Learning Styles and Critical Thinking Skills as Correlates of Academic Achievement among University Students

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ABSTRACT: The purpose of this study was to examine the relationships among learning styles, critical thinking skills, and academic achievement among undergraduate students in Pakistan. A quantitative, cross-sectional correlational research design was employed. Data were collected from 300 undergraduate students (150 males and 150 females) enrolled at Government College University Faisalabad (GCUF) and the University of Education, Lahore (Faisalabad Campus). Two self-developed Likert-scale instruments were used: the 21-item Students' Learning Styles Scale (SLSS; Cronbach's α = .963) and the 21-item Critical Thinking Skills Scale (CTSS; Cronbach's α = .942). Academic achievement was measured using students' cumulative grade point average (CGPA). Descriptive statistics, independent samples t-tests, and Pearson correlation analysis were performed using SPSS. The findings revealed that reading (M = 3.80, SD = 0.77) and Sequential (M = 3.73, SD = 0.79) learning styles were the most preferred among participants, whereas visual, auditory, and kinesthetic learning styles were moderately preferred. Most students (76%) demonstrated good critical thinking skills, and 40.3% achieved a moderate level of academic performance. Female students scored significantly higher than male students on learning styles and critical thinking skills. Students from GCUF also reported significantly higher scores than their counterparts from the University of Education in learning styles and critical thinking skills. Reading Learning Style (RLS) showed the strongest significant positive correlation with Critical Thinking Skills, while Sequential Learning Style (SLS) demonstrated a moderate positive correlation.

KEYWORDS: Critical Thinking Skills, Academic Achievement, Undergraduate Students, Higher Education, Pakistan, Learning Styles

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Introduction

Higher education institutions are responsible for the continuation of two functions: passing on disciplinary knowledge and developing students' cognitive skills, including analytical reasoning, reflective judgment, and

independent problem solving, to prepare them for the ever-changing professional landscape (Ren et al., 2020; Van Gelder, 2005). In this sense, two constructs have long been the focus of research, i.e., learning *styles* and *critical thinking skills*. Learning styles refer to the relatively consistent ways in which people perceive, process, and remember information (Fleming & Mills, 1992; Kolb, 2019), while critical thinking (CT) is the deliberate use of interpretation, analysis, evaluation, and inference to make well-reasoned judgments (Ennis, 2018; Facione, 2015).

Although there is a plethora of literature focusing on each construct individually, the combined effect of these constructs on academic outcomes, especially in the context of higher education in the South Asian region, has not been well explored. Students entering Pakistani universities are diverse in their educational backgrounds, socio-cultural environments, and learning strategies; however, most institutional pedagogies remain relatively homogeneous, relying on lecture-based instruction and rote assessment. This mismatch between individual learning styles and the dominant pedagogy can decrease academic engagement, hinder the development of higher-order thinking, and consequently reduce academic performance (Felder & Spurlin, 2005).

The current empirical literature shows mixed views. Some studies have found positive links between learning style alignment and students' academic achievement (Almutairi et al., 2025), while others report weak or insignificant links when learning style categories serve as the sole predictor (Almutairi et al., 2025; Mozaffari et al., 2020). In terms of critical thinking, a meta-analysis found a correlation ($r = 0.43$) with academic achievement (Orhan, 2022). A landmark study published in Intelligence demonstrated that critical thinking skills predict academic achievement beyond general cognitive ability, working memory, and processing speed (Ren et al., 2020). However, few studies have looked at these two constructs together, and even fewer have explored them within the context of Pakistani universities.

The present study aims to examine the following: (a) the distribution of learning style preferences and critical thinking skill levels among undergraduate university students; (b) the differences in learning style preferences and CT skill levels between genders and across different institutions; and (c) the bivariate relationship between learning styles and CT skills and their impact on academic achievement. The following research questions guided the study at hand:

1. What is the most common learning style among university students?
2. What is the level of critical thinking ability among university students?
3. What is the level of academic performance among university students?
4. Is there a statistically significant difference between male and female students in learning styles?
5. Is there a statistically significant difference between male and female students in terms of critical thinking skills?
6. Do universities differ in terms of students' learning styles?
7. Is there a statistically significant difference in the critical thinking skills of students across universities?
8. What is the relationship between learning styles and critical thinking skills, and how does this relationship impact academic achievement?

The study provides new evidence for the growing body of research on learner diversity in higher education. It can inform curriculum designers, university educators, and policy makers seeking to improve academic outcomes in developing country contexts.

This study is based on three theories. These theories complement each other. Kolb's Experiential Learning Theory (ELT) proposes that learning occurs through a four-stage cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 2019). Individual learning styles emerge from how a learner characteristically engages with these four stages.

Second, Fleming and Mills (1992) proposed the VARK model. It classifies learning types according to information processing preferences for visual, aural, read/write, and kinesthetic. It provides a practical insight into how learners respond to different approaches to learning. The proposed four-channel taxonomy by Fleming and Mills (1992) included Visual (V), Aural (A), Read/Write ®, and Kinesthetic (K), based on the sensory modality through which students prefer to receive instructional information. Subsequent empirical work has consistently documented that university students tend to report multimodal rather than unimodal preferences (Lujan & DiCarlo, 2006; Wehrwein et al., 2007).

Kolb (2019) theorizes that learning is a dialectical process oscillating between concrete and abstract perception and between active and reflective transformation. The four significant learning styles (diverging, assimilating, converging, and accommodating) have been linked to discipline-specific academic engagement: science and engineering students tend toward convergent styles while social sciences students favor divergent orientations (Manolis et al. 2013). Morris (2020) demonstrated that ELT-aligned instructional environments supported multiple learning styles simultaneously while promoting the reflective practices that underpin CT development. Felder and Silverman (1988) describe learning styles as falling on four bipolar dimensions: Active–Reflective, Sensing–Intuitive, Visual–Verbal, and Sequential. Graf et al. (2007) identified the need for collaborative problem solving for active learners and sufficient time for individual analysis for reflective learners. Wehrwein et al. (2007) found gender differences in learning styles: female students were more reflective, verbal, and collaborative, whereas male students were more visual and problem-solving oriented. Third, critical thinking involves the cognitive skills of analysis, interpretation, evaluation, inference, explanation, and self-regulation according to Facione's Delphi model of critical thinking (Facione, 2015).

Large-scale empirical syntheses have reached a consensus that CT is one of the strongest cognitive predictors of academic performance in higher education. In a meta-analysis of 47 studies, Orhan (2022) reported a moderate positive correlation of $r = 0.43$ between CT and academic achievement. Importantly, Ren et al. (2020) showed, in a sample of adults and school-age children, that CT skills explained unique variance in academic performance beyond general fluid intelligence, working memory, and processing speed. This finding provides evidence that CT should be viewed not merely as a proxy for general cognitive ability but as a distinct and educationally relevant predictor of academic achievement. Ku (2009) separated the cognitive dimension of CT (reasoning, analysis, and evaluation) from the dispositional dimension (open-mindedness, intellectual curiosity, and tolerance for ambiguity) and proposed that both dimensions should be cultivated at the same time to achieve the best academic outcomes of CT.

The empirical research on learning styles and CT is varied, but mostly converging. Hayat et al. (2024) conducted a meta-analysis involving science education studies and concluded that learning styles significantly affected the development of CT, especially in science learning contexts, and showed a large effect size. Among nursing students, Shirazi and Heidari (2019) identified significant relationships between some learning style profiles and CT scores for different measurement instruments and clinical settings. Dilekli (2017) found that abstract conceptualization (assimilating) and reflective observation (converging) learning types showed significantly higher scores on CT assessments than abstract observation (diverging) and practical action (accommodating) types.

The research on the relationship between learning styles and CT with academic performance in higher education in Pakistan is still in the early stages. Fatima et al. (2024) reported that university students have different learning preferences and that students perceived alignment between their learning preferences and instructional activities positively predicts academic engagement. Generally, the study by Lodhi et al. (2023) found that the overall CT level of university students in Pakistan was moderate and did not significantly improve over the course of the academic years, suggesting that the educational approach in Pakistan may not be effectively fostering CT throughout the

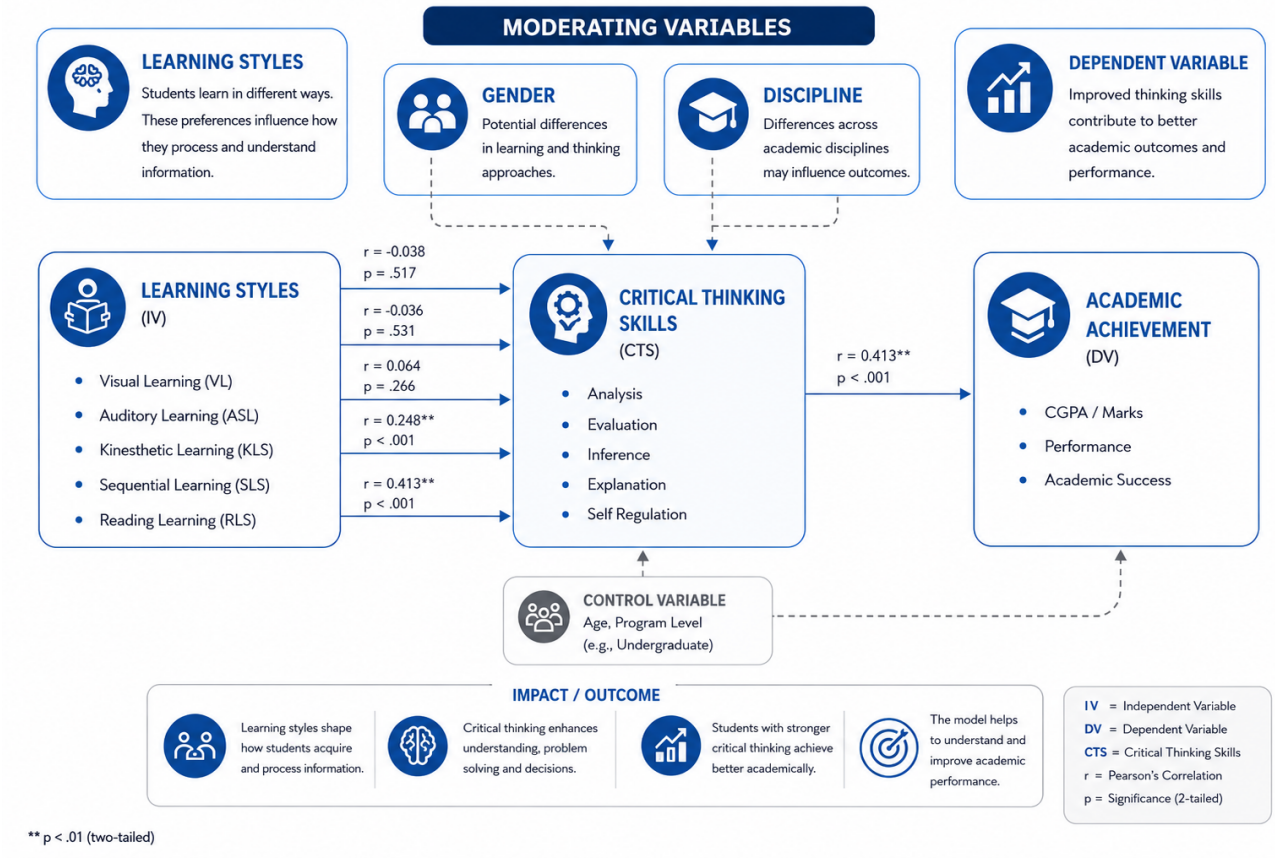
undergraduate program. Zulfiqar and Hayat (2023) studied students from a public sector university and reported that there was a positive association between CT skills and academic achievement (CGPA), indicating that pedagogical investments in CT could lead to better academic outcomes.

The present study builds on this growing body of work by exploring the relationships between learning styles, CT skills, and CGPA in a multi-institutional, gender balanced sample. It explores bivariate relationships and group differences to gain a more holistic understanding of these constructs in the setting of higher education in Pakistan.

The conceptual framework suggests that learning styles influence students' engagement with course material, the effectiveness of information encoding, and the activation and integration of prior knowledge, as illustrated in Figure 1. The depth of cognitive processing is then mediated by critical thinking skills, which serve as a bridge between surface and meaningful learning and can predict academic achievement. This theoretical approach suggests that learning styles and CT skills are not merely additive but rather complementary and mutually reinforcing predictors of academic success.

Figure 1

Conceptual Framework Showing the Proposed Relationships between Learning Styles, Critical Thinking Skills, and Academic Achievement



Methodology

Research Design

A quantitative, cross-sectional, descriptive correlational research design was used. This design is appropriate when the objective is to describe the distribution of theoretical constructs within a sample and quantify the relationships among these constructs without manipulating the research setting (Creswell & Creswell, 2017). The correlational component enabled the analysis of the strength and direction of the relationship between learning styles and CT skills, whereas the group comparison examined gender and institution-based differences.

Participants and Sampling

The accessible population consisted of students enrolled in four-year Bachelor of Science (BS Hons) programs at two public sector universities in Faisalabad, Punjab, Pakistan: Government College University Faisalabad (GCUF) and the University of Education Lahore, Faisalabad Campus (UE-Faisalabad Campus).

Sample

To ensure balance across institutions, gender, and disciplinary streams, the sample of 300 students was selected (Table 1). To ensure the representation of disciplines, students from three departments of Sciences (Zoology, Physics, and Chemistry) and three departments of Social Sciences/Humanities (English, Urdu, and Education) were selected. The number of male students (n = 150) was equal to the number of female students (n = 150), and both were equally distributed at each institution.

Table 1

Sample Distribution by Institution and Gender

Institution	Male	Female	Total
Government College University Faisalabad (GCUF)	75	75	150
University of Education Lahore, Faisalabad Campus (UE-FSD)	75	75	150
Total	150	150	300

Demographic Profile

The GPA distribution indicated that the majority of participants (56.0%) fell within the 2.6–3.0 range, followed by 23.6% in the 3.6–4.0 range and 20.3% in the 2.0–2.5 range. This distribution reflects a realistic range of academic performance among BS students in Pakistan and supports the suitability of the sample for the correlational analysis.

Instruments

Two research instruments, having a five-point Likert scale (Strongly Agree = 5, Agree = 4, Undecided = 3, Disagree = 2, Strongly Disagree = 1), were used to collect the data. The Students' Learning Styles Scale (SLSS) measures five learning style dimensions in 21 items, such as Visual, Auditory, Kinesthetic, Sequential, and Reading. The items were developed based on the VARK and ELT frameworks (Felder & Spurlin, 2005; Fleming & Mills, 1992; Kolb, 2019). Another 21-item instrument measured six dimensions of critical thinking: Problem Identification, Analysis, Evaluation, Reflection/Metacognition, Interpretation, and Reasoning/Communication. The content of these items was based on Facione's Delphi framework (Facione, 2020) and the critical thinking framework proposed by Paul and Elder (2019). Academic achievement was measured by self-reported CGPA, which was categorized as Low (2.00–2.66), Medium (2.67–3.33), and High (3.34–4.00).

Validity and Reliability

Content validity was ensured through experts' opinions. During the revision process, items were revised to reduce ambiguities, clarify the items, and ensure consistency with the theoretical definitions of the constructs. The SLSS and CTSS showed excellent reliability (Table 2) with Cronbach's α values of 0.963 and 0.942, respectively.

Table 2

Reliability Statistics for Study Instruments

Instrument	N	Cronbach's α
Students' Learning Styles Scale (SLSS)	21	0.963
Critical Thinking Skills Scale (CTSS)	21	0.942

Data Collection Procedure

Institutional approval was obtained from both universities before collecting data. Voluntary participation, anonymity, and confidentiality were clearly explained, and all participants gave verbal informed consent. At the beginning of the study, participants were told they could withdraw at any point during the study. The questionnaires were administered in class and picked up right after the class to ensure high response rates. A 100% response rate on the final questionnaire was obtained (N = 300).

Data Analysis

The data were coded and analyzed using IBM SPSS Statistics (Version 25). The following analyses were conducted:

- All SLSS and CTSS items and composite subscale scores (RQ1, RQ2, and RQ3) were calculated for frequencies, percentages, and means (M), as well as standard deviations (SD).
- Gender differences in learning styles and CT skills (RQ4 and RQ5) were investigated by using independent samples *t-tests*. The institutional differences in learning styles (RQ6) and CT skills (RQ7) were also analyzed using independent samples *t-tests*. The significance level chosen for this study was $\alpha = 0.01$ (two-tailed).
- To measure the bivariate linear association between the overall learning style scores and the overall CT skill scores (RQ8), Pearson's correlation coefficient (r) was computed. Before inferential testing, assumptions of normality and homogeneity of variance were examined and were reasonably satisfied for all comparisons. The traditional guidelines for the interpretation of effect sizes (r = 0.10 for small, r = 0.30 for medium, and r = 0.50 for large) were taken from Cohen (2013).

Results

Descriptive Statistics: Learning Style Preferences (RQ1)

The mean and standard deviation scores of the five learning style dimensions measured by SLSS are shown in Table 3. Mean scores on the five-point Likert scale were interpreted as follows: Low (1.00–2.33), Moderate (2.34–3.66), and High (3.67–5.00).

Table 3

Descriptive Statistics for Learning Style Dimensions (N = 300)

Learning Style	Items	*M*	*SD*	Level
Visual	1–7	3.46	1.15	Moderate
Auditory	8–10	3.54	0.99	Moderate
Kinesthetic	11–13	3.66	0.85	Moderate
Sequential	14–17	3.73	0.78	High
Reading	18–21	3.80	0.77	High

Reading learning was the most highly preferred style (M = 3.80, SD = 0.77), and Sequential learning (M = 3.73, SD = 0.78) was also in the high category. Kinesthetic (M = 3.66, SD = 0.85), Auditory (M = 3.54, SD = 0.99), and Visual (M = 3.46, SD = 1.15) styles registered in the moderate range, with Visual learning showing the highest variability across respondents. Overall, it can be concluded that this sample of Pakistani university students seems to prefer internalizing and collaborative modes of learning over sensory-receptive modes of learning.

The individual statements at the item level ranged from M = 3.43 (color coding in notes) to M = 3.81 (identifying problems clearly before solving them), as shown in Table 4. Overall, the items that tapped reflective practice and social evaluation of ideas had higher agreement scores (63–68 percent) than those that tapped passive visual reception (50–51 percent).

Table 4

Item-Level Summary Statistics: Selected SLSS and CTSS Items (N = 300)

Item Statement (Abbreviated)	Scale	*M*	Agreed/SA (%)
Use color coding in notes	SLSS-Visual	3.43	50.3
Learn better with visual aids	SLSS-Visual	3.44	50.6
Prefer listening to lectures	SLSS-Auditory	3.54	51.4
Learn better through practice	SLSS-Kinesthetic	3.60	52.0
Group work motivates learning	SLSS-Sequential	3.68	56.7
Sharing ideas improves learning	SLSS-Sequential	3.69	58.7
Reflection connects new/prior knowledge	SLSS-Reading	3.73	63.6
Reflect on the study process	SLSS-Reading	3.79	67.7
Identify problems before solving	CTSS-Problem ID	3.81	69.7
Apply prior knowledge to new problems	CTSS-Analysis	3.87	72.3
Analyze information before concluding	CTSS-Analysis	3.95	75.3
Judge argument strengths/weaknesses	CTSS-Evaluation	4.17	78.3
Evaluate alternative viewpoints	CTSS-Evaluation	4.21	77.0
Examine assumptions during reflection	CTSS-Reflection	4.26	77.0
Reflect on thinking to improve understanding	CTSS-Reflection	4.28	77.0
Interpret information accurately	CTSS-Interpretation	4.29	75.3
Interpret different viewpoints	CTSS-Interpretation	4.31	76.7
Provide reasoned explanations	CTSS-Reasoning	4.30	76.3
Communicate ideas clearly/logically	CTSS-Reasoning	4.30	78.0
Make decisions based on careful reasoning	CTSS-Reasoning	4.31	78.6

Note: Agreed/SA = combined proportion of Agree and Strongly Agree responses.

Critical Thinking Skill Levels (RQ2)

The composite scores from the CTSS were classified into three skill bands as shown in Table 5. The large majority of students (76.0%) fall in the high CT category (3.67–5.00), 23.3% in the medium category, and only 0.67% in the low category. The distribution is skewed to the right, suggesting that CT proficiency is generally high in this sample. Interestingly, endorsement ratings for items related to metacognitive reflection and evaluative reasoning were the highest, while endorsement ratings for items related to analytical decomposition were somewhat more variable (e.g., "break complex ideas into simpler parts": $M = 3.48$, $SD = 1.34$).

Table 5

Critical Thinking Skill Levels Among University Students (N = 300)

Level	Score Range	Frequency	Percentage (%)
Low	1.00–2.33	2	0.67
Medium	2.34–3.66	70	23.33
High	3.67–5.00	228	76.00

Academic Performance Distribution (RQ3)

The academic achievement (based on self-reported CGPA) was spread across the three levels as described in Table 6. The modal category was medium performance (40.3%), followed by high (34.7%) and low (25.0%). This distribution shows that the sample falls within the moderately performing range, consistent with the national average for BS students in Pakistani public universities. Notably, 25% of the students are at risk of underperforming academically.

Table 6

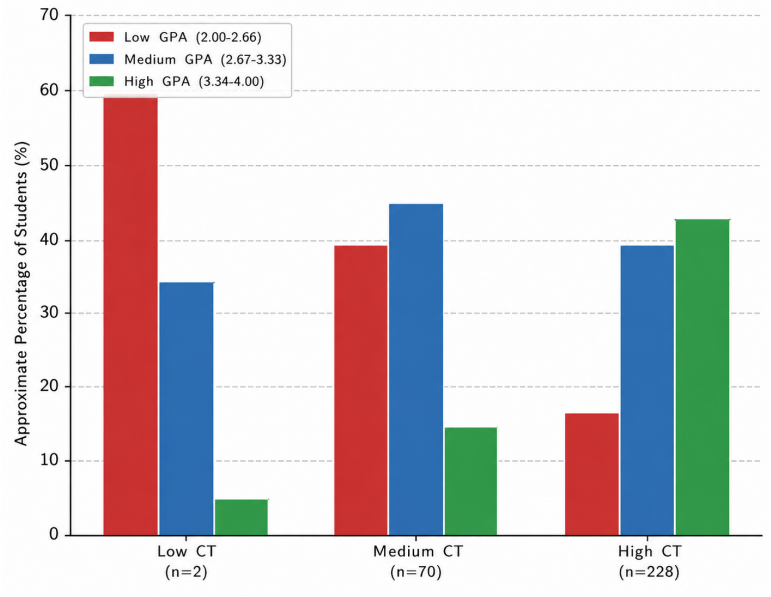
Academic Performance Levels of University Students (N = 300)

Level	CGPA Range	Frequency	Percentage (%)
Low	2.00–2.66	75	25.00
Medium	2.67–3.33	121	40.33
High	3.34–4.00	104	34.67

The joint distribution of CT skill levels and academic performance categories is plotted in Fig. 2, which shows that high CT students are concentrated in medium-to-high academic performance categories.

Figure 2

Joint Distribution of Critical Thinking Skill Levels and Academic Performance Categories



Gender Differences in Learning Styles (RQ4)

An independent samples *t*-test revealed a statistically significant difference in composite SLSS scores between male and female students (Table 7). Female students ($M = 3.85$, $SD = 0.68$) scored significantly higher than male students ($M = 3.43$, $SD = 0.69$), $t(298) = -5.305$, $p < 0.001$, two-tailed. The effect size (Cohen's $d = 0.61$) falls in the medium-to-large range, indicating practically meaningful differences in learning style engagement.

Table 7

Gender-Wise Differences in Learning Styles

Group	M	SD	T	df	P
Male	3.43	0.69	−5.305	298	0.001**
Female	3.85	0.68			

Note: $^{**}p < 0.01$. Cohen's $d = 0.61$, indicating a medium to large effect size.

Gender Differences in Critical Thinking Skills (RQ5)

A significant gender difference was also observed for CTSS composite scores (Table 8). Female students ($M = 4.25$, $SD = 0.58$) demonstrated significantly higher CT skills than male students ($M = 4.03$, $SD = 0.59$), $t(298) = -3.23$, $p < 0.001$, Cohen's $d = 0.37$ (small-to-medium effect).

Table 8

Gender-Wise Differences in Critical Thinking Skills

Group	M	SD	T	df	P
Male	4.03	0.59	−3.23	298	0.001**
Female	4.25	0.58			

Note: $^{**}p < 0.01$. Cohen's $d = 0.37$, indicating a small to medium effect size.

Institution-Based Differences in Learning Styles (RQ6)

GCUF students ($M = 3.90$, $SD = 0.57$) reported significantly higher composite SLSS scores than UE students ($M = 3.38$, $SD = 0.75$), t (298) =−6.68, $p < 0.001$, Cohen's $d = 0.77$ (large effect).

Table 9

Institution-Wise Differences in Learning Styles

Institution	M	SD	T	df	P
UE-FSD	3.38	0.75	−6.68	298	0.001**
GCUF	3.90	0.57			

Note: $^{**}p < 0.01$. Cohen's $d = 0.77$, indicating a large effect size.

Institution-Based Differences in Critical Thinking Skills (RQ7)

Similarly, GCUF students ($M = 4.24$, $SD = 0.602$) demonstrated significantly higher CT skills than UE students ($M = 4.03$, $SD = 0.576$), t (298) =−3.07, $p = 0.002$, Cohen's $d = 0.36$ (small-to-medium effect).

Table 10

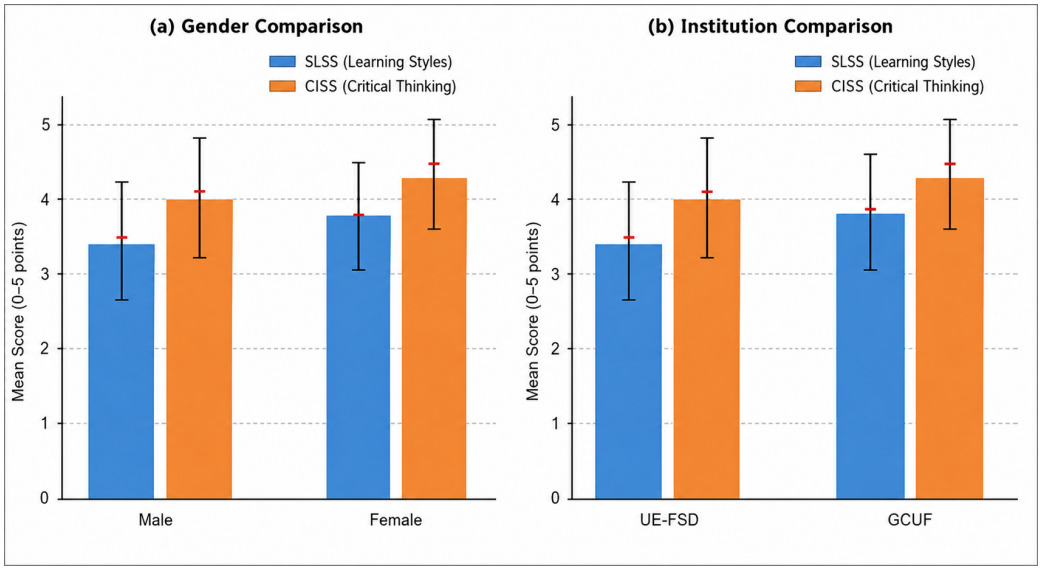
Institution-Wise Differences in Critical Thinking Skills

Institution	M	SD	T	df	P
UE-FSD	4.03	0.57	−3.07	298	0.002**
GCUF	4.24	0.60			

Note: $^{**}p < 0.01$. Cohen's $d = 0.36$, indicating a small to medium effect size.

Figure 3

Side-by-side Comparisons of Mean SLSS and CTSS Scores across Gender and Institution Groups



Relationship Between Learning Styles and Critical Thinking Skills (RQ8)

Pearson correlation analysis revealed a statistically significant positive relationship between the five learning styles and students' critical thinking skills.

Table 11

Relationship Between Students' Learning Styles and Critical Thinking Skills

Variables	1	2	3	4	5	6
1. Visual Learning (VL)	—					
2. Auditory Learning (ASL)	.758**	—				
3. Kinesthetic Learning (KLS)	.435**	.743**	—			
4. Sequential Learning (SLS)	.296**	.516**	.780**	—		
5. Reading Learning (RLS)	.172**	.332**	.492**	.777**	—	
6. Critical Thinking Skills (CTS)	-.038	-.036	.064	.248**	.413**	—

Note: N = 300. Values are Pearson's correlation coefficients (*r*). p < .01 (two-tailed).

Reading Learning Style (RLS) showed the strongest significant positive correlation with Critical Thinking Skills ($r = .413, p < .01$). Sequential Learning Style (SLS) demonstrated a statistically significant moderate positive correlation with Critical Thinking Skills ($r = .248, p < .01$). Visual (VL) ($r = -.038$), Auditory (AL) ($r = -.036$), and Kinesthetic (KLS) learning styles ($r = .064$) showed no statistically significant relationship with Critical Thinking Skills.

Discussion

These results align with previous findings from non-Western contexts, where cultures emphasize collaborative learning, discussion with peers, and collective knowledge construction (Zhang & Sternberg, 2011; Oxford, 2017). The findings contrast somewhat with findings from Western, individualistic academic settings, where kinesthetic and visual learning styles are typically dominant (Lujan and DiCarlo, 2006; Wehrwein et al., 2007). The stronger preference for reflective learning indicates that students in this sample are more comfortable with the metacognitive and integrative aspects of higher-order thinking, which is consistent with the high levels of CT skills observed in the CTSS data. The moderate preference for visual learning is significant ($M = 3.46$) in the higher education context in Pakistan, where lectures are the most common pedagogy. The pattern could be adaptive in a pedagogical context where visual and multimodal teaching media are scarce, or it could be a student's inherent multimodal learning style. Learning styles are preference-based rather than ability-based, and students can adapt their learning orientations according to the instructional opportunities available (Felder and Spurlin, 2005). The relatively moderate visual learning scores observed in this sample may provide evidence of this adaptation.

Many of the students had high CT scores (76% in the high category); however, these findings should be interpreted with caution. There is no standardized performance-based measure of CT used; therefore, the actual level of CT may be underestimated by self-report measures. Future research should include objective, performance-based CT assessments for more accurate CT estimates.

There was a significant difference between the female students and male students in both learning styles, $d = 0.61$, and CT skills, $d = 0.37$. This finding is consistent with the literature on gender differences in learning styles, which has consistently reported that female students tend to exhibit stronger reflective, verbal, and collaborative learning orientations than male students (Li et al., 2016; Wehrwein et al., 2007). The observed gender differences

may partly reflect the stronger preference for Sequential and reflective learning styles identified in this sample, which is consistent with previous studies of learning styles and gender in educational settings. Another possible explanation is the institutional socialization hypothesis, whereby female students in Pakistani universities are subjected to higher expectations of becoming good learners. Lodhi et al. (2023) similarly reported that female students in Pakistani universities generally demonstrated higher levels of academic metacognition, which is a prerequisite for the reflective thinking measured by the CTSS. One possible, though speculative, explanation is that sociocultural expectations placed on female students in Pakistani higher education may encourage more structured study habits and reflective practice; this interpretation would benefit from direct empirical testing in future research.

The differences observed are more likely to stem from cultural norms, pedagogical approaches, and prior learning experiences than from any cognitive differences between males and females. Wehrwein et al. (2007) mention that learning style profiles are context-dependent and that the learning style profile may vary with changes in instructional environments and/or course content.

Students from GCUF showed a large effect size (d = 0.77) for learning styles and a small to medium effect size (d = 0.36) for CT skills when compared to students from UE. Such institutional differences are more likely due to the differences in institutional quality, resource availability, faculty pedagogical practices, or student selection processes than to differences in the cognitive abilities of students. In addition to individual learner factors, structural factors such as institutional learning climate, faculty quality, access to library and digital resources, and assessment practices play a significant role in cognitive development. The small effect size observed in the present study suggests that although students with more developed and flexible learning style repertoires tend to demonstrate higher CT skills, most of the variance in CT is explained by factors beyond learning style preferences. These factors include instructional quality, academic motivation, metacognitive awareness, prior academic experiences, and dispositions toward critical inquiry (Ku, 2009; Ren et al.,2020).

Hayat et al. (2024) reported that learning styles influence the development of CT, particularly in science education settings, whereas Shirazi and Heidari (2019) found inconsistent relationships between learning style profiles and CT outcomes among nursing students, with significant associations observed only for certain learning style profiles. From a theoretical perspective, this finding is important for two reasons. First, it challenges strong claims that aligning instruction with learning styles is, by itself, a sufficient strategy for developing CT. If learning styles explained a substantial proportion of the variance in CT, instructional alignment would be expected to produce large improvements in CT development.

Conclusion

The present study aimed to explore the learning style preferences and critical thinking (CT) skills of undergraduate students in Pakistan and their association with academic performance, gender, and the institutional context. The results obtained from 300 undergraduate students across two public universities offer several important insights.

The results indicate that reading and social learning styles were the most preferred among participants, while visual, auditory, and kinesthetic styles were moderately preferred. Overall, 76% of the students expressed high levels of CT skills; metacognitive reflection and evaluative reasoning were the areas where students performed best. In terms of academic performance, 40.3% of the students were in the medium, 34.7% had high, and 25.0% had low academic performance, which means that there is a need for targeted academic support. There were significant differences between the genders and institutions. The female students were found to have significantly higher learning style preferences (d = 0.61) and higher CT skills (d = 0.37) than male students. Likewise, the students of GCUF also performed better than the students of UE in both learning styles (d = 0.77) and CT skills (d = 0.36), indicating

variations in cognitive development of students in different institutional learning environments. Reading Learning Style (RLS) showed the strongest significant positive correlation with Critical Thinking Skills ($r = .413, p < .01$). Sequential Learning Style (SLS) demonstrated a statistically significant moderate positive correlation with Critical Thinking Skills ($r = .248, p < .01$). Visual (VL) ($r = -.038$), Auditory (AL) ($r = -.036$), and Kinesthetic (KLS) learning styles ($r = .064$) showed no statistically significant relationship with Critical Thinking Skills. The conclusions from the findings indicate that more effective instructional design strategies for higher education can be developed that will consider multiple modes of learning and, at the same time, build CT skills. Reflective learning, collaborative work, problem-based instruction, authentic assessment, and structured analytical reasoning are likely to improve students' academic growth when coupled with teaching strategies. Moreover, CT may help mitigate institutional disparities and enhance educational outcomes by means of faculty development programs, equitable learning resources, and curricula that explicitly address CT as a graduate attribute.

This study has several limitations. First, both learning styles and critical thinking were assessed through self-report Likert scales rather than performance-based tasks, which could inflate or bias scores. Second, academic achievement was based on self-reported CGPA instead of verified transcripts. Third, the cross-sectional design does not allow for causal inference between learning styles, critical thinking, and academic achievement. Finally, the sample was taken from only two public universities in Punjab, restricting generalizability to other regions or private-sector institutions.

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