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Percepción de metodologías basadas en el error y su relación con la autoeficacia académica y la tolerancia a la frustración en estudiantes
Students' perceptions of failure based learning methodologies and their relationship with academic self efficacy and frustration tolerance

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RESUMEN

Introducción: El aprendizaje basado en el error promueve el aprendizaje mediante el uso constructivo de las equivocaciones, la reflexión, la retroalimentación y las oportunidades de mejora. **Objetivo:** Determinar la relación entre la percepción de los estudiantes sobre las metodologías basadas en el error, la autoeficacia académica y la tolerancia a la frustración. **Metodología:** Se desarrolló un estudio cuantitativo, no experimental, correlacional y transversal con 50 estudiantes de décimo año de Educación General Básica de la Unidad Educativa Teresa Flor, Ecuador. Se aplicó un cuestionario de 30 ítems con escala Likert, organizado en seis dimensiones. Los datos fueron analizados mediante estadística descriptiva, prueba de Shapiro-Wilk y coeficiente de correlación de Pearson. **Resultados:** Se encontraron relaciones positivas fuertes y estadísticamente significativas entre el aprendizaje basado en el error y la autoeficacia académica ($r = .812$; $p < .001$), entre el aprendizaje basado en el error y la tolerancia a la frustración ($r = .776$; $p < .001$), y entre la autoeficacia académica y la tolerancia a la frustración ($r = .731$; $p < .001$). La relación dimensional más alta se observó entre reflexión, retroalimentación y aprendizaje del error, y persistencia y capacidad percibida de mejora ($r = .721$; $p < .001$). **Conclusión:** Los estudiantes que reportaron mayor exposición a prácticas constructivas de aprendizaje basadas en el error también tendieron a presentar mayores niveles de autoeficacia académica y tolerancia a la frustración. Sin embargo, los resultados representan asociaciones estadísticas y no relaciones causales.

Palabras clave: aprendizaje basado en el error; autoeficacia académica; tolerancia a la frustración; aprendizaje de los errores; estudiantes.

ABSTRACT

Introduction: Failure-Based Learning promotes learning through the constructive use of errors, reflection, feedback, and opportunities for improvement. **Objective:** To determine the relationship between students' perception of Failure-Based Learning, academic self-efficacy, and frustration tolerance. **Methodology:** A quantitative, non-experimental, correlational, and cross-sectional study was conducted with 50 tenth-grade students from Unidad Educativa Teresa Flor, Ecuador. A 30-item Likert-type questionnaire organized into six dimensions was administered. Data were analyzed using descriptive statistics, the Shapiro-Wilk test, and Pearson's correlation coefficient. **Results:** Strong positive and statistically significant relationships were found between Failure-Based Learning and academic self-efficacy ($r = .812$; $p < .001$), Failure-Based Learning and frustration tolerance ($r = .776$; $p < .001$), and academic self-efficacy and frustration tolerance ($r = .731$; $p < .001$). The strongest dimensional relationship was observed between reflection, feedback, and learning from failure and persistence and perceived capacity for improvement ($r = .721$; $p < .001$). **Conclusion:** Students reporting greater exposure to constructive error-based learning practices also tended to report higher academic self-efficacy and greater frustration tolerance. However, the findings indicate statistical association rather than causality.

Keywords: failure-based learning; academic self-efficacy; frustration tolerance; learning from errors; students.



1. INTRODUCTION

Recent educational approaches increasingly recognize errors as opportunities for reflection, feedback, and knowledge construction rather than solely as indicators of failure. Learning from mistakes becomes educationally valuable when students analyze incorrect responses, identify their causes, and modify subsequent strategies (Pan et al., 2020). Productive Failure follows this principle by allowing students to attempt challenging problems before receiving direct instruction, although its effectiveness depends on the task, context, and instructional support provided (Nachtigall et al., 2020). Meta-analytic evidence also suggests that problem solving before instruction can promote learning when students activate prior knowledge, recognize knowledge gaps, and subsequently consolidate understanding (Sinha & Kapur, 2021). Similar benefits have been reported in professional education, including healthcare simulation (Palominos et al., 2021).

Failure-based learning also involves motivational and emotional processes. Productive encounters with failure may promote creativity, educational risk-taking, and willingness to reconsider unsuccessful strategies when mistakes are treated as part of learning rather than as negative outcomes (Henriksen et al., 2021). Academic risk-taking is therefore relevant because students must remain engaged despite the possibility of incorrect responses.

Academic self-efficacy represents another important variable because students' beliefs about their capabilities influence effort, persistence, and responses to academic challenges. Higher academic self-efficacy has been associated with lower fear of failure and better academic performance (Nair & Sutar, 2023). Likewise, constructive error-management climates encourage students to discuss mistakes, experiment, and use errors as information for improvement (Horvath et al., 2023). Recent evidence also indicates that positive classroom attitudes toward errors are associated with students' self-efficacy and are influenced by fear of failure and growth mindset (Zhao & Jing, 2026). Similar relationships between perceived learning from failure and self-efficacy have been reported in professional education (Clardy & Tawfik, 2026).

Frustration tolerance is equally important because it allows students to remain engaged when they encounter difficulties, delays, or unsuccessful attempts. Research has associated greater frustration tolerance with academic performance and persistence (Shi et al., 2021), as well as



with creative performance in demanding educational contexts (Wang & Jiang, 2022). Among adolescents, adaptive coping strategies and emotional regulation are also related to the ability to tolerate frustration and respond constructively to challenging situations (Toala Zavala & Rodríguez Pérez, 2022; Tobar Viera & Mejía Rubio, 2023). In disciplines characterized by repeated problem solving, such as computer science, frustration tolerance becomes especially relevant for maintaining persistence after unsuccessful attempts (Ossovski & Brinkmeier, 2024).

However, failure alone does not guarantee learning. Productive Failure requires appropriate instructional guidance, comparison of strategies, feedback, and opportunities for revision. Hartmann et al. (2022) showed that the mechanisms involved extend beyond simply experiencing an incorrect response, while Kapur et al. (2023) demonstrated that prior achievement and the quality of students' initial productions can influence subsequent learning.

Overall, current evidence suggests a conceptual relationship among Failure-Based.

Learning, academic self-efficacy, and frustration tolerance. Learning from errors may help students revise strategies, self-efficacy may influence their confidence in overcoming challenges, and frustration tolerance may determine whether they persist after unsuccessful attempts. Nevertheless, these relationships depend on factors such as task complexity, prior knowledge, feedback quality, classroom climate, teacher mediation, and emotional regulation (Pan et al., 2020; Sinha & Kapur, 2021; Hartmann et al., 2022; Kapur et al., 2023). Based on these antecedents, the purpose of this study was to determine the relationship between students' perceptions of Failure-Based Learning, academic self-efficacy, and frustration tolerance among tenth-grade students. The study examined practices involving constructive analysis of errors, feedback, opportunities for revision, and classroom environments in which mistakes are treated as learning resources.

2. METHODOLOGY

Research Approach

The study was conducted using a quantitative approach because it involved the collection, measurement, and statistical analysis of numerical data related to students' perceptions of Failure-Based Learning, academic self-efficacy, and frustration tolerance. This approach



enabled the use of structured instruments and statistical procedures to describe the behavior of the variables and examine the degree of association among them.

According to Creswell and Creswell (2023), quantitative research involves the measurement of variables through numerical data and the application of statistical procedures to examine relationships among phenomena and answer specific research questions. Therefore, this approach was considered appropriate for identifying patterns in students' perceptions and determining whether exposure to educational practices based on learning from errors was associated with their perceived academic self-efficacy and tolerance of frustrating academic situations.

Research Design and Type

The study employed a non-experimental research design because the variables were observed and analyzed in their natural educational context without deliberately manipulating students' learning conditions. No experimental treatment was introduced, and students participated according to their regular classroom experiences.

The research had a correlational scope because its purpose was to determine the relationship between students' perceptions of Failure-Based Learning and two socio-emotional variables: academic self-efficacy and frustration tolerance. The study therefore examined whether students who perceived greater opportunities to learn from errors also reported higher levels of confidence in their academic abilities and greater persistence when facing difficulties.

A cross-sectional design was also adopted because the data were collected at a single point in time. Cross-sectional quantitative designs allow researchers to examine variables within a specific population and identify statistical associations without introducing an experimental intervention (Creswell & Creswell, 2023).

Because of the non-experimental and correlational nature of the study, the statistical analysis was used to identify associations among the variables rather than to establish causal relationships.

Population and Participants

The accessible population consisted of 50 tenth-grade students from Unidad Educativa Teresa Flor, located in Ambato, Ecuador. The participants were enrolled in the tenth year of Educación General Básica during the academic period in which the study was conducted.



Because the entire accessible population of 50 students participated in the study, a census approach was used. Consequently, no probabilistic sampling procedure was required.

Data collection was conducted on May 22, 2026.

The inclusion criteria were: (a) being officially enrolled in the tenth grade at Unidad Educativa Teresa Flor; (b) attending the institution on the day of data collection; (c) having informed consent from a parent or legal representative; and (d) voluntarily agreeing to participate in the study.

The exclusion criteria were: (a) absence on the day of data collection; (b) lack of parental or legal representative consent; and (c) incomplete questionnaires that prevented the calculation of the study variables.

Ethical Considerations

Because the participants were minors, informed consent was obtained from their parents or legal representatives, and student assent was obtained before the administration of the research instrument.

Participation was voluntary, and anonymity and confidentiality were guaranteed throughout the research process. Students were informed that participation or non-participation would not affect their academic grades or their relationship with the institution.

No personally identifiable information was collected. Questionnaires were coded numerically to protect participants' identities, and the information obtained was used exclusively for academic and research purposes.

The study involved minimal risk because it consisted of the administration of a structured questionnaire without experimental manipulation or procedures that could adversely affect the participants. Questions focused on students' perceptions of classroom errors, their confidence when completing academic activities, and their responses to academic difficulties.

The study was conducted with the authorization of the Rector of Unidad Educativa Teresa Flor. Permission was granted to administer the questionnaire to tenth-grade students during the regular school schedule. Because no formal ethics committee review was available within the institution, the study followed institutional procedures for educational research involving minimal risk. Parental informed consent and student assent were obtained before participation.



Study Variables

The study examined three variables: students' perception of Failure-Based Learning, academic self-efficacy, and frustration tolerance.

The first variable was students' perception of Failure-Based Learning, understood as students' perception of educational experiences in which errors, unsuccessful attempts, feedback, reflection, and opportunities for correction are incorporated as meaningful components of the learning process.

Recent research emphasizes that learning from errors does not depend exclusively on making mistakes but also on the opportunities students receive to analyze incorrect responses, obtain feedback, revise strategies, and attempt improved solutions (Pan et al., 2020; Sinha & Kapur, 2021).

For statistical analysis, this variable was represented by 10 items distributed across two dimensions: error acceptance and constructive error climate (D1), and reflection, feedback, and learning from failure (D2).

The second variable was academic self-efficacy, understood as students' perception of their ability to successfully organize and perform the actions required to complete academic tasks, overcome learning difficulties, and continue working when challenges arise.

Within the present study, academic self-efficacy focused specifically on students' confidence when facing demanding tasks and their perceived capacity to improve their performance after making mistakes.

This variable was represented by 10 items distributed across two dimensions: confidence in academic capabilities (D3), and persistence and perceived capacity for improvement (D4).

The third variable was frustration tolerance, understood as students' capacity to manage negative emotional reactions and maintain engagement when they encounter difficulties, unsuccessful attempts, delayed results, or errors during academic activities.

Frustration tolerance is particularly relevant in Failure-Based Learning because students may need to experience temporary difficulty before identifying an appropriate strategy or reaching the expected solution. Recent research has associated frustration tolerance with persistence, emotional regulation, and the ability to continue working despite setbacks (Shi et al., 2021; Ossovski & Brinkmeier, 2024).



For statistical purposes, this variable was represented by 10 items distributed across two dimensions: emotional response to academic difficulty (D5), and persistence and adaptive response to frustration (D6).

Consequently, the study instrument contained six dimensions and allowed the three variables to be analyzed independently as well as relationally.

Data Collection Technique and Instrument

The survey technique was used because it enabled standardized information to be collected regarding students' perceptions of Failure-Based Learning, academic self-efficacy, and frustration tolerance.

A structured questionnaire consisting of 30 items was administered. The instrument was organized into six dimensions, with five items assigned to each dimension.

The questionnaire employed a five-point Likert-type response scale with the following options: 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, and 5 = Always.

The first 10 items, corresponding to dimensions D1 and D2, measured students' perceptions of Failure-Based Learning.

The next 10 items, corresponding to dimensions D3 and D4, measured students' academic self-efficacy.

The final 10 items, corresponding to dimensions D5 and D6, measured students' frustration tolerance.

Higher scores indicated greater perception of constructive Failure-Based Learning practices, higher academic self-efficacy, and greater frustration tolerance.

Content Validity and Reliability of the Instrument

Content validity was assessed through expert judgment. Four experts with experience in education, educational psychology, research methodology, and instrument validation were selected through purposive expert sampling. The selection considered their academic background, professional experience in education and research, and familiarity with educational assessment and instrument evaluation.

The experts evaluated each item according to the criteria of clarity, pertinence, and relevance in relation to the theoretical definition and dimensions of the three study variables. Each item was evaluated using a four-point ordinal scale: 1 = not adequate, 2 = slightly adequate, 3 = adequate, and 4 = highly adequate.



Aiken's V coefficient was used to quantify the degree of agreement among the experts. A coefficient of $V \geq .80$ was established as the criterion for acceptable content validity. Items with coefficients below this criterion were reviewed and modified according to the observations provided by the evaluators before the final administration of the questionnaire. At the item level, Aiken's V coefficients ranged from .792 to 1.000 across the 30 questionnaire items. Most items obtained coefficients equal to or above the established criterion of .80, supporting their retention for the final version of the instrument. Items that received observations from the experts were revised in terms of wording and conceptual alignment before administration. The overall Aiken's V coefficients were .882 for clarity, .861 for pertinence, and .889 for relevance, providing favorable evidence of content validity. All questionnaire items were positively worded; therefore, no reverse scoring was required before statistical analysis. Higher scores indicated greater perceptions of constructive Failure-Based Learning practices, higher academic self-efficacy, and greater frustration tolerance.

Internal consistency was examined using Cronbach's alpha coefficient as the reliability assessment procedure. Reliability was calculated separately for the Failure-Based Learning scale, academic self-efficacy scale, frustration tolerance scale, and the complete questionnaire. The reliability analysis was conducted using the responses obtained from the study participants.

The complete 30-item questionnaire is provided in Appendix A to facilitate methodological transparency and replication of the study.

Data Collection Procedure

Before administering the questionnaire, authorization was obtained from the educational institution and informed consent was requested from parents or legal representatives.

Students were informed about the purpose of the study, the voluntary nature of their participation, the confidentiality of their responses, and their right to withdraw at any time without academic consequences.

The questionnaire was administered collectively during the regular school schedule. Instructions were presented before students began answering the instrument, and participants were encouraged to respond individually according to their own experiences and perceptions.



Once the questionnaires were completed, responses were reviewed to identify missing information. Valid questionnaires were subsequently coded and entered into the statistical database for analysis.

Data Analysis Procedure

Data processing and statistical analysis were performed using IBM SPSS Statistics, version 27.

Initially, descriptive statistics were calculated to characterize students' responses and examine the behavior of the six dimensions and three study variables. Measures such as frequencies, percentages, means, and standard deviations were calculated according to the characteristics of the data.

For each participant, the Failure-Based Learning score was calculated from the 10 items corresponding to dimensions D1 and D2.

The academic self-efficacy score was calculated from the 10 items corresponding to dimensions D3 and D4.

The frustration tolerance score was calculated from the 10 items corresponding to dimensions D5 and D6.

Before conducting the correlational analysis, the assumptions required for parametric statistical procedures were examined. Normality was assessed using the Shapiro–Wilk test. The linearity of the relationships among the three study variables was examined through visual inspection of bivariate scatterplots for each pair of variables. Potentially atypical observations were assessed using standardized scores (z-scores), with absolute values approaching or exceeding |3.00| considered indicative of potentially extreme observations. Observations identified through this procedure were additionally reviewed for possible data-entry errors and for plausibility within the questionnaire response range.

When the assumptions for parametric analysis were satisfied, Pearson's correlation coefficient (r) was used to determine the direction and magnitude of the relationships between Failure-Based Learning and academic self-efficacy, Failure-Based Learning and frustration tolerance, and academic self-efficacy and frustration tolerance.

Statistical significance was established at $p < .05$.



Positive coefficients indicated that higher scores in one variable tended to be associated with higher scores in the other variable, whereas negative coefficients indicated an inverse relationship.

If the normality assumptions were not satisfied, Spearman’s rank-order correlation coefficient (ρ) was considered as the non-parametric alternative.

The analysis was interpreted according to the correlational nature of the research. Therefore, statistically significant associations were not considered evidence of causal effects between Failure-Based Learning, academic self-efficacy, and frustration tolerance.

3. RESULTS

Content Validity and Reliability of the Instrument

Content validity was assessed through expert judgment using Aiken’s V coefficient. At the item level, coefficients ranged from .792 to 1.000 across the 30 questionnaire items. Most items obtained coefficients equal to or above the established criterion of $V \geq .80$. The overall coefficients were .882 for clarity, .861 for pertinence, and .889 for relevance.

Internal consistency was assessed using Cronbach’s alpha. The complete instrument obtained $\alpha = .912$. The coefficients for students’ perception of Failure-Based Learning, academic self-efficacy, and frustration tolerance were .835, .822, and .801, respectively. At the dimensional level, D1 obtained $\alpha = .687$, while the remaining dimensions showed coefficients ranging from .703 to .781.

Table 1.

Content validity and internal consistency of the instrument

Evidence	Criterion /		No. of items	Coefficient	Interpretation
	Dimension /	Variable			
Content validity	Clarity	—		$V = .882$	Favorable
Content validity	Pertinence	—		$V = .861$	Favorable
Content validity	Relevance	—		$V = .889$	Favorable
Reliability	D1. Error				
	acceptance and	5		$\alpha = .687$	Caution
	constructive error				
	climate				



Evidence	Criterion / Dimension / Variable	No. of items	Coefficient	Interpretation
Reliability	D2. Reflection, feedback, and learning from failure	5	$\alpha = .762$	Adequate
Reliability	D3. Confidence in academic capabilities	5	$\alpha = .744$	Adequate
Reliability	D4. Persistence and perceived capacity for improvement	5	$\alpha = .781$	Adequate
Reliability	D5. Emotional response to academic difficulty	5	$\alpha = .703$	Adequate
Reliability	D6. Persistence and adaptive response to frustration	5	$\alpha = .736$	Adequate
Reliability	Failure-Based Learning perception (D1 + D2)	10	$\alpha = .835$	Adequate
Reliability	Academic self- efficacy (D3 + D4)	10	$\alpha = .822$	Adequate
Reliability	Frustration tolerance (D5 + D6)	10	$\alpha = .801$	Adequate
Reliability	Complete instrument	30	$\alpha = .912$	High

Note. Aiken's V values refer to content-validity evidence; Cronbach's α values refer to internal consistency.



The results supported favorable content validity and adequate internal consistency for the instrument. Dimension D1 obtained $\alpha = .687$, slightly below the conventional .70 reference value; therefore, results involving this dimension should be interpreted with caution.

Descriptive Statistics

Descriptive statistics were calculated for the six dimensions and the three main variables. Mean scores for the dimensions ranged from 3.38 to 3.55. D2, reflection, feedback, and learning from failure, showed the highest mean ($M = 3.55$, $SD = 0.51$), whereas D5, emotional response to academic difficulty, showed the lowest mean ($M = 3.38$, $SD = 0.52$). Among the main variables, Failure-Based Learning perception obtained $M = 3.51$ ($SD = 0.44$), academic self-efficacy $M = 3.50$ ($SD = 0.43$), and frustration tolerance $M = 3.41$ ($SD = 0.45$).

Table 2.

Descriptive statistics for the dimensions and main study variables

Dimension / Variable	Mean	SD	Minimum	Maximum
D1. Error acceptance and constructive error climate	3.46	0.49	2.20	4.60
D2. Reflection, feedback, and learning from failure	3.55	0.51	2.20	4.80
D3. Confidence in academic capabilities	3.48	0.47	2.40	4.60
D4. Persistence and perceived capacity for improvement	3.51	0.50	2.20	4.80
D5. Emotional response to academic difficulty	3.38	0.52	2.00	4.60



Dimension / Variable	Mean	SD	Minimum	Maximum
D6. Persistence and adaptive response to frustration	3.44	0.49	2.20	4.60
Failure-Based Learning perception	3.51	0.44	2.40	4.60
Academic self-efficacy	3.50	0.43	2.40	4.60
Frustration tolerance	3.41	0.45	2.20	4.60

Note. SD = standard deviation.

Overall, scores were above the midpoint of the five-point response scale, indicating generally favorable perceptions of learning from errors, academic self-efficacy, and frustration tolerance.

Normality, Linearity, and Outlier Assessment

Before conducting the correlational analyses, normality was assessed using the Shapiro–Wilk test. All p-values were greater than .05; therefore, normality was not rejected for any of the three variables.

Table 3.

Normality test for the main study variables

Variable	Shapiro–Wilk W	p	Decision
Failure-Based Learning perception	.981	.598	Normality not rejected
Academic self-efficacy	.976	.405	Normality not rejected
Frustration tolerance	.972	.279	Normality not rejected

Visual inspection of bivariate scatterplots showed approximately linear positive relationships among the three variables, with no evident curvilinear patterns. Standardized scores were also examined to identify potentially atypical observations. One participant presented a standardized score of approximately $z = -2.91$ for frustration tolerance. Because this value did not exceed the predefined criterion of $|z| \geq 3.00$ and no data-entry error or implausible



response pattern was identified, the observation was retained. Consequently, Pearson's correlation coefficient was used with the complete dataset of 50 participants.

Correlations Among the Main Study Variables

Pearson's correlation coefficient showed strong, positive, and statistically significant relationships among the three main variables. Failure-Based Learning perception was associated with academic self-efficacy ($r = .812, p < .001$) and frustration tolerance ($r = .776, p < .001$). Academic self-efficacy was also positively associated with frustration tolerance ($r = .731, p < .001$).

Table 4.

Correlations among the main study variables

Variables	1	2	3
1. Failure-Based Learning perception	1	.812***	.776***
2. Academic self-efficacy	.812***	1	.731***
3. Frustration tolerance	.776***	.731***	1

Note. *** $p < .001$.

The squared correlation coefficients indicated substantial statistical overlap between Failure-Based Learning perception and academic self-efficacy ($r^2 = .659$), between Failure-Based Learning perception and frustration tolerance ($r^2 = .602$), and between academic self-efficacy and frustration tolerance ($r^2 = .534$). These values represent shared statistical variance and should not be interpreted as evidence of causation.

Correlations Among the Six Dimensions

Pearson correlations were also calculated among the six dimensions. All coefficients were positive and statistically significant. The strongest relationship was observed between D2 and D4 ($r = .721, p < .001$).

Table 5.

Correlations among the six dimensions

Dimensions	D1	D2	D3	D4	D5	D6
D1	1	.612***	.641***	.603***	.528***	.574***
D2	.612***	1	.668***	.721***	.589***	.684***



Dimensions	D1	D2	D3	D4	D5	D6
D3	.641***	.668***	1	.626***	.515***	.603***
D4	.603***	.721***	.626***	1	.581***	.671***
D5	.528***	.589***	.515***	.581***	1	.607***
D6	.574***	.684***	.603***	.671***	.607***	1

Note. *** $p < .001$.

All dimensions showed positive and statistically significant correlations. The strongest association was observed between reflection, feedback, and learning from failure (D2) and persistence and perceived capacity for improvement (D4), $r = .721$, $p < .001$. D2 was also strongly related to D6 ($r = .684$), while D4 showed a strong positive association with D6 ($r = .671$). Overall, the dimensional results supported consistent positive relationships among error-related learning practices, academic self-efficacy, and frustration tolerance.

4. DISCUSSION

The results showed strong, positive, and statistically significant relationships among students’ perceptions of Failure-Based Learning, academic self-efficacy, and frustration tolerance. Failure-Based Learning perception was associated with academic self-efficacy ($r = .812$, $p < .001$) and frustration tolerance ($r = .776$, $p < .001$), while academic self-efficacy was related to frustration tolerance ($r = .731$, $p < .001$). These findings suggest that students who perceived more constructive opportunities to analyze errors, receive feedback, and improve also tended to report greater confidence and persistence. This is consistent with research showing that errors can become meaningful learning opportunities when accompanied by reflection and correction (Pan et al., 2020) and that problem solving before instruction can support learning when students identify knowledge gaps and subsequently consolidate understanding (Sinha & Kapur, 2021).

The descriptive results were relatively homogeneous across the six dimensions ($M = 3.38$ – 3.55). Reflection, feedback, and learning from failure (D2) obtained the highest mean ($M = 3.55$, $SD = 0.51$), whereas emotional response to academic difficulty (D5) obtained the lowest ($M = 3.38$, $SD = 0.52$). This finding is consistent with evidence linking frustration tolerance with emotional regulation and persistence when students face challenging situations (Tobar Viera & Mejía Rubio, 2023; Ossovski & Brinkmeier, 2024).



All six dimensions were positively and significantly correlated. The strongest association was between reflection, feedback, and learning from failure (D2) and persistence and perceived capacity for improvement (D4), $r = .721$, $p < .001$. D2 was also related to persistence and adaptive response to frustration (D6), $r = .684$, $p < .001$. These results suggest that constructive feedback and opportunities to analyze mistakes may be associated with both motivational and emotional responses to academic difficulty. Henriksen et al. (2021) similarly emphasized that productive failure can encourage educational risk-taking when unsuccessful attempts are treated as opportunities for learning.

Error acceptance and constructive error climate (D1) was positively related to confidence in academic capabilities (D3; $r = .641$), persistence and perceived capacity for improvement (D4; $r = .603$), emotional response to academic difficulty (D5; $r = .528$), and adaptive response to frustration (D6; $r = .574$). Previous research also indicates that teachers' responses to errors can contribute to a constructive classroom climate and that opportunities to learn from mistakes vary according to classroom and subject context (Soncini et al., 2021; Steuer et al., 2022).

Academic self-efficacy was also associated with frustration tolerance. D3 correlated with D5 ($r = .515$) and D6 ($r = .603$), while D4 correlated with D5 ($r = .581$) and D6 ($r = .671$). Likewise, the strong association between Failure-Based Learning perception and frustration tolerance ($r = .776$) suggests that students who perceived more opportunities to reflect on errors and receive feedback also tended to report greater persistence. This is consistent with Shi et al. (2021), who identified a positive relationship between frustration tolerance and academic performance.

However, these findings must be interpreted according to the non-experimental, cross-sectional, and correlational design. No Failure-Based Learning intervention was implemented; rather, the study examined students' perceptions of practices already present in their educational experiences. Therefore, the observed relationships represent statistical associations rather than causal effects. The shared variance was $r^2 = .659$ between Failure-Based Learning perception and academic self-efficacy, $r^2 = .602$ between Failure-Based Learning perception and frustration tolerance, and $r^2 = .534$ between academic self-efficacy and frustration tolerance.



Several limitations should also be considered. The study involved only 50 tenth-grade students from one institution, limiting generalizability. All variables were assessed through self-report using the same Likert-type questionnaire, which may introduce common-method variance. Moreover, the cross-sectional design does not show how the variables change over time. Aiken's V and Cronbach's α provide evidence of content validity and internal consistency but do not confirm the factorial structure of the six dimensions. Given the sample size, robust exploratory or confirmatory factor analysis was not conducted. In addition, D1 showed $\alpha = .687$, slightly below the conventional $.70$ reference value, so results involving this dimension should be interpreted with caution.

Future research should include larger and more diverse samples, longitudinal or quasi-experimental designs, classroom observations, academic performance measures, interviews, and behavioral indicators. Factorial analyses with larger samples are also recommended to examine the construct validity of the instrument and provide stronger evidence regarding the relationships among Failure-Based Learning perception, academic self-efficacy, and frustration tolerance.

5. CONCLUSION

The study determined that students' perception of Failure-Based Learning was strongly, positively, and significantly associated with both academic self-efficacy and frustration tolerance. Failure-Based Learning showed a strong positive relationship with academic self-efficacy ($r = .812$, $p < .001$) and with frustration tolerance ($r = .776$, $p < .001$). Academic self-efficacy was also positively associated with frustration tolerance ($r = .731$, $p < .001$).

These findings provide a direct response to the research objective and indicate that students who reported greater exposure to classroom practices involving error acceptance, reflection, constructive feedback, and opportunities for improvement also tended to report greater confidence in their academic abilities and greater persistence when facing frustrating academic situations.

The descriptive analysis showed generally favorable responses across the six dimensions. Reflection, feedback, and learning from failure obtained the highest mean ($M = 3.55$, $SD = 0.51$), while emotional response to academic difficulty obtained the lowest mean ($M = 3.38$, $SD = 0.52$). Although the differences among the dimensions were relatively small, the results



suggest that students perceived constructive learning-from-error practices more favorably than their own emotional responses when encountering academic difficulties.

The dimensional analysis also showed positive and statistically significant associations among all components of the study. The strongest relationship was observed between reflection, feedback, and learning from failure and persistence and perceived capacity for improvement ($r = .721$, $p < .001$). This finding suggests that students who reported more opportunities to examine mistakes and receive constructive feedback also tended to perceive themselves as more capable of improving their academic performance.

The results also support the importance of frustration tolerance within error-based learning environments. Students who reported more adaptive responses to academic difficulty tended to show higher academic self-efficacy and stronger perceptions of constructive error-based learning practices. Therefore, learning from error appears to be related not only to cognitive processes but also to motivational and socio-emotional dimensions that may influence students' willingness to persist when tasks become difficult.

However, the results should not be interpreted as evidence that Failure-Based Learning directly caused higher academic self-efficacy or frustration tolerance. The study employed a non-experimental, correlational, and cross-sectional design, and all variables were measured through students' self-reported perceptions. Consequently, the findings establish statistical associations rather than causal relationships.

Finally, the study was conducted with the entire accessible population of 50 tenth-grade students from Unidad Educativa Teresa Flor in Ambato, Ecuador. The findings therefore provide useful evidence for this specific educational context but cannot automatically be generalized to other populations. Future research should include students from different institutions and educational levels, incorporate objective and behavioral measures, and employ longitudinal, quasi-experimental, or experimental designs. These approaches could provide more robust evidence regarding the role of Failure-Based Learning in the development of academic self-efficacy and frustration tolerance among students.

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