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Self-Efficacy, Chemistry Anxiety, and Perceived Learning Outcomes among BSEd Science Majors in One Catholic College: A Control-Value Theory Perspective

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A R T I C L E I N F O

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A B S T R A C T

This cross-sectional study examined chemistry self-efficacy, chemistry anxiety, and perceived learning outcomes among 122 first- to third-year BSEd Science majors recruited through self-selection sampling. Analyses were conducted in jamovi. Self-efficacy had a weak, no significant correlation with anxiety, r (120) = .178, p = .050018. Anxiety had a weak positive correlation with perceived cognitive outcomes, r = .202, p = .026, but was not a significant unique predictor after self-efficacy was included. The regression models explained 36.6% of the variance in cognitive outcomes, 14.8% in affective outcomes, and 40.9% in psychomotor outcomes. Self-efficacy was a significant positive statistical predictor in all three models (β = .580, .384, and .625, respectively; all p < .001). The bootstrapped indirect effects through anxiety were not statistically significant for cognitive (B = .0164, 95% CI [−.0102, .0645]), affective (B = .00059, 95% CI [−.0358, .0399]), or psychomotor outcomes (B = .0103, 95% CI [−.0152, .0529]). The cross-sectional, self-reported data do not establish causation

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INTRODUCTION

Chemistry knowledge and skills are important for BSEd Science majors because they strengthen scientific literacy and prepare future teachers to address real-life concerns. Chemistry helps students explain how chemical processes affect health and the environment and supports informed decision-making (Pascal & Chisca, 2023; Sevian & Bulte, 2015). Chemistry instruction can also develop critical thinking, communication, collaboration, and problem-solving skills required in science teaching. Chemistry learning involves cognitive, affective, and psychomotor outcomes. Cognitive outcomes include understanding, applying, and analyzing chemistry concepts ("Indispensability of Integrating Three Levels…," 2024). Affective outcomes involve students' interest, motivation, and attitudes toward chemistry (Agustian, 2024). Psychomotor outcomes include performing experiments, using laboratory equipment, making measurements, and following safety procedures (Galloway & Bretz, 2015). These domains are connected and contribute to meaningful chemistry learning (Pesimo, 2014; Chakraborty, 2025; Erlina et al., 2025).

Chemistry self-efficacy refers to students' task-specific judgments of their capability to organize and perform the actions required for chemistry learning. It is related to, but conceptually more precise than, general confidence. Students with stronger chemistry self-efficacy often demonstrate greater motivation, persistence, engagement, and achievement (Odedokun et al., 2024; Zaluddin et al., 2025). Mastery experiences, constructive feedback, teacher support, and laboratory participation may strengthen these capability beliefs (Cheung, 2015a, 2015b; Vishnumolakala et al., 2017). Chemistry anxiety is the worry or tension students experience when studying chemistry, taking examinations, or performing laboratory activities. High anxiety may reduce concentration, participation, confidence, and performance. Studies have reported that anxiety is negatively associated with science and chemistry learning outcomes (Muslihah et al., 2025; Liday, 2025; Eddy, 2000).

Self-efficacy, chemistry anxiety, and learning outcomes may be related. Students with stronger self-efficacy tend to experience less anxiety and demonstrate more positive attitudes toward chemistry (Kurbanoglu & Akin, 2010; Kurbanoğlu & Akin, 2012). Strong confidence may also support better laboratory participation and performance (Ogunde, 2019; Pulukuri et al., 2024). Learning activities such as virtual laboratories may further increase self-efficacy and reduce anxiety (Kolil et al., 2020).

Although previous studies have examined chemistry self-efficacy, chemistry or laboratory anxiety, and academic outcomes, fewer studies have tested anxiety as a mediator between self-efficacy and multidimensional perceived learning outcomes among Philippine BSEd Science majors. Existing local research has more often emphasized laboratory facilities, theory-practice gaps, research proficiency, and inquiry competencies (Catubig et al., 2025; Pablo et al., 2025; Park et al., 2024). Examining the proposed pathway in a teacher-education context may clarify whether a control-related belief is associated with perceived cognitive, affective, and psychomotor learning directly or indirectly through chemistry anxiety.

Chemistry anxiety may also explain how self-efficacy affects perceived learning outcomes. Students with higher self-efficacy may experience less anxiety, allowing them to participate and learn more effectively. In contrast, anxiety may interfere with confidence, thinking, and learning strategies (Lončarić, 2008). Therefore, this study examines whether chemistry anxiety mediates the relationship between self-efficacy and students perceived cognitive, affective, and psychomotor learning outcomes.

Thus, this study examined the levels of chemistry self-efficacy, chemistry anxiety, and perceived learning outcomes and tested their relationships, predictive effects, and proposed indirect relationships.

Research Questions

This study aims to assess self-efficacy, anxiety, and perceived learning outcomes in chemistry. Specifically, the study aims to address the questions:

1. What is the level of self-efficacy of BSEd Science majors in chemistry classes?
2. What is the level of chemistry anxiety among BSEd Science majors?
3. What is the level of students' perceived learning outcomes in chemistry in the dimensions of cognitive, affective, and psychomotor*?*
4. Is there a significant relationship between students' self-efficacy and chemistry anxiety?
5. Is students' chemistry anxiety significantly related to their perceived learning outcomes?
6. Do self-efficacy and chemistry anxiety significantly predict students' perceived learning outcomes?
7. Does chemistry anxiety significantly mediate the relationship between students' self-efficacy and their perceived learning outcomes?

THEORETICAL REVIEW

This study uses Control–Value Theory (CVT) to examine chemistry self-efficacy, chemistry anxiety, and BSEd Science majors' perceived cognitive, affective, and psychomotor learning outcomes. CVT explains that students' emotions are related to how much control they believe they have over a task and how much they value it (Pekrun, 2019, 2024). Students who believe they can succeed in an important task may experience more positive emotions, whereas uncertainty about success may contribute to anxiety (Abuzant et al., 2023; Liu et al., 2025). In this study, chemistry self-efficacy is treated as a control-related belief, rather than a direct measure of CVT's control appraisal. Previous studies have generally linked stronger chemistry self-efficacy with lower anxiety, although findings may vary across tasks and settings (Kurbanoglu & Akin, 2010; Kurbanoğlu & Akin, 2012; Rummey et al., 2019).

Chemistry anxiety may be associated with students' understanding, participation, and laboratory work, while stronger self-efficacy may be associated with greater engagement and persistence (Avraamidou et al., 2022; Naibert et al., 2024). The study therefore tests whether self-efficacy is related to anxiety (H_{01}); whether anxiety is related to those outcomes (H_{02}); whether self-

efficacy and anxiety statistically predict each outcome (H_{03}); and whether anxiety mediates between self-efficacy and each outcome (H_{04}). The corresponding null hypotheses state that these relationships, predictions, and indirect effects are not statistically significant. Because value appraisal was not measured, this is only a partial application of CVT. The cross-sectional data also cannot establish that self-efficacy causes changes in anxiety or learning outcomes. Value appraisal was not separately measured because the study's instrument focused on chemistry self-efficacy, chemistry anxiety, and perceived learning outcomes. Accordingly, Control–Value Theory is used as an interpretive framework rather than tested in its entirety. Self-efficacy represents a control-related belief, while chemistry anxiety represents an achievement emotion.

Conceptual Framework

Figure 1 presents the conceptual framework. Chemistry self-efficacy is the independent variable, chemistry anxiety is the proposed mediator, and perceived cognitive, affective, and psychomotor learning outcomes are examined separately as dependent variables. The model tests the association between self-efficacy and anxiety (path a), the association between anxiety and each outcome while controlling for self-efficacy (path b), the total association between self-efficacy and each outcome (path c), the direct association after anxiety is included (path c-prime), and the bootstrapped indirect effect (ab). Because the data are cross-sectional, these paths indicate statistical relationships rather than temporal or causal effects. This is a statistical indirect-effect model. Because all variables were measured at one time, the paths do not establish temporal ordering or causal mediation. Value appraisal is acknowledged as a component of Control–Value Theory but was not measured or included in the statistical model.

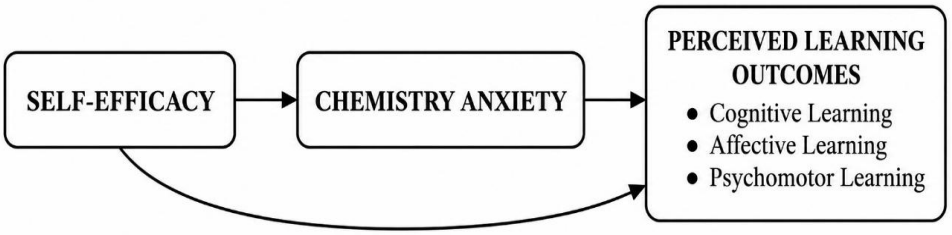


Figure 1. The conceptual diagram.

METHODOLOGY

This study used a cross-sectional, correlational-predictive design to examine relationships among chemistry self-efficacy, chemistry anxiety, and perceived learning outcomes; estimate the unique statistical contribution of self-efficacy and anxiety to each outcome; and estimate the proposed indirect effect through anxiety in the relationship between self-efficacy and each perceived outcome. Correlation, multiple regression, and indirect-effect analysis were appropriate for these objectives. The design estimates associations and statistical prediction but does not establish temporal order or causation; statistical prediction and indirect effects must be interpreted as associations (Curtis et al., 2016).

The researchers obtained permission for main-study data collection on September 15, 2026, from the Dean of the College and the Teacher Education Department Program Chairperson of Divine Word College of San Jose. Year-level representatives invited eligible students through private messages and face-to-face announcements. The invitation explained that participation was voluntary and that students could decline or withdraw without penalty or effect on their academic standing.

Before completing the questionnaire, students were informed of the study's purpose, procedures, and protections for their responses. Participants provided signed informed consent in print or electronically. De-identified electronic data were stored in a password-protected Microsoft account accessible only to the corresponding author. De-identified files will be retained until the manuscript is approved by the journal for publication, after which the corresponding author will securely delete them.

The target population comprised 177 BSEd Science majors enrolled at Divine Word College of San Jose during the first semester of academic year 2026–2027. The main-study participants were first- to third-year BSEd Science majors; 30 fourth-year students participated only in reliability testing and were excluded from the main analysis. Through self-selection sampling, 122 of 147 eligible first- to third-year students who had completed, were taking chemistry courses, and those who found time participated (83.0%). Voluntary participation introduces possible nonresponse bias and limits generalizability. Year level was not recorded for the main-study respondents; therefore, frequencies and percentages by year level cannot be reported.

The study used a 50-item questionnaire consisting of five 10-item scales: chemistry self-efficacy, chemistry anxiety, perceived cognitive learning outcomes, perceived affective learning outcomes, and perceived psychomotor learning outcomes. Self-efficacy items assessed task-specific capability beliefs using a four-point scale from 1 (Very Low Self-Efficacy) to 4 (Very High Self-Efficacy). Anxiety items used a four-point intensity scale from 1 (Not at All) to 4 (Extremely). The perceived learning-outcome items used a four-point agreement scale from 1 (Strongly Disagree) to 4 (Strongly Agree).

Table 1 presents scale-specific Cronbach's alpha coefficients of .865–.920. Chemistry anxiety and affective learning outcomes showed excellent internal consistency ($\alpha \geq .90$); self-efficacy and cognitive and psychomotor learning outcomes showed good internal consistency ($.80 \leq \alpha < .90$). These five coefficients are the principal reliability evidence for the distinct constructs.

Table 1. Reliability analysis

Constructs	**Items**	**α**	**Interpretation**
Chemistry Self-Efficacy	10	.871	Good internal consistency
Chemistry Anxiety	10	.911	Excellent internal consistency
Cognitive Learning Outcome	10	.867	Good internal consistency
Affective Learning Outcome	10	.920	Excellent internal consistency
Psychomotor Learning Outcome	10	.865	Good internal consistency

Table 2 presents the scale-level content validity indices, calculated using the average method (S-CVI/Ave). The questionnaire was evaluated by four experts: two in science education, one in English language, and one in instructional leadership. The S-CVI/Ave values were .975 for chemistry self-efficacy, .800 for chemistry anxiety, 1.000 for cognitive learning outcomes, .950 for affective learning outcomes, and .925 for psychomotor learning outcomes. Four of the five scales exceeded the .90 benchmark for excellent scale-level content validity. The chemistry anxiety scale, with an S-CVI/Ave of .800, did not meet that benchmark. The four validators rated item relevance on a four-point scale; ratings of 3 or 4 counted as relevant. Each item-level CVI was the proportion of validators rating the item relevant, and S-CVI/Ave was the mean of the item-level indices within a scale.

Table 2. Content-Validity Index of the Instrument

Indicators	S-CVI	Interpretation
Self-Efficacy	0.975	Excellent
Chemistry Anxiety	0.800	Below the .90 benchmark for excellent scale-level content validity
Cognitive Learning Outcomes	1.000	Excellent
Affective Learning Outcomes	0.950	Excellent
Psychomotor Learning Outcomes	0.925	Excellent

Data were analyzed using jamovi 2.7.38. Descriptive statistics summarized the five constructs. Pearson product–moment correlation examined pairwise associations. Separate multiple linear regressions estimated the unique statistical contributions of self-efficacy and anxiety to each perceived outcome.

Residual diagnostics included Shapiro–Wilk, visual residual plots, Breusch–Pagan, variance inflation factors, and Durbin–Watson as an additional diagnostic. Separate indirect-effect analyses used medmod with self-efficacy as the predictor, anxiety as the proposed mediator, and each perceived outcome in turn. The models included no covariates. Indirect effects were evaluated with 5,000 bootstrap samples and 95% confidence intervals; an interval excluding zero was considered evidence of an indirect effect.

Ethical Considerations

Permission for main-study data collection was obtained on September 15, 2026, from the Dean of the College, Dr. Luis I. Gante, Jr., and Teacher Education Department Program Chairperson, Mrs. Elvie D. Aragones. Eligible students received information on the purpose, procedures, risks, benefits, confidentiality, and voluntary nature of the study. Participants received printed or electronic informed-consent forms and could decline or withdraw without academic penalty. Recruitment was arranged to minimize pressure from instructors. De-identified electronic data were stored in a password-protected Microsoft account accessible only to the corresponding author. De-identified files will be retained until the manuscript is approved by the journal for publication, after which the corresponding author will securely delete them.

RESEARCH RESULTS

Table 3 shows high chemistry self-efficacy overall, with a composite mean of 2.82 (SD = .597). The three highest-rated indicators were performing well in chemistry assessments (M = 3.06), safely handling hazardous chemicals (M = 2.92), and interpreting experimental data (M = 2.91). The two lowest were designing low-cost inquiry experiments (M = 2.75) and troubleshooting laboratory and equipment problems (M = 2.67).

Table 3. Level of Self-Efficacy

Indicator	Mean	SD	Interpretation
CSE5. I can interpret experimental data accurately.	2.91	.546	High Self-Efficacy
CSE6. I can safely handle hazardous chemicals.	2.92	.597	High Self-Efficacy
CSE7. I can perform well in chemistry assessments.	3.06	.550	High Self-Efficacy
CSE8. I can design low-cost inquiry chemistry experiments.	2.75	.621	High Self-Efficacy
CSE9. I can troubleshoot laboratory and equipment problems.	2.67	.673	High Self-Efficacy
Composite Mean	2.82	0.597	High Self-Efficacy

Scale: 4.00 - 3.26 - Very High Self-Efficacy, 3.25 - 2.51 - High Self-Efficacy, 2.50 - 1.76 - Low Self-Efficacy, 1.75 - 1.00 - Very Low Self-Efficacy

Note: The three highest- and two lowest-rated indicators are shown. The composite mean and SD are based on all ten items in the scale.

Table 4 shows high chemistry anxiety overall (M = 2.56, SD = .794). The three highest-rated concerns were failing chemistry (M = 3.10), starting difficult chemistry work (M = 2.60), and receiving unexpected results (M = 2.54). The two lowest were using laboratory equipment (M = 2.30) and participating in chemistry demonstrations (M = 2.25).

Table 4. Level of Chemistry Anxiety

Indicator	Mean	SD	Interpretation
CA1. I feel nervous when starting difficult chemistry work.	2.60	.746	High Anxiety
CA3. I feel anxious when using laboratory equipment.	2.30	.768	Low Anxiety
CA6. I worry about failing chemistry.	3.10	.857	High Anxiety
CA9. Chemistry demonstrations during instruction make me nervous.	2.25	.745	Low Anxiety
CA10. Unexpected results make me feel overwhelmed.	2.54	.794	High Anxiety
Composite Mean	2.56	.794	High Anxiety

Scale: 4.00 - 3.26 - Very High Anxiety, 3.25 - 2.51 - High Anxiety, 2.50 - 1.76 - Low Anxiety, 1.75 - 1.00 - Very Low Anxiety

Note: The three highest- and two lowest-rated indicators are shown. The composite mean and SD are based on all ten items in the scale.

Table 5 shows a high level of perceived cognitive learning outcomes with a composite mean of 3.04, SD = .509. The highest-rated indicators were evaluating procedures (M = 3.18), analyzing visualized data (M = 3.13), and applying chemistry to Philippine environmental issues (M = 3.11). The lowest-rated were designing assessments of students' chemistry understanding (M = 2.96) and performing stoichiometric calculations (M = 2.84). All five indicators were rated high.

Table 5. Level of Perceived Cognitive Learning Outcomes

Indicator	Mean	SD	Interpretation
CLO2. I can perform stoichiometric calculations accurately.	2.84	.536	High
CLO3. I can analyze visualized data.	3.13	.444	High
CLO7. I can evaluate procedures.	3.18	.464	High
CLO8. I can apply chemistry to Philippine environmental issues.	3.11	.578	High
CLO10. I can design assessments of students' chemistry understanding.	2.96	.521	High

Composite Mean	3.04	.509	High

Scale: 4.00 - 3.26 - Very High, 3.25 - 2.51 - High, 2.50 - 1.76 - Low, 1.75 - 1.00 - Very Low

Note. The three highest- and two lowest-rated indicators are shown. The composite mean and SD are based on all ten items in the scale.

Table 6 shows a very high level of perceived affective learning outcomes composite mean of 3.26, SD = .519. The highest-rated indicators were valuing teamwork (M = 3.39), feeling satisfied with chemistry accomplishments (M = 3.33), and valuing honest reporting of results (M = 3.32); all were rated very high. The lowest-rated were enjoying new chemical concepts (M = 3.18) and independently exploring chemistry resources (M = 3.07); both were still rated high.

Table 6. Level of Perceived Affective Learning Outcomes

Indicator	Mean	SD	Interpretation
ALO2. I enjoy discovering new chemical concepts.	3.18	.546	High
ALO3. Chemistry accomplishments give me satisfaction.	3.33	.505	Very High
ALO4. I independently explore additional chemistry resources.	3.07	.571	High
ALO5. I value honest reporting of experimental results.	3.32	.468	Very High
ALO7. I value teamwork in chemistry learning.	3.39	.507	Very High
Composite Mean	3.26	0.519	Very High

Scale: 4.00 - 3.26 - Very High, 3.25 - 2.51 - High, 2.50 - 1.76 - Low, 1.75 - 1.00 - Very Low

Note. The three highest- and two lowest-rated indicators are shown. The composite mean and SD are based on all ten items in the scale.

Table 7 shows a high level of perceived psychomotor learning outcomes with a composite mean of 3.06, SD = .512. Following laboratory safety practices received the highest rating (M = 3.28, very high). Handling chemical waste and maintaining a hazard-free workstation followed (both M = 3.10, high). The lowest-rated indicators were making precise volumetric measurements (M = 2.93) and performing emergency laboratory procedures (M = 2.89); both were still rated high.

Table 7. Level of Perceived Psychomotor Learning Outcomes

Indicator	Mean	SD	Interpretation
PLO2. I can make precise volumetric measurements.	2.93	.563	High
PLO3. I consistently follow laboratory safety practices.	3.28	.468	Very High
PLO6. I can handle chemical waste safely.	3.10	.471	High
PLO7. I maintain a hazard-free workstation.	3.10	.488	High
PLO10. I can perform emergency laboratory procedures.	2.89	.572	High
Composite Mean	3.06	.512	High

Scale: 4.00 - 3.26 - Very High, 3.25 - 2.51 - High, 2.50 - 1.76 - Low, 1.75 - 1.00 - Very Low

Note. The three highest- and two lowest-rated indicators are shown. The composite mean and SD are based on all ten items in the scale.

Table 8 shows a weak positive relationship between chemistry self-efficacy and chemistry anxiety (r = .178, p = .050). Because the unrounded p value (.050018) exceeds .05, the relationship was not statistically significant. Thus, H_{01} was not rejected.

Table 8. Correlational analysis between self-efficacy and anxiety in chemistry classes

Indicators	r-value	p-value	Interpretation
Self-Efficacy → Anxiety	.178	0.050	Weak positive not statistically significant

Table 9 shows a weak positive relationship between chemistry anxiety and perceived cognitive learning outcomes (r = .202, p = .026). Its relationships with affective outcomes (r = .072, p = .433) and psychomotor outcomes (r = .175, p = .054) were not statistically significant. Thus, H_{02} was rejected for the cognitive domain only. These correlations do not establish that anxiety caused the reported outcomes.

Table 9. Correlational analysis between anxiety in chemistry classes and perceived learning outcomes

Indicators	r-value	p-value	Interpretation
Anxiety → Cognitive Learning Outcomes	.202	.026	Weak positive, significant
Anxiety → Affective Learning Outcomes	.072	.433	Very weak positive, not significant
Anxiety → Psychomotor Learning Outcomes	.175	.054	Weak positive, not significant

Table 10. Model fit. All three regression models were statistically significant: cognitive, F (2, 119) = 34.4, p < .001; affective, F (2, 119) = 10.3, p < .001; and psychomotor, F (2, 119) = 41.1, p < .001. Self-efficacy and anxiety together explained 36.6% of the variation in perceived cognitive outcomes (R^2 = .366, adjusted R^2 = .356), 14.8% in affective outcomes (R^2 = .148, adjusted R^2 = .133), and 40.9% in psychomotor outcomes (R^2 = .409, adjusted R^2 = .399).

Table 10. Multiple Regression Model Fit for Perceived Learning Outcomes

Outcome	*R*	R^2	Adjusted R^2	*F* (2, 119)	*p*
Cognitive	.605	.366	.356	34.4	< .001
Affective	.384	.148	.133	10.3	< .001
Psychomotor	.639	.409	.399	41.1	< .001

Note: Three separate multiple-regression models were conducted in jamovi (N = 122), one for each perceived learning outcome, with self-efficacy and anxiety as predictors in each. R = multiple correlation; R^2 = coefficient of determination; adjusted R^2 adjusts for the number of predictors; F = overall model test.

Table 11. Individual predictors. After accounting for anxiety, chemistry self-efficacy significantly predicted perceived cognitive (β = .580), affective (β = .384), and psychomotor outcomes (β = .625; all p < .001). Chemistry anxiety was not a significant predictor in any model (all p > .05). Thus, H_{o3} was rejected for self-efficacy across all three outcomes, but not for anxiety.

Table 11. Regression Coefficients for Perceived Learning Outcomes

Outcome	Predictor	*B*	*SE*	β	*t*	*p*
Cognitive	Self-efficacy	.543	.069	.580	7.82	< .001
	Chemistry anxiety	.064	.048	.098	1.33	.187
Affective	Self-efficacy	.368	.083	.384	4.46	< .001
	Chemistry anxiety	.002	.057	.003	0.04	.968
Psychomotor	Self-efficacy	.569	.065	.625	8.72	< .001
	Chemistry anxiety	.040	.045	.064	0.89	.376

Note. Separate multiple-regression models in jamovi. B = unstandardized coefficient; SE = standard error; β = standardized coefficient.

Table 12 shows low multicollinearity (VIF = 1.03) and no detected heteroscedasticity in the cognitive, affective, or psychomotor models (Breusch–Pagan p = .885, .607, and .509, respectively). Shapiro–Wilk tests indicated departures from residual normality (p = .019, p < .001, and p < .001, respectively), which should be considered alongside the Q–Q plots. The cognitive model had DW = 1.62, p = .034; the affective and psychomotor models had DW = 1.71, p = .126, and DW = 1.74, p = .144. Durbin–Watson was an additional diagnostic for these independently recruited, cross-sectional respondents; these results alone do not invalidate the models.

Table 12. Regression Diagnostic Results

Outcome	Shapiro–Wilk *p*	Breusch–Pagan *p*	Durbin–Watson	DW *p*	VIF
Cognitive	.019	.885	1.62	.034	1.03
Affective	< .001	.607	1.71	.126	1.03
Psychomotor	< .001	.509	1.74	.144	1.03

To test H_{04}, separate indirect-effect analyses were conducted using the medmod module in jamovi. Chemistry self-efficacy was the predictor, chemistry anxiety the proposed mediator, and perceived cognitive, affective, and psychomotor learning outcomes the separate dependent variables. The models included no covariates. Using 5,000 bootstrap samples, the indirect-effect 95% confidence intervals were [−.0102, .0645] for cognitive, [−.0358, .0399] for affective, and [−.0152, .0529] for psychomotor outcomes. Each included zero; no statistically significant indirect effect through chemistry anxiety was found. Chemistry self-efficacy had significant positive direct statistical associations with cognitive (B = .5428), affective (B = .36789), and psychomotor outcomes (B = .5690; all p < .001). Across the three medmod outputs, path a (self-efficacy → anxiety) was B = .2556, SE = .1713, z = 1.492, p = .136, 95% CI [−.0891, .581]. The conditional paths from anxiety to the outcomes were nonsignificant.

Table 13. Mediation Analysis

Learning outcome	Effect	*B*	*SE*	*z*	*p*	95% CI	Interpretation
All three	Self-efficiency → anxiety (a)	.2556	.1713	1.49	.136	[−.0891, .581]	Not significant
Cognitive	Anxiety → outcome (*b*)	.0641	.0476	1.35	.178	[−.0267, .1580]	Not significant
	Direct (*c′*)	.5428	.0777	6.98	< .001	[.3910, .6967]	Significant
	Indirect (*ab*)	.0164	.0190	0.87	.387	[−.0102, .0645]	No evidence of mediation
	Total (*c*)	.5592	.0766	7.30	< .001	[.4125, .7136]	Significant
Affective	Anxiety → outcome (*b*)	.00231	.0547	0.04	.966	[−.1048, .1100]	Not significant

	Direct (*c′*)	.36789	.0766	4.80	< .001	[.2137, .5203]	Significant
	Indirect (*ab*)	.00059	.0172	0.03	.973	[−.0358, .0399]	No evidence of mediation
	Total (*c*)	.368	.0759	4.85	< .001	[.2170, .5200]	Significant
	Anxiety → outcome (*b*)	.0403	.0477	0.85	.398	[−.0535, .1370]	Not significant
Psychomotor	Direct (*c′*)	.5690	.0795	7.16	< .001	[.4154, .7262]	Significant
	Indirect (*ab*)	.0103	.0171	0.60	.546	[−.0152, .0529]	No evidence of mediation
	Total (*c*)	.5793	.0771	7.52	< .001	[.4319, .7322]	Significant

DISCUSSION

Control-Value Theory (CVT) explains how students' beliefs about their control over a task and its value relate to emotions and learning (Pekrun, 2019, 2024). This study examined chemistry self-efficacy, anxiety, and perceived learning outcomes. It did not directly measure control or value appraisals, so it provides only a partial test of CVT.

Respondents reported high chemistry self-efficacy (M = 2.82). They were most confident in chemistry assessments, handling hazardous chemicals, and interpreting data. They were relatively less confident in designing low-cost experiments and troubleshooting equipment. Practice, supportive instruction, and guided inquiry may help strengthen confidence in these tasks (Cheung, 2015a, 2015b; Vishnumolakala et al., 2017).

Chemistry anxiety was also high (M = 2.56). Respondents worried most about failing chemistry and were less anxious about using laboratory equipment and participating in demonstrations. CVT suggests that anxiety may arise when students value success but are unsure of their control over a task (Abuzant et al., 2023; Pekrun, 2024). This study did not measure why respondents felt anxious.

Perceived cognitive (M = 3.04) and psychomotor (M = 3.06) learning outcomes were high, while affective outcomes were very high (M = 3.26). Ratings were relatively lower for stoichiometric calculations, assessment design, precise measurements, and emergency laboratory procedures. Guided practice in these tasks may be helpful (Buil et al., 2016; Agustian et al., 2022; Galloway & Bretz, 2015; Kolil et al., 2020). The affective ratings describe students' perceived learning and do not directly measure CVT's value appraisal.

Self-efficacy and chemistry anxiety had a weak positive correlation that did not reach statistical significance, r (120) = .178, p = .050018. The medmod path-an estimate was also nonsignificant (B = .2556, bootstrap SE = .1713, p = .136). The p-values differ because medmod used 5,000 bootstrap samples to estimate its standard error, while the Pearson correlation used a conventional significance test.

Higher self-efficacy was associated with, and significantly predicted, stronger perceived outcomes in all three domains. This agrees with earlier research on chemistry self-efficacy (Odedokun et al., 2024; Selian et al., 2018). Anxiety had a weak positive correlation with cognitive outcomes, but it did not significantly predict any outcome after self-efficacy was included. The positive correlation does not show that anxiety improved learning (Eddy, 2000; "Correlation Between Test Anxiety and Students' Chemistry Achievement," 2023).

The absence of a separate value-appraisal measure limits the study's application of Control–Value Theory. Future studies should measure both control and value appraisals to examine their relationships with chemistry anxiety and learning outcomes.

Finally, no statistically significant indirect effect through anxiety was found for any perceived learning outcome. All three indirect-effect confidence intervals included zero. Because the study used cross-sectional self-reports, these findings show associations, not cause and effect. Future studies could measure both control and value appraisals over time to test CVT more fully.

CONCLUSIONS AND RECOMMENDATIONS

Respondents reported high chemistry self-efficacy and high perceived cognitive and psychomotor learning outcomes. Perceived affective outcomes were very high. They gave relatively lower ratings to experimental design, troubleshooting, stoichiometry, precise measurement, and emergency procedures. These are self-reported ratings, so they do not establish actual skill deficits. Anxiety was greatest for failing chemistry, starting difficult tasks, and receiving unexpected results.

Self-efficacy was positively associated with all three perceived learning outcomes and remained a significant predictor when anxiety was included. Its relationship with anxiety was not statistically significant (p = .050018). Anxiety was weakly associated with cognitive learning but was not a significant predictor of any outcome after self-efficacy was included.

No, statistically significant indirect effect through anxiety was found for any perceived learning outcome. Overall, the findings support a relationship between self-efficacy and perceived learning, but they do not show that self-efficacy caused the outcomes.

The following are proposed applications for faculty consideration and topics for future evaluation; their effectiveness was not tested in this study:

1. Provide guided practice in experimental design, troubleshooting, stoichiometry, precise measurement, and emergency procedures, then assess students' actual performance.
2. Use practice quizzes, clear criteria, and helpful feedback to address anxiety about difficult tasks and failure.
3. Introduce laboratory activities gradually to help students build confidence through successful practice.
4. Teach simple anxiety-management and test-preparation strategies before exams and demanding laboratory work.
5. Review access to equipment, safety materials, virtual laboratories, and low-cost experiment resources.
6. Use larger samples from multiple schools in future studies.
7. Measure control and value appraisals and consider prior achievement, year level, laboratory experience, and teacher support.
8. Combine student ratings with test scores, laboratory assessments, and observations, using longitudinal or experimental designs where possible.

FUTURE STUDY

Researchers may recruit participants from several institutions, combine self-reports with examination and laboratory performance, measure both control and value appraisals, and follow students over time. Action research could evaluate guided inquiry, virtual laboratories, laboratory skills training, and anxiety management.

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REFERENCES

Abuzant, M., Daher, W., & Mahamid, F. A. (2023). Control–Value Appraisals and Achievement Emotions: A Moderation Analysis. Psych. https://doi.org/10.3390/psych5040080

Agustian, H. Y. (2024). Recent advances in laboratory education research. Chemistry Teacher International. https://doi.org/10.1515/cti-2024-0071

Agustian, H. Y., Finne, L. T., Jørgensen, J. T., Pedersen, M. I., Christiansen, F. V., Gammelgaard, B., & Nielsen, J. (2022). Learning outcomes of university chemistry teaching in laboratories: A systematic review of empirical literature. Review of Education, 10(2). https://doi.org/10.1002/rev3.3360

Avraamidou, L., Kolk, K. vans der, Tromp, M., Kool, D., Romé, Y. M., Iji, T. O., Nagal, A., Tiwari, P. S., Pawan Kumar, & … G. Y. S. (2022). The Use of

Virtual Reality in A Chemistry Lab and Its Impact on Students' Self-Efficacy, Interest, Self-Concept and Laboratory Anxiety. 18(3), em2090–em2090. https://doi.org/10.29333/ejmste/11814

Aydin, Y. Ç., Uzuntiryaki, E., & Demirdöğen, B. (2011). Interplay of motivational and cognitive strategies in predicting self-efficacy and anxiety. Educational Psychology, 31(1), 55–66. https://doi.org/10.1080/01443410.2010.518561

Buil, I., Catalán, S., & Martínez, E. (2016). Do clickers enhance learning? A CVT approach. Computer Education, 103, 170–182. https://doi.org/10.1016/J.COMPEDU.2016.10.009

Catubig, D., Tantog, A. J., Naparan, G., Catubig, D., & Tantog, A. J. (2025). Exploring The Experiences of The BSED Major in Science Students in The Use of Laboratory Facilities and Equipment. Journal of Elementary and Secondary School, 3(2), 70–85. https://doi.org/10.31098/jess.v3i2.2963

Chai, T., & Sha, C. (2025). Prevention of AI learning anxiety: The chain mediation role of technophilia and AI self-efficacy under the context of teacher support. Acta Psychologica, 261, 105979–105979. https://doi.org/10.1016/j.actpsy.2025.105979

Chakraborty, P. K. (2025). Intercorrelations Among Cognitive, Affective, and Psychomotor Learning Style Preferences in Higher Secondary School Students in Tripura, India. Journal of Informatics Education and Research, 5(3). https://doi.org/10.52783/jier.v5i3.3336

Cheung, D. (2015a). Secondary School Students' Chemistry Self-Efficacy: Its Importance, Measurement, and Sources. 195–215. https://doi.org/10.1007/978-3-662-45085-7_10

Cheung, D. (2015b). The Combined Effects of Classroom Teaching and Learning Strategy Use on Students' Chemistry Self-Efficacy. Research in Science Education, 45(1), 101–116. https://doi.org/10.1007/S11165-014-9415-0

Context-Based Chemistry Learning: A Systematic Literature Review. (2022). Jurnal Pendidikan MIPA, 23(4), 1446–1463. https://doi.org/10.23960/jpmipa/v23i4.pp1446-1463

Correlation between test anxiety and students' chemistry achievement. (2023). Journal of Research in Instructional, 3(1), 31–40. https://doi.org/10.30862/jri.v3i1.93

Denes, S., & Enrico, T. (2023). Supplementary publication file from Maths anxiety and subjective perception of control, value and success expectancy in mathematics. https://doi.org/10.6084/m9.figshare.24581743.v2

Eddy, R. M. (2000). Chemophobia in the College Classroom: Extent, Sources, and Student Characteristics. Journal of Chemical Education, 77(4), 514–514. https://doi.org/10.1021/ED077P514

Erlina, Ulfah, M., Mayasari, E., & Marisa. (2025). Capturing Meaningful Learning in Chemistry Practical Work Using MLLIv2. JPPIPA (Jurnal Penelitian Pendidikan IPA). https://doi.org/10.29303/jppipa.v11i9.12393

Florescu, M. C., Barth, K. M., Muntean, L., Pascariu, C. C., & Albulescu, I. (2024). Self-efficacy, Anxiety, Positive Affect, and Students' Expected Grades in

the Context of the Bachelor Exam. Revista Romaneasca Pentru Educatie Multidimensionala, 16(2), 550–568

Galloway, K. R., & Bretz, S. L. (2015). Development of an Assessment Tool to Measure Students' Meaningful Learning in the Undergraduate Chemistry Laboratory. Journal of Chemical Education, 92(7), 1149–1158. https://doi.org/10.1021/ED500881Y

Hamzavi, R., Sharifi, H., Kalantari, S., & Imani, S. S. A. (2023). Iranian University EFL Students' Cognitive Appraisals of Control and Value, Learning Related Achievement Emotions, and Academic Achievement. 47(3), 1–10. https://doi.org/10.61871/mj.v47n3-16

Indispensability of integrating three learning domains in teaching and learning. (2022). https://doi.org/10.5281/zenodo.10573835

Indispensability of integrating three learning domains in teaching and learning. (2024). https://doi.org/10.5281/zenodo.10573834

Jian-lin, L. (n.d.). Exploration and Practice of the Course of Basic Chemistry Set Up in Primary Education Major.

Juriya, D. (2023). A Control-Value Approach to Affective Growth. 328-C8.7F1. https://doi.org/10.1093/oso/9780197662359.003.0055

Kolil, V. K., Muthupalani, S., & Achuthan, K. (2020). Virtual experimental platforms in chemistry laboratory education and its impact on experimental self-efficacy. International Journal of Educational Technology in Higher Education, 17(1), 1–22. https://doi.org/10.1186/S41239-020-00204-3

Kurbanoglu, N. I., & Akin, A. (2010). The Relationships between University Students' Chemistry Laboratory Anxiety, Attitudes, and Self-Efficacy Beliefs. Australian Journal of Teacher Education, 35(8), 48–59. https://doi.org/10.14221/AJTE.2010V35N8.4

Kurbanoglu, N. I., & Akin, A. (n.d.). The Relationships Between University Students' Organic Chemistry Anxiety, Chemistry Attitudes, and Self-Efficacy: A Structural Equation Model. https://doi.org/10.33225/jbse/12.11.347

LENG, X. (n.d.). Cultivation of Chemistry Majors' Scientific Literacy in Normal Universities. https://doi.org/10.3969/j.issn.1674-344x.2015.09.021

Liday, D. (2025). Making sense of students' attitude towards college general chemistry: A partial least squares structural equation modeling (PLS-SEM) approach. Journal of Technology and Science Education, 15(2), 380–380. https://doi.org/10.3926/jotse.2971

Liu, M., Du, N., Li, X., & Wang, Y. (2025). Control-value appraisals, achievement emotions and English performance in Chinese middle school students. Acta Psychologica, 260, 105751–105751. https://doi.org/10.1016/j.actpsy.2025.105751

Liu, S., Leung, F. K. S., & Jiang, Z. (2022). The appraisal antecedents of Shanghai students' mathematics anxiety and the moderating effects of teacher behaviours: from the perspective of the CVT. Asia Pacific Journal of Education, 1–14. https://doi.org/10.1080/02188791.2022.2049699

Lončarić, D. (2008). How anxiety and self-efficacy affect school performance: Mediating role of learning and coping strategies.

Losh, S. C., & Nzekwe, B. (2011). The foundations: How education major influences basic science knowledge and pseudoscience beliefs. 1–16. https://doi.org/10.1109/ACSIP.2011.6064476

Mindset and achievement in general chemistry: insights from Turkish undergraduate students. (2025). Chemistry Education Research and Practice, 27(1), 591–606. https://doi.org/10.1039/d5rp00379b

Mino, L. J. D. D., Limetares, F. F. D., Pitogo, J. D., & Nabua, E. B. (n.d.). Bridging Learning Gaps in General Chemistry: Diagnostic Insights into Mastery and Self-Efficacy. International Journal of Research and Innovation in Social Science. https://doi.org/10.47772/ijriss.2025.91200249

Mun, N. K., Rahim, A. A. A., Addi, M. Mohd., & Osman, M. (2023). An Instrument to Measure Perceived Cognitive, Affective, and Psychomotor (CAP) Learning for Online Laboratory in Technology and Engineering Courses. Pertanika Journal of Science and Technology, 31(4). https://doi.org/10.47836/pjst.31.4.28

Muslihah, F., Rahmat, A., Winarno, N., Muslihah, F., Rahmat, A., & Winarno, N. (2025). Psychological Barriers in Science Education: Correlation of Science Anxiety and Academic Performance. Unnes Science Education Journal, 14(2), 391–404. https://doi.org/10.15294/usej.v14i2.20037

Naibert, N., Mooring, S. R., & Barbera, J. (2024). Investigating the Relations between Students' Chemistry Mindset, Self-Efficacy, and Goal Orientation in General and Organic Chemistry Lecture Courses. Journal of Chemical Education. https://doi.org/10.1021/acs.jchemed.3c00929

Odedokun, O. A., Ishola, K. T., Bolarinwa, O. T., & Abubakar, A. (2024b). Appraisal of the Role of Self-efficacy on Students' Academic Achievement in Secondary School Chemistry. https://doi.org/10.60692/8faz2-ev417

Ogunde, J. C. (2019). Cross-sectional study of the relationship between Attitudes, Self-efficacy beliefs, Career aspirations and Learning outcomes of Undergraduate chemistry students in Universities in Australia, New Zealand and United Kingdom. https://doi.org/10.26180/5C9BFB1CE948B

Pablo, J. D., Esmeralda, P. A. A., & Isaran, P. B. (2025). Research Proficiency, Challenges, and Engagement of BSED Science Students. International Journal of Research and Innovation in Social Science, IX(VIII), 3893–3914. https://doi.org/10.47772/ijriss.2025.908000314

Park, J., Jung, D., & Nam, J. (n.d.). A Study on the Scientific Inquiry Competencies of First-Year Science Major Students at a College of Education: Focusing on the General Chemistry Experiment Course. https://doi.org/10.5012/jkcs.2024.68.5.274

Pascal, M., & Chisca, D. (2023). Developing of scientific literacy in chemistry through oral assessment.

Pekrun, R. (2019). Achievement emotions: A control-value theory perspective. In T. Urdan & S. A. Karabenick (Eds.), Advances in motivation and

achievement (pp. 142–157). Routledge. https://doi.org/10.4324/9781351133319-13

Pekrun, R. (2024). Control-value theory: From achievement emotion to a general theory of human emotions. Educational Psychology Review. https://doi.org/10.1007/s10648-024-09909-7

Pesimo, A. R. (2014). Developing the Learning Outcomes of the Students through Microscale Experiments in Chemistry. Open Access Library Journal, 1(3), 1–11. https://doi.org/10.4236/OALIB.1100479

Pulukuri, S., Torres, D., & Abrams, B. (2024). Investigating Attitudinal Profiles and Disparities in Attitudes among Historically Marginalized Undergraduate Chemistry Students. Journal of Chemical Education. https://doi.org/10.1021/acs.jchemed.4c00640

Putwain, D. W., & Wood, P. (2022). Anxiety in the mathematics classroom: reciprocal relations with control and value, and relations with subsequent achievement. 55(2), 285–298. https://doi.org/10.1007/s11858-022-01390-2

Rebecca, L. (2021). CVT in the context of teaching. https://doi.org/10.25932/publishup-51971

Roos, A.-L., Goetz, T., Krannich, M., Donker, M. H., Bieleke, M., Caltabiano, A., & Mainhard, T. (2022). Control, anxiety and test performance: Self-reported and physiological indicators of anxiety as mediators. British Journal of Educational Psychology, 93(S1), 72–89. https://doi.org/10.1111/bjep.12536

Rummey, C., Clemons, T. D., & Spagnoli, D. (2019). The impact of several demographic factors on chemistry laboratory anxiety and self-efficacy in students' first year of university. 10(1), 87–98. https://doi.org/10.5204/SSJ.V10I1.1104

Selian, M., Sibuea, A. M., & Panjaitan, K. (2018). The Influence of Learning Models and Self-Efficacy Against Chemistry Learning Outcomes at Kutacane State High School. 254–257.

Sellioğ, A., & Uzun, N. B. (2025). The Mediating Role of Anxiety in the Relationship Between Self-Efficacy Beliefs and Critical Thinking Skills of Socioeconomically Disadvantaged Middle School Students*. https://doi.org/10.1080/10824669.2025.2511610

Sevian, H., & Bulte, A. M. W. (2015). Learning Chemistry to Enrich Students' Views on the World They Live In. 55–78.

Skues, J., Freeman, E., & Allen, K. (2025). Basic psychological needs and achievement emotions: the role of control and value appraisals in higher education. Australian Journal of Psychology. https://doi.org/10.1080/00049530.2025.2500937

Symes, W., Lichtenfeld, S., Wood, P., & Putwain, D. W. (2025). Profiles of control, value and achievement emotions in primary school mathematics lessons. British Journal of Educational Psychology, 95(3), 888–902. https://doi.org/10.1111/bjep.12768

Trends in providing chemical knowledge to students based on a competency-based approach. (2025). https://doi.org/10.5281/zenodo.16949535

Villafañe, S. M., Garcia, C. A., & Lewis, J. E. (2014). Exploring diverse students' trends in chemistry self-efficacy throughout a semester of college-level preparatory chemistry. Chemistry Education Research and Practice, 15(2), 114–127. https://doi.org/10.1039/C3RP00141E

Vishnumolakala, V. R., Southam, D., Treagust, D. F., Mocerino, M., & Qureshi, S. S. (2017). Students' attitudes, self-efficacy and experiences in a modified process-oriented guided inquiry learning undergraduate chemistry classroom. Chemistry Education Research and Practice, 18(2), 340–352. https://doi.org/10.1039/C6RP00233A

Yarahmadi, M. (n.d.). Understanding the Motivation–Anxiety Interface Through the Lens of Control–Value Theory: Evidence from Iranian Intermediate EFL Learners. https://doi.org/10.61838/japes.143

Zaluddin, N. F., Afrouzi, H. N., Aripin, Z. A., Azlin, M. F., Halim, M., Ash'ari, I., Jagat, J., Ibrahim, N. H., Surif, J., & Ni, H. S. (2025). Self-Efficacy Level of Chemistry Students. International Journal of Research and Innovation in Social Science, IX(IIIS), 6180–6189. https://doi.org/10.47772/ijriss.2025.903sedu0448