

# ALGORITHMIC LANGUAGE EXPOSURE AND LINGUISTIC IDENTITY FORMATION: A MULTILEVEL ANALYSIS OF AI-DRIVEN EDUCATIONAL PLATFORMS AMONG MULTILINGUAL UNIVERSITY STUDENTS IN PAKISTAN

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## ABSTRACT

The rapid integration of Artificial Intelligence (AI)-driven educational platforms in higher education has significantly transformed multilingual learning environments and reshaped linguistic practices among university students. This study examined the influence of algorithmic language exposure on linguistic identity formation among multilingual university students in Pakistan. Grounded in Sociocultural Theory, the study employed a quantitative cross-sectional survey design using a sample of 450 multilingual students selected through multistage sampling. Data were collected through a structured Likert-scale questionnaire and analyzed using descriptive statistics, correlation, regression analysis, and Structural Equation Modeling. The findings revealed that algorithmic language exposure significantly influenced linguistic identity formation, emerging as the strongest predictor among all study variables. Results indicated that frequent interaction with AI-driven educational platforms increased students' exposure to English-dominant linguistic structures, which in turn shaped their perceptions of linguistic prestige, communicative behavior, and identity negotiation. Sociocultural factors and perceived linguistic prestige were also found to significantly contribute to identity formation processes. The study further highlighted that AI-mediated educational systems function not only as learning tools but also as sociotechnical agents that shape multilingual learners' linguistic self-concept and cultural affiliation. The study concludes that AI-driven educational platforms play a critical role in shaping linguistic identity among multilingual learners in Pakistan, while also reinforcing existing linguistic hierarchies. The research underscores the need for culturally responsive and linguistically inclusive AI integration in higher education to preserve multilingual diversity and reduce digital linguistic inequality.

**Keywords:** Artificial Intelligence, Algorithmic Language Exposure, Linguistic Identity, Multilingual Education, AI-Driven Learning, Sociocultural Theory, Higher Education, Pakistan

## INTRODUCTION

The rapid advancement of Artificial Intelligence (AI) has transformed the educational landscape by introducing intelligent, adaptive, and personalized

learning environments that significantly influence language acquisition and communication practices. AI-driven educational platforms such as intelligent tutoring systems, generative AI

chatbots, automated writing assistants, and adaptive language learning applications are increasingly integrated into higher education worldwide. These technologies provide multilingual learners with personalized feedback, real-time language correction, translanguaging opportunities, and algorithmically curated linguistic content that shape not only academic performance but also linguistic identity formation (Rahimi & Mosalli, 2025). In multilingual societies such as Pakistan, where English, Urdu, and regional languages coexist in educational and social domains, algorithmic language exposure through AI systems is becoming a critical factor influencing students' linguistic preferences, identity negotiation, and communicative behavior.

Pakistan represents a linguistically diverse context characterized by complex multilingual realities involving Urdu as the national language, English as the language of higher education and socioeconomic mobility, and several regional languages including Pashto, Punjabi, Sindhi, Balochi, and Saraiki. Within this environment, university students increasingly rely on AI-powered educational technologies for academic writing, language learning, translation, and communication support. AI-driven educational platforms employ algorithmic recommendation systems and natural language processing mechanisms that continuously expose learners to specific linguistic structures, discourse styles, and language hierarchies. Such algorithmic exposure has the potential to influence how multilingual students perceive linguistic prestige, cultural belonging, and identity alignment within academic and social contexts. Recent studies indicate that AI-mediated learning environments facilitate translanguaging practices and multilingual engagement while simultaneously reshaping perceptions of language legitimacy and digital participation among Pakistani learners.

The concept of linguistic identity refers to the ways individuals construct and negotiate their social, cultural, and linguistic selves through language use and interaction. In multilingual educational contexts, linguistic identity is fluid and dynamically influenced by sociocultural

experiences, institutional language policies, peer interactions, and technological mediation. The emergence of AI-driven educational systems has introduced a new dimension to identity formation because algorithmic systems selectively prioritize particular linguistic norms, accents, vocabulary patterns, and communicative styles. Unlike traditional language learning environments, AI-powered platforms continuously adapt content according to learner behavior, engagement patterns, and predictive analytics, thereby creating individualized linguistic ecosystems. These systems may reinforce dominant global languages such as English while marginalizing indigenous or regional linguistic expressions, ultimately affecting learners' perceptions of linguistic authenticity and cultural affiliation.

Recent developments in generative AI technologies, including conversational AI and large language models, have accelerated the integration of AI-mediated communication into higher education. Studies on AI-assisted language learning reveal that multilingual learners increasingly depend on AI systems for grammar correction, vocabulary enhancement, translation, and academic writing support. Such interactions expose students to algorithmically generated linguistic norms that often reflect dominant globalized English discourses embedded within AI training data. Research further suggests that AI-mediated educational environments influence learner autonomy, engagement, and language confidence while simultaneously reshaping linguistic behavior and identity expression among multilingual learners. In Pakistani universities, the growing adoption of AI-based educational tools has generated new opportunities for inclusive language learning; however, concerns remain regarding linguistic homogenization, digital inequality, and cultural representation within AI-generated educational content.

From a sociolinguistic perspective, algorithmic language exposure can be understood through the interaction between technology, discourse, and identity construction. AI systems function not merely as passive educational tools but as active agents that mediate language practices, regulate discourse visibility, and shape communicative

norms through algorithmic personalization. Multilingual students interacting with AI platforms may gradually internalize algorithmically preferred linguistic structures and communication styles, influencing their attitudes toward native and non-native languages. This phenomenon becomes particularly significant in Pakistan, where language is deeply associated with social mobility, educational access, ethnicity, and power relations. English proficiency is often linked with academic prestige and professional advancement, while regional languages symbolize cultural heritage and local identity. Consequently, AI-driven educational platforms may contribute to both linguistic empowerment and linguistic stratification depending on patterns of algorithmic exposure and digital accessibility. Furthermore, the increasing normalization of AI technologies in higher education has generated debates regarding educational authenticity, learner dependence, and digital ethics. Discussions among Pakistani learners and educators reveal mixed perceptions concerning AI integration in education. While many students consider AI systems valuable for personalized learning and academic support, concerns have also emerged regarding overdependence, reduction in critical thinking, and the potential erosion of authentic linguistic competence. Such debates demonstrate that AI technologies are not merely instructional tools but sociocultural mechanisms that influence how learners position themselves within academic and linguistic communities. Despite the growing body of research on AI-assisted language learning, limited empirical attention has been given to the relationship between algorithmic language exposure and linguistic identity formation in multilingual higher education contexts, particularly in Pakistan. Existing studies primarily focus on technology acceptance, language proficiency, learner engagement, and translanguaging practices, while the sociolinguistic and identity-related implications of AI-driven educational platforms remain underexplored. Moreover, few studies adopt a multilevel analytical perspective that simultaneously examines individual, institutional, technological, and sociocultural

dimensions influencing linguistic identity in AI-mediated environments. This gap highlights the need for comprehensive research investigating how algorithmic educational systems shape multilingual students' linguistic self-concept, communicative preferences, and cultural alignment within Pakistani universities.

Therefore, the present study aims to examine the relationship between algorithmic language exposure and linguistic identity formation among multilingual university students in Pakistan through a multilevel analytical framework. The study seeks to explore how AI-driven educational platforms mediate language practices, influence linguistic self-perception, and shape identity negotiation across diverse linguistic communities. By integrating perspectives from sociolinguistics, educational technology, and AI-mediated communication, this research contributes to emerging scholarship on the sociocultural implications of artificial intelligence in multilingual education. The findings may provide valuable insights for policymakers, educators, platform developers, and researchers seeking to design culturally responsive and linguistically inclusive AI-driven educational systems in Pakistan and other multilingual societies.

### **Problem Statement**

The rapid integration of Artificial Intelligence (AI)-driven educational platforms into higher education has significantly transformed language learning environments across the globe. Intelligent tutoring systems, generative AI tools, automated writing assistants, and adaptive language learning applications increasingly mediate how multilingual learners interact with language, access knowledge, and construct academic discourse. In Pakistan, where multilingualism constitutes a central sociolinguistic reality, university students are increasingly exposed to algorithmically curated linguistic content through AI-powered educational technologies. These platforms continuously shape learners' exposure to English, Urdu, and regional languages by prioritizing specific linguistic structures, communication patterns, and discourse norms. Consequently, algorithmic language exposure has emerged as a

critical factor influencing linguistic preferences, communicative practices, and identity negotiation among multilingual learners.

Despite the growing adoption of AI-driven educational technologies in Pakistani universities, limited scholarly attention has been directed toward understanding how algorithmic systems influence linguistic identity formation among multilingual students. Existing studies predominantly emphasize technological adoption, learner satisfaction, language proficiency, and academic performance, while the sociolinguistic implications of AI-mediated educational environments remain insufficiently explored. In particular, there is a significant lack of empirical research examining how algorithmic personalization, AI-generated linguistic norms, and digital language hierarchies influence students' perceptions of linguistic belonging, cultural affiliation, and language prestige within multilingual educational contexts.

The issue becomes more critical in Pakistan because language is strongly associated with social mobility, educational opportunity, ethnicity, and cultural identity. English is widely perceived as a symbol of academic success and socioeconomic advancement, whereas regional languages represent cultural heritage and indigenous identity. AI-driven educational platforms often reinforce dominant global language structures embedded within algorithmic systems, potentially contributing to linguistic homogenization and marginalization of local linguistic identities. Such dynamics may affect multilingual students' self-perception, language attitudes, and communicative behavior, particularly when AI systems disproportionately privilege English-oriented discourse practices over culturally diverse linguistic expressions.

Furthermore, the increasing dependence on AI-mediated learning environments has raised concerns regarding digital inequality, cultural representation, algorithmic bias, and the erosion of authentic linguistic competence. Multilingual students may unconsciously internalize algorithmically preferred communication styles and linguistic norms, thereby reshaping their identity construction processes within academic

and social spaces. However, little is known about the extent to which AI-driven educational platforms influence linguistic identity formation at individual, institutional, and sociocultural levels in Pakistan's higher education sector.

Moreover, previous research lacks a comprehensive multilevel analytical framework capable of examining the interconnected influence of technological, educational, sociolinguistic, and cultural dimensions on multilingual learners' identity formation. Without such investigation, policymakers, educators, and educational technology developers may fail to address the broader sociocultural consequences of AI integration in multilingual learning environments. Therefore, there is a pressing need to investigate how algorithmic language exposure through AI-driven educational platforms shapes linguistic identity formation among multilingual university students in Pakistan. This study seeks to fill this gap by providing a multilevel analysis of the relationship between AI-mediated language exposure, linguistic self-perception, communicative preferences, and identity negotiation within multilingual higher education contexts.

### Research Questions

1. How does algorithmic language exposure through AI-driven educational platforms influence linguistic identity formation among multilingual university students in Pakistan?
2. What is the relationship between AI-mediated language learning practices and students' perceptions of linguistic prestige, belonging, and cultural affiliation?
3. How do multilingual university students negotiate their linguistic identities within AI-driven educational environments?
4. To what extent do institutional, technological, and sociocultural factors moderate the influence of AI-driven educational platforms on linguistic identity formation?
5. What challenges and opportunities do multilingual learners experience regarding language diversity and identity representation in AI-mediated educational systems?

## Research Objectives

### General Objective

To examine the influence of algorithmic language exposure through AI-driven educational platforms on linguistic identity formation among multilingual university students in Pakistan.

### Specific Objectives

1. To analyze the impact of AI-driven educational platforms on multilingual students' linguistic identity formation in Pakistani universities.
2. To investigate the relationship between AI-mediated language learning practices and perceptions of linguistic prestige, cultural affiliation, and communicative behavior.
3. To explore how multilingual university students negotiate and reconstruct their linguistic identities within AI-mediated educational environments.
4. To examine the moderating role of institutional, technological, and sociocultural factors in shaping the relationship between algorithmic language exposure and linguistic identity formation.
5. To identify the opportunities and challenges associated with language diversity, cultural representation, and algorithmic bias in AI-driven educational systems.

### Significance of the Study

This study is significant because it contributes to the emerging body of knowledge on the sociolinguistic implications of Artificial Intelligence (AI) in multilingual higher education contexts. By examining the relationship between algorithmic language exposure and linguistic identity formation among multilingual university students in Pakistan, the research extends existing literature beyond technology adoption and language learning outcomes toward deeper issues of identity negotiation, cultural representation, and language hierarchy in AI-mediated educational environments.

The study provides theoretical significance by integrating perspectives from sociolinguistics, AI-mediated communication, multilingual education, and identity formation into a

comprehensive multilevel framework. It enhances scholarly understanding of how algorithmic systems influence linguistic self-perception, communicative behavior, and cultural affiliation among multilingual learners in digitally mediated learning spaces. The findings may also contribute to future research on language ideology, digital linguistics, and educational technology in developing multilingual societies.

Practically, the study offers valuable insights for educators, curriculum developers, and higher education institutions regarding the sociocultural effects of AI-driven educational platforms. Understanding how multilingual students interact with algorithmically curated linguistic content can assist universities in designing more linguistically inclusive, culturally responsive, and ethically balanced AI-supported learning environments. The findings may further support educators in promoting equitable language representation and preserving multilingual diversity within digital education systems.

The research is also important for policymakers and educational technology developers. The study may guide the formulation of AI-related educational policies that address issues of linguistic inclusion, algorithmic bias, and cultural sensitivity in Pakistan's higher education sector. For AI developers and platform designers, the findings may provide evidence-based recommendations for creating adaptive educational technologies that support multilingual engagement without marginalizing local or indigenous languages.

Furthermore, the study holds social significance because language is closely connected to identity, cultural heritage, and social mobility in Pakistan. By investigating the influence of AI-driven educational systems on linguistic identity formation, the research highlights the broader societal implications of digital transformation in education. It may contribute to promoting linguistic diversity, cultural preservation, and responsible AI integration in multilingual societies facing rapid technological change.

Finally, this study fills an important empirical gap in Pakistani research by providing context-specific evidence regarding the impact of AI-mediated

educational platforms on multilingual learners. The findings may serve as a foundation for future regional and international studies exploring the intersection of AI, language, and identity in higher education contexts.

### Literature Review

#### Artificial Intelligence and Educational Transformation

Artificial Intelligence (AI) has emerged as a transformative force in higher education by reshaping instructional delivery, learner engagement, and language acquisition processes. AI-driven educational platforms utilize machine learning, natural language processing, predictive analytics, and adaptive learning algorithms to personalize educational experiences according to learners' cognitive and linguistic needs. These systems include intelligent tutoring systems, automated writing assistants, conversational chatbots, AI-based translation tools, and adaptive language learning applications that facilitate multilingual interaction and individualized learning pathways. Recent studies indicate that AI technologies enhance learners' autonomy, academic performance, and engagement through personalized feedback and real-time language support (Rahimi & Mosalli, 2025).

The integration of AI in educational environments has accelerated following the emergence of generative AI tools such as ChatGPT and other large language models. These technologies enable learners to interact dynamically with AI-generated content for grammar correction, writing assistance, translation, summarization, and language practice. Researchers argue that AI-mediated educational systems not only improve linguistic competence but also shape communicative behavior, discourse practices, and digital learning cultures among students (Yaacoub et al., 2025). Consequently, AI-driven educational environments have become influential sociotechnical spaces where language learning and identity construction increasingly intersect.

In developing countries such as Pakistan, AI-driven educational technologies are gradually gaining importance within universities due to

expanding digitalization and online learning initiatives. Pakistani university students increasingly use AI-assisted applications for academic writing, language learning, and research support. Although these technologies provide opportunities for inclusive and personalized learning, scholars have raised concerns regarding unequal access, algorithmic dependency, and the dominance of English-centric digital content in multilingual educational settings (Raza & Farooq, 2025).

#### Algorithmic Language Exposure in AI-Mediated Learning

Algorithmic language exposure refers to the continuous interaction of learners with language patterns, vocabulary structures, discourse styles, and communicative norms generated or prioritized by AI-driven systems. Educational algorithms operate through recommendation systems, adaptive feedback mechanisms, predictive analytics, and automated content generation that influence learners' exposure to specific linguistic forms. Unlike traditional classroom instruction, AI systems dynamically personalize linguistic input according to learners' behaviors, preferences, and engagement histories.

Research suggests that algorithmic systems significantly influence language acquisition and communication practices by prioritizing dominant linguistic structures embedded within training datasets. Large language models are primarily trained on globalized English-language corpora, which may unintentionally reinforce linguistic hierarchies favoring standardized English discourse over localized multilingual expressions (Nadeem et al., 2025). Such algorithmic prioritization may affect multilingual learners' perceptions of language prestige, correctness, and academic legitimacy.

In multilingual educational contexts, algorithmic language exposure may contribute to translanguaging practices while simultaneously influencing learners' linguistic preferences and identity alignment. Studies on AI-mediated language learning reveal that multilingual learners frequently adapt their writing styles and communication patterns to align with AI-

generated linguistic norms (Fatima & Faraz, 2025). This adaptive process may enhance language proficiency but can also produce subtle forms of linguistic homogenization in which local linguistic identities become marginalized within digitally mediated educational environments.

Within Pakistani universities, students regularly engage with AI-driven platforms that predominantly promote English-language discourse practices. Since English functions as the primary language of higher education and professional advancement in Pakistan, AI-mediated exposure may reinforce existing sociolinguistic hierarchies between English and regional languages. Consequently, algorithmic language exposure represents not merely a technological process but also a sociocultural mechanism influencing linguistic behavior and identity formation.

### **Linguistic Identity Formation in Multilingual Contexts**

Linguistic identity refers to the ways individuals construct, negotiate, and express their social and cultural identities through language use. In multilingual societies, linguistic identity is fluid and continuously shaped by educational experiences, institutional practices, social interactions, and sociopolitical structures. Language functions not only as a communication tool but also as a marker of ethnicity, cultural belonging, social status, and ideological affiliation. Scholars in sociolinguistics argue that multilingual individuals frequently negotiate multiple linguistic identities depending on context, power relations, and communicative demands. In postcolonial societies such as Pakistan, language carries strong symbolic significance because English is associated with prestige, higher education, and socioeconomic mobility, whereas regional languages represent indigenous identity and cultural heritage. This linguistic hierarchy often influences students' educational experiences and self-perception within academic institutions.

The emergence of digital educational technologies has introduced new dimensions to linguistic identity formation. AI-mediated communication environments expose learners to standardized

linguistic norms and globalized communication practices that may reshape their perceptions of linguistic legitimacy and cultural belonging. According to sociocultural theories of language, repeated exposure to algorithmically preferred discourse patterns may gradually influence how learners perceive themselves linguistically within academic and digital spaces.

Recent studies indicate that multilingual learners interacting with AI-based educational tools often experience shifts in communicative confidence, language preference, and identity expression. AI-driven educational systems may encourage students to privilege globally dominant languages such as English in formal academic communication while reducing the visibility of local linguistic practices. This phenomenon becomes particularly relevant in Pakistan, where multilingual students simultaneously navigate institutional expectations, cultural affiliations, and digital communication norms.

### **AI-Mediated Translanguaging and Multilingual Engagement**

Translanguaging refers to the flexible use of multiple linguistic resources by multilingual speakers to construct meaning and facilitate communication. AI-driven educational platforms increasingly support translanguaging practices through automated translation, multilingual interfaces, speech recognition, and adaptive feedback systems. Such technologies enable multilingual learners to move fluidly between languages while engaging with academic content. Studies conducted in multilingual educational settings demonstrate that AI-mediated translanguaging enhances learner engagement, comprehension, and communicative participation. Amin and Mirza (2025) found that multilingual university students in Pakistan utilized AI-assisted learning tools to combine English, Urdu, and regional languages in ways that improved comprehension and academic interaction. These findings suggest that AI technologies can create linguistically inclusive learning environments when designed to accommodate multilingual realities.

However, scholars also caution that AI systems may privilege certain languages due to uneven representation within training datasets and algorithmic architectures. Many AI-based educational platforms are optimized primarily for English-language communication, potentially limiting the visibility and functionality of regional languages. As a result, multilingual learners may unconsciously perceive dominant languages as more academically valuable or technologically legitimate than local linguistic identities.

The relationship between AI-mediated translanguaging and linguistic identity formation remains underexplored, particularly in developing multilingual contexts. Although translanguaging practices can strengthen multilingual engagement and cultural inclusivity, excessive reliance on English-dominant AI systems may contribute to linguistic assimilation and reduced cultural representation. Therefore, understanding how multilingual students negotiate their linguistic identities within AI-mediated translanguaging environments represents an important area of contemporary educational research.

### **Sociocultural Implications of AI in Multilingual Education**

The sociocultural implications of AI-driven educational technologies extend beyond academic performance to broader issues of identity, inclusion, cultural representation, and linguistic equity. AI systems are not neutral technological tools; rather, they reflect the sociocultural assumptions and linguistic patterns embedded within their training data and algorithmic design. Consequently, AI-mediated educational environments may reproduce existing linguistic inequalities and power relations within multilingual societies.

Researchers have highlighted concerns regarding algorithmic bias, digital colonialism, and linguistic homogenization in AI-powered communication systems. Since most generative AI models are trained predominantly on Western and English-language datasets, multilingual learners from non-Western contexts may encounter educational content that inadequately represents local linguistic and cultural realities. Such limitations

may influence learners' perceptions of language legitimacy and cultural identity within academic settings.

In Pakistan, where linguistic diversity constitutes an essential component of national and regional identity, the dominance of English-oriented AI systems may reinforce social stratification linked to language proficiency and digital literacy. Students from rural or linguistically marginalized backgrounds may experience unequal access to AI-mediated educational opportunities, thereby widening educational and sociolinguistic disparities. Additionally, excessive dependence on AI-generated academic language may reduce opportunities for authentic linguistic creativity and indigenous knowledge expression.

At the same time, AI technologies also possess transformative potential for promoting linguistic inclusivity and multilingual accessibility. AI-assisted translation tools, speech technologies, and adaptive educational platforms can facilitate participation among linguistically diverse learners and support multilingual educational practices. Therefore, the sociocultural impact of AI in multilingual education remains multidimensional, involving both opportunities for inclusion and risks of linguistic marginalization.

### **Empirical Gap in Existing Literature**

Existing literature on AI-driven educational technologies primarily focuses on learner performance, technology acceptance, language proficiency, and digital engagement. While studies increasingly examine AI-assisted language learning and multilingual communication, limited empirical research has explored the relationship between algorithmic language exposure and linguistic identity formation among multilingual university students. Most previous studies address technical efficiency and pedagogical outcomes while overlooking the sociolinguistic and identity-related implications of AI-mediated learning environments.

In the Pakistani context, research on AI in education remains relatively limited and predominantly concentrates on technology adoption, online learning readiness, and AI-

assisted academic support. Few studies investigate how AI-driven educational platforms shape multilingual learners' perceptions of language prestige, communicative identity, and cultural belonging. Moreover, there is a lack of multilevel analytical approaches that simultaneously consider technological, institutional, sociocultural, and linguistic factors influencing identity formation in AI-mediated educational environments.

Therefore, the present study addresses an important gap in the literature by examining how algorithmic language exposure through AI-driven educational platforms influences linguistic identity formation among multilingual university students in Pakistan. The study contributes to emerging scholarship on AI-mediated communication, multilingual education, and sociolinguistic identity by providing context-specific evidence from a developing multilingual society.

### **Underpinning Theory: Sociocultural Theory (SCT)**

The present study is underpinned by the **Sociocultural Theory (SCT)** proposed by Lev Vygotsky. Sociocultural Theory explains that learning, cognitive development, and identity formation occur through social interaction, cultural mediation, and engagement with symbolic tools within a particular sociocultural environment. According to the theory, language functions as a central mediating tool through which individuals construct knowledge, negotiate meaning, and develop personal and social identities.

In the context of multilingual education, Sociocultural Theory emphasizes that learners' linguistic identities are shaped through continuous interaction with social agents, institutional structures, cultural norms, and communicative practices. AI-driven educational platforms can therefore be understood as modern mediational tools that influence how multilingual students engage with language, construct meaning, and negotiate their linguistic identities. Through algorithmic personalization, adaptive feedback, automated communication, and AI-generated

discourse, these platforms mediate students' exposure to specific linguistic patterns and sociocultural representations.

The theory is particularly relevant to this study because multilingual university students in Pakistan interact with AI-powered educational technologies within a sociolinguistic environment characterized by the coexistence of English, Urdu, and regional languages. According to Sociocultural Theory, repeated exposure to algorithmically curated linguistic content may influence learners' perceptions of language prestige, communicative competence, and cultural belonging. AI-mediated educational environments therefore become socially constructed spaces where students internalize dominant linguistic norms and reconstruct their linguistic identities through digital interaction.

Furthermore, Sociocultural Theory supports the multilevel analytical perspective of this study by recognizing that identity formation is not an isolated psychological process but a socially situated phenomenon influenced by cultural, institutional, technological, and interpersonal factors. The theory explains how multilingual learners actively negotiate their linguistic identities while interacting with AI-driven educational systems that privilege certain languages, discourse styles, and communication practices.

By applying Sociocultural Theory, this study seeks to examine how algorithmic language exposure through AI-driven educational platforms mediates linguistic identity formation among multilingual university students in Pakistan. The theory provides a comprehensive framework for understanding the relationship between technological mediation, multilingual interaction, and identity construction within contemporary digital learning environments.

### **Methodology**

#### **Research Design**

The study adopted a quantitative research approach using a cross-sectional survey design to examine the influence of algorithmic language exposure through AI-driven educational platforms on linguistic identity formation among multilingual university students in Pakistan. A

multilevel analytical framework was employed to investigate the relationship between AI-mediated language exposure, sociocultural factors, and linguistic identity formation within higher education contexts. The quantitative design was considered appropriate because it enabled the researcher to collect standardized data from a large population and statistically analyze the relationships among the study variables.

### **Research Paradigm**

The study was grounded in the positivist research paradigm, which emphasizes objective measurement, empirical investigation, and statistical analysis of observable phenomena. The positivist approach enabled the researcher to quantify multilingual students' experiences with AI-driven educational platforms and examine their influence on linguistic identity formation using measurable indicators and inferential statistical techniques.

### **Population of the Study**

The population of the study consisted of multilingual undergraduate and postgraduate students enrolled in public and private universities in Pakistan. The target population included students from diverse linguistic backgrounds who regularly used AI-driven educational platforms such as ChatGPT, Grammarly, Duolingo, Google Translate, QuillBot, and other AI-assisted academic learning applications for educational purposes. The study focused on multilingual students because they represented the most relevant group for examining linguistic identity negotiation within AI-mediated learning environments.

The accessible population comprised students from selected universities located in Punjab, Khyber Pakhtunkhwa, Sindh, and Islamabad Capital Territory. These institutions were selected because of their increasing integration of digital educational technologies and linguistically diverse student populations.

### **Sample Size**

A sample size of 450 multilingual university students was selected for the study. The sample

size was considered adequate for multivariate statistical analysis and structural relationship testing. The selection was guided by recommendations for social science research, which suggest that larger samples increase statistical reliability, representativeness, and generalizability of findings.

Among the participants, undergraduate and postgraduate students from various academic disciplines including education, linguistics, literature, social sciences, computer science, and management sciences were included to ensure diversity of perspectives regarding AI-mediated educational experiences.

### **Sampling Technique**

The study employed a multistage sampling technique. In the first stage, purposive sampling was used to select universities that had access to AI-driven educational technologies and diverse multilingual student populations. In the second stage, stratified random sampling was applied to categorize students according to academic level, discipline, and linguistic background. Finally, simple random sampling was used to select participants from each stratum to ensure equal representation and minimize sampling bias.

### **Data Collection Instrument**

Data were collected through a structured questionnaire developed based on previous literature related to AI-assisted language learning, multilingual education, algorithmic exposure, and linguistic identity formation. The questionnaire consisted of five sections:

1. Demographic information
2. AI-driven educational platform usage
3. Algorithmic language exposure
4. Linguistic identity formation
5. Sociocultural and institutional influences

The instrument utilized a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). The questionnaire items measured students' experiences with AI-mediated educational systems, language preferences, communicative behavior, perceptions of linguistic prestige, and identity negotiation processes.

### **Validity and Reliability**

The instrument was validated through expert review by specialists in educational technology, sociolinguistics, and research methodology to ensure content validity and conceptual relevance. A pilot study was conducted with 40 multilingual university students prior to the final data collection process to assess the clarity and reliability of the instrument.

Reliability analysis was performed using Cronbach's Alpha coefficient. The overall reliability value exceeded the acceptable threshold of 0.70, indicating satisfactory internal consistency of the research instrument.

### **Data Collection Procedure**

The data collection process was conducted after obtaining formal approval from the respective university authorities. Questionnaires were distributed both physically and electronically through institutional learning platforms, email, and online survey forms. Participants were informed about the purpose of the study, confidentiality of responses, and voluntary nature of participation before completing the survey. The researcher ensured that ethical considerations including anonymity, informed consent, privacy protection, and voluntary participation were maintained throughout the data collection process.

### **Data Analysis Techniques**

The collected data were analyzed using Statistical Package for Social Sciences (SPSS) and Structural Equation Modeling (SEM) techniques. Descriptive statistics including frequency, percentage, mean, and standard deviation were used to summarize demographic information and participants' responses. Inferential statistical analyses including correlation analysis, multiple regression analysis, and multilevel modeling were conducted to examine the relationships between algorithmic language exposure and linguistic identity formation.

Structural Equation Modeling was further employed to test the direct and indirect relationships among AI-mediated language exposure, sociocultural influences, institutional factors, and linguistic identity formation. The findings were presented through tables, statistical interpretations, and graphical representations to ensure clarity and comprehensive understanding of the results.

### **Ethical Considerations**

The study adhered to standard ethical research principles throughout the investigation process. Participants' identities remained anonymous, and all collected information was used solely for academic purposes. Respondents participated voluntarily and retained the right to withdraw from the study at any stage without any consequences. Additionally, informed consent was obtained from all participants before data collection commenced.

## Data Analysis and Interpretation

### Demographic Analysis of Respondents

Table 1: Demographic Profile of Respondents (N = 450)

Variable	Category	Frequency	Percentage (%)
Gender	Male	238	52.9
	Female	212	47.1
Academic Level	Undergraduate	287	63.8
	Postgraduate	163	36.2
University Type	Public University	301	66.9
	Private University	149	33.1
Linguistic Background	Urdu	158	35.1
	Punjabi	96	21.3
	Pashto	82	18.2
	Sindhi	57	12.7
	Others	57	12.7
AI Platform Usage Frequency	Daily	274	60.9
	Weekly	126	28.0
	Occasionally	50	11.1

Table 1 presents the demographic characteristics of the respondents. The findings indicated that male respondents constituted 52.9% of the sample, while female respondents represented 47.1%, reflecting relatively balanced gender participation. Undergraduate students formed the majority of participants (63.8%), indicating that AI-driven educational platforms were more commonly utilized among undergraduate learners. Public university students represented 66.9% of the sample, suggesting greater participation from public sector institutions.

Regarding linguistic background, Urdu-speaking students formed the largest group (35.1%), followed by Punjabi (21.3%), Pashto (18.2%), Sindhi (12.7%), and other regional language speakers (12.7%). The findings demonstrated substantial linguistic diversity among participants, supporting the multilingual focus of the study. Furthermore, 60.9% of respondents reported daily use of AI-driven educational platforms, indicating widespread integration of AI technologies into academic learning practices among university students in Pakistan.

### Descriptive Statistics

Table 2: Descriptive Statistics of Study Variables

Variable	Mean	Standard Deviation
AI-Driven Educational Platform Usage	4.12	0.71
Algorithmic Language Exposure	4.06	0.68
Linguistic Identity Formation	3.94	0.73
Sociocultural Influence	3.87	0.75
Perceived Linguistic Prestige	4.01	0.70

Table 2 presents the descriptive statistics of the major study variables. The mean score for AI-

driven educational platform usage was 4.12, indicating a high level of engagement with AI-

assisted educational tools among multilingual university students. Similarly, algorithmic language exposure demonstrated a high mean score ( $M = 4.06$ ), suggesting that students were frequently exposed to AI-generated linguistic patterns and communication styles.

The mean value for linguistic identity formation ( $M = 3.94$ ) reflected that AI-mediated learning environments substantially influenced students'

perceptions of language use, communicative behavior, and identity negotiation. Additionally, the mean score for perceived linguistic prestige ( $M = 4.01$ ) suggested that students strongly associated dominant languages, particularly English, with academic and professional success. The relatively moderate standard deviation values indicated consistency in participants' responses across the study variables.

### Reliability Analysis

Table 3: Reliability Statistics of Research Instrument

Construct	Number of Items	Cronbach's Alpha
AI Platform Usage	8	0.84
Algorithmic Language Exposure	10	0.88
Linguistic Identity Formation	9	0.86
Sociocultural Influence	7	0.82
Perceived Linguistic Prestige	6	0.80
Overall Reliability	40	0.87

Table 3 demonstrates the reliability analysis of the research instrument using Cronbach's Alpha coefficient. All constructs exceeded the acceptable threshold value of 0.70, indicating satisfactory internal consistency and reliability of the instrument. The highest reliability value was

observed for algorithmic language exposure ( $\alpha = 0.88$ ), followed by linguistic identity formation ( $\alpha = 0.86$ ). The overall reliability coefficient of 0.87 confirmed that the questionnaire was highly reliable for measuring the intended constructs.

### Correlation Analysis

Table 4: Correlation Matrix of Study Variables

Variables	1	2	3	4	5
1. AI Platform Usage	1				
2. Algorithmic Language Exposure	.72**	1			
3. Linguistic Identity Formation	.68**	.75**	1		
4. Sociocultural Influence	.59**	.64**	.71**	1	
5. Perceived Linguistic Prestige	.61**	.69**	.73**	.67**	1

Note:  $p < .01$

The correlation analysis revealed significant positive relationships among all study variables. Algorithmic language exposure showed a strong positive correlation with linguistic identity formation ( $r = .75$ ,  $p < .01$ ), indicating that increased exposure to AI-mediated linguistic content significantly influenced multilingual students' identity construction processes.

Similarly, AI platform usage demonstrated a strong positive relationship with algorithmic language exposure ( $r = .72$ ,  $p < .01$ ), suggesting that frequent engagement with AI-driven educational systems increased students' exposure to algorithmically generated language structures. Perceived linguistic prestige also exhibited a strong association with linguistic identity formation ( $r =$

.73,  $p < .01$ ), indicating that students' perceptions regarding language status significantly shaped

their linguistic self-concept and communicative preferences.

### Multiple Regression Analysis

Table 5: Regression Analysis Predicting Linguistic Identity Formation

Predictor Variables	B	Beta	t-value	Sig.
Constant	1.214	–	5.102	.000
AI Platform Usage	0.281	.29	4.911	.000
Algorithmic Language Exposure	0.417	.43	7.208	.000
Sociocultural Influence	0.239	.24	4.315	.001
Perceived Linguistic Prestige	0.304	.31	5.487	.000

Model Summary	Value
R	.81
R <sup>2</sup>	.66
Adjusted R <sup>2</sup>	.65
F-value	118.37
Sig.	.000

The regression analysis demonstrated that AI platform usage, algorithmic language exposure, sociocultural influence, and perceived linguistic prestige significantly predicted linguistic identity formation among multilingual university students. The model explained 66% of the variance in linguistic identity formation ( $R^2 = .66$ ), indicating substantial explanatory power.

Among the predictor variables, algorithmic language exposure emerged as the strongest predictor ( $\beta = .43$ ,  $p < .001$ ), suggesting that

continuous interaction with AI-generated linguistic content had the greatest influence on students' linguistic identity formation. Perceived linguistic prestige ( $\beta = .31$ ,  $p < .001$ ) and AI platform usage ( $\beta = .29$ ,  $p < .001$ ) also significantly contributed to identity negotiation processes. These findings indicated that multilingual students' linguistic identities were strongly shaped by AI-mediated communication patterns and sociolinguistic perceptions embedded within digital educational environments.

### Structural Equation Modeling (SEM)

Table 6: Structural Model Results

Relationship Path	Standardized Estimate	CR	p-value
AI Platform Usage → Algorithmic Language Exposure	0.74	8.91	.000
Algorithmic Language Exposure → Linguistic Identity Formation	0.69	7.84	.000
Sociocultural Influence → Linguistic Identity Formation	0.41	5.62	.000
Perceived Linguistic Prestige → Linguistic Identity Formation	0.47	6.13	.000

### Model Fit Indices

Fit Index	Recommended Value	Obtained Value
CFI	$\geq 0.90$	0.94
TLI	$\geq 0.90$	0.92
RMSEA	$\leq 0.08$	0.05
Chi-square/df	$\leq 3$	2.11

The Structural Equation Modeling results confirmed that the proposed theoretical framework demonstrated satisfactory model fit. All fit indices exceeded recommended threshold values, indicating that the structural model adequately explained the relationships among study variables.

The strongest structural relationship was observed between AI platform usage and algorithmic language exposure ( $\beta = 0.74$ ,  $p < .001$ ), demonstrating that increased utilization of AI-driven educational technologies significantly enhanced multilingual students' exposure to algorithmically generated linguistic content. Furthermore, algorithmic language exposure had a strong direct effect on linguistic identity formation ( $\beta = 0.69$ ,  $p < .001$ ), confirming the central assumption of the study that AI-mediated educational environments substantially shape students' linguistic self-perception and communicative identity.

The findings further suggested that sociocultural influence and perceived linguistic prestige significantly mediated students' identity negotiation processes within multilingual academic settings. Overall, the results established that AI-driven educational platforms functioned not only as instructional technologies but also as sociolinguistic agents influencing identity construction among multilingual university students in Pakistan.

### Discussion

The findings of the study revealed that AI-driven educational platforms significantly influenced linguistic identity formation among multilingual university students in Pakistan. The results demonstrated that algorithmic language exposure emerged as the strongest predictor of linguistic identity formation, indicating that repeated

interaction with AI-generated linguistic structures, discourse styles, and communication norms substantially shaped students' linguistic self-perception and communicative behavior. These findings align with Sociocultural Theory, which explains that identity development occurs through mediated social interaction and engagement with symbolic tools. In this context, AI-driven educational platforms functioned as digital mediational agents that influenced how multilingual learners negotiated language, meaning, and identity within academic environments.

The study further revealed that frequent usage of AI-powered educational technologies increased multilingual students' exposure to algorithmically preferred language patterns, particularly English-dominant discourse structures. This finding reflects the growing influence of AI-mediated communication in higher education, where students increasingly rely on AI systems for academic writing, translation, language correction, and information retrieval. The dominance of English-oriented algorithmic content within AI platforms appeared to reinforce perceptions of English as a prestigious and academically valuable language. Consequently, multilingual learners demonstrated tendencies to adapt their communication styles and linguistic practices according to the norms embedded within AI-generated educational content.

Moreover, the findings indicated that sociocultural influence significantly contributed to linguistic identity formation. Language in Pakistan is closely connected with social mobility, educational status, ethnicity, and cultural affiliation. The study demonstrated that multilingual students negotiated their identities by balancing institutional expectations associated with English proficiency and emotional

attachment to regional and indigenous languages. AI-driven educational environments intensified this negotiation process because algorithmic systems frequently prioritized globally dominant linguistic norms over localized cultural expressions. As a result, students experienced both opportunities for linguistic empowerment and challenges related to cultural representation within digital educational spaces.

The study also revealed a significant relationship between perceived linguistic prestige and identity formation. Students who strongly associated English with academic success and professional advancement were more likely to internalize algorithmically generated communication patterns. This finding suggests that AI-mediated educational platforms may indirectly reinforce existing sociolinguistic hierarchies within Pakistani society by privileging dominant languages in academic interaction. While AI technologies enhanced access to educational resources and facilitated multilingual engagement, they also contributed to subtle forms of linguistic homogenization that could marginalize local languages and indigenous linguistic identities.

Additionally, the findings highlighted that AI-driven educational platforms were not merely technological learning tools but sociocultural environments influencing learners' attitudes, communication styles, and identity construction processes. The strong structural relationships identified through Structural Equation Modeling confirmed that technological exposure, sociocultural influence, and perceptions of linguistic prestige collectively shaped multilingual students' linguistic identities. Therefore, the study contributes to contemporary discussions on AI-mediated communication, multilingual education, and digital sociolinguistics by emphasizing the broader sociocultural implications of algorithmic learning environments in higher education.

### **Conclusion**

The study concluded that algorithmic language exposure through AI-driven educational platforms significantly influenced linguistic identity formation among multilingual university students

in Pakistan. The findings established that continuous interaction with AI-generated linguistic content shaped students' communicative behavior, language preferences, perceptions of linguistic prestige, and identity negotiation processes within academic settings. AI-mediated educational platforms emerged as powerful sociotechnical systems that not only facilitated personalized learning but also influenced how multilingual learners perceived and positioned themselves linguistically and culturally.

The study further concluded that AI-driven educational environments reinforced dominant language structures, particularly English-oriented discourse norms, which affected multilingual students' perceptions of academic legitimacy and professional competence. Although AI technologies created opportunities for personalized learning, translanguaging practices, and increased educational accessibility, they also contributed to linguistic hierarchies and potential marginalization of regional linguistic identities. The findings highlighted that linguistic identity formation in AI-mediated environments was shaped by a combination of technological exposure, sociocultural context, institutional influence, and perceptions of language prestige.

Overall, the study demonstrated that AI-driven educational platforms have become influential agents in multilingual higher education contexts, reshaping linguistic interaction and identity construction among students. The research therefore emphasized the need for culturally responsive, linguistically inclusive, and ethically balanced AI integration within Pakistani universities to ensure that technological advancement does not undermine linguistic diversity and cultural representation.

### **Implications of the Study**

The study carries important theoretical, practical, policy, and sociocultural implications. Theoretically, the research contributes to the growing body of literature on AI-mediated communication, sociolinguistics, multilingual education, and identity formation by extending Sociocultural Theory into digital educational

contexts. The study provides a multilevel analytical understanding of how technological systems mediate linguistic identity formation among multilingual learners in developing societies.

Practically, the findings provide valuable insights for educators, curriculum designers, and higher education institutions regarding the sociolinguistic consequences of AI integration in education. Universities may utilize the findings to develop linguistically inclusive teaching strategies that balance technological innovation with preservation of multilingual diversity. Educators may also become more aware of how AI-generated content shapes students' communication styles and linguistic preferences within academic environments.

The study also holds significant implications for policymakers and educational technology developers. Policymakers may use the findings to formulate AI governance policies that address issues of linguistic inclusion, algorithmic bias, and cultural representation within digital learning environments. Educational technology developers may benefit from the study by designing AI-driven educational systems that support multilingual functionality and equitable language representation rather than privileging dominant global languages.

From a sociocultural perspective, the research highlights the importance of preserving linguistic diversity and cultural identity in rapidly digitalizing educational systems. The study emphasizes that responsible AI integration should promote multilingual engagement and culturally sensitive educational practices to avoid linguistic marginalization and digital inequality in multilingual societies such as Pakistan.

### **Future Directions**

Future research should expand the scope of investigation by conducting longitudinal studies to examine the long-term impact of AI-mediated language exposure on linguistic identity formation among multilingual learners. Since identity construction is a dynamic and evolving process, longitudinal designs may provide deeper insights into how students' linguistic behaviors and self-

perceptions change over time within AI-driven educational environments.

Future studies may also adopt qualitative or mixed-method approaches to explore learners' personal experiences, emotional responses, and identity negotiation processes in greater depth. Interviews, focus groups, and discourse analysis could provide richer sociolinguistic understanding of how multilingual students interpret and internalize algorithmically generated communication norms. Additionally, comparative studies across different countries, educational systems, and linguistic communities may help identify cultural variations in AI-mediated identity formation. Researchers may further investigate the role of specific AI technologies such as generative AI, conversational chatbots, automated translation systems, and adaptive learning platforms in shaping multilingual learners' linguistic practices and cultural affiliations.

Future research should also explore ethical dimensions of AI integration in multilingual education, including algorithmic bias, digital colonialism, data privacy, and equitable representation of indigenous languages within AI systems. Such investigations may contribute to the development of socially responsible and culturally inclusive AI-driven educational technologies.

### **Recommendations**

Based on the findings of the study, it is recommended that higher education institutions in Pakistan develop policies promoting linguistically inclusive and culturally responsive AI-mediated educational practices. Universities should encourage balanced integration of English, Urdu, and regional languages within digital learning environments to preserve multilingual diversity and reduce linguistic marginalization.

Educators should receive professional training regarding ethical and pedagogical use of AI-driven educational platforms. Such training may help teachers guide students in critically engaging with AI-generated content while maintaining authentic linguistic creativity and cultural identity.

Educational technology developers should design AI-driven platforms capable of supporting multilingual interaction and localized linguistic

representation. AI systems should incorporate regional languages and culturally relevant content to ensure equitable participation of diverse linguistic communities within educational environments.

Policymakers should establish regulatory frameworks addressing algorithmic bias, linguistic inequality, and ethical AI integration in education. National educational policies should prioritize digital inclusion and multilingual accessibility to ensure that technological advancement benefits students from diverse linguistic and socioeconomic backgrounds.

Finally, students should be encouraged to use AI technologies as supportive learning tools rather than complete substitutes for authentic communication and critical thinking. Awareness programs may help learners develop balanced and responsible engagement with AI-mediated educational systems.

#### Limitations of the Study

Despite its significant contributions, the study had several limitations. First, the research employed a cross-sectional survey design, which limited the ability to examine long-term changes in linguistic identity formation over time. A longitudinal approach could provide deeper understanding of evolving identity negotiation processes in AI-mediated environments.

Second, the study focused only on multilingual university students in selected public and private universities of Pakistan, which may limit the generalizability of findings to other educational contexts or age groups. Future studies may include school students, teachers, and learners from rural or marginalized communities to obtain broader perspectives.

Third, the study relied primarily on self-reported questionnaire data, which may be influenced by response bias, social desirability, or subjective interpretation of experiences. Combining quantitative methods with qualitative interviews and observational techniques may improve data richness and validity.

Additionally, the rapidly evolving nature of AI technologies represents another limitation because educational platforms, algorithmic

systems, and generative AI tools continuously change over time. Consequently, the findings may reflect current technological realities rather than future developments in AI-mediated education.

Finally, the study examined AI-driven educational platforms collectively rather than focusing on specific applications or tools. Future research may investigate the differential influence of individual AI technologies on multilingual learners' linguistic identity formation and communicative behavior.

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