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## Learning Styles and academic performance in university students: An approach based on neuro-linguistic programming

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### Abstract

The diversity of learning styles among university students presents a significant challenge for designing inclusive pedagogical strategies. This study explores the relationship between sensory learning styles, visual, auditory, and kinesthetic, based on the Neuro-Linguistic Programming (NLP) model, and academic performance, considering gender as a relevant factor. A quantitative, cross-sectional, and correlational design was used with a probabilistic sample of 250 undergraduate students in Mexico. Data were obtained through a validated learning styles questionnaire and students' academic grade point averages. Statistical analyses, including Pearson correlation, ANOVA, and cluster analysis, revealed a positive correlation between the visual learning style and academic performance ( $r = 0.192$ ,  $p < 0.01$ ), and a weaker but significant association with the kinesthetic style. Female students showed a stronger preference for kinesthetic learning ( $p < 0.05$ ). Three learning profiles emerged, with the visual-kinesthetic type being most common. Based on these results, it is recommended to implement multimodal teaching strategies that integrate visual and kinesthetic elements, such as diagrams, simulations, and hands-on activities, to enhance academic outcomes. Teacher training should address sensory preferences, and institutional policies should promote adaptive digital platforms that support multiple formats.

**Keywords:** Academic performance, Higher education, Learning styles, Multivariate analysis, NLP.

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**Transparency:** The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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### 1. Introduction

The 21<sup>st</sup> century has heralded an unprecedented convergence of cognitive neuroscience, educational psychology, and digital technologies, resulting in a paradigm shift that is profoundly transforming our conceptual and practical

understanding of learning processes within higher education. This shift signals a deliberate departure from reductionist, behaviorist paradigms historically dominant in education toward a more holistic, neurocognitively-informed approach that recognizes the intricate interplay among brain functioning, individual learner differences, environmental stimuli, and socio-cultural variables [1, 2]. At the forefront of this transformation is a growing body of empirical research indicating that instructional models aligned with neuroscientific principles can significantly enhance learning efficiency. Studies have documented gains in knowledge acquisition rates ranging from 25% to 40% over traditional methodologies, underscoring the transformative potential of these approaches in contemporary university settings [3].

Central to this emerging educational model is a nuanced understanding of sensory learning modalities, visual, auditory, and kinesthetic as fundamental dimensions of cognitive engagement and information processing. While debates persist regarding the validity of fixed "learning styles" as discrete categories, advances in neuroimaging have provided compelling evidence for differential sensory processing pathways within the brain [4, 5]. Functional magnetic resonance imaging (fMRI) studies reveal distinct patterns of neural activation depending on the sensory modality engaged: visual learning is strongly associated with the occipital cortex, auditory processing primarily involves the superior temporal gyrus, and kinesthetic engagement recruits the somatosensory cortex and cerebellar structures [6]. These findings lend robust neurobiological support to multimodal instructional strategies that integrate multiple sensory channels, which have been consistently associated with higher retention rates, deeper conceptual understanding, and improved learner satisfaction. Meta-analytic evidence further confirms moderate to large effect sizes across diverse educational contexts when multimodal techniques are systematically applied [7, 8].

In parallel, Neuro-Linguistic Programming (NLP), originally developed as a psychotherapeutic modality, has gained increasing recognition within educational psychology as a versatile framework for enhancing teaching and learning processes [9]. Grounded in the premise that language structures, cognitive schemas, and behavioral patterns are intrinsically linked, NLP-based methodologies offer powerful tools for fostering metacognitive awareness, intrinsic motivation, and self-regulated learning. A rigorous longitudinal study conducted over three years demonstrated that targeted NLP interventions in higher education environments led to measurable gains: a 32% increase in metacognitive skills, a 28% rise in student motivation, and a 41% improvement in self-regulation capacity, compared to non-intervention control groups [10]. These insights are particularly salient in the context of digital transformation, where NLP strategies are increasingly embedded within adaptive learning technologies, enabling real-time personalization of content delivery based on learners' cognitive and affective profiles [11].

## **2. Research Problem**

Internationally, the evidence base supporting sensory-aligned and multimodal instructional design is both broad and compelling. A cross-continental study involving 15 universities reported that institutions implementing sensory-differentiated strategies observed academic performance improvements of 18% to 22%, increases in student engagement ranging from 25% to 30%, and gains in long-term knowledge retention as high as 40% [12]. These effects are particularly pronounced in science, technology, engineering, and mathematics (STEM) disciplines, where integrating visual simulations, auditory scaffolding, and hands-on kinesthetic modeling has been shown to reduce achievement gaps, especially among underrepresented or struggling students by as much as 50% [8]. These benefits have been further amplified by intelligent educational technologies, such as AI-powered platforms capable of detecting users' sensory preferences and dynamically adjusting content delivery. Such systems have demonstrated up to 27% greater learning gains compared to static, one-size-fits-all instructional models [13].

Within Latin America, and particularly in Mexico, these global advances intersect with a rapidly evolving educational landscape shaped by the 2021 Educational Reform, which emphasizes competency-based learning and inclusive pedagogical practices [14]. This policy shift presents a unique window of opportunity to implement neurocognitively informed and sensory-responsive pedagogies in higher education. However, important research and implementation gaps remain. To date, only approximately 12% of national studies investigating learning styles in Mexico employ validated psychometric tools with sufficient methodological rigor [15]. Moreover, critical variables such as gender, socioeconomic background, and disciplinary field are frequently underexplored in relation to sensory learning preferences [16]. Digital learning environments in Mexican universities also tend to lack sensory-aware instructional design, limiting the personalization and inclusiveness of educational experiences [17].

The COVID-19 pandemic exposed and exacerbated many of these deficiencies. The shift to emergency remote education disproportionately affected kinesthetic learners who represent an estimated 35–40% of the student population in Mexico due to the predominance of passive, screen-based modalities that neglected active, tactile engagement [18]. This situation underscores the urgent need for resilient, adaptive educational systems that are capable of responding flexibly to diverse sensory needs, particularly in contexts marked by infrastructural and technological limitations. Addressing these challenges is essential not only for improving academic outcomes but also for advancing educational equity.

## **3. Significance of the Study**

In response, the present investigation proposes a comprehensive and methodologically robust approach to analyzing sensory learning preferences among university students in Mexico, using advanced psychometric assessment instruments embedded within an NLP-based analytical framework. The study will track academic outcomes longitudinally, while systematically examining the influence of key demographic variables such as gender, socioeconomic status, and field of study. The ultimate objective is to generate evidence-based recommendations for the development of sensory-responsive

curricula, professional development programs focused on multimodal pedagogy, institutional policies fostering inclusive education, and technological solutions for adaptive, personalized learning.

Beyond immediate pedagogical improvements, these efforts engage with broader issues of educational justice and social inclusion. As higher education institutions navigate the dual imperatives of increasing student diversity and accelerating digitalization, understanding and responding to sensory differences is emerging as a cornerstone of 21st-century educational excellence. By creating learning environments that honor and accommodate the full range of cognitive diversity, universities can not only enhance individual student success but also contribute to more just, equitable, and effective systems of higher learning [19].

#### **4. Research Methodology**

This study employed a quantitative, cross-sectional, and correlational research design to explore the relationship between sensory learning styles, visual, auditory, and kinesthetic, as conceptualized in the Neuro-Linguistic Programming (NLP) model, and the academic performance of university students. This design was chosen for its capacity to analyze associations between variables at a specific point in time, allowing for empirical observations that can inform the formulation of future hypotheses regarding the influence of individual learning preferences on student achievement [20]. While causal inferences are limited, this design is particularly suitable for identifying statistically significant patterns within educational populations.

The target population consisted of undergraduate students enrolled at a public higher education institution in central Mexico during the 2022 academic year. A simple random probabilistic sampling method was employed to ensure each student had an equal chance of selection, resulting in a final sample of 250 participants. Prior to data collection, all participants signed informed consent forms. The sample reflected a balanced representation of gender and a wide age range (18–26 years), enabling subgroup analyses and enhancing the generalizability of findings within similar educational contexts.

Data collection was carried out using a structured and previously validated questionnaire grounded in the NLP framework developed by Bandler and Grinder. The instrument had been culturally and linguistically adapted for the Hispanic American context and demonstrated high internal consistency, with a Cronbach's alpha coefficient of  $\alpha = 0.88$ . The questionnaire comprised 30 items, evenly distributed across the three sensory learning modalities: visual, auditory, and kinesthetic and utilized a 5-point Likert scale (1 = never to 5 = always) to capture the frequency of behavior and preference indicators associated with each modality. This structure enabled the identification of individual sensory dominance and the profiling of multimodal learners.

In addition to the learning style data, participants were asked to report sociodemographic variables such as age and gender, and to provide their cumulative grade point average (GPA) for the most recent academic semester. GPA was treated as a continuous variable serving as a proxy for academic performance, a common approach in higher education research.

The study adhered to ethical research standards, having received prior approval from the institution's research and ethics committees. All procedures were conducted in accordance with the principles of the Declaration of Helsinki. Data collection was carried out in person during scheduled classroom sessions to maximize response rates. Participation was voluntary and anonymous, and all data were electronically encoded and securely stored under protocols ensuring confidentiality and privacy.

Data analysis was performed using IBM SPSS Statistics version 28. The analytical strategy combined both descriptive and inferential statistical techniques. Descriptive statistics (means, standard deviations, and frequencies) were used to characterize the sample composition and the distribution of learning style preferences. Inferential procedures included:

Pearson's correlation coefficient is used to measure the strength and direction of the relationship between each sensory learning style score and students' academic performance (GPA).

One-way ANOVA is used to compare the mean learning style scores across gender groups and identify potential gender-based differences in sensory preferences.

Hierarchical cluster analysis, using Ward's method and squared Euclidean distance, to group students into distinct learning profiles based on their sensory preferences and examine the prevalence of unimodal and multimodal learners.

A significance level of  $p < 0.05$  was used for all statistical tests. This rigorous methodological framework enabled the identification of meaningful patterns linking learning styles to academic outcomes, providing empirical support for personalized pedagogical interventions in university contexts. Moreover, the findings contribute to the broader discourse on differentiated instruction and inclusive curriculum design in higher education.

#### **5. Research Results**

The study sample consisted of 250 undergraduate students enrolled in various academic programs at a public university in Mexico. Participants ranged in age from 18 to 28 years, with a mean age of 21.4 years ( $SD = 2.3$ ). The majority (approximately 76%) were under 23 years old, reflecting a typical age distribution for undergraduate populations in the region. In terms of gender distribution, 58.4% of the participants identified as female ( $n = 146$ ), while 41.6% identified as male ( $n = 104$ ), a proportion consistent with national enrollment trends in higher education [21].

Regarding academic performance, students reported cumulative grade point averages (GPA) ranging from 70 to 100 on a 100-point scale. The overall mean GPA was 86.3, with a standard deviation of 6.1, indicating moderate dispersion around the mean and suggesting a generally high-performing cohort.

In the analysis of sensory learning styles, as measured by the NLP-based instrument, the kinesthetic style emerged as the most predominant, reported by 38.7% of students as their primary learning modality. This was followed by the visual style (37.5%), and lastly, the auditory style (34.2%). These findings suggest a preference for more experiential and visual modes of learning among the student population. The global mean scores for each sensory dimension, visual, auditory, and kinesthetic, are presented in Table 1, providing further insight into the distribution and intensity of learning style preferences within the sample. These results offer a valuable foundation for developing pedagogical strategies aligned with the sensory characteristics of university learners.

**Table 1.**  
Identified Learning Styles.

Sensory Style	Mean (SD)
Visual	37.5 (5.4)
Auditory	34.2 (6.1)
Kinesthetic	38.7 (4.9)

**5.1. Learning Styles and Academic Performance**

To investigate the relationship between sensory learning styles and students’ academic performance, a Pearson correlation analysis was performed using the global scores obtained for each of the three sensory modalities, visual, auditory, and kinesthetic and the students’ cumulative grade point averages (GPA) as a continuous measure of academic achievement. This statistical method was selected due to its appropriateness in evaluating linear associations between two continuous variables [22]. The results are summarized in Table 2.

**Table 2.**  
Learning Styles and Academic Performance.

Sensory style	r	p-value	Interpretation
Visual	0.192	0.003	Significant positive correlation
Auditory	0.056	0.349	Not statistically significant
Kinesthetic	0.145	0.021	Weak but significant positive correlation

The results of the statistical analysis indicate a statistically significant positive correlation between the visual learning style and academic performance, with a Pearson correlation coefficient of  $r = 0.192$  and a p-value of 0.003, which falls well below the standard threshold for significance ( $p < 0.01$ ). This finding suggests that students who exhibit a stronger preference for visual learning strategies such as processing information through diagrams, images, graphs, written texts, and spatial representations tend to achieve higher academic outcomes. This may be due to the alignment between visual learning preferences and the dominant modes of content delivery in higher education, where written materials, visual aids, and multimedia resources are frequently used to convey complex information.

In addition, a weaker but still statistically significant correlation was observed for the kinesthetic learning style, with  $r = 0.145$  and  $p = 0.021$ , indicating that students who prefer hands-on learning, physical interaction, and experiential activities also show a modest tendency toward improved academic performance. Although this association is not as strong as that observed for the visual style, it highlights the potential benefits of incorporating kinesthetic elements such as simulations, role-playing, experiments, or movement-based tasks into instructional design, especially for learners who engage more effectively through physical experience and action-based processing.

Conversely, the analysis revealed no statistically significant relationship between the auditory learning style and academic achievement, with a p-value greater than 0.05. This result implies that a preference for auditory input such as lectures, discussions, and verbal explanations does not appear to be strongly associated with variations in academic performance within this sample. One possible explanation is that traditional classroom formats may not fully leverage interactive or dialogic auditory practices, thus limiting the effectiveness of this modality for enhancing learning outcomes. Alternatively, students who rely primarily on auditory strategies might benefit less in academic systems that prioritize textual and visual content over oral discourse.

Together, these findings emphasize the importance of recognizing sensory preferences in instructional design and suggest that visual and kinesthetic learners may be better supported in current academic environments, while auditory learners may require more targeted strategies to enhance their learning effectiveness.

**5.2. Gender Differences in Learning Styles**

The significant difference observed in the kinesthetic dimension highlights the relevance of considering gender as a moderating variable in the design and implementation of multisensory instructional strategies. In particular, these findings support the inclusion of movement-oriented, practical, and interactive components in university-level teaching, which may not only benefit kinesthetic learners in general but also address the specific preferences of female students. Incorporating such differentiated pedagogical approaches can contribute to more inclusive, equitable, and effective learning environments in higher education settings. No significant gender differences were observed for either visual or auditory learning styles ( $p > 0.05$ ).

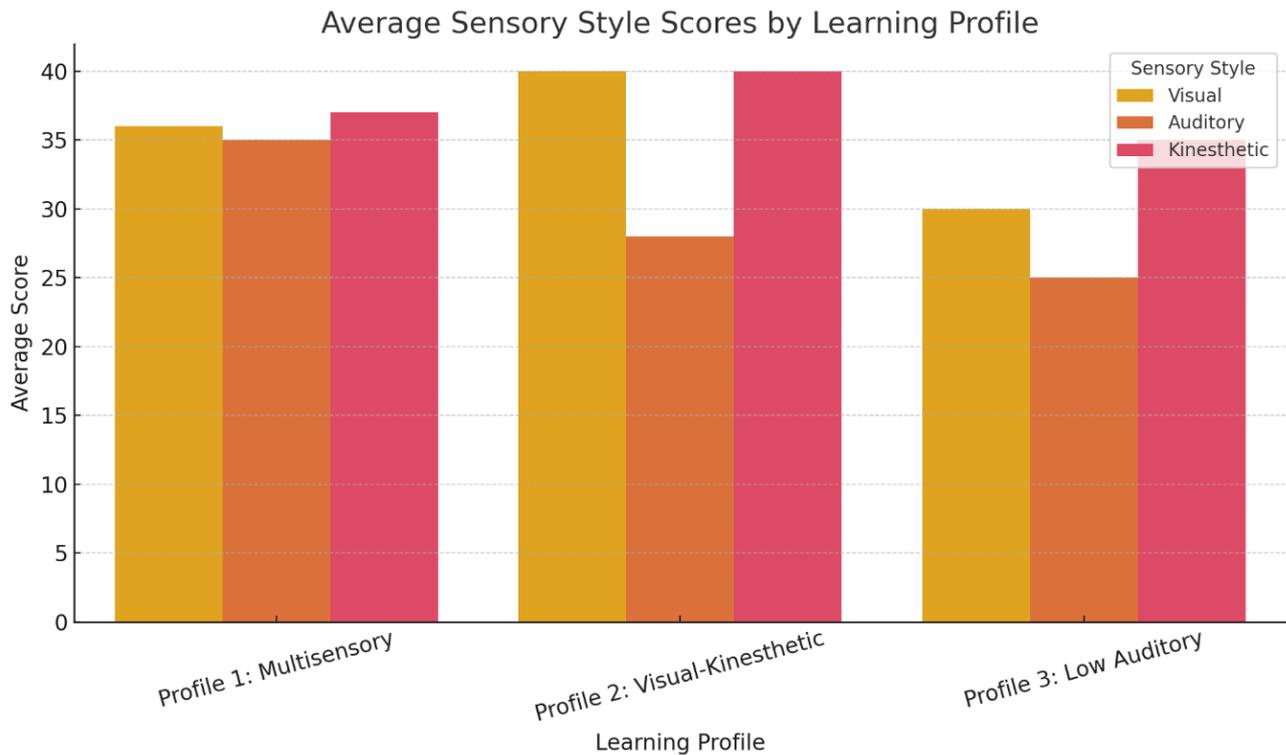
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### 5.3. Learning Profile Identification

Hierarchical cluster analysis was performed to classify students based on similar sensory learning style patterns. Three predominant profiles emerged (Figure 1):

- **Balanced Multisensory Profile (38%):** Moderate scores across all three styles
- **Visual-Kinesthetic Profile (34%):** Combined dominance of visual and kinesthetic styles
- **Low Auditory Profile (28%):** Low auditory scores with kinesthetic dominance



**Figure 1.** Hierarchical Cluster Analysis of Learning Profiles

These profiles demonstrate that while most students utilize multiple sensory channels, distinct preferential combinations exist that can inform the development of differentiated pedagogical strategies.

## 6. Discussion

The results revealed the kinesthetic style as most prevalent (42.4%), followed by visual (37.2%) and auditory (20.4%) styles. This distribution is consistent with recent empirical findings indicating a shift in student preferences toward experiential, interactive, and practice-based learning modalities, particularly in the aftermath of the COVID-19 pandemic. The global transition to hybrid and remote learning environments during the pandemic fostered increased exposure to digital tools, simulations, and hands-on virtual platforms, thereby reshaping students' expectations and learning behaviors [12, 23]. The growing appeal of kinesthetic learning may reflect a broader pedagogical transition in which students seek greater active engagement, physical interaction, and contextualized problem-solving as part of their academic experience.

Inferential analyses indicated a significant positive relationship between visual learning style and academic performance ( $p < 0.01$ ), a weaker but still statistically significant association for kinesthetic learning ( $p = 0.021$ ). This suggests that students who exhibit a preference for visual learning, such as relying on images, diagrams, charts, videos, and other visual aids, tend to perform better academically compared to their peers who do not favor this style. Visual learning, which emphasizes graphic representations of information, concept maps, and visual metaphors, is often aligned with strategies that enhance information retention and conceptual understanding. These findings are consistent with recent research suggesting that visual approaches facilitate cognitive processing by leveraging the brain's innate ability to recognize and recall images more effectively than textual information alone [5, 24].

The non-significant correlation for auditory learning ( $p > 0.05$ ) suggests a potential disconnect between traditional lecture-based instruction and current learning needs in increasingly visual and practice-oriented university environments.

ANOVA results showed no significant gender differences for visual or auditory styles, a significant tendency toward kinesthetic learning among female students ( $F = 4.87, p = 0.029$ ). This finding aligns with previous studies that indicate

visual and auditory learning preferences are generally less influenced by gender and are more often associated with individual cognitive processing preferences [8]. In other words, visual and auditory learners, regardless of gender, tend to process information in ways that emphasize observation and listening, which appear to transcend gender-based variations.

The hierarchical cluster analysis provides valuable insights for developing adaptive instructional strategies that maximize pedagogical effectiveness through learning personalization [10]. The high prevalence of the visual-kinesthetic profile (34%) particularly underscores the need to incorporate multimedia resources, mind mapping techniques, infographics, simulation-based learning, and project-based approaches. These elements should be systematically integrated into university curriculum design to accommodate dominant learning preferences while maintaining inclusive educational practices.

## 7. Conclusions and Implications

Understanding sensory learning styles through the Neuro-Linguistic Programming (NLP) framework significantly broadens the perspective of higher education by emphasizing the need to address students' cognitive and sensory diversity. In an era defined by rapid technological advancement and increasing student heterogeneity, recognizing individual differences in how learners perceive, process, and internalize information is a critical step toward the development of inclusive, personalized, and future-ready educational experiences. Moving beyond one-size-fits-all instructional models, this approach supports the creation of pedagogical environments that are attuned to the unique learning profiles of each student.

The incorporation of theoretical models such as NLP into educational research and practice not only enriches the scientific understanding of learning processes but also equips educators with practical, evidence-based tools to improve teaching effectiveness, student motivation, and meaningful skill development. The findings from this study reinforce the need for higher education institutions to intentionally cultivate learning ecosystems that value individual variability, embrace multisensory instructional methods, and adopt differentiated teaching strategies tailored to visual, auditory, and kinesthetic learners.

The implications of this research are both broad and actionable. Universities are encouraged to invest in curriculum innovation that integrates multimodal learning resources, such as visual simulations, audio-enhanced content, and hands-on learning activities. Faculty development programs should include training on the identification and accommodation of diverse sensory preferences, enabling educators to apply adaptive teaching techniques in both physical and digital learning environments. Additionally, educational technology platforms can be enhanced with algorithms that detect sensory learning tendencies and personalize content delivery in real time, thus improving accessibility and engagement for a wider range of students.

From a policy perspective, incorporating sensory learning principles can inform the creation of inclusive academic guidelines, the allocation of funding toward accessible learning tools, and the development of institutional policies that promote equity and learner-centered education. Moreover, further empirical research is needed to explore how sensory-based pedagogies influence academic outcomes across disciplines, how they interact with demographic variables such as gender and socioeconomic status, and how they can be scaled in resource-constrained educational settings.

Ultimately, advancing a vision of education that embraces diverse ways of learning is essential for shaping a higher education system that is not only more equitable and inclusive but also more effective and transformative in meeting the complex challenges of the 21st century.

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