions of their chemistry learning.

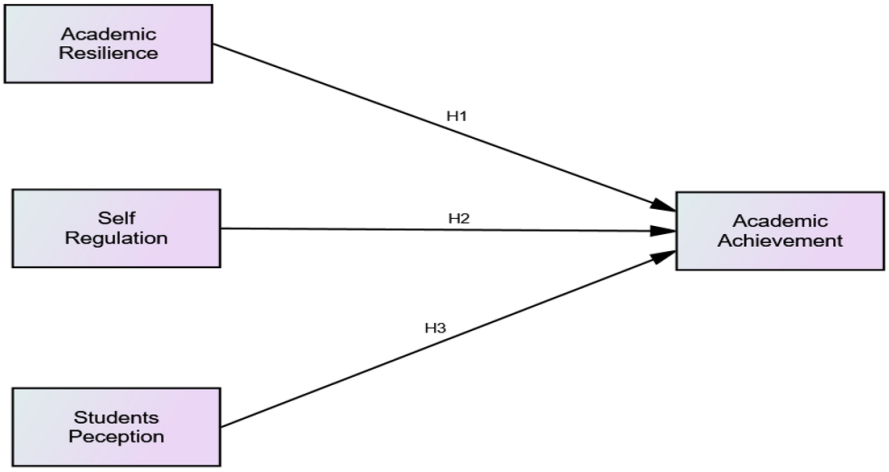

Figure 1: Research Framework

METHODS

Sample

The sample consisted of 791 high school students from 14 schools in Pekanbaru and its surrounding areas, Indonesia. For this study, a cluster random sampling technique was used to collect samples aged 15-17 years. There were 516 (65.23%) female students and 275 (34.77%) male students. This cross-sectional study involved high school students. The researcher was granted permission by the Provincial Education Office to conduct the study in 14 schools. Students from public schools majoring in science from grades one to three were the selected subjects. Before taking part in the study, students were given informed consent explaining the purpose and benefits of the study. They were also allowed to refuse or leave the study at any time. Student data was kept confidential and was used only for academic purposes by research ethics standards. Furthermore, the researcher sent a link to the questionnaire to the WhatsApp class to collect student responses.

Research Instrument

The items in the questionnaire come from previously published works, which are used as references in this study. The researcher synthesized the questionnaire items, namely academic resilience, which has been adopted by (Ramirez-Granizo et al., 2020; Idris et

al., 2019; Cassidy, 2016), then self-regulation assessment adapted by (Jakesova et al., 2016; Lehmann et al., 2014; Toering et al., 2012), and student perceptions adapted by (Agung et al., 2022; Ansow et al., 2022; Ngugi et al., 2020). The questionnaire was compiled based on several previously identified sub-dimensions. Academic resilience consists of spirituality, emotional regulation, and self-reflection. Self-regulation consists of self-planning, motivation, and impulse control, and student perception consists of learning materials, learning attitudes, and learning concepts. The interval from 1 (strongly disagree) to 5 (strongly agree) is used in this study as a Likert scale.

The procedure for working on the questionnaire is in section a (name, gender, school, and likes/dislikes of chemistry subjects) when respondents fill in the Google Form as their identity. In section B (11 items on cognitive achievement, 11 items in the statement section regarding academic resilience to chemistry learning, 11 items in the section on self-regulation regarding chemistry learning, and 11 items in the section on student perceptions of chemistry learning). The Cronbach's Alpha statistical technique is widely used to assess the reliability or internal consistency of research instruments such as questionnaires, tests, or surveys. This method determines how well a set of items can measure a unidimensional construct by looking at how correlated they are with each other (Tavakol and Dennick, 2011). The instrument has satisfactory internal consistency if the Cronbach's Alpha score exceeds 0.6 (Hair et al., 2019). Details can be seen in the following Table 1.

Variable /dimension	Code	Items	Internal reliability Cronbach Alpha
Academic resilience			0.788
Spirituality	RA49	I believe I will perform well and become successful if I surrender myself to the Lord.	0.757
	RA50	I pray before and after studying chemistry	0.763
	RA53	I reject an invitation to see my friend to skip a chemistry lesson	0.765
	RA54	I am choosing to do positive things like exercise, playing music, reading books, and drawing when I get a mark less in chemistry Good.	0.771
	RA57	I tend to panic when there are lots of urgent tasks in chemistry	0.765
	RA58	I finished in a way Alone exam chemistry although I did not understand about lesson.	0.778
Emotional control	RA51	I surrender just to get low value without praying to God for help	0.776
	RA55	I prefer to the canteen instead of attending chemistry lessons in class.	0.767
	RA60	I see a friend's answer when it's difficult to complete the chemistry exam.	0.787
Self-reflection	RA52	I do not give thanks to God when I get high value	0.769
	RA56	I was confused when my grades were bad and preferred to stay in my room.	0.791
Self-regulation			0.784
Self-planning	RD37	I remember and collect all information related to chemistry through book reading and discussion class	0.764
	RD38	I am learning chemistry repeatedly before the teacher teaches in class	0.762
	RD41	I like chemistry Because arouse curiosity for I although That difficult For studied.	0.765
	RD42	I think that important To learn material chemistry Because will be beneficial later day.	0.747
	RD45	I ask for help from Friends only when I feel difficulty in doing a task or when I find understanding material chemistry difficult.	0.770
	RD46	I ask for help from the teacher when difficult to question chemistry.	0.757
Academic motivation	RD43	I am certain that the material chemistry that I learn will be useful for me.	0.764
	RD47	I went out of class while studying chemistry	0.774
Impulse control	RD39	I have a hard time making plans to Study chemistry.	0.780
	RD44	I surrender to ethics and face material difficult chemistry	0.771
	RD48	I am embarrassed to ask the teacher when difficult question	0.789
Student's perception			0.854
Learning materials	PSB73	I understand material chemistry with Good when he learns interesting	0.839
	PSB74	I am interested in studying chemistry when the teacher uses various methods	0.834
	PSB78	Studying chemistry gives benefits in life on I daily	0.837
	PSB82	Studying chemistry That pleasant when We understand the material studied	0.837
Learning attitude	PSB75	I am more interested in the lessons other than lesson chemistry	0.850
	PSB76	I am not interested in studying chemistry If only listening to the teacher's lecture	0.846
	PSB79	I feel like I don't understand chemistry very well. because the material is complicated to learn	0.846
	PSB80	Learning chemistry is not enough beneficial for I	0.850
	PSB83	Studying chemistry is boring and makes me sleepy	0.843
Learning concept	PSB77	I often read chemistry teaching materials to increase my understanding of chemical materials I	0.843
	PSB81	My chemistry learning results improved because I Study with truly	0.836

Table 1: Research instrument

Data Analysis

The research model was tested using structural equation modeling in the IBM-SPSS AMOS 23.0 software. In the beginning, Confirmatory Factor Analysis (CFA) was utilized as construct confirmation (Khine et al., 2013). CFA assesses each construct measurement model based on four criteria: Construct Validity, Convergence Validity, Discriminant Validity, and Composite Reliability (CR).

Reliability and Validity of the Study

The measuring model's applicability was confirmed using Construct Validity, Convergent Validity CR, and Discriminant Validity. Convergent Validity of a construct is determined by calculating its Average Variance Extracted (AVE), which must be at least 0.5. However, if the CR is greater than 0.6 and the AVE is less than 0.5, the construct's convergent validity is still sufficient (Fornell and Larcker, 1981). The measuring model for a construct needs to satisfy CR standards regarding dependability requirements. According to Aimran et al. (2017), a minimum CR value of 0.60 is advised. The modification index shows that a construct's measurement model lacks superfluous components. When the measurement model lacks superfluous components, discriminant validity is attained. Construct Validity is confirmed using many computed Fitness Indices, such as Absolute Fit, Incremental Fit, and Parsimonious Fit. When one fitness index per category hits the target value, construct validity is established (Ahmad et al., 2016).

RESULTS

Description of analysis

The results show that the average cognitive achievement of students (M = 63.48, SD = 31.805) in the chemistry test was 34.77% male students and 65.23% female students. As can be shown in Table 2, the average student perception (M = 3.27, SD = 0.97), self-regulation (M = 3.41, SD = 0.91), and academic resilience (M = 3.50, SD = 0.97) in chemistry learning were recorded. Although in the same category, the average value of students' academic resilience towards chemistry was higher than that of self-regulation and students' perceptions towards the subject. This is shown in detail in Table 2 below.

Construct	Mean (M)	Standard Deviation (SD)
Academic resilience	3.50	0.97
Spirituality	3.35	0.92
Emotion control	3.53	0.95
Self-reflection	3.63	1.04
Self-regulation	3.41	0.91
Self-planning	3.25	0.83
Academic motivation	3.71	1.05
Impulse control	3.26	0.85
Student's perception	3.27	0.97
Learning materials	3.36	1.06
Learning attitude	3.17	0.87
Student learning concept	3.27	0.98

Table 2: Grade of Academic resilience, Self-regulation, and Students' perceptions of chemistry

Construct Validity Evaluation

Questionnaire on Academic Resilience

The 11-item academic resilience questionnaire is divided into three sub-dimensions: spirituality, emotional regulation, and self-reflection. The scale's final validity-reliability study involved 200 students, and the results showed that the overall Cronbach alpha reliability coefficient was 0.813, with the subscales of spirituality, emotional regulation, and self-reflection having the highest respective Cronbach alpha reliability coefficients of 0.796, 0.656, and 0.518. Chi-square criteria (χ^2/df ≤ 5, perfect fit; Hooper et al., 2008; Kline, 2016) and other goodness-of-fit indices (Goodness of Fit Index ≥ 0.90, acceptable; Tabachnick and Fidell, 2007), Comparative Fit Index (CFI ≥ 0.90, acceptable; Hooper et al. 2008), and Root Mean Square Error of Approximation (RMSEA ≤ 0.08, good; Hooper et al., 2008) can be used to assess the model's accuracy. Additionally, CFA results were confirmed for the academic resilience questionnaire, which has a three-factor scale structure. The results demonstrate appropriateness and reliability: χ^2/df = 1.812, GFI = 0.934, CFI = 0.950, and RMSEA = 0.064. Figure 1 below illustrates it in further detail.

Questionnaire on Self-Regulation

The 11-item self-regulation questionnaire is divided into three sub-dimensions: academic motivation, impulsive control, and self-planning. The Cronbach alpha reliability coefficient for each subscale was determined to be 0.876 (self-planning), 0.487 (academic motivation), and 0.674 (impulse control) in the scale's final validity-reliability study, which involved 200 students. The overall Cronbach alpha reliability coefficient was 0.816. The self-regulation questionnaire, which has a three-factor scale structure, yielded verified CFA results. Suitability and reliability are demonstrated by the values of χ^2/df = 2.087, GFI = 0.936, CFI = 0.954, and RMSEA = 0.074. Figure 2 below illustrates it in further detail.

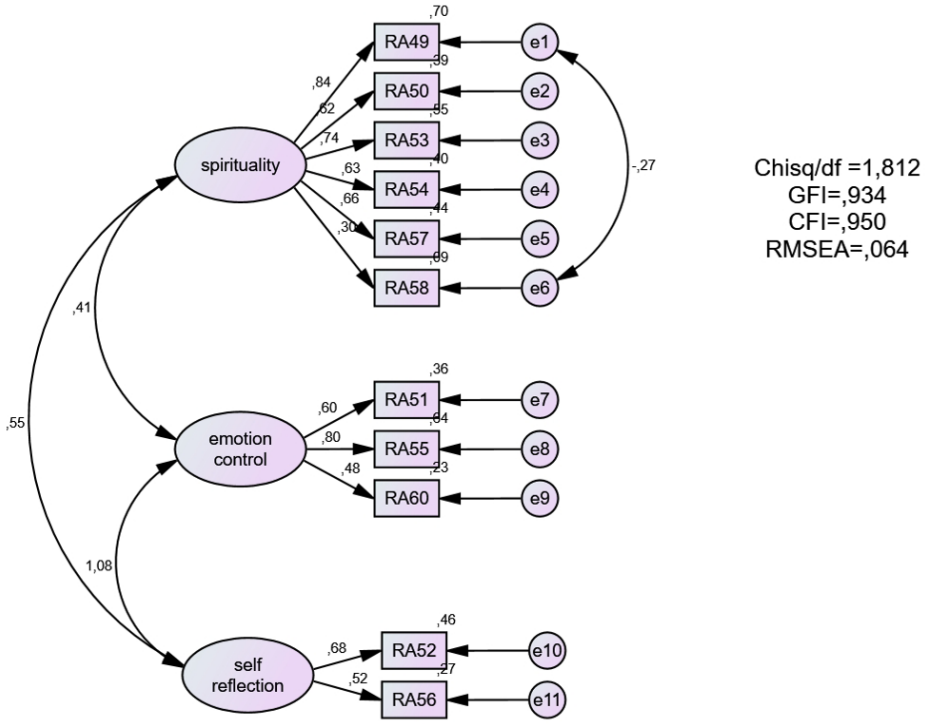

Figure 2: CFA for Academic Resilience

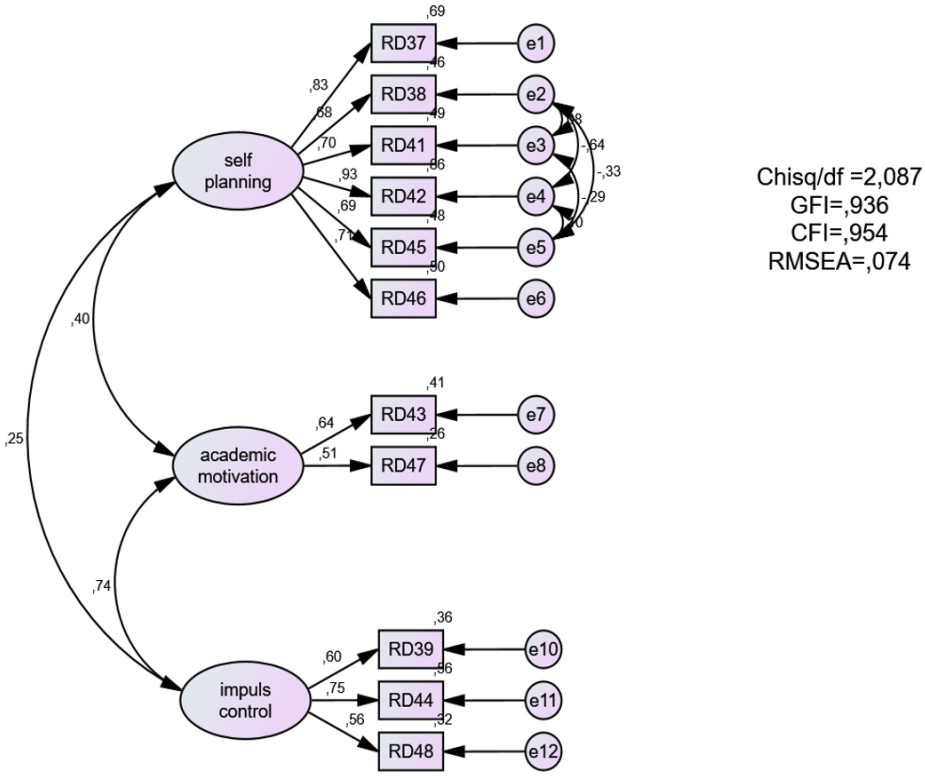

Figure 3: CFA for Self-Regulation

Questionnaire on Students' Perception

The 11-item student perception questionnaire is divided into three sub-dimensions: learning concepts, learning attitudes, and learning content. The Cronbach alpha reliability coefficient for each subscale was determined to be 0.847 (learning material), 0.789 (learning attitude), and 0.723 (learning concept) in the final validity-reliability study of the scale, which involved 200 students. The overall Cronbach alpha reliability coefficient was 0.859. The student perception questionnaire, which had a three-factor scale structure, yielded validated CFA results. Suitability and reliability are indicated by the obtained values of $\chi^2/df = 1.796$, GFI = 0.940, CFI = 0.967, and RMSEA = 0.063. Figure 3 below shows it in further depth.

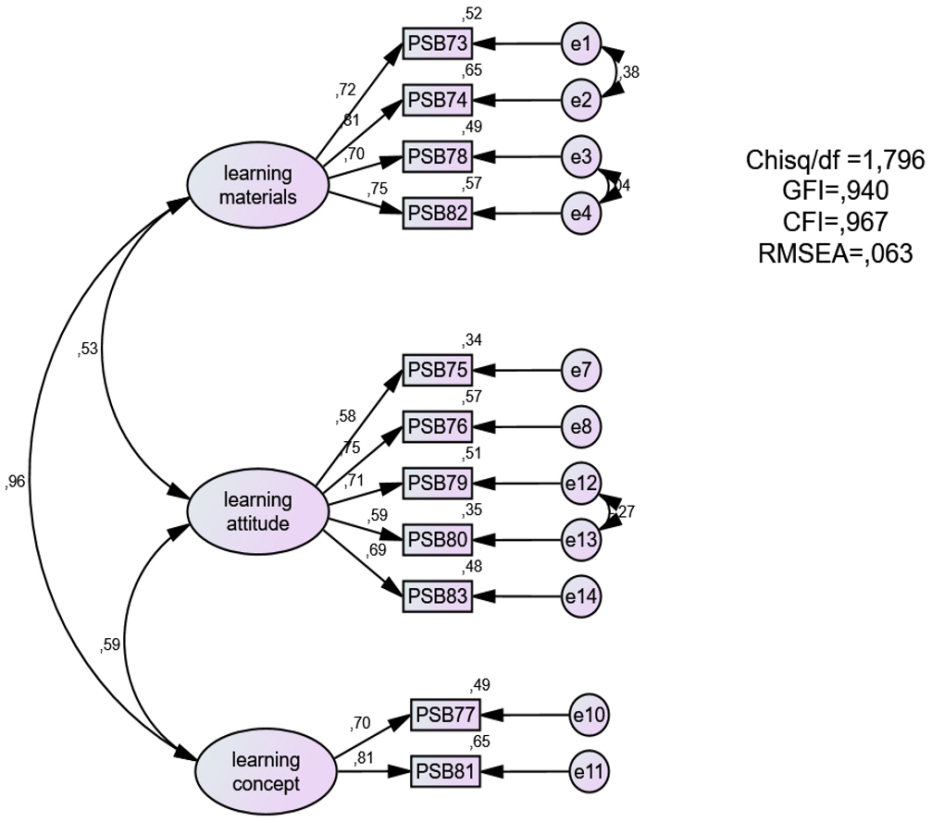

Figure 4: CFA Students Perception

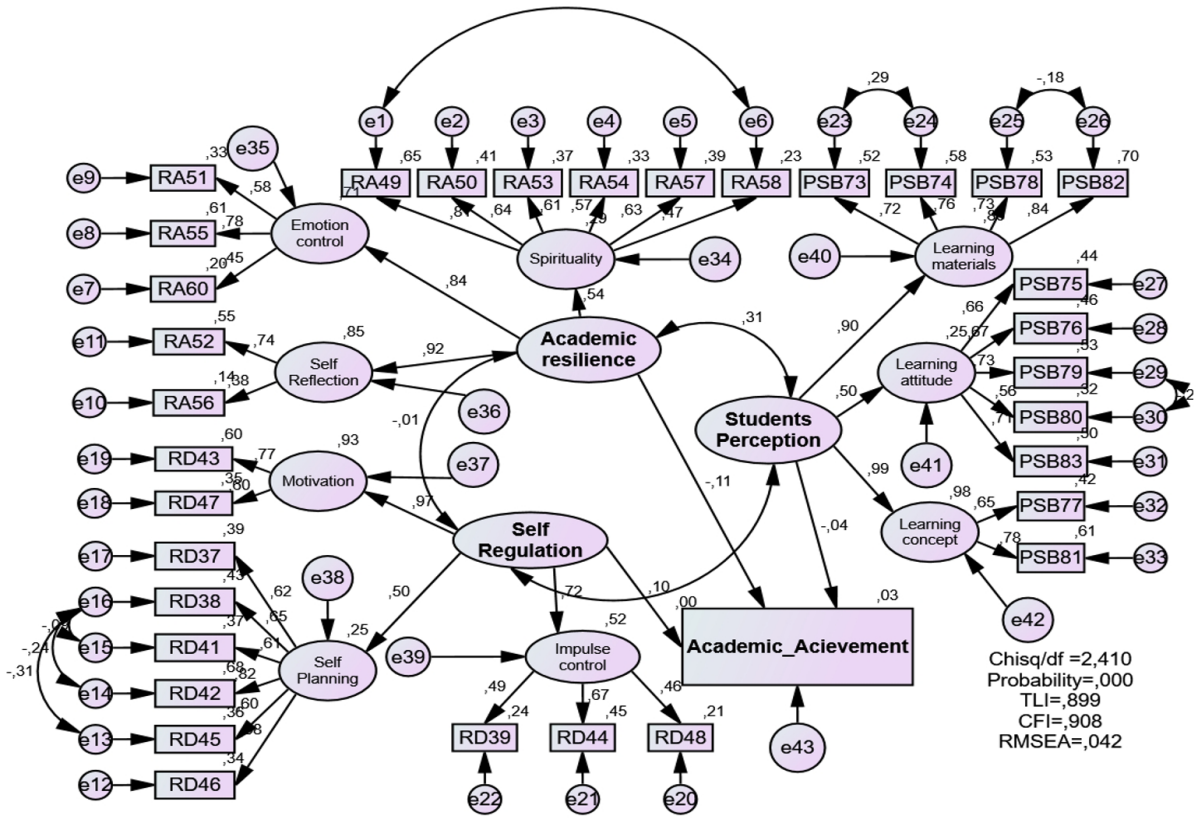

Figure 5: the CFA results are pooled, and the output that displays every fitness index attained

Convergent Validity and Composite Reliability Evaluation

Table 3 indicates that students' perceptions of chemistry, academic resilience, and self-regulation have AVE scores of 0.84, 0.86, and 0.88, respectively (with a minimum value of 0.5), indicating that the assessment of convergent validity was effective (Ahmad et al., 2016). In the meantime, students' views of chemistry, academic resilience, and self-regulation all had CR values of 0.89, 0.91, and 0.94, respectively (with at least 0.6 as the minimum value) (Ahmad et al., 2016). The CR value for this variable is known to show that CR has been attained.

Construct	Factor loading	CR	AVE
Academic resilience	6.59	0.89	0.84
Spirituality	3.67	0.90	0.97
Emotion control	1.8	0.89	0.94
Self-reflection	1.12	0.85	0.87
Self-regulation	6.77	0.91	0.86
Self-planning	3.79	0.93	0.98
Academic motivation	1.37	0.90	0.93
Impulse control	1.61	0.89	0.93
Student's perception	7.81	0.94	0.88
Learning materials	3.09	0.95	0.98
Learning attitude	3.29	0.93	0.98
Learning concept	1.43	0.94	0.96

Table 3: Presents composite reliability (CR) and average variance extracted (AVE) values

Evaluation of the Discriminant Validity of Constructs and Normality

The discriminant validity results are shown in Table 4. Discriminant validity was employed to gauge how distinct a construct is from other constructs, according to (Hair et al., 2010). Table 4 results indicate that every construct in the study met the criteria for discriminant validity. According to Mohamad et al. (2016) Malaysia using self-administered questionnaires among Malay youths. A total of 431 youths were involved in this study, comprising 204 males and 227 females. Structural Equation Modelling (SEM, there are greater values for the square root of the average variance derived from each construct (diagonal values in bold) than for the correlations between each construct. If there are no redundant construct problems, a correlation of less than 0.85 is valid (Awang et al., 2015).

Variable	Academic resilience	Self-regulation	Student's perception
Academic resilience	**0.84**		
Self-regulation	-0.02	**0.86**	
Student's perception	0.31	-0.01	**0.88**

Table 4: A summary of each construct's discriminant validity index

The data was examined for normalcy using the skewness and kurtosis criteria for normality testing. To show that the data is regularly distributed, the skewness score should be between -3.0 and 3.0 (Kline, 2016). Furthermore, to presume that multivariate normality is attained, the multivariate kurtosis value must be less than 50.0 (Mohamad et al., 2016). All of the variables' skewness values fall within the permitted range. Consequently, the data is considered normal.

Testing the Hypothesis

The regression coefficients between the constructs and the outcomes indicated in Tables 5 and 6 are depicted in Figure 4. The outcomes suggest a substantial correlation ($P < 0.05$) between students' academic achievement in chemistry and their academic resistance towards the subject. Students' academic progress in learning chemistry is, therefore, influenced by their academic resilience towards the subject, which is comprised of the sub-dimensions of spirituality, emotional regulation, and self-reflection. In addition, the study's findings demonstrate that chemistry students' academic success in the subject is significantly influenced by their ability to self-regulate, which encompasses motivation, impulse control, and self-planning ($P < 0.05$). Lastly, the findings indicate no significant relationship between student perceptions of the learning materials, learning attitudes, and learning concepts and academic achievement in chemistry ($P > 0.05$). Consequently, one hypothesis is not statistically supported at the 5% significance level, whereas two are.

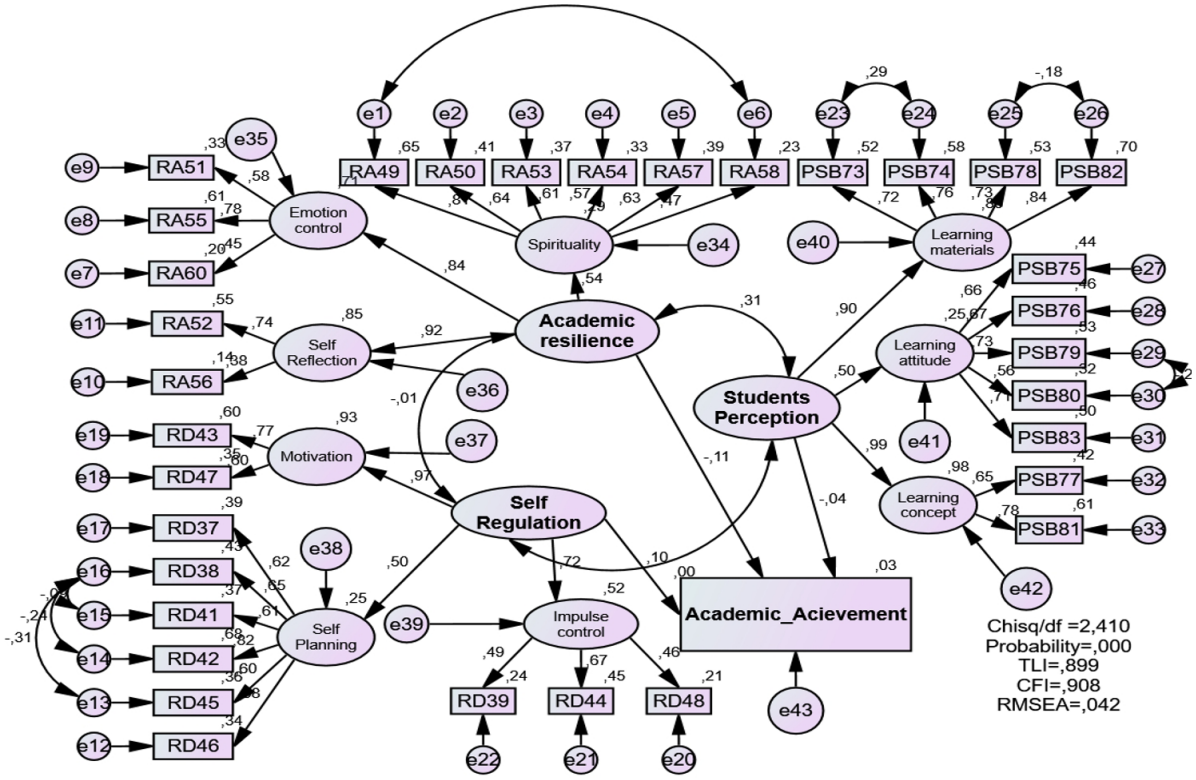

Figure 5: Study constructs' standardized regression path coefficients

Regression Path	Estimate	S. E	C.R	P	Result
Academic achievement <--- Academic resilience (H_1)	-5.40	2.26	-2.39	0.02	Significant
Academic achievement <--- Self-regulation (H_2)	8.83	3.86	2.29	0.02	Significant
Academic achievement <--- Student's perception (H_3)	-1.84	1.56	-1.17	0.24	No Significant

Table 5: the correlation coefficient of the regression path between the construct and its importance

Hypothesis statement	Result on hypothesis
H_1: Academic achievement is significantly impacted by the academic resilience of learning chemistry.	Supported
H_2: Academic achievement is significantly impacted by the self-regulation of chemistry learning.	Supported
H_3: Academic achievement is significantly impacted by students' perceptions of their chemistry learning	No Supported

Table 6: the testing of hypotheses

DISCUSSION AND CONCLUSION

This study examined the impact of academic resilience, self-regulation, and student perception on high school students' cognitive achievement in chemistry. The findings of our study showed that the average cognitive achievement of students in chemistry was 63.48, which is considered moderate. Studies have reported similar moderate achievement in chemistry, suggesting that instructional strategies play an important role in shaping students' cognitive outcomes (Nwafor et al., 2024). Furthermore, studies have shown that cognitive factors such as prior knowledge, reasoning ability, and memory capacity significantly influence chemistry achievement, with students at higher cognitive operational levels performing better in conceptual and computational tasks (Oloyede, 2012; Van Hootegem et al., 2023). These findings emphasize the need for innovative instructional approaches, such as inquiry-based strategies or cognitive modeling, to enhance students' reasoning abilities and improve their overall cognitive performance in chemistry (Aziz and Ahmed, 2018). Therefore, while moderate achievement levels reflect a basic understanding of chemical concepts, they also highlight the need for targeted interventions to foster higher-order cognitive skills and improve learning outcomes.

In addition, academic resilience, self-regulation, and students' perceptions of chemistry were all at a moderate level on average. Judging from the average value, academic resilience scored higher than self-regulation or students' perceptions. Spirituality can act as a buffer and help people cope with difficult situations. People who believe in themselves often have strong coping mechanisms to handle stress better (Imron et al., 2023). Emotional regulation is also important to academic resilience, helping them manage stress (Chye et al., 2024). Self-reflection also helps resilience because it allows students to assess their learning experiences, identify their strengths, and create

strategies for improvement (Phan et al., 2021). Self-regulation relies more on individual cognitive control and discipline, which may not always be enough to overcome academic difficulties. This contrasts with academic resilience, which is influenced by deep personal and external support systems (de la Fuente et al., 2018). In addition, students' perceptions of chemistry lessons are often influenced by things that come from outside, such as teaching styles and assessment methods. This can lead to lower overall self-assessments than resilience (Biswas and Bhowmick, 2024).

The first hypothesis (H_1) suggests that students' academic resilience in chemistry significantly affects their academic achievement in chemistry exams, even though the correlation is negative. In this context, a negative correlation means that the higher students' academic resilience in chemistry, the lower their academic achievement in chemistry exams, or vice versa. This suggests that high levels of negative academic resilience in this study may lead to low academic achievement. Nakhostin-Khayyat et al. (2024) examined the connection between self-regulation, cognitive flexibility, and resilience. They discovered that resilience promotes emotional health but does not always lead to improved cognitive performance. In addition, the study found that although resilience can reduce the impact of socioeconomic disadvantage, it does not always result in increased high cognitive scores (Rakesh et al., 2024). In contrast to the results of the study, it was found that there is a relationship between student achievement and academic resilience, and this relationship is positive (Amzil, 2022; Almulla, 2024). Strong interpersonal and social affective skills are associated with academic resilience (Hwang and Shin, 2018). On the other hand, the self-reflection dimension has the greatest influence on academic resilience, indicating how important self-reflection is to students' ability to overcome academic challenges. Students who actively engage in self-reflection develop better learning strategies and adaptability, which enhances academic resilience and well-being (Hammad Al-Rashidi and Aberash, 2024) both self-evaluation (SE).

The second hypothesis (H2) posits that students' self-regulation considerably impacts their cognitive achievement on chemistry tests. In line with that, self-regulation positively and significantly correlates with cognitive achievement (Yasmintya et al., 2024). Students who use self-regulation strategies often succeed in future planning and self-efficacy because it allows them to manage their emotions and have better educational performance (Sahranavard et al., 2018). Research shows that self-regulation strongly predicts academic achievement (Hindradjat et al., 2022). Self-regulated learning can explain 26.7% of the variation in learning achievement (Syahniar, 2018). The same thing is stated by Kashif and Shahid (2021), namely that self-regulation significantly influences academic success. Higher academic achievement is shown by students who show high levels of self-regulation. In addition, it offers evidence of the moderating role of academic achievement in the relationship between academic achievement and self-regulated learning (Xiao et al., 2019). The findings show a statistically significant positive correlation between academic achievement and SRL. Thus, academic achievement increases with increasing levels of SRL, while academic achievement decreases with decreasing levels of SRL (Rosário et al., 2008). Students who have self-regulation are responsible for their actions and can exercise self-control and self-improvement (Sumarni et al., 2020).

Motivation drives students to maintain learning efforts and engage in goal-directed behaviors. Therefore, the motivational dimension has the greatest influence on self-regulation. More motivated students show better self-regulation skills, especially in psychology classes emphasizing self-directed learning and critical thinking (Avecilla et al., 2023). In addition, the effect of self-regulation in virtual reality learning was investigated, and it was found that motivation plays a significant role in determining how effectively students manage their learning strategies and stay engaged in complex tasks (Sindu and Kertiasih, 2024). Furthermore, Martha et al. (2023) online learning has become commonplace in higher education. Various factors influence the success of online learning. Factors such as low self-regulation and co-regulation of learning skills can affect student engagement and motivation in online learning activities. Therefore, it is essential to provide external support in the online learning process. Pedagogical agents are one solution to increasing self-regulation and co-regulation learning in online learning environments. This study aims to determine the effect of integrating metacognitive and motivation scaffolding support provided through pedagogical agents on self-regulation and co-regulation learning skills. This study uses a mixed-method explanatory sequential approach. A quasi-experimental method of the nonequivalent type (pretest and posttest showed that incorporating metacognitive and motivational-based scaffolding into an online learning environment significantly improved students' self-regulation ability. It also strengthened the relationship between motivation and self-regulated learning.

According to the third hypothesis (H3) findings, students' perceptions of chemistry have an insignificant negative effect on academic achievement in studying chemistry. Based on identical research findings, Ahmad et al. (2017) concluded that there was no significant difference between the perspectives of male and female students regarding the teaching and learning process. Similar research by Dewi et al. (2023) found that students' perceptions of the use of online chemistry learning were negative. A person will be inspired to perform better in a subject if they understand it well. Perception is the capacity to perceive, feel, analyze, and evaluate one's surroundings. In addition to perception, various elements can affect academic achievement because they are components of learning activities. The element of learning interest can impact academic achievement because motivated students perform better academically (Salifu and Bakari, 2022).

All predictor variables studied in this review can have positive and negative effects, both directly and indirectly, on students' academic achievement. In this study, academic resilience significantly negatively influenced academic achievement and significantly positively influenced self-regulation. Finally, students' positive and negative perceptions did not affect their academic achievement. This suggests that poor academic achievement may arise from high levels of negative academic resilience in their studies. In contrast, strong

academic achievement may arise from high levels of positive self-regulation in their studies. Finally, students' negative but negligible perceptions were insignificant to good or low academic achievement. Therefore, these percentages imply that more factors influence students' academic achievement in chemistry. Therefore, it is highly recommended that this issue be investigated further by considering additional factors.

Limitations and Implications

There are various limitations to this study. Firstly, this survey only included 14 public schools; it did not include all Indonesian schools. Second, because of the study's cross-sectional design, no causal relationship between students' perception of chemistry learning and academic achievement can be established; only associations can be detected. The results revealed no substantial relationship between students' perception of chemistry learning and cognitive achievement. This shows that students' perception of learning chemistry may be more concerned with comprehending, assessing, and evaluating the subject matter than directly influencing their achievement.

Other elements, such as self-regulation and academic resilience, are likely to impact cognitive achievement. Future research should investigate these elements and their possible influence on students' cognitive achievement. Longitudinal or experimental research may also provide more information on the causal mechanisms that underpin these relationships.

This variable and others identical to it can be used to test alternative models in future research. Additionally, while this study only employs a quantitative methodology, more qualitative approaches should be added to broaden the conversation. Therefore, limitations in this study may limit the generalizability of our findings, making the results less applicable to a wider audience. However, this issue can be addressed by repeating this study in the future, perhaps with improvements to address these limitations.

REFERENCES

Agung, S., Pertiwi, T. and Bahriah, E. S. (2022) 'Student's perception of the online-based chemistry', *Journal of Chemistry Education Research*, Vol. 6, No. 2, pp. 110–118. https://doi.org/10.26740/jcer.v6n2.p110-118

Ahmad, N. A., Azizan, F. L., Rahim, N. F., Jaya, N. H., Shaipullah, N. M. and Siaw, E. S. (2017) 'Relationship between students' perception toward the teaching and learning methods of mathematics lecturers and their achievement in Pre-University Studies', *International Education Studies*, Vol. 10, No. 11, p. 129. https://doi.org/10.5539/ies.v10n11p129

Ahmad, S., Zulkurnain, N. and Khairushalimi, F. (2016) 'Assessing the validity and reliability of a measurement model in structural equation modeling (SEM) ', *British Journal of Mathematics & Computer Science*, Vol. 15, No. 3, pp. 1–8. https://doi.org/10.9734/bjmcs/2016/25183

Aimran, A. N., Ahmad, S., Afthanorhan, A. and Awang, Z. (2017) 'The assessment of the performance of covariance-based structural equation modeling and partial least square path modeling', *AIP Conference Proceedings*, Vol. 1842, p. 030001. https://doi.org/10.1063/1.4982839

Almulla, M. O. (2024) 'Academic resilience and its relationships with academic achievement among students of King Faisal University in Saudi Arabia', *Revista de Gestão Social e Ambiental*, Vol. 18, No. 9, p. e07391. https://doi.org/10.24857/rgsa.v18n9-134

Altundağ, C. K., Mustafaoğlu, F. M. and Yücel, A. S. (2022) 'Developing a scale: Perceptions of High School Students about the relationship between chemistry and daily life', *Jurnal Ilmiah Peuradeun*, Vol. 10, No. 3, pp. 721–746. https://doi.org/10.26811/peuradeun.v10i3.718

Amzil, A. (2022) 'Academic resilience and its relation to academic achievement for Moroccan university students during the Covid-19 pandemic', *International Education Studies*, Vol. 16, No. 1, pp. 1. https://doi.org/10.5539/ies.v16n1p1

Annisa, D., Sutrisno, H., Laksono, E. W. and Yanda, S. N. (2024a) 'Evaluating students' academic resilience in chemistry learning: Insights from a Rasch Model Analysis', *Indonesian Journal on Learning and Advanced Education*, Vol. 6, No. 3, pp. 328–349. https://doi.org/10.23917/ijolae.v6i3.23522

Annisa, D., Sutrisno, H. and Widjajanti, E. (2023) 'Academic resilience in chemistry during COVID-19: a systematic review', *Jurnal Penelitian Pendidikan IPA*, Vol. 9, No. 11, pp. 1111–1119. https://doi.org/10.29303/jppipa.v9i11.4354

Annisa, R. F., Firman, Nurfarhanah and Hariko, R. (2024b) 'The role of emotional regulation and self-efficacy toward students ' academic resilience', *Journal of Educational, Health and Community*, Vol. 13, No. 2, pp. 380–399.

Ansow, D. F., Olii, S. T. and Kumayas, T. (2022) 'A study on students' perception toward English learning at SMP Katolik St. Theresia Tanawangko', *JoTELL Journal of Teaching English, Linguistics, and Literature*, Vol. 1, No. 3, pp. 375–385.

Ataii, M., Saleh-Sedghpour, B., Asadzadeh-Dahraei, H. and Sadatee-Shamir, A. (2021) 'Effect of self-regulation on academic resilience mediated by perceived competence', *International Journal of Behavioral Sciences*, Vol. 15, No. 3, pp. 156–161. https://doi.org/10.30491/ijbs.2021.269390.1463

Avecilla, P. A. S., Capina, X. E. R. and Javier, A. Y. (2023) 'Teachers' teaching style as perceived by students and its influence on students' level of self-regulation and motivation in learning psychology', *Technium Social Sciences Journal*, Vol. 43, pp. 213–240. https://doi.org/10.47577/tssj.v43i1.8693

Awang, Z., Afthanorhan, A. and Mohamad, M. (2015) 'An evaluation of measurement model for medical tourism research : the confirmatory factor analysis approach', *International Journal of Tourism Policy*, Vol. 6, No. 1, pp. 29–45. https://doi.org/10.1504/ijtp.2015.075141

Aziz, M. S. and Ahmed, S. D. (2018) 'The effect of cognitive modeling strategy in chemistry achievement for students', *Opcion*, Vol. 34, No. 17, pp. 276–294.

Biswas, J. and Bhowmick, D. A. (2024) 'Educational relevance of Srimadbhagavadgita to inculcate scientific value among the students', *International Journal of Multidisciplinary Trends*, Vol. 6, No. 1, pp. 16–21. https://doi.org/10.22271/multi.2024.v6.i1a.363

Cassidy, S. (2016) 'The Academic Resilience Scale (ARS-30): A new multidimensional construct measure', *Frontiers in Psychology*, Vol. 7, pp. 1–11. https://doi.org/10.3389/fpsyg.2016.01787

Chen, X., Huang, Z., and Lin, W. (2022) 'The effect of emotion regulation on happiness and resilience of university students: The chain mediating role of learning motivation and target positioning', *Front. Psychol*, Vol. 13, pp. 01–10. https://doi.org/10.3389/fpsyg.2022.1029655

Cherian, J., Kumari, P. and Sinha, S.P. (2021) 'Self-concept, emotional maturity and spirituality as predictors of academic resilience among undergraduates', *International Journal of Applied Research*, Vol. 7, No. 1, pp. 7–11.

Chikendu, R. E., Ejesi, N. S. and Agu, N. A. (2021) 'Motivation and academic resilience as correlates of achievement in chemistry', *African Journal of Educational Management, Teaching and Entrepreneurship Studies*, Vol. 2, pp. 286–299. Retrieved from: https://www.ajemates.org/index.php/ajemates/article/view/37%0Ahttps://www.ajemates.org/index.php/ajemates/article/download/37/35

Chye, S. M., Kok, Y. Y., Chen, Y. S. and Er, H. M. (2024) 'Building resilience among undergraduate health professions students: identifying influencing factors', *BMC Medical Education*, Vol. 24, No. 1, pp. 1168. https://doi.org/10.1186/s12909-024-06127-1

Clayton Bernard, R. and Kermarrec, G. (2022) 'Peer assessment and video feedback for fostering self, co, and shared regulation of learning in a higher education language classroom', *Frontiers in Education*, Vol. 7, pp. 1–13. https://doi.org/10.3389/feduc.2022.732094

Crossdale, R., Scott, F. J. and Sweeney, G. (2022) 'Decision-making factors of female A-level chemistry students when choosing to study a degree in chemistry', *Chemistry Teacher International*, Vol. 4, No. 3, pp. 231–242. https://doi.org/10.1515/cti-2021-0030

de la Fuente, J., Martínez-Vicente, J. M., Peralta-Sánchez, F. J., González-Torres, M. C., Artuch, R. and Garzón-Umerenkova, A. (2018) 'Satisfaction with the self-assessment of university students through e-Coping with academic stress utility', *Frontiers in Psychology*, Vol. 9, pp. 1–14. https://doi.org/10.3389/fpsyg.2018.01932

Deng, L., Daverpanah, N. and Izadpanah, S. (2023) 'The effect of educational computer games on the academic resilience, academic self-regulation, and academic achievement of EFL students', *Frontiers in Psychology*, Vol. 13, pp. 1–12. https://doi.org/10.3389/fpsyg.2022.947577

Dewi, C. A., Afrahamiryano, Inayah, S., Purba, L. S. L. and Awaliyah, N. (2023) 'Student perceptions of Online-Based Chemistry Learning implementation during the Covid-19 pandemic', *Jurnal Penelitian Pendidikan IPA*, Vol. 9, No. 6, pp. 4827–4835. https://doi.org/10.29303/jppipa.v9i6.4098

Fazriah, S., Irwandi, D. and Fairusi, D. (2021) 'Relationship of self-regulated learning with student learning outcomes in chemistry study', *Journal of Physics: Conference Series*, Vol. 1836, No. 1, pp. 1–8. https://doi.org/10.1088/1742-6596/1836/1/012075

Feldman-Maggor, Y. (2023) 'Identifying self-regulated learning in chemistry classes - A good practice report', *Chemistry Teacher International*, Vol. 5, No. 2, pp. 203–211. https://doi.org/10.1515/cti-2022-0036

Finklestein, M., Pagorek-Eshel, S. and Laufer, A. (2022) 'Adolescents' individual resilience and its association with security threats, anxiety, and family resilience', *Journal of Family Studies*, Vol. 28, No. 3, pp. 1023–1039. https://doi.org/10.1080/13229400.2020.1778504

Fornell, C. and Larcker, D. F. (1981) 'Evaluating structural equation models with unobservable variables and measurement error', *Journal of Marketing Research*, Vol. 18, No. 1, pp. 39–50. https://doi.org/10.2307/3151312

Forstmeier, S. and Rueddel, H. (2007) 'Improving volitional competence is crucial for the efficacy of psychosomatic therapy: A controlled clinical trial', *Psychotherapy and Psychosomatics*, Vol. 76, No. 2, pp. 89–96. https://doi.org/10.1159/000097967

García-Ros, R., Pérez-González, F., Tomás, J. M. and Sancho, P. (2023) 'Effects of self-regulated learning and procrastination on academic stress, subjective well-being, and academic achievement in secondary education', *Current Psychology*, Vol. 42, No. 30, pp. 26602–26616. https://doi.org/10.1007/s12144-022-03759-8

Ghozali, I. (2011) *Aplikasi Analisis Multivariate Dengan Program IBM SPSS 19*, Semarang: Universitas Diponegoro.

Gnanaprakash, C. (2013) 'Spirituality and Resilience among Post-Graduate University Students. *Journal of Health Management*', Vol. 15, No. 3, pp. 383–396. https://doi.org/10.1177/0972063413492046

Habibi, N., Hariastuti, R. and Rusijono, R. (2022) 'High school students' self-regulated learning and academic procrastination level in blended learning model: A correlation analysis', *Proceedings of the Eighth Southeast Asia Design Research (SEA-DR) & the Second Science, Technology, Education, Arts, Culture, and Humanity (STEACH) International Conference (SEADR-STEACH 2021)*, Vol. 627, pp. 311–316. https://doi.org/10.2991/assehr.k.211229.048

Hair, J. F., Black, W. C., Babin, B. J. and Anderson, R. E. (2010) *Multivariate Data Analysis*, 7th Ed., Pearson Prentice Hall.

Hair, J. F., Black, W. C., Babin, B. J. and Anderson, R. E. (2019) *Multivariate Data Analysis, 8th Ed.,* Saddle River, NJ: Pearson Prentice Hall.

Hairida, H., Rasmawan, R., Sartika, R. P. and Masriani, M. (2023) 'Educators' perception of the Utilization of Information and Communication Technology (ICT) in chemistry learning', *Jurnal Penelitian Pendidikan IPA*, Vol. 9, No. 10, pp. 9105–9024. https://doi.org/10.29303/jppipa.v9i10.4375

Hammad Al-Rashidi, A. and Aberash, A. (2024) 'Reflective thinking and self-evaluation in language learning: mirroring the impacts on Saudi Arabian EFL students' growth mindfulness, resilience, and academic well-being', *Asian-Pacific Journal of Second and Foreign Language Education*, Vol. 9, No. 1, pp. 1–24. https://doi.org/10.1186/s40862-024-00265-1

Higgins, N. L., Rathner, J. A. and Frankland, S. (2021) 'Development of self-regulated learning: a longitudinal study on academic performance in undergraduate science', *Research in Science and Technological Education*, Vol. 41, No. 4, pp. 1242–1266. https://doi.org/10.1080/02635143.2021.1997978

Hindradjat, J., Hambali, I., Atmoko, A. and Livana, P. H. (2022) 'The effect of achievement motivation and self-regulated learning on student learning behavior in the time of online learning in Indonesia', *Open Access Macedonian Journal of Medical Sciences*, Vol. 10(A), pp. 262–272. https://doi.org/10.3889/oamjms.2022.8279

Hooper, D., Coughlan, J. and Mullen, M. (2008) 'Structural Equation Modelling : Guidelines for Determining Model Fit', *Electronic Journal of Business Research Methods Volume*, Vol. 6, No. 1, pp. 53–60. Retrieved from: https://academic-publishing.org/index.php/ejbrm/article/view/1224/1187

Huang, H., Ding, Y., Zhang, Y., Peng, Q., Liang, Y., Wan, X. and Chen, C. (2022) 'Resilience and positive coping style affect the relationship between maladaptive perfectionism and academic procrastination among Chinese undergraduate nursing students', *Frontiers in Psychology*, Vol. 13, pp. 1–11. https://doi.org/10.3389/fpsyg.2022.1014951

Hussain, S., Muhsin, Z. F., Salal, Y. K., Theodorou, P., Kurtoğlu, F. and Hazarika, G. C. (2019) 'Prediction model on student performance based on internal assessment using deep learning', *International Journal of Emerging Technologies in Learning*, Vol. 14, No. 8, pp. 4–22. https://doi.org/10.3991/ijet.v14i08.10001

Hwang, E. and Shin, S. (2018) 'Nurse education today characteristics of nursing students with high levels of academic resilience : A cross-sectional study', *Nurse Education Today*, Vol. 71, pp. 54–59. https://doi.org/10.1016/j.nedt.2018.09.011

Idris, I., Khairani, A. Z. and Shamsuddin, H. (2019) 'The influence of resilience on psychological well-being of Malaysian University undergraduates', *International Journal of Higher Education*, Vol. 8, No. 4, pp. 153–163. https://doi.org/10.5430/ijhe.v8n4p153

Imron, I., Mawardi, I. and Şen, A. (2023) 'The influence of spirituality on academic engagement through achievement motivation and resilience', *International Journal of Islamic Educational Psychology*, Vol. 4, No. 2. https://doi.org/10.18196/ijiep.v4i2.19428

Indriani, N. C. L., Mustaji and Mariono, A. (2023) 'The Influence of Web-Based Learning on students' self-regulated learning in high school chemistry learning', *International Journal of Educational Research Review*, Vol. 8, No. 2, pp. 257–267. https://doi.org/10.24331/ijere.1249689

Ishak, N. H. F. B., Yusoff, N. F. B. M. and Madihie, A. (2020) 'Resilience in mathematics, academic resilience, or mathematical resilience?: An overview', *Universal Journal of Educational Research*, Vol. 8(5 A), pp. 34–39. https://doi.org/10.13189/ujer.2020.081905

Jakesova, J., Gavora, P. and Kalenda, J. (2016) 'Self-regulation of behavior: Students versus other adults', *International Journal of Educational Psychology*, Vol. 5, No. 1, pp. 56–79. https://doi.org/10.17583/ijep.2016.1661

Jamaluddin, A. Bin, Pratiwi, A. C., Safira, I. and Nurdiyanti, N. (2023) 'Character, resilience, and critical thinking of biology students after the COVID-19 pandemic: How they are correlated', *Jurnal Penelitian Pendidikan IPA*, Vol. 9, No. 4, pp. 1585–1592. https://doi.org/10.29303/jppipa.v9i4.1574

Jusniar, J., Syamsidah and Auliah, A. (2023) 'Teacher's and student's perceptions of green chemistry and its principles in chemistry learning in high schools', *Jurnal Penelitian Pendidikan IPA*, Vol. 9, No. 10, pp. 7924–7934. https://doi.org/10.29303/jppipa.v9i10.4756

Karsli Baydere, F. (2021) 'Effects of a context-based approach with prediction-observation-explanation on conceptual understanding of the states of matter, heat, and temperature', *Chemistry Education Research and Practice*, Vol. 22, No. 3, pp. 640–652. https://doi.org/10.1039/d0rp00348d

Kashif, M. F. and Shahid, R. (2021) 'Students' Self-regulation in online learning and its effect on their academic achievement', *Global Educational Studies Review*, Vol. VI(III), pp. 11–20. https://doi.org/10.31703/gesr.2021(vi-iii).02

Khan, Y. M., Shah, M. H. and Sahibzada, H. E. (2020) 'Impact of self-regulated learning behavior on the academic achievement of university students', *FWU Journal of Social Sciences*, Vol. 14, No. 2, pp. 117–130.

Khine, M. S., Ping, L. C. and Cunningham, D. (2013) *Application of Structural Modeling in Educational Research and Practice*, Rotterdam: Sense Publishers.

Kiliç, M. S., Tekin, Ö. E. and Keçeci, B. (2022) 'Self-regulation and psychological resilience as predictors of the academic self-efficacy of University students', *Journal of Computer and Education Research*, Vol. 12, No. 24, pp. 403–421. https://doi.org/10.18009/jcer.1448525

Kline, R. B. (2016) *Principles and Practice of Structural Equation Modeling,* 4th Ed., New York City, NY: The Guilford Press.

Lee, D., Watson, S. L. and Watson, W. R. (2020) 'The influence of successful MOOC learners' self-regulated learning strategies, self-efficacy, and task value on their perceived effectiveness of a massive open online course', *International Review of Research in Open and Distributed Learning*, Vol. 21, No. 3, pp. 81–98. https://doi.org/10.19173/irrodl.v21i3.4642

Lehmann, T., Hähnlein, I. and Ifenthaler, D. (2014) 'Cognitive, metacognitive and motivational perspectives on preflection in self-regulated online learning', *Computers in Human Behavior*, Vol. 32, pp. 313–323. https://doi.org/10.1016/j.chb.2013.07.051

Lim, C. L., She, L. and Hassan, N. (2022) 'The impact of live lectures and pre-recorded videos on students'' online learning satisfaction and academic achievement in a Malaysian Private University', *International Journal of Information and Education Technology*, Vol. 12, No. 9, pp. 874–880. https://doi.org/10.18178/ijiet.2022.12.9.1696

Machmud, A. and Ramadhan, I. A. (2022) 'High school learning outcomes: The effect of self-regulation, resilience, and family environment', *Cakrawala Pendidikan*, Vol. 41, No. 3, pp. 764–778. https://doi.org/10.21831/cp.v41i3.43562

Malik, M. and Parveen, N. (2019) 'Self-regulation and academic achievement: A comparative analysis of high and low academic achievers', *Journal of Behavioural Science*, Vol. 29, No. 2, pp. 53–70. Retrieved from: https://pu.edu.pk/images/journal/doap/PDF-FILES/04_V29-2-2019.pdf

Mannopovna, J. O. (2019) 'Psychological and pedagogical foundations of the formation of the artistic perception of students in secondary schools', *European Journal of Research and Reflection in Educational Sciences*, Vol. 7, No. 10, pp. 9–14. Available: https://www.idpublications.org/wp-content/uploads/2019/08/Full-Paper-PSYCHOLOGICAL-AND-PEDAGOGICAL-FOUNDATIONS-OF-THE-FORMATION-OF-THE-ARTISTIC-PERCEPTION.pdf

Martha, A. S. D., Santoso, H. B., Junus, K. and Suhartanto, H. (2023) 'The Effect of the Integration of Metacognitive and Motivation Scaffolding through a Pedagogical Agent on self- and Coregulation Learning', *IEEE Transactions on Learning Technologies*, Vol. 16, No. 4, pp. 573–584. https://doi.org/10.1109/TLT.2023.3266439

Masbukhin, F. A. A. M., Sandra Sukmaning Adji and Ayu Fahimah Diniyah Wathi. (2023) 'Project-Based Learning (PjBL) model in chemistry learning: students' perceptions', *European Journal of Education and Pedagogy*, Vol. 4, No. 1, pp. 93–98. https://doi.org/10.24018/ejedu.2023.4.1.567

Mohamad, M., Mohammad, M., Ali, N. A. M. and Awang, Z. (2016) 'Measuring positive youth development: Confirmatory factor analysis', *International Journal of Applied Business and Economic Research*, Vol. 14, No. 13, pp. 9441–9451.

Moreno, C., Pham, D. and Ye, L. (2021) 'Research and Practice courses : changes after a semester of instruction and gaps still remain between student groups', *Chemistry Education Research and Practice*, Vol. 22, No. 3, pp. 772–785. https://doi.org/10.1039/d0rp00345j

Nakhostin-Khayyat, M., Borjali, M., Zeinali, M., Fardi, D. and Montazeri, A. (2024) 'The relationship between self-regulation, cognitive flexibility, and resilience among students: a structural equation modeling', *BMC Psychology*, Vol. 12, No. 1, pp. 1–8. https://doi.org/10.1186/s40359-024-01843-1

Nasir, S., Nurhidayah, N. and Suprianto, A. (2020) 'Effect of self-regulated learning on academic achievement of Puangrimaggalatung University Educational Administration Study program students', *International Journal of Educational Management and Innovation*, Vol. 1, No. 3, p. 205. https://doi.org/10.12928/ijemi.v1i3.2152

Ngugi, D. G., Borden-King, L., Markovic, D. and Bertsch, A. (2020) 'Measuring students' perception of learning: The systematic development of an instrument', *Alberta Journal of Educational Research*, Vol. 66, No. 4, pp. 435–453. https://doi.org/10.55016/ojs/ajer.v66i4.68240

Nwafor, S. C., Ezeanya, M. C., Ameh, R. F. and Muoneke, N. M. (2024) 'Improving secondary school students ' achievement in chemistry through interaction pattern approach', *Journal Of Digital Learning and Distance Education (JDLDE)*, Vol. 3, No. 4, pp. 1047–1056. https://doi.org/10.56778/jdlde.v3i4.340

Oke, K., Ayodele, K., Aladenusi, O. and Oyinloye, C. (2016) 'Academic motivation, satisfaction, and resilience as predictors of secondary school students ' academic confidence in Ogun State, Nigeria', *IOSR Journal of Research & Method in Education*, Vol. 6, No. 6, pp. 59–64. Retrieved from: https://www.iosrjournals.org/iosr-jrme/papers/Vol-6%20Issue-6/Version-1/J06606015964.pdf

Oladejo, A. I., Ademola, I. A., Ayanwale, M. A. and Tobih, D. (2023) 'Concept difficulty in secondary school chemistry – an intra-play of gender, school location, and school type', *Journal of Technology and Science Education*, Vol. 13, No.1, pp. 255–275. https://doi.org/10.3926/jotse.1902

Oloyede, O. I. (2012) 'The Relationship between Acquisition of Science Process Skills, Formal Reasoning Ability and Chemistry Achievement', *IJAAAS*, Vol. 8, No. 1, pp. 1–4.

Oyelekan, O. S., Jolayemi, S. S. and Upahi, J. E. (2019) 'Relationships among senior school students' self-efficacy, metacognition and their achievement in chemistry', *Cypriot Journal of Educational Sciences*, Vol. 14, No. 2, pp. 208–221. https://doi.org/10.18844/cjes.v14i2.2564

Paz-Baruch, N. and Hazema, H. (2023) 'Self-regulated learning and motivation among gifted and high-achieving students in science, technology, engineering, and mathematics disciplines: examining differences between students from diverse socioeconomic levels', *Journal for the Education of the Gifted*, Vol. 46, No. 1, pp. 34–76. https://doi.org/10.1177/01623532221143825

Peker, A. and Cengiz, S. (2022) 'Covid-19 fear, happiness and stress in adults: the mediating role of psychological resilience and coping with stress', *International Journal of Psychiatry in Clinical Practice*, Vol. 26, No. 2, pp. 123–131. https://doi.org/10.1080/13651501.2021.1937656

Phan, H. P., Ngu, B. H. and White, M. O. (2021) 'Introducing 'holistic psychology' for life qualities: A theoretical model for consideration', *Heliyon*, Vol. 7, No. 1, p. e05843. https://doi.org/10.1016/j.heliyon.2020.e05843

Priliyanti, A., Muderawan, I. W. and Maryam, S. (2021) 'Analisis kesulitan belajar siswa dalam mempelajari kimia kelas XI.', *Jurnal Pendidikan Kimia Undiksha*, Vol. 5, No. 1, pp. 11–18. https://doi.org/10.23887/jjpk.v5i1.32402

Purwoko, A. A., Anwar, Y. A. S., Hadisaputra, S. and Burhanudin. (2024) 'Motivation, Laboratory activities, and self-regulated learning: how are they related', *E3S Web of Conferences*, Vol. 481, p. 04005. https://doi.org/10.1051/e3sconf/202448104005

Rahmawan, S., Rian Nurhadi, A., Mursalin, E. and Darwis, R. (2024) 'Why is chemistry education? exploring the motivation of student choices', *Indonesian Journal of Science and Education*, Vol. 8, No. 1, pp. 81–90. https://doi.org/10.31002/ijose.v8i1.1565

Rakesh, D., Sadikova, E. and McLaughlin, K. A. (2024) 'Beyond the income-achievement gap: The role of individual, family, and environmental factors in cognitive resilience among low-income youth', *JCPP Advances*, *October 2024*, pp. 1–14. https://doi.org/10.1002/jcv2.12297

Ramirez-Granizo, I. A., Sánchez-Zafra, M., Zurita-Ortega, F., Puertas-Molero, P., González-Valero, G. and Ubago-Jiménez, J. L. (2020) 'Multidimensional self-concept depending on levels of resilience and the motivational climate directed towards sport in schoolchildren', *International Journal of Environmental Research and Public Health*, Vol. 17, No. 2, p. 534. https://doi.org/10.3390/ijerph17020534

Říčan, J., Chytrý, V. and Medová, J. (2022) 'Aspects of self-regulated learning and their influence on the mathematics achievement of fifth graders in the context of four different proclaimed curricula', *Frontiers in Psychology*, Vol. 13, pp. 1–15. https://doi.org/10.3389/fpsyg.2022.963151

Rosário, P., Valle, A., Núñez, J. C., Cabanach, R. G., González-Pienda, J. A., Rodríguez, S., Cerezo, R. and Muñoz-Cadavid, M. A. (2008) 'Self-regulated profiles and academic achievement', *Psicothema*, Vol. 20, No. 4, pp. 724–731.

Rosly, N. N., Hamid, S. A. and Rahman, N. A. A. (2021) 'Exploring the perception of chemistry students at Kulliyyah of Science in learning organic chemistry', *IIUM Journal of Educational Studies*, Vol. 9, No. 2, pp. 6–30. https://doi.org/10.31436/ijes.v9i2.299

Saefudin, W. and Sriwiyanti. (2023) 'Boosting academic resilience through spiritual well-being: A study in Juvenile Prison in Indonesia', *Restorative : Journal of Indonesian Probation and Parole System*, Vol. 1, No. 1, pp. 14–32. https://doi.org/10.61682/restorative.v1i1.3

Sahranavard, S., Miri, M. R. and Salehiniya, H. (2018) 'The relationship between self-regulation and educational performance in students', *Journal of Education and Health Promotion*, Vol. 7, No. 1, p. 154. https://doi.org/10.4103/jehp.jehp_93_18

Salame, I. I. and Khalil, A. Y. (2023) 'Examinar algunos de los desafíos que enfrentan los estudiantes al aprender sobre reacciones de reordenamiento en química orgánica', *Interdisciplinary Journal of Environmental and Science Education*, Vol. 19, No. 3, p. e2310. https://doi.org/10.29333/ijese/13203

Salem, H. A. (2024) 'Self-competence of online technologies and academic resilience among STEM and ordinary programs students at the Faculty of Education - Zagazig University', *Port Said Journal of Educational Research*, Vol. 3, No. 2, pp. 1–40. https://doi.org/10.21608/psjer.2024.253785.1030

Salifu, A. S. and Bakari, A. (2022) 'Exploring the relationship between students' perception, interest, and mathematics achievement', *Mediterranean Journal of Social & Behavioral Research*, Vol. 6, No. 1, pp. 13–20. https://doi.org/10.30935/mjosbr/11491

Siddique, M., Hisham Ul Hassan, D. K. and Akmal, F. (2023) 'The role of resilience for developing the self-efficacy among chemistry students in Pakistan', *VFAST Transactions on Education and Social Sciences*, Vol. 11, No. 1, pp. 38–48. https://doi.org/10.21015/vtess.v11i1.1401

Sindu, I. G. P. andKertiasih, N. K. (2024) 'The influence of self-efficacy and self-regulation on learning motivation in simulation of immersive virtual reality-based laptop assembly practicum', *Conhecimento & Diversidade*, Vol. 16, No. 43, pp. 153–175.

Sultanova, G., Shilibekova, A., Rakhymbayeva, Z., Rakhimbekova, A. and Shora, N. (2024) 'Exploring the influence of non-cognitive skills on academic achievement in STEM education: the case of Kazakhstan', *Frontiers in Education*, Vol. 9, pp. 1–21. https://doi.org/10.3389/feduc.2024.1339625

Syahniar, S. (2018) 'The correlation between self-regulated and learning achievement of underachiever students', *International Conferences on Education, Social Sciences and Technology*, pp. 95–99. https://doi.org/10.29210/2018114

Tabachnick, B. G. and Fidell, L. S. (2007) *Using Multivariate Statistics*, Boston: Allyn and Bacon.

Taheri, M., Nasiri, E., Moaddab, F., Nayebi, N. and Asadi Louyeh, A. (2016) 'Strategies to Improve Students' Educational Achievement Motivation at Guilan University of Medical Sciences', *Research and Development in Medical Education*, Vol. 4, No. 2, pp. 133–139. https://doi.org/10.15171/rdme.2015.024

Tavakol, M. and Dennick, R. (2011) 'Making sense of Cronbach's alpha', *International Journal of Medical Education*, Vol. *2*, pp. 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

Thürmer, J. L., Bieleke, M., Wieber, F. and Gollwitzer, P. M. (2020) 'If-then plans help regulate automatic peer influence on impulse buying', *European Journal of Marketing*, Vol. 54, No. 9, pp. 2079–2105. https://doi.org/10.1108/EJM-05-2018-0341

Timilsena, N. P., Maharjan, K. B. and Devkota, M. (2022) 'Teachers' And Students' Experiences In Chemistry Learning Difficulties', *Journal of Positive School Psychology*, Vol. 6, No. 10, pp. 2856–2867. Retrieved from: https://journalppw.com/index.php/jpsp/article/view/13764/8923

Toering, T., Elferink-Gemser, M. T., Jordet, G., Pepping, G. J. and Visscher, C. (2012) 'Self-regulation of learning and performance level of elite youth soccer players', *International Journal of Sport Psychology*, Vol. 43, No. 4, pp. 312–325. Retrieved from: https://research.rug.nl/en/publications/self-regulation-of-learning-and-performance-level-of-elite-youth-

Van Hootegem, A., Røgeberg, O., Bratsberg, B. and Lyngstad, T. H. (2023) 'Correlation between cognitive ability and educational attainment weakens over birth cohorts', *Scientific Reports*, Vol. 13, No. 1, pp. 1–5. https://doi.org/10.1038/s41598-023-44605-6

van Vorst, H. and Aydogmus, H. (2021) 'One context fits all?–analysing students' context choice and their reasons for choosing a context-based task in chemistry education', *International Journal of Science Education*, Vol. 43, No. 8, pp. 1250–1272. https://doi.org/10.1080/09500693.2021.1908640

Wandler, J. B. and Imbriale, W. J. (2017) 'Promoting undergraduate student self-regulation in online learning environments', *Online Learning Journal*, Vol. 21, No. 2, pp. 1–16. https://doi.org/10.24059/olj.v21i2.881

Xiao, S., Yao, K. and Wang, T. (2019) 'The Relationships of Self-regulated Learning and Academic Achievement in University Students', *SHS Web of Conferences*, Vol. 60, No. 01003, pp. 1–4. https://doi.org/10.1051/shsconf/20196001003

Yasmintya, A., Muth, A. and Hidayat, F. (2024) 'The relationship between self-regulated learning and students' academic achievement of batch 2017', *Lingua Educatia Journal*, Vol. 6, No. 1, pp. 13–23.

APPENDIX

APPENDIX 1: REPLY DOCUMENT

	Reviewer	Author Revision
Introduction/ Theoretical Framework	The authors should focus exclusively on explaining academic resilience and exclude from this paragraph the discussion on the general concept. Also, they affirm that there is no background on resilience in chemistry, yet they also state that a plethora of studies has focused on resilience in other subjects. As a consequence, the authors should present at least some of the said papers: what did other authors find in their studies in other subjects? What were the major conclusions from said works? A similar approach should be taken for the other variables (predictors) in the model, with a higher focus on their direct relationship with the academic/educational environment and more details regarding previous studies. Hence, I would suggest removing the general explanations (definitions, meaning of the studied variables in the overall life) and only providing information directly related to the study. An additional suggestion after reviewing the results section: the authors should put their efforts into presenting the theory and previous research on the sub-dimensions of each studied variable: so, not only presenting the overall relationship academic achievement-resilience, academic achievement-self-regulation, etc., but also explaining and presenting previous work on impulse control, self-planning,… spirituality, emotion control,…etc. The reader needs to understand what the theoretical background is that shows that these dimensions belong to their corresponding latent variable. This way, it is then easy to navigate through the results.	• The author has added an explanation of academic resilience in chemistry, self-regulation in chemistry. • Then the author has added an explanation of the dimensions related to the variables of academic resilience (spirituality, emotional regulation and self-reflection), self-regulation (self-planning, impulse control and motivation) and the perception of chemistry students (learning materials, learning attitudes and learning concepts). • Furthermore, the author adds the relationship between these dimensions to each variable and why choose these dimensions.
Methods	Please provide descriptive information on the sample in “sample” section rather than in results, since it helps understanding the segment of population considered in the study. In the results section, you should only include the results that directly respond to your hypotheses. How were schools and students recruited? Which sampling technique was used? Were there exclusion/inclusion criteria? Is the study supported by ethical approval? Please provide information in the sample section. Regarding the instrument, I believe the study would benefit from providing more (and better) information: for example, from the current text I understand that Part A proposes items related to the predictors (resilience, perceptions, etc.) and the outcome variable (achievement), with 11 items per each. Where do these items come from? How were they selected? From previous published works? To add to confusion, it seems that part c also includes questionnaires on the same variables – why taking data on the same variables twice? Also, if the questionnaires used were adjusted from previous works (as it is suggested), what kind of adaptation has been done? Were they translated into the students’ language? Regarding part B, what is the purpose of questions on structure-related chemistry? Which variable/s is this questionnaire measuring? (also considering that all variables in the study seem to be already assessed in parts a and c). Please be as specific as you can, since this is an essential part of your study if you wish to demonstrate that your results are valid and sound – and also for repeatability purposes. Moreover, since the questionnaires present structures with sub-dimensions (as presented in the results section, for example, academic resilience is composed by spirituality, emotional control, etc.), the authors should also explain how the structure of the questionnaire is (for instance, items per sub-dimension? Sample question/s?). Beyond the needed information I mentioned above, a table clearly summarizing the questionnaire would be helpful. The table is just a suggestion, and the authors can add it or not, but the above-mentioned extra information must be added. A limitation to be considered is that, since the study is cross-sectional, the cause-effect relationship between predictors and outcome variable cannot be confirmed – only pure association. This is quite a common approach in research with SEM or mediation analysis, nonetheless, the authors should still point it out.	• The author has changed the position of the research results to the research sample and added some additional information so that readers can understand the purpose of this research. • Improvements have been made to the instrument so that readers can understand this research well • I have also added input from reviewers regarding making the instrument table more detailed and structured • I have made improvements to the limitations of this research according to the reviewer’s instructions

	Reviewer	Author Revision
Overall Aspects	The authors should review and adjust the format of the paper based on general formatting rules (for instance, when authors are cited directly in the text, the brackets are not needed) and based on the journal's guidelines. Also, it is uncommon to use sentences such as "the author has found/the author has come across…/we have done this or that" etc. Scientific papers do not use this language, but they keep an "external view". For example, if the author has not found any literature background on a topic, they should say (example from the resilience section) "despite a plethora of studies have focused on resilience in education, there exists a literature gap in the area of chemistry". This is just an example, the authors are free to make changes as they consider fitting, however, they need to review this aspect somehow in order to increase the "scientific shape" of the paper Additionally, I recommend that the authors revise the use of English throughout the paper – in some sections, such as, at the beginning of "Theoretical Framework", some sentences are hard to follow, limiting the fluidity of the reading and its understanding	• The author has revised and adjusted the format and writing style of the paper to align with general academic standards and journal guidelines. Here is a description of what this means: • The author has revised the scientific writing style according to the reviewer's suggestions. • Clarity and Readability: the author has revised the initial section of the Theoretical Framework) to make it look better • The author has revised the English to improve readability and can be understood well