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An Ecological Systems Analysis of University Students' ChatGPT Use in Higher Education

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ABSTRACT

Educational technology research has largely conceptualised students' ChatGPT adoption through individual-level cognitive or integrity frameworks, leaving multilevel systemic conditions undertheorised. This study applies Bronfenbrenner's ecological systems theory (EST) to examine how students at a research-intensive university in Istanbul, Turkey, comprising native Turkish speakers, international students in language preparatory programmes and proficient multilinguals, negotiate ChatGPT use across nested ecological contexts. Drawing on 43 semistructured interviews analysed through reflexive thematic analysis, five themes spanning EST's ecological levels were identified. Key findings reveal ChatGPT functioning as a relational and compensatory resource, cross-level cascades from policy ambiguity to microsystem anxiety, macrosystem linguistic ideologies producing inequitable consequences for multilingual students, and chronosystem identity transformations under policy instability. The study contributes an ecological framework with contextually grounded principles that may inform understanding of AI adoption in comparable multilingual, internationalising university contexts and points to multilevel interventions addressing policy coherence, resource equity and pedagogical transformation.

1 | Introduction

Since its public release in November 2022, ChatGPT has been adopted by university students across disciplines and national contexts at a pace that has outrun both institutional policy and scholarly understanding. Within months of its launch, researchers were documenting adoption rates, use cases and integrity concerns across diverse higher education settings (Kasneci et al. 2023). This rapid scholarly response has generated a substantial and growing body of evidence on how students engage with generative AI tools. However, a close reading of this literature reveals a persistent and consequential analytical limitation: The overwhelming majority of frameworks locate explanatory weight at the level of the individual student.

Whether framed in terms of academic integrity (Dawson 2023; Bittle and El-Gayar 2025), cognitive performance (Bhullar et al. 2024; Lim et al. 2023) or self-regulation (Baidoo-Anu and Owusu Ansah 2023), the student's disposition, motivation or ethical orientation is treated as the primary driver of behaviour. Detection tools, literacy programmes and compliance policies follow logically from this framing: If adoption is an individual-level phenomenon, then intervention must target individuals. This logic has shaped both institutional responses and research agendas in ways that are understandable given the speed of adoption, but increasingly difficult to sustain empirically.

Three converging patterns in the recent literature challenge the individualistic framing and demand a structural explanation. First, students' relationships with AI tools have been documented as fundamentally relational and affective, characterised by companion metaphors, emotional bonding and anthropomorphic attribution that cognitive frameworks were not designed to capture (Chaturvedi et al. 2023; Yin et al. 2024). Second, AI

[Correction added on 20 July 2026, after first online publication: The copyright line was changed.]

usage patterns vary systematically by institutional position, linguistic background and cultural context in ways that cannot be attributed to individual dispositions alone, suggesting that macro-level ideologies and structural conditions shape micro-level interactions (Ma et al. 2024; Crompton and Burke 2023). Third, and most significantly for the present study, institutional policy ambiguity and resource scarcity have emerged as structural drivers of adoption: Students describe turning to ChatGPT not because they prefer it but because institutional alternatives are unavailable, inaccessible or inadequate (Cotton et al. 2024; Chan and Hu 2023). Taken together, these patterns suggest that AI adoption emerges from dynamic interactions across relational, institutional, cultural and temporal forces simultaneously, a complexity that individual-level frameworks are structurally incapable of capturing.

A growing body of scholarship in education and technology studies has responded to this limitation by foregrounding the role of context in shaping technology use. Critical perspectives on AI in education have drawn attention to political economy, institutional governance and commercial forces as structural determinants of how AI is adopted and experienced (Williamson et al. 2023; Selwyn 2021). Policy-oriented research has documented how national and institutional governance frameworks shape the conditions under which students encounter AI tools (Holmes and Miao 2023; Jiang et al. 2025). Comparative cross-cultural research has demonstrated that the moral meanings students attach to AI use are not universal but are shaped by cultural frameworks about authorship, collaboration and academic authenticity (Ma et al. 2024; Cao et al. 2025). These perspectives collectively establish that AI adoption is contextually structured, but they have not yet converged on a theoretically unified, multilevel analytical framework capable of explaining how these forces interact across system levels to produce the patterns observed.

This gap is particularly visible in multilingual and internationalising university contexts, where linguistic heterogeneity adds a dimension of structural inequity that monolingual-context research does not address. When institutional AI policies are designed around monolingual assumptions, multilingual students navigate not only policy ambiguity but also the intersection of that ambiguity with linguistic vulnerability, a compounded risk that existing frameworks, whether individual-level or contextual, have not theorised (Bin-Hady et al. 2025; Du and Alm 2024). Turkish higher education, combining rapid internationalisation with structurally diverse instructional models, Turkish-medium, English-medium, bilingual programmes and TÖMER language preparation centres, offers a theoretically strategic setting in which these compounded dynamics are visible in their most developed form though the transferability of these patterns to other contexts requires direct comparative testing.

The present study addresses this gap by applying Bronfenbrenner's ecological systems theory (EST) as a multilevel analytical framework for understanding university students' ChatGPT adoption. EST's nested architecture of microsystem, mesosystem, exosystem, macrosystem and chronosystem levels provides a theoretically rigorous basis for explaining how distal institutional and cultural forces shape proximal student behaviour, a capacity that neither individualistic nor single-context frameworks possess (Bronfenbrenner 1979; Bronfenbrenner and Morris 2007). Drawing on 43 semistructured interviews with students at a research-intensive university in Istanbul, the study examines how these ecological levels interact to produce patterns of relational attachment, strategic concealment, equity differentials and identity transformation that cannot be explained at any single level of analysis.

The study contributes to higher education systems research in two interconnected ways. First, it demonstrates that AI adoption is an ecologically situated phenomenon shaped by the intersection of relational deficits, institutional failures, cultural ideologies and developmental trajectories and that effective institutional responses therefore require coordinated intervention across system levels rather than student-focused compliance measures. Second, it develops four cross-level interaction mechanisms, cascading effects, macrosystem amplification and buffering, chronosystem reorganisation and contextual congruence and incongruence, that constitute a transferable analytical vocabulary for ecological analysis of AI governance in multilingual, institutionally diverse higher education contexts.

2 | Literature Review and Conceptual Framework

2.1 | Limitations of Individualistic Models

Existing scholarship on AI in higher education clusters around two dominant but limited paradigms. Cognitive-instrumental approaches treat adoption as performance optimization (Bhullar et al. 2024; Lim et al. 2023), while integrity-centric approaches frame AI use through detection and compliance logics (Dawson 2023; Cotton et al. 2024). Although contextually sensitive studies have begun to emerge (Jiang et al. 2025), the individualistic unit of analysis persists across both strands.

Three empirical patterns reveal this framing's inadequacy. First, students' AI relationships prove fundamentally relational and affective, characterised by companion metaphors and emotional bonding that cognitive frameworks cannot capture (Kasneci et al. 2023). Second, usage patterns vary systematically by institutional position and cultural background, suggesting macrosystem ideologies shape microsystem interactions (Ma et al. 2024; Crompton and Burke 2023). Third, institutional policy ambiguity and resource scarcity function as structural forces students describe ChatGPT as compensating for insufficient resources (Cotton et al. 2024). Taken together, these patterns demonstrate that AI adoption emerges from dynamic interactions across interpersonal relationships, institutional structures and cultural contexts simultaneously, a complexity that demands multilevel analytical theory.

2.2 | Ecological Systems Theory as Analytical Framework

Bronfenbrenner's EST conceptualises behaviour as resulting from dynamic interactions across nested environmental layers (Bronfenbrenner 1979; Bronfenbrenner and Morris 2007). Increasingly applied to technology adoption in educational contexts (Crompton and Burke 2023), EST distinguishes between direct interactions, mesosystem (cross-context contradictions),

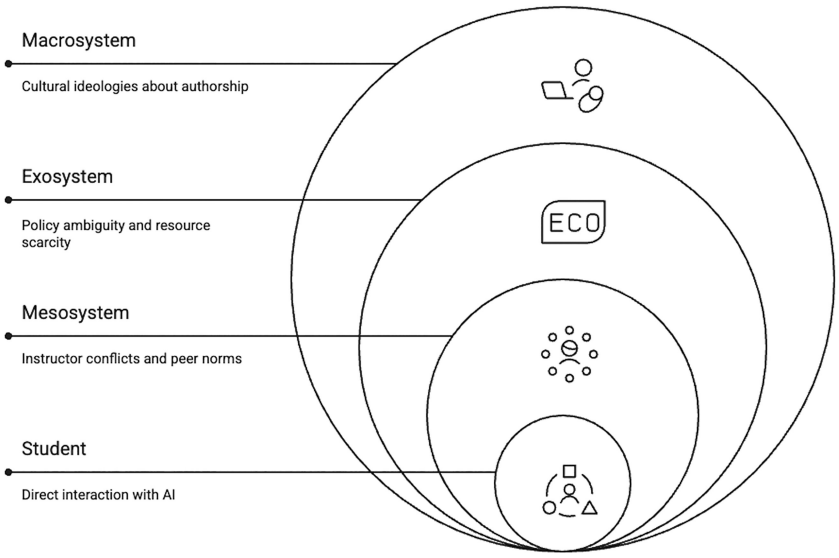

FIGURE 1 | Bronfenbrenner's ecological systems theory applied to university students' ChatGPT adoption in Turkish higher education. The nested structure represents the hierarchical relationship between ecological levels: The student's direct interaction with ChatGPT occupies the centre (microsystem), while mesosystem contradictions, exosystem policy and resource conditions, macrosystem cultural ideologies and chronosystem temporal dynamics constitute progressively distal but equally consequential forces shaping adoption patterns.

exosystem (institutional structures), macrosystem (cultural ideologies) and chronosystem (temporal change).

EST's analytical power derives from four features. First, unlike sociocultural theories analysing contexts individuals inhabit, EST explains how distal structures shape proximal experiences. The exosystem concept reveals why policy committees and budget allocations students never participate in nevertheless structure their daily anxieties and strategic adaptations (Bronfenbrenner 1979), illuminating why behavioural interventions targeting students fail when problems originate at institutional levels.

Figure 1 illustrates Bronfenbrenner's nested ecological levels as applied to university students' ChatGPT adoption in the present study, with direct student-AI interaction at the centre and progressively distal institutional and cultural forces constituting each surrounding layer.

Second, EST theorises cascading interactions across system levels. Exosystem policy ambiguity generates mesosystem contradictions (inconsistent instructor expectations), intensifying microsystem anxieties (detection fears and strategic concealment), filtered through macrosystem cultural beliefs. These cascading effects explain why international students experience heightened integrity anxieties despite lower violation rates (linguistic vulnerability intersects with policy ambiguity and deficit ideologies), why identical behaviours carry divergent moral meanings across cultures and why resource-constrained students adopt AI despite ethical discomfort.

Third, the chronosystem recognises technology relationships evolve across time with cumulative effects on identity and skill development. Students describe transformation from experimentation through increasing reliance to psychological dependency; developmental trajectories cross-sectional research misses (Bronfenbrenner and Morris 2007). Policy instability creates temporal disjunctures, particularly disadvantaging students with less institutional power to absorb volatility.

Fourth, EST foregrounds contextual (in)congruence: Alignment or misalignment across levels produces legitimacy or moral paralysis. When exosystem policies remain ambiguous while macrosystem ideologies condemn AI use and mesosystem expectations contradict, students experience profound normative confusion. Crucially, EST suggests that policy clarity, regardless of its specific content, matters more for student wellbeing than the direction of the policy itself, because consistency across ecological levels reduces the normative confusion that generates strategic concealment and academic disengagement (Jiang et al. 2025).

2.3 | Multilingual Contexts and Linguistic Equity

EST's macrosystem and exosystem levels prove valuable for analysing multilingual contexts. Academic language standards represent socially constructed rather than purely meritocratic criteria, with 'standard academic English/Turkish' functioning as privileged dialects systematically accessible to native speakers while denied to multilingual learners through inadequate institutional support (Rosa and Flores 2017; Canagarajah 2012). When universities fail to provide adequate linguistic support for multilingual students, they create exosystem resource scarcity, making AI use strategically necessary. ChatGPT functions not as optional enhancement but as compensatory infrastructure mediating basic participation, translating terminology, modelling structures and providing register guidance unavailable

from native-speaker-designed writing centres (Smutny and Schreiberova 2020; Du and Alm 2024).

This reframes AI ethics for multilingual students. Rather than framing use as misconduct, an ecological reading positions adoption as pragmatic navigation of structural inequities, a distinction with significant implications for policy design (Bin-Hady et al. 2025). Within this framework, macrosystem ideologies about linguistic authenticity interact with exosystem resource distribution to shape the risk landscape disproportionately for international students, who face amplified consequences from the same policy ambiguities that affect domestic students.

2.4 | Research Questions

Five research questions, each corresponding to a distinct level, guide this inquiry:

- RQ1 (Microsystem): How do students describe direct ChatGPT interactions, and what proximal relational, linguistic and emotional processes shape experiences?
- RQ2 (Mesosystem): How do students navigate contradictions between contexts, and how do cross-institutional inconsistencies affect usage patterns and moral interpretations?
- RQ3 (Exosystem): How do institutional policies, resource availability and administrative structures influence ChatGPT use, wellbeing and perceived equity?
- RQ4 (Macrosystem): How do cultural values regarding authorship, learning and linguistic standards shape moral interpretations across student populations?
- RQ5 (Chronosystem): How do relationships with ChatGPT evolve across academic transitions and policy changes, and what cumulative effects emerge on identity and self-efficacy?

3 | Method

3.1 | Research Design and Epistemological Positioning

This study employs an interpretive phenomenological approach combined with reflexive thematic analysis (Braun and Clarke 2021; van Manen 2016) to explore how students at a research-intensive institution in Istanbul experience ChatGPT adoption across nested ecological contexts. This aligns with our ecological framework: Student AI experiences cannot be abstracted from the institutional, cultural and temporal contexts that constitute them. Interview protocols were structured to elicit experiences across all five EST levels, with researchers actively shaping interpretation through reflexive practices (Braun and Clarke 2021).

3.2 | Research Context

The study was conducted at a research-intensive university in Istanbul, Turkey, between April and June 2025. The institution offers Turkish-medium, English-medium and bilingual programmes and operates a Turkish Language Teaching Center (TÖMER) serving international and domestic students. This multilingual environment creates differentiated ecological conditions that motivated the study's theoretical framework.

3.3 | Participants and Sampling

Participant selection employed maximum variation purposive sampling (Patton 2014) to capture diverse perspectives across disciplinary fields, academic levels, language backgrounds and ChatGPT usage patterns. The sample size ($N = 43$) was determined by information power (Malterud et al. 2016) rather than traditional saturation, as ecological diversity requires sufficient participants across multiple stratification dimensions to illuminate system-level patterns while maintaining phenomenological depth.

Participants were recruited through the following three channels: (1) email invitations sent via academic department listservs describing study purposes and eligibility criteria; (2) physical flyers posted on campus (library, student centre and TÖMER facilities); (3) limited snowball sampling wherein initial participants referred peers representing under sampled categories (e.g., PhD students and specific disciplinary fields). Of 67 initially interested, 49 met eligibility criteria and 43 ultimately participated. No compensation was provided.

3.4 | Inclusion and Exclusion Criteria

Participants were required to be currently enrolled undergraduate or graduate students who had used ChatGPT at least once for academic purposes and were proficient in English (the interview language). Nondegree visiting students and students under 18 were excluded.

3.5 | Sample Characteristics

The final sample ($N = 43$) represents strategic ecological diversity aligned with EST's multilevel framework (Table 1). Linguistic stratification was theoretically essential: Native Turkish speakers (39.5%), proficient multilinguals in English-medium programmes (34.9%) and international students developing Turkish/English proficiency through TÖMER (25.6%) each occupy distinct ecological positions. Academic level and disciplinary variations ensured representation across developmental transitions and pedagogical cultures.

3.6 | Data Collection Procedures

3.6.1 | Interview Protocol Development

The semistructured interview protocol was developed iteratively, informed by Bronfenbrenner's ecological systems theory and piloted with three students (excluded from final sample) to refine question clarity and ecological coverage. Six protocol sections corresponded to the five EST levels, with probing

TABLE 1 | Participant demographic characteristics ($N = 43$).

Characteristic	*n*	Percentage
Academic level		
Undergraduate (year 1–2) early	11	25.6%
Undergraduate (year 3–4) advanced	14	32.6%
Graduate (master's)	11	25.6%
Graduate (PhD)	7	16.3%
Disciplinary field		
Faculty of education	16	37.2%
Faculty of humanities and social sciences	12	27.9%
Faculty of communication	9	20.9%
Faculty of business	6	14.0%
Language background		
Native Turkish speaker	17	39.5%
Proficient multilingual (Turkish/English)	15	34.9%
International students developing Turkish/English proficiency	11	25.6%
ChatGPT usage frequency		
Daily/multiple times weekly	18	41.9%
Weekly/biweekly	16	37.2%
Monthly/occasional	9	20.9%
Gender identity		
Woman	24	57.1%
Man	18	42.9%
Age range	18–29 years	Mean: 22.7 years

questions to maintain conversational flow and allow unanticipated themes to emerge.

3.6.2 | Interview Procedures

Interviews were conducted by a research team consisting of the lead researcher and two trained research assistants; all completed training in phenomenological interviewing, EST concepts, ethical and cultural sensitivity protocols and data security procedures.

Interviews lasted between 62 and 94 min ($M = 78$, $SD = 11.3$). Although English was the interview language (per inclusion criteria), participants were encouraged to use Turkish when more precise; such instances were noted and translated by bilingual team members.

Interviews were conducted in private settings chosen by participants (university rooms, dormitories or Zoom). All interviews were audio-recorded using encrypted digital recorders with participant consent. Immediately following each interview, interviewers completed reflexive memos documenting initial impressions, notable emotional dynamics, potential themes and methodological reflections (Charmaz 2014).

3.6.3 | Transcription and Data Management

Audio recordings were transcribed verbatim by professional services with confidentiality agreements, then verified by research team members who added contextual notes about emotional tone, pauses and nonverbal markers (Gubrium and Holstein 2002). Transcripts were anonymised using pseudonyms (P-01 through P-43) with institutional details generalised and managed using NVivo 12 software.

3.6.4 | Ethical Considerations

Participants provided written informed consent detailing study purposes, voluntary participation, right to withdraw and confidentiality protections. Given the sensitive nature of disclosing prohibited AI use, enhanced confidentiality measures were implemented, including encrypted storage, interviewer-only identity access and password-protected linking documents. The study received ethical approval from Ibn Haldun University Ethical Committee (Approval No E-71395021-050.04-67180).

3.6.5 | Data Analysis

Data were analysed using reflexive thematic analysis (Braun and Clarke 2021), emphasising researchers' active, interpretive role in theme construction. This approach aligns with interpretivist epistemology, accommodates theoretical frameworks while remaining open to inductive emergence and supports both semantic and latent meaning dimensions essential for ecological analysis (Nowell et al. 2017).

Analysis unfolded in the following five phases over 13 weeks. (1) familiarisation involved reading all transcripts while listening to recordings and noting marginal observations in reflexive journals. (2) Structural deductive coding organised segments by EST levels (MICRO, MESO, EXO, MACRO and CHRONO). Twenty percent of transcripts ($n = 9$) were independently coded by two team members, achieving 82% initial agreement and 94% after clarifying decision rules. (3) Inductive coding identified experiential patterns within each level, generating 127 participant-grounded codes. (4) Theme development clustered codes into five primary themes with 14 subthemes, assessing coherence data fit and theoretical alignment. (5) Theme finalisation involved naming, defining and selecting representative quotes prioritising vividness and participant diversity.

Trustworthiness procedures included reflexive journaling documenting interpretive choices and biases, weekly peer debriefing interrogating analytical decisions, member reflections with six participants confirming thematic resonance and NVivo audit trails documenting decisions from raw data through final themes (Lincoln and Guba 1985; Tracy 2010). These measures address credibility, dependability and confirmability while acknowledging that the analysis represents one theoretically informed interpretation among possible others.

4 | Results

Analysis of 43 interviews generated five themes whose alignment with EST's ecological levels (Table 2) reflects a post hoc interpretive coherence rather than a predetermined analytical outcome. Themes were not produced by assigning participant data to pre-established EST categories; inductive coding of participants' language first generated 127 participant-grounded codes, organised iteratively into experiential patterns, and these empirically derived patterns were subsequently read through the EST framework, which functioned as a sensitising theoretical lens rather than a deductive template. The distinction matters because several subthemes emerged from the data in ways the framework did not anticipate and could not have generated deductively. The 'underground curriculum' of peer intelligence networks (Theme 2c), through which students collectively constructed informal knowledge-sharing systems to navigate institutional silence on AI policy, and the boundary-blurring emotional support function (Theme 1c), through which students described therapeutic-style interactions with AI that exceeded anything EST's original microsystem formulation envisaged, are analysed as findings that extend the theoretical framework rather than merely illustrate it. The account that follows presents five themes spanning the full range of EST's ecological levels, alongside four cross-level interaction mechanisms that constitute the study's primary theoretical contribution. Where themes align with EST levels, this alignment is reported as evidence of the framework's explanatory purchase, not as confirmation that the data were organised to fit it.

4.1 | Theme 1: Microsystem-ChatGPT as Intimate Learning Companion (RQ1)

4.1.1 | Relational Substitution

Students consistently described ChatGPT in relational rather than instrumental terms, employing metaphors of companionship, tutorship and intellectual partnership that positioned the technology within social rather than cognitive frameworks. P-07 (domestic Turkish student, advanced undergraduate) explained:

> 'It's like having a study buddy who's always available. I can ask the same question five different ways until I understand, and it never gets frustrated with me.'

This relational framing reflects not merely affective preference but a structural response to microsystem conditions: Instructors operate under time pressures limiting availability, while peer networks carry social costs to vulnerability. ChatGPT's perceived unconditional patience filled a relational gap that the microsystem, as currently structured, leaves unfilled. This has implications for how institutions conceptualise academic support beyond formal tutoring services.

4.1.2 | Linguistic Scaffolding

Linguistic scaffolding was the most widely reported microsystem function, particularly prominent among international students. P-23 (international student, early undergraduate)_ described:

> 'In seminars, I'm always worried is my question too basic? Will my accent make people not take me seriously? With ChatGPT, I can practice formulating my ideas privately, check if I'm using Turkish terms correctly, make sure my grammar is right before I speak in class. It's like a safe space to rehearse.'

This rehearsal function reveals a microsystem dynamic EST's original formulation did not anticipate: ChatGPT becomes an intermediate zone between private cognition and public performance. Students were not merely improving their language; they were negotiating the performance demands of the microsystem itself: checking email tone, disciplinary conventions and argument structures before exposure to faculty evaluation. For international students navigating simultaneous content mastery and language acquisition, this intermediary function was experienced as essential rather than supplementary.

4.1.3 | Emotional Regulation

Beyond cognitive and linguistic functions, many students described ChatGPT as an emotional regulation resource, a dimension largely absent from existing educational AI frameworks. P-14 (domestic Turkish student, advanced undergraduate) reflected:

> 'When I'm staring at a blank page having a panic attack about a paper due in six hours, ChatGPT helps me calm down. Just typing "I don't know how to start" and having it respond with "Let's break this down together" it's like emotional first aid.'

The students disclosed feelings of inadequacy to AI and experienced its responses 'weirdly comforting', pointing to a boundary blurring with broader chronosystem implications. As reliance on AI for emotional regulation deepens over time, students may develop patterns of support-seeking that bypass human institutional resources (counselling services and academic advisors). This is not a moral critique of the practice but an analytical observation about how microsystem-level

TABLE 2 | Thematic structure aligned with research questions ($N = 43$).

Ecological level and theme	Subtheme	Representative codes	Aligned RQ	*n*	Cross-level process
Microsystem					
Theme 1: ChatGPT as intimate learning companion			RQ1		
	Relational gap-filling	Personification; emotional attachment; 'study buddy' metaphors; unconditional availability		38	Microsystem structural deficit → relational substitution
	Linguistic scaffolding	Safe questioning; nonjudgmental interaction; private rehearsal before public performance		41	Exosystem resource scarcity → microsystem compensatory use
	Emotional support	Anxiety management; panic reduction; boundary-blurring with therapeutic function		35	Chronosystem accumulation of dependency over time
Mesosystem					
Theme 2: Cross-institutional conflicts			RQ2		
	Pedagogical inconsistency	Contradictory policies; instructor variation; structural resolution deficit		40	Exosystem policy vacuum → mesosystem contradictions
	Peer norm navigation	Informal intelligence networks; collective strategies; compensatory peer infrastructure		33	Students construct informal meso-bridge absent institutionally
	Academic integrity anxiety	Detection fear; surveillance perception; quality-suppressing adaptation		37	Exosystem ambiguity → mesosystem contradiction → microsystem behavioural inversion

(Continues)

TABLE 2 | (Continued)

Ecological level and theme	Subtheme	Representative codes	Aligned RQ	*n*	Cross-level process
Exosystem Theme 3: Institutional policy gaps			RQ3		
	Policy ambiguity	Absent guidelines; retroactive enforcement; institutional inertia vs. Adoption pace		42	Exosystem temporal mismatch cascades to all lower levels
	Resource scarcity	Absence of viable alternatives; inaccessible writing centres; wait time barriers		31	Exosystem budget decisions → microsystem compensatory adoption
	Inequitable consequences	Differential burden of proof; nonnative speaker profiling; compounded vulnerability		29	Exosystem gap × macrosystem ideology → differential microsystem risk
Macrosystem Theme 4: Cultural & ideological tensions			RQ4		
	Pedagogical philosophy divides	Authenticity debates; generational divides; pre-existing epistemological conflict made visible by AI		36	Macrosystem ideology amplifies mesosystem normative confusion
	Linguistic ideology	Native speaker privilege; socially constructed academic register; code-switching necessity		34	Macrosystem belief activates exosystem resource inequity
	Neoliberal efficiency demands	Productivity demands; time scarcity; 'survival tool' framing		32	Macrosystem conditions render AI adoption structurally necessary
Chronosystem Theme 5: Temporal Evolution			RQ5		
	Progressive workflow integration	Increasing reliance; skill atrophy concerns; default-tool shift over time		28	Chronosystem accumulation reorganises microsystem practice
	Policy transition navigation	Mid-semester changes; retroactive prohibitions; cumulative cynicism and risk-uncertainty		26	Nonnormative chronosystem disruption × exosystem inequity
	Identity reconstruction	Self-efficacy shifts; attribution uncertainty; learner identity reconstruction		30	Chronosystem × macrosystem interaction shapes identity trajectory

(Continues)

tool use can cumulatively reorganise students' institutional ecology.

4.2 | Theme 2: Mesosystem-Cross-Institutional Conflicts (RQ2)

4.2.1 | Pedagogical Inconsistency

The mesosystem level captured how contradictions between students' simultaneous institutional contexts (courses, departments and faculties) generated normative confusion that no single microsystem interaction could resolve. P-29 (domestic Turkish student, advanced undergraduate) described:

> 'My professor actively encourages ChatGPT for brainstorming. My writing instructor threatens to fail anyone using it. Same university, same semester, completely opposite rules. How are we supposed to navigate that?'

What is analytically significant here is not merely the inconsistency itself, which might be expected during any period of rapid technological changes, but the absence of any meso-level mechanism for resolution. EST predicts that mesosystem contradictions intensify when no bridging structure connects conflicting microsystems. The absence of institutional written guidelines meant students faced what might be termed a structural resolution deficit: Contradictions that could not be addressed by navigating any single relationship, because the contradiction existed precisely between relationships. STEM faculty were generally more permissive than humanities instructors, but substantial variation within fields meant disciplinary affiliation provided no reliable guidance.

4.2.2 | Academic Integrity Anxiety

Pedagogical inconsistency cascaded downward to generate pervasive integrity anxiety at the microsystem level, an exemplary instance of the cross-level cascade EST predicts. P-08 (international student, advanced undergraduate) explained:

> 'I sometimes deliberately keep mistakes in my writing because if it's too polished, it might look AI-generated. I'm intentionally submitting lower-quality work to avoid accusations. How absurd is that?'

This perverse adaptive strategy of deliberate quality suppression represents a finding with significant policy implications. Students were not simply anxious about detection; they were modifying their academic outputs in ways that directly inverted the pedagogical goals of their assignments. The cascade here is traceable: exosystem policy ambiguity → mesosystem instructor inconsistency → microsystem behavioural adaptation that undermines learning. This is precisely the multilevel dynamic that individualistic frameworks, which would frame this as a student behaviour problem, cannot capture.

TABLE 2 | (Continued)

Ecological level and theme	Subtheme	Representative codes	Aligned RQ	*n*	Cross-level process
Cross-level interactions Integrative analysis (all RQs)	Cascading effects	Exosystem ambiguity → mesosystem contradiction → microsystem anxiety	RQ2, RQ3	40	Primary cascade pathway across all linguistic groups
	Macrosystem amplification/buffering	Linguistic ideology intensifies consequences; collectivist values buffer authorship anxiety	RQ4	34	Modulates cascade effects differentially by student positioning
	Chronosystem reorganisation	Repeated policy shifts → cumulative destabilisation; AI integration alters ecological configurations over time	RQ5	28	Distinguishes normative from nonnormative transition effects
	Contextual (in)congruence	Level alignment → legitimacy; level misalignment → normative paralysis and strategic concealment	RQ2, RQ3, RQ4	37	Policy coherence across levels reduces integrity anxiety regardless of policy content

4.2.3 | Peer Norm Navigation

In the absence of formal meso-level guidance, students developed informal peer networks that functioned as a parallel information infrastructure. P-24 (domestic Turkish student, early undergraduate) elaborated:

> 'There's this informal network of students sharing information about which professors check for AI use, which detection software they use. We've essentially created an underground curriculum about how to use AI without getting caught.'

The emergence of this 'underground curriculum' is analytically notable because it represents the mesosystem generating its own informal compensatory structure in the absence of formal institutional guidance. EST's concept of mesosystem linkage typically refers to bridges between existing contexts; here, students constructed an entirely new informal context, the peer intelligence network, to perform the bridging function that institutional structures failed to provide. This informal system carried moral costs: Students expressed discomfort with the opacity it required, and the blurring of legitimate and prohibited practice left many in a state of sustained normative uncertainty.

4.3 | Theme 3: Exosystem-Institutional Policy Gaps (RQ3)

4.3.1 | Policy Ambiguity

Policy ambiguity was the most universally reported exosystem condition, illustrating how institutional structures students never directly participate in, such as policy committees, administrative decision-making processes, nonetheless penetrate every dimension of their daily academic experience. P-35 (domestic Turkish student, PhD) explained:

> 'The university keeps saying they're "developing" AI policies, but nothing's actually published. Meanwhile, professors are making up their own rules, and students are getting penalized retroactively for things that weren't prohibited when we did them.'

What P-35 describes is not simply frustration with slow institutional processes but a structural condition with specific consequences: In the absence of published guidance, enforcement authority migrated to individual instructors, producing a landscape of locally imposed rules with no coordinating logic. This is precisely the exosystem dynamic EST predicts: Institutional inaction at the policy level does not produce a neutral vacuum but actively restructures the conditions students navigate at every lower level. The retroactive penalisation P-35 references is particularly analytically significant: It transformed students' prior decisions, made in good faith under the conditions that existed at the time, into retrospective violations, generating a form of normative instability that no amount of individual caution could have prevented.

P-20 (international student, Master's) described:

> 'I used ChatGPT for an assignment in September following what the professor said verbally. In November, the professor changed their mind. Now that September assignment is being questioned. The rules changed retroactively.'

P-20's account illustrates a specific chronosystem-exosystem interaction that the data revealed consistently across participant groups: Policy instability at the exosystem level did not merely create uncertainty about future behaviour but retroactively destabilised past behaviour, placing students in a position of unresolvable normative jeopardy. The intersection of institutional inaction and individual instructor volatility created a governance environment in which compliance itself became structurally impossible, because the rules students were expected to follow were neither stable nor transparent at the point of decision. This has direct implications for how institutions understand the relationship between policy design and student integrity behaviour: What appears, from an individualistic framework, as student misconduct may more accurately reflect rational behaviour under conditions of institutionally produced normative indeterminacy.

4.3.2 | Resource Constraints

Exosystem resource allocation emerged as a structural driver of AI adoption, reframing tool use as institutional compensation rather than individual preference. P-08 (international student, advanced undergraduate) stated:

> 'The writing centre has 3-week wait times. I can't wait three weeks when my draft is due Friday. ChatGPT is available 24/7, doesn't charge, doesn't judge my accent. What am I supposed to do?'

This framing ('what am I supposed to do?') is analytically telling. The student is not rationalising a preference; they are describing an absence of viable alternatives. EST's exosystem concept illuminates why budget and planning decisions made in administrative contexts students never access determine which support services exist. The writing centre's inadequate capacity is an exosystem outcome; the student's turn to ChatGPT is a microsystem response. Individual-level frameworks locate the behaviour in the student; ecological analysis locates its origin in the institution.

4.3.3 | Inequitable Consequences

The intersection of policy ambiguity and resource scarcity produced inequitable consequences that were distributed along linguistic lines. P-26 (international student, Master's) stated:

> 'Domestic students get more benefit of the doubt. When my grammar's off, professors assume I used AI. When native Turkish speakers make similar errors, they just get feedback. Same mistake, different assumption.'

P-03 (international student, early undergraduate) described:

> 'A professor told me my paper was "too well-written for a nonnative speaker" and must be AI-generated. I had to prove I wrote it by showing drafts, outlines, research notes. Native speakers don't have to provide that documentation.'

This differential burden of proof is an exosystem phenomenon operating through macrosystem ideology: The assumption that nonnative speakers cannot produce high-quality writing is a macrosystem belief about linguistic capability; the absence of institutional policies specifying equitable evidence standards is an exosystem gap; and the micro-level interaction, the professor's accusation, is the point where these two levels intersect in the student's immediate experience.

4.4 | Theme 4: Macrosystem-Cultural and Ideological Tensions (RQ4)

4.4.1 | Pedagogical Philosophy Conflicts

Students' accounts of faculty attitudes toward AI revealed a deeper macrosystem tension: competing epistemological beliefs about what constitutes authentic learning and legitimate authorship. P-33 (domestic Turkish student, Master's) observed:

> 'Older professors see ChatGPT as fundamentally incompatible with education. They talk about "authentic" student voice. Younger instructors see it as just another tool. But nobody agrees on what "authentic" even means anymore.'

The generational divide P-33 identifies is a macrosystem phenomenon: It reflects competing cultural frameworks about knowledge production that exist prior to, and independent of, ChatGPT. What AI has done is render these frameworks visible by forcing explicit articulation of standards that previously operated implicitly. Students occupied the mesosystem between competing macrosystem orientations, required to satisfy instructors operating from incompatible epistemological positions without any institutional mechanism for resolution. This framing repositions AI's disruptive impact: The disruption is not primarily technological but ideological, and it pre-existed the technology.

4.4.2 | Linguistic Ideology

A macrosystem ideological pattern that cut across linguistic groups was the recognition of academic language standards as socially constructed rather than neutral. P-11 (international student, PhD) reflected:

> 'The assumption is that "good" academic writing sounds like native Turkish speakers. But that's not a neutral standard; it's an ideological position. ChatGPT helps me code-switch into that privileged dialect.'

P-11's articulation of 'code-switching into a privileged dialect' is analytically precise: It locates the macrosystem ideology (native-speaker-as-standard) and identifies ChatGPT as the tool that mediates access to it. Notably, both international and domestic multilingual students articulated this structural critique, suggesting that awareness of linguistic ideology is generated by the experience of navigating between language systems rather than being simply a consequence of nonnative speaker status.

4.4.3 | Neoliberal Efficiency Pressures

A third macrosystem theme involved how institutional productivity demands, characteristic of neoliberal higher education, shaped students' relationship to AI as a survival tool rather than an enhancement. P-21 (international student, early undergraduate) stated:

> 'I'm taking six classes, working 20 hours weekly, and expected to produce "excellent" work in my third language. ChatGPT isn't a luxury its survival.'

The 'survival' framing recurred across participant groups and linguistic backgrounds, suggesting it reflects a macrosystem condition: the neoliberal structuring of higher education around output volume and efficiency, rather than individual circumstances. When multiple students facing different specific pressures converge on the same survival framing, the explanation lies in the shared macrosystem they inhabit, not in their individual situations.

4.5 | Theme 5: Chronosystem-Temporal Evolution (RQ5)

4.5.1 | Technological Dependency Development

Chronosystem analysis revealed that students' relationships with ChatGPT were not static but underwent meaningful transformation over time, a dimension cross-sectional survey research systematically misses. P-16 (international student, advanced undergraduate) articulated:

> '*I worry I'm losing the ability to write without ChatGPT. Am I becoming dependent, or just efficient? I genuinely don't know.*'

P-04 (international student, early undergraduate) described:

> '*I used to brainstorm on paper, create outlines by hand. Now my first instinct is to open ChatGPT. My natural writing skills have been replaced by a collaborative human–AI process.*'

The uncertainty both students express 'am I becoming dependent, or just efficient?' is not resolvable at the individual level because it depends on how future contexts will value AI-mediated versus unassisted competencies, which is itself an exosystem and macrosystem question currently unresolved. This is an instance of chronosystem-macrosystem interaction: Students' developmental trajectories are being shaped by temporal uncertainty about future institutional and professional standards. The anxiety is not irrational; it is an accurate reading of genuine structural indeterminacy.

4.5.2 | Policy Transition Navigation

Policy instability emerged as a distinct chronosystem stressor: not simply the content of any particular policy but the cumulative effect of repeated, unpredictable change. P-09 (international student, early undergraduate) described:

> '*We were allowed to use ChatGPT for the first assignment. Then the professor prohibited it for assignment two. My entire workflow depended on it, I had to completely readjust overnight.*'

EST's chronosystem concept distinguishes between normative transitions (expected, predictable change) and nonnormative transitions (unexpected disruption). These mid-semester policy reversals represent nonnormative chronosystem events: They were unpredictable, externally imposed and required rapid reorganisation of established workflows. Crucially, the capacity to absorb such disruption was unequally distributed: Domestic students could leverage cultural capital and institutional familiarity to negotiate retroactive enforcement, while international students faced consequences (academic probation triggering visa conditions) with no equivalent buffer.

4.5.3 | Identity Transformation

The most profound chronosystem finding concerned cumulative shifts in academic identity: changes in how students understood themselves as learners and authors. P-27 (international student, Master's) reflected:

> 'I used to feel proud submitting papers I wrote entirely alone. Now I feel almost foolish like I was handicapping myself. My whole sense of what it means to be a "good student" has changed.'

P-12 (domestic Turkish student, advanced undergraduate) noted:

> 'Using ChatGPT initially made me feel more capable. But over time, I've started feeling less capable because I'm not sure which capabilities are mine and which are ChatGPT's.'

The divergence between P-27 and P-12 is analytically significant: Identical tool use produced opposite identity trajectories. P-27 reframed prior unassisted work as inefficiency, reconstructing identity around AI-integrated practice. P-12 experienced growing self-doubt as attribution became uncertain. Both trajectories are chronosystem outcomes; they accumulated over time through repeated tool use, but they were shaped by different macrosystem frameworks about what 'capability' means and different microsystem relationships with the technology. Identity transformation was not a uniform outcome but a differentiated process whose direction depended on the ecological configurations students inhabited.

4.6 | Cross-Level Ecological Interactions

Beyond level-specific dynamics, four cross-level interaction patterns constitute the study's primary theoretical contribution. Figure 2 presents the four cross-level interaction mechanisms identified in the present study, illustrating how cascading effects, macrosystem amplification and buffering, chronosystem reorganisation, as well as contextual congruence and incongruence operate as distinct but interrelated pathways through which ecological levels shape students' ChatGPT adoption patterns.

Exosystem-to-Microsystem Cascades: The most consistent cross-level pattern was the cascade from exosystem policy ambiguity through mesosystem instructional inconsistency to microsystem behavioural adaptation. Students did not simply experience policy ambiguity as an abstract institutional condition; they experienced it as detection anxiety, quality-suppressing adaptive strategies and underground knowledge networks. The cascade was traceable in participants' narratives: Students explicitly connected institutional inaction (exosystem) to instructor inconsistency (mesosystem) to their own anxious, concealment-oriented practices (microsystem). This finding is consistent with Jiang et al.'s (2025) broader observation that ambiguous institutional AI policies generate uncertainty that penetrates student behaviour at the classroom level, though the present study extends this by identifying the specific microsystem adaptations that such uncertainty produces.

Macrosystem Amplification and Buffering: Macrosystem ideological conditions did not merely coexist with other levels; they amplified or attenuated cascade effects depending on students' linguistic positioning. For international students, native-speaker-privilege ideology (macrosystem) amplified the consequences of exosystem resource scarcity: inadequate writing centre support combined with presumptions of nonnative incompetence to produce disproportionate integrity scrutiny. For native Turkish speakers, linguistic security buffered the effects of the same policy ambiguity that generated severe anxiety in international peers. Students from collectivist educational cultures more readily framed AI collaboration as normative, which buffered the moral confusion that individualist authorship frameworks intensified for others. Macrosystem beliefs thus functioned as ecological modulators: not independent causes but amplifiers and attenuators of effects originating at other levels.

Chronosystem Reorganisation: Temporal dynamics did not simply add a developmental dimension to the cross-sectional

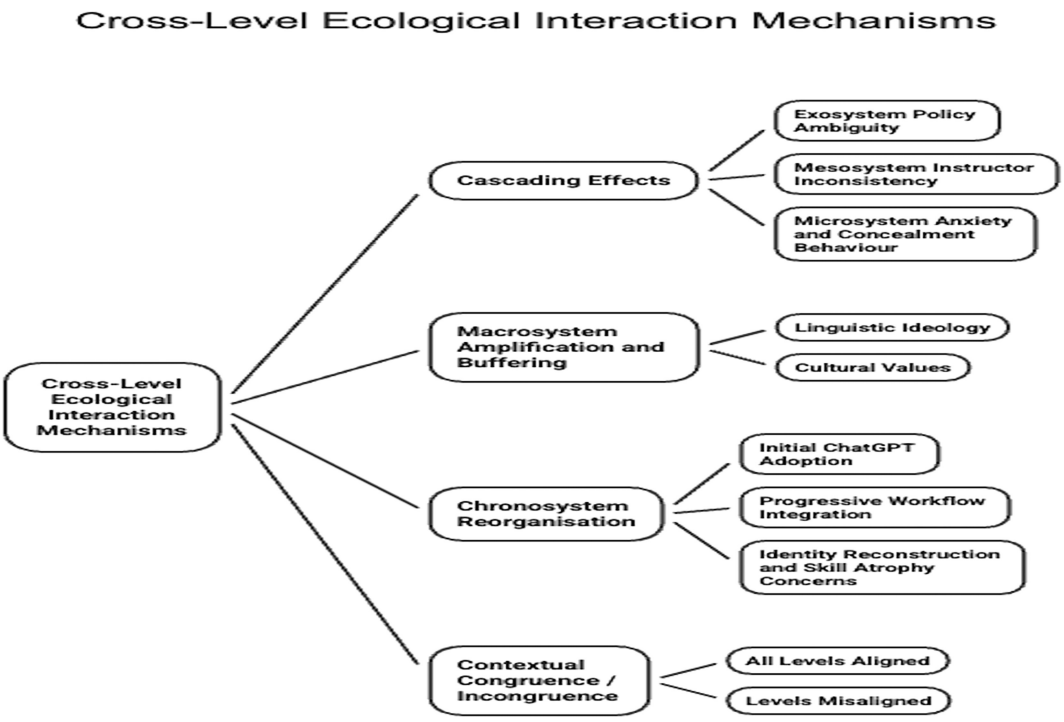

FIGURE 2 | Cross-level ecological interaction mechanisms shaping university students' ChatGPT adoption. The following four mechanisms are as follows: cascading effects (exosystem policy ambiguity flowing through mesosystem instructor inconsistency to microsystem anxiety and concealment), macrosystem amplification and buffering (linguistic ideology and cultural values modulating cascade severity), chronosystem reorganisation (temporal progression from initial adoption through workflow integration to identity reconstruction) and contextual congruence and incongruence (level alignment producing confident AI use; level misalignment producing normative paralysis), together constitute the study's primary theoretical contribution to ecological systems analysis of AI adoption in higher education.

pattern; they reorganised it. Students who had used ChatGPT extensively over multiple semesters described qualitative changes in their relationships with other ecological levels: Their microsystem interactions with the tool had become more automatic and less reflective; their mesosystem navigation of instructor expectations had become more strategic; and their macrosystem orientation to academic identity had shifted. These longitudinal reorganisations were most pronounced among international students, for whom AI use compressed language acquisition timelines and restructured the chronological sequence of academic skill development. Language learners experienced AI as a developmental accelerator; native speakers experienced it as an optional efficiency tool, a divergence that reflects not different tools but different ecological configurations.

Contextual (In)congruence: A fourth cross-level pattern concerned the effects of congruence or incongruence across levels. When multiple levels aligned (consistent instructor expectations, clear institutional policies and cultural frameworks supportive of collaborative learning), students described integrated, confident AI use with minimal moral burden. When levels misaligned (permissive instructors within prohibitive departments, supportive peer cultures in tension with institutional surveillance), students experienced normative paralysis: the inability to act confidently regardless of what they chose. This finding suggests that the content of AI policies matters less than their coherence across ecological levels. Students navigating congruent ecologies, whatever their specific rules, showed markedly lower integrity anxiety than those navigating incongruent ones.

5 | Discussion

The five themes and four cross-level interaction mechanisms identified in this study converge on a single overarching argument: University students' ChatGPT adoption is not primarily a behavioural or dispositional phenomenon but an ecologically situated response to the intersection of relational deficits, institutional failures, cultural ideologies and developmental trajectories that no single ecological level produces in isolation. The student who uses AI to rehearse seminar contributions before speaking publicly, the one who deliberately degrades the quality of their writing to avoid algorithmic detection, and the one who frames AI as a survival necessity under neoliberal productivity pressures are not exhibiting different levels of academic integrity or motivation. They are responding rationally to different configurations of the same nested ecological conditions. This insight, that identical technology produces systematically different behaviours because it is embedded in different ecological positions, is the study's core contribution to the educational AI literature, and it demands a corresponding shift in how institutions design both research and intervention. Individual-focused compliance and detection frameworks are not merely insufficient: They actively misdiagnose the problem by locating causation at the level of student behaviour when the generative conditions lie

in institutional, cultural and temporal structures students did not create and cannot individually resolve. The five discussions that follow develop this argument in relation to the broader empirical literature. Critically, they are not five parallel arguments but five dimensions of a single one: That ecological position, rather than individual disposition, is the primary determinant of how students experience, adopt and are affected by AI tools. This cumulative argument is brought together in the final section, where the cross-level interaction mechanisms identified in the study are positioned as the analytical infrastructure through which ecological position does its work.

5.1 | Repositioning AI Adoption as Ecologically Situated

Tsao (2025), examining students and teachers at a research-intensive Hong Kong university, similarly found that institutional policy ambiguity generated uneven enforcement, student concealment strategies and equity disparities. These findings suggest that the cascade from exosystem policy gaps through mesosystem instructor inconsistency to microsystem anxiety is not a Turkish-specific phenomenon; the available comparative evidence suggests it may reflect a structural dynamic worth investigating in other institutions navigating AI governance without established frameworks, though systematic cross-national evidence remains limited. Chan and Hu (2023) likewise identified resource constraints and peer norm dynamics as structural determinants of AI adoption. What distinguishes the present findings from these comparable studies is the amplifying role of linguistic heterogeneity. In more linguistically homogeneous contexts, policy ambiguity generates broadly distributed anxiety; in multilingual institutions like Turkish universities, the same ambiguity interacts with macrosystem linguistic ideologies to produce differentially distributed consequences, with international students bearing disproportionate risk. This intersection of systemic ambiguity and linguistic stratification extends Jiang et al.'s (2025) cross-national framework by demonstrating that ecological cascade effects are not uniform but are modulated by students' macrosystem positioning. Multilevel interventions must therefore be equity-sensitive, addressing how structural risk is differentially distributed across student populations.

This equity dimension is not only a feature of policy ambiguity at the institutional level; it is reproduced and intensified through the relational and affective dynamics that students develop in response to the gaps that policy ambiguity creates, the dimension the following section addresses.

5.2 | The Relational and Affective Dimensions of AI Integration

The relational and affective dimensions of AI use identified in this study find parallels in a growing body of international research. Scholars across multiple cultural contexts have documented companion metaphors and emotional bonding with AI among student populations, suggesting that anthropomorphising responsive technologies reflects a broadly distributed human tendency rather than a culturally idiosyncratic pattern (Chaturvedi et al. 2023; Turkle 2011). However, the emotional functions AI served in the present study were more ecologically embedded than this literature suggests: Students did not value ChatGPT's relational quality in the abstract but specifically because it filled gaps in instructor availability, peer safety and institutional support that their specific ecological configurations created. The affective attachment was a structural response, not a personality trait.

This structural interpretation extends the relational AI literature by specifying the ecological conditions under which affective bonding intensifies. Studies from well-resourced institutional contexts tend to document AI use primarily in terms of productivity and task completion rather than relational attachment (Stöhr et al. 2024; Chan and Hu 2023). This pattern is consistent with the present study's proposition that relational depth may be inversely related to the adequacy of institutional human support, though this relationship requires direct longitudinal testing. Future research should examine this proposition comparatively across institutions with varying resource profiles.

Understanding why students develop relational attachments to AI tools requires, in turn, understanding how cultural and linguistic positioning shapes what those tools mean, and what moral weight their use carries, which is the concern of the following section.

5.3 | Cultural and Linguistic Heterogeneity in Technology Meaning-Making

The finding that macrosystem cultural values shape the moral meaning of identical AI practices resonates with comparative cross-cultural research, while also adding specificity that such research has lacked. Collectivist orientations have been associated with more positive evaluations of collaborative AI use, attributed to cultural comfort with collectively produced rather than individually authored knowledge (Cao et al. 2025; Ma et al. 2024). The present study corroborates this pattern within a single multilingual institutional context, in that students from Turkish, Central Asian and East Asian educational backgrounds expressed less authorship anxiety than those from Western European traditions. However, an important qualification emerges: Cultural orientation alone did not determine AI meaning; it interacted with linguistic positioning.

International students did not simply hold collectivist values that reduced authorship anxiety; they occupied exosystem positions of resource scarcity and linguistic vulnerability that made AI structurally necessary, regardless of their cultural orientation. Native Turkish speakers holding individualist authorship values experienced authentic-voice anxiety; those holding collaborative values did not. Cultural orientation thus functioned as a macrosystem modulator operating in interaction with exosystem positioning, not as a deterministic cause. This qualification matters for the cross-cultural AI literature: Studies that attribute differential AI attitudes purely to cultural values risk obscuring the structural conditions

that activate or suppress those values in practice (Du and Alm 2024; Bin-Hady et al. 2025). An ecological reading of cross-cultural AI research would attend to both the cultural values students bring and the institutional ecologies within which those values are activated.

The interaction between cultural positioning and institutional structure does not operate only at a single point in time; it unfolds across the duration of students' engagement with AI tools, accumulating in ways that cross-sectional research cannot detect, and which the following section examines through the chronosystem lens.

5.4 | Temporal and Developmental Dimensions of AI Integration

The chronosystem findings contribute to an emerging literature on the longitudinal dynamics of AI adoption that cross-sectional research cannot access. Existing studies document initial adoption patterns and perceptions but are not designed to track cumulative developmental effects (Baidoo-Anu and Owusu Ansah 2023; Hua and Cunningham 2025). Even the most methodologically advanced longitudinal study available acknowledges that two measurement points cannot capture the continuous evolution of students' AI relationships over time (Polyportis 2024). The present study's retrospective accounts suggest three temporal dynamics that deserve longitudinal investigation: progressive workflow integration, where AI shifts from optional supplement to workflow-embedded default; identity reorganisation, where students' conceptions of their own capabilities are restructured around human–AI collaboration; and policy volatility effects, where repeated mid-semester changes produce cumulative cynicism and risk-aversion independent of the content of any specific policy. This last finding has not been reported in the cross-national literature to our knowledge and may reflect the Turkish higher education context's particular phase of institutional adaptation to generative AI. This phase is characterised by rapid, uncoordinated policy change that other systems have since moved beyond or not yet reached.

The differential absorption of policy volatility across student groups, with international students facing visa-contingent consequences that domestic students did not, represents an interaction between chronosystem instability and exosystem structural inequity that existing temporal frameworks do not theorise. EST's chronosystem concept was originally developed for developmental psychology contexts where normative and nonnormative transitions were relatively well-defined. Applied to rapidly evolving technological and policy environments, the concept requires extension to accommodate institutional volatility as a distinct category of chronosystem stressor. This extension represents one of the study's contributions to EST theory itself, beyond its application to educational AI research.

The theoretical extension proposed here, accommodating institutional volatility as a distinct chronosystem stressor, is one component of a broader analytical contribution the study makes: the identification of four cross-level mechanisms that explain not merely that ecological levels interact but precisely how they do so, and with what consequences for student behaviour and wellbeing. It is to these mechanisms, and their implications for the field, that the final section turns.

5.5 | Cross-Level Ecological Interactions and Systemic Intervention Logic

The cross-level interaction mechanisms identified in this study (cascading effects, macrosystem amplification and buffering, chronosystem reorganisation and contextual incongruence) contribute an analytical vocabulary that the educational AI literature currently lacks. Existing multilevel studies of AI in higher education (Tsao 2025; Crompton and Burke 2023) identify that contextual factors matter but do not theorise the mechanisms by which they interact. The present study proposes that these four mechanisms may transfer analytically beyond the Turkish context, though direct comparative evidence is needed before strong claims can be made. Multilingual, institutionally diverse higher education environments undergoing rapid AI governance development may exhibit cascade, amplification and contextual incongruence dynamics, even if the specific cultural content of the macrosystem differs. The Turkish context provided particularly visible instances of these mechanisms due to its simultaneous navigation of multilingualism, internationalisation and AI governance. Whether analogous dynamics operate in other internationalising university systems is a question this study raises rather than resolves, and one that comparative research should treat as an empirical rather than an assumed connection.

The four cross-level interaction mechanisms identified in this study, cascading effects, macrosystem amplification and buffering, chronosystem reorganisation and contextual congruence and incongruence, do not operate independently. They constitute an integrated ecological system in which each mechanism activates, modulates and is modulated by the others. Cascades originating in exosystem policy ambiguity are amplified or attenuated by macrosystem cultural positioning, their effects accumulate through chronosystem reorganisation over time and the experience of that accumulation is shaped by whether the ecological levels students inhabit are mutually reinforcing or contradictory. What this study demonstrates, across all five themes and all four mechanisms, is that students are not passive recipients of these conditions but active navigators of them, constructing informal peer infrastructures where formal guidance is absent, developing relational attachments to AI tools where human support is unavailable, and reconstructing their academic identities in response to normative instability that no individual decision could have prevented. The ecological framework developed here accounts for this active navigation without reducing it to individual agency, because the conditions being navigated are structural. For the field of educational AI research, this has a clear implication: Studies that examine what students do with AI tools without examining the ecological configurations that make those tools necessary, available or prohibited will continue to misattribute structural effects to individual causes. Accounting for students' ecological positioning is therefore

not a methodological refinement but a theoretical prerequisite for understanding AI adoption in higher education.

6 | Practical Implications

The ecological analysis yields four grounded implications for institutional policy and pedagogical practice, relevant to Turkish universities and comparable multilingual, internationalising institutions.

The most urgent implication concerns institutional policy. The cascade from exosystem policy ambiguity through mesosystem inconsistency to microsystem anxiety and concealment, documented consistently across participant groups, demonstrates that the absence of transparent, institution-wide AI guidance is not a neutral condition but an active structural harm. Institutions should move beyond instructor-level discretion toward policies that operationalise three principles in an integrated, prospective framework: contextual appropriateness, which acknowledges that AI acceptability varies meaningfully by assignment type and learning objective; transparency, which requires disclosure when AI has substantially shaped a piece of work; and linguistic equity, which recognises that multilingual students perform differentiated linguistic labour that monolingually designed policies systematically misread as misconduct. Guidelines meeting these criteria should be published centrally, available in multiple languages and applied prospectively rather than retroactively, so that students can make genuinely informed decisions rather than managing retrospective risk.

A second and closely related implication concerns academic support infrastructure. The finding that students consistently frame ChatGPT in compensatory rather than supplementary terms, filling gaps left by inaccessible writing centres, inadequate disciplinary language support and insufficient tutoring availability, reframes the ethical question of AI use in higher education: The relevant question is not only why students turn to AI, but what institutional conditions have rendered AI the only available resource. For linguistically diverse institutions, this demands coordinated investment in multilingual writing support staffed by specialists in both Turkish and English academic literacy, enhanced TÖMER curricula that incorporate discipline-specific language preparation rather than general proficiency alone and expanded peer tutoring capacity operating on timescales compatible with actual assignment deadlines. Without this infrastructure investment, even well-designed AI policies risk displacing the conditions driving adoption rather than addressing them.

Third, the relational and affective dimensions of AI use identified in this study point toward the need for pedagogical transformation that extends well beyond technology management. Students described turning to ChatGPT for nonjudgmental questioning, emotional regulation and rehearsal of ideas before public academic exposure, all functions that reflect genuine gaps in the relational fabric of their learning environments rather than simply preferences for digital convenience. Addressing these gaps requires faculty development focused on creating low-stakes questioning cultures that reduce the social cost of foundational enquiry, assessment redesign that values iterative process-based portfolios over single-submission final products, and the explicit validation of multilingual students' linguistic repertoires, including code-switching, as legitimate academic practice rather than evidence of deficit. These are pedagogical changes, not technology policies, and they address causes rather than symptoms of AI dependency.

Fourth, the cultural and ideological heterogeneity in AI meaning-making documented across participant groups points toward the need for AI literacy education that cultivates reflective, contextually sensitive judgement rather than framing AI governance primarily through a compliance and detection lens. Such curricula should be delivered through integrated mechanisms, including first-year seminars, discipline-specific workshops and reflective assignment components, rather than as standalone interventions, and should be designed with the cultural diversity of the student body explicitly in mind. The finding that collectivist and individualist orientations produce genuinely different but not epistemologically inferior approaches to authorship and collaboration (Jiang et al. 2025) implies that literacy programmes built around a single normative framework risk reinforcing the macrosystem inequities this study has documented. Effective AI literacy education validates multiple epistemic orientations while building shared capacity for transparent, contextually appropriate decision-making about tool use.

These four interventions are most effective when implemented coordinately: Policy coherence without expanded infrastructure risks displacing rather than resolving the conditions driving AI adoption; infrastructure investment without pedagogical transformation leaves the relational and affective dimensions unaddressed. An ecological approach to AI governance recognises that no single intervention, however well-designed, can substitute for coordinated action across multiple system levels.

7 | Limitations and Future Directions

This study's contributions must be understood within five methodological constraints that suggest future research directions. First, examining a single research-intensive institution in Istanbul limits transferability to other institutional types and national contexts. The specific configuration of Turkish-medium instruction, English-medium instruction and the university's language preparation program may not represent Turkey's heterogeneous higher education landscape or institutions with different linguistic profiles and internationalisation trajectories. Future research should examine AI experiences across diverse institutional settings, including technical universities, private versus public institutions and regional variations. Comparative international studies are also needed to explore how educational philosophy, language policy and support infrastructure shape ecological dynamics.

Second, the qualitative phenomenological approach prioritises experiential depth over statistical generalisability. The 43-participant sample cannot establish the prevalence of identified patterns across larger populations. Mixed-methods designs combining phenomenological interviews with surveys could quantify patterns while preserving nuanced understanding, and longitudinal designs tracking students across semesters would

illuminate chronosystem developmental processes more fully than cross-sectional data.

Third, this study centred student perspectives without systematically examining faculty, administrator or support staff viewpoints. Multiperspectival research examining how various stakeholders interpret AI challenges, negotiate policy development and implement pedagogical responses would reveal convergences and divergences informing multilevel interventions. Fourth, the pace of generative AI development means that specific tool affordances described here may evolve rapidly. Longitudinal and technology-tracking designs will be necessary to understand how ecological dynamics shift as new capabilities emerge and institutional responses mature.

Fifth, this study examined AI use through self-report without direct observation of interactions or analysis of AI-mediated products. Future research incorporating prompt analysis and comparisons of AI-assisted versus unassisted writing would triangulate subjective accounts with behavioural evidence. A sixth limitation is that, while sampling captured linguistic diversity, systematic cross-group comparison was not the primary analytical focus. Future research should explicitly test whether ecological patterns operate identically or differentially across linguistic positions, a question this study raises but does not fully resolve.

8 | Conclusions

This study contributes an ecological framework for understanding university students' ChatGPT adoption, one that positions technology use as a response to nested systemic conditions shaped by intersecting relational, institutional, cultural and temporal forces. Applying Bronfenbrenner's ecological systems theory to a multilingual, internationalising Turkish university context, the findings demonstrate that these forces produce patterns of relational attachment, strategic concealment, equity differentials and identity transformation whose origins lie in ecological configurations rather than individual characteristics.

The practical corollary is that effective institutional responses to AI adoption require coordinated intervention across ecological levels (policy coherence, resource investment, pedagogical transformation and AI literacy) rather than student-focused compliance and detection measures. The Turkish context, characterised by rapid internationalisation and linguistic diversity, provides a particularly transparent view of ecological dynamics whose presence in other multilingual higher education systems undergoing AI governance development is a theoretically plausible but empirically open question. The analytical framework developed here is offered as a tool for investigating that question comparatively, not as evidence that the specific patterns documented have been confirmed elsewhere.

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Disclosure

During the preparation of this work, the authors used Grammarly AI in order to enhance fluency and maintain an academic tone. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Ethics Statement

The study received ethical approval from an Ibn Haldun University Ethical Committee (Approval No E-71395021-050.04-67180). The participants provided their written informed consent to participate in this study.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author, T.N.

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