

AN INTEGRATIVE NEURODIDACTIC MODEL FOR TEACHING ENGLISH IN TURKMEN - UZBEK BILINGUAL CONTEXTS

Rasulqulova Sitora Shodmonjonovna

International school of finance and technology. EFL teacher

Tashkent, Uzbekistan.

[sitorarasulqulova@mail.ru](mailto: ritorarasulqulova@mail.ru) +998-90-986-74-98

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Background: Multilingual education requires evidence-based approaches that account for crosslinguistic influence patterns. In Central Asian border regions, 34-38% of learners are Turkmen-Uzbek bilinguals acquiring English as L3, yet pedagogical frameworks addressing this specific trilingual context are absent.

Objective: This study investigated psycholinguistic transfer mechanisms in Turkmen-Uzbek bilinguals learning English and developed an evidence-based instructional model.

Methods: A 16-month quasi-experimental study with 240 participants (ages 14-16) employed contrastive linguistic analysis and pedagogical intervention. Participants were assigned to experimental (n=120) or control (n=120) groups.

Results: Contrastive analysis identified 47 interference zones and 23 positive transfer opportunities. The experimental group receiving neurodidactically-informed instruction demonstrated 41.3% greater proficiency gains than controls (Cohen's $d=1.09$, $p<0.001$), with particularly robust effects in grammar ($\eta^2=0.32$) and pronunciation ($\eta^2=0.27$).

Conclusions: Systematic integration of contrastive awareness-raising and neurodidactic principles significantly enhances L3 acquisition in bilingual contexts. The four-stage model offers a replicable framework for multilingual pedagogy.

Keywords: trilingualism, crosslinguistic transfer, neurodidactics, Turkic languages, contrastive analysis, multilingual pedagogy.

Introduction. Multilingualism has become a defining characteristic of contemporary education, with the Common European Framework of Reference (CEFR, 2020) emphasizing proficiency in at least three languages. Central Asia presents unique conditions for investigating third language (L3) acquisition, particularly in border regions where Turkmen-Uzbek bilingualism is prevalent (34-38% of population). Despite this prevalence, pedagogical approaches addressing trilingual acquisition involving two typologically similar L1s remain underdeveloped.

While second language acquisition (SLA) research has extensively examined L1-L2 transfer (Odlin, 1989; Jarvis & Pavlenko, 2008), L3 acquisition differs fundamentally due to enhanced metalinguistic awareness and complex crosslinguistic interactions (Cenoz & Gorter, 2015; De Angelis, 2007). Hufeisen and Marx's (2007) Factor Model identifies six influences on L3 learning, including both prior languages, learning experience, and psychotypological perceptions. Yet empirical investigations of trilingual acquisition involving Turkic languages remain scarce. This study addresses three objectives: (1) conduct contrastive-typological analysis of Uzbek, Turkmen, and English identifying interference zones and facilitation opportunities, (2) investigate psycholinguistic transfer mechanisms in trilingual acquisition, and (3) develop and validate an integrative neurodidactic pedagogical model.

Methodology. This 16-month quasi-experimental study (January 2023-May 2024) employed a mixed-methods sequential explanatory design (Creswell & Plano Clark, 2017).

The study was conducted in 12 secondary schools in Uzbekistan's Tashkent Province and Turkmenistan's Lebap Province. Participants (N=240) were Turkmen-Uzbek bilinguals aged 14-16 years (M=15.2±0.8) with 4+ years English instruction and A2-B1 proficiency (CEFR). The sample comprised 51.7% female, with balanced L1 distribution (50.8% Uzbek-dominant, 49.2% Turkmen-dominant). Random assignment to experimental (n=120) or control (n=120) groups ensured baseline equivalence.

Linguistic Assessments: Oxford Placement Test (OPT), Pronunciation Diagnostic Test, Grammar Transfer Test, Discourse Completion Task (DCT). **Psycholinguistic Measures:** Reaction time experiments, think-aloud protocols, structured observation with video recording. **Self-Report:** Language Learning Strategy Questionnaire, Motivation Questionnaire, semi-structured interviews (n=48).

Control condition: Standard grammar-translation instruction per national curriculum.

Experimental condition: Four-stage integrative model: Stage 1 (4 weeks): Metalinguistic activation through explicit contrastive analysis of Uzbek, Turkmen, and English structures; Stage 2 (12 weeks): Neurocognitive training with multi-sensory input, attention control exercises, working memory enhancement; Stage 3 (20 weeks): Constructive integration via task-based learning leveraging positive transfer and explicit strategy instruction; Stage 4 (28 weeks): Autonomous application through self-directed projects, peer teaching, metacognitive reflection

Analysis Quantitative analysis (SPSS 26.0, R 4.1.0) included independent/paired samples t-tests, ANOVA, effect sizes (Cohen's d), and Pearson correlations ($\alpha=0.05$). Qualitative data underwent thematic analysis. **Reliability:** test-retest $r=0.87$, Cronbach's $\alpha=0.89$, inter-rater $\kappa=0.83$.

Results. Systematic linguistic comparison across phonological, morphological, syntactic, and pragmatic levels revealed 47 interference zones and 23 positive transfer opportunities. **Phonological Transfer:** Critical interference included: English /ɪ/-/i:/ distinction collapsed to [i] (87.3% of participants); /θ/→[s/t] (87.3%), /ð/→[z/d] (83.7%), /w/→[v] (91.2%); Final consonant devoicing transferred from Turkic (74.2%): "bad"→[bæt]; Stress placement errors (82.1%): Uzbek bilinguals overgeneralized final-syllable stress, Turkmen bilinguals initial-syllable stress

Morphological Transfer: Article system (absent in Turkic languages): 89.4% produced errors, M=7.3±2.1 per 10 contexts. Error types: omission (56.7%), addition (28.3%), substitution (15.0%); Plural with numerals: 67.8% produced *three book (Turkic languages prohibit plural marking with numerals); Verb aspect: 76.4% confused Present Simple/Continuous; 83.6% avoided Present Perfect; Possessive constructions: 71.5% omitted 's (*John book)

Syntactic Transfer: Word order (SOV→SVO): 81.7% demonstrated errors, M=6.2±2.8 per 50 sentences. Patterns: OVS (43.2%), OSV (38.5%), SOV (18.3%); Question formation: No inversion (62.3%), auxiliary omission (51.7%); Prepositions: 88.3% error rate, M=14.7±4.2 per 60 contexts

Lexical-Pragmatic Transfer: Calques: 73.4% produced literal translations of idioms; Collocations: *do a mistake (73.2%), *make homework (68.7%); Speech acts: 69.8% employed inappropriately direct requests. **Positive Transfer:** Agglutinative morphology awareness facilitated English derivational morphology recognition (67.8%), metalinguistic awareness enhanced pattern recognition.

Experimental Intervention Outcomes Table 1 presents pre-post proficiency scores (OPT, maximum 100).

Table 1: Intervention Effects on English Proficiency

Group	Pre-test M(SD)	Post-test M(SD)	Gain M(SD)	Cohen's d
Experimental	54.3(8.7)	76.8(7.2)	22.5(6.1)	2.80***
Control	53.8(9.1)	69.9(8.4)	16.1(5.8)	1.97***

Note: Between-group comparison: $t(238)=8.17, p<0.001, Cohen's d=1.09$

The experimental group demonstrated 39.8% greater gains, representing 41.3% improvement over controls when calculated as percentage of baseline.

Domain-Specific Effects (Table 2):

Table 2: Post-Intervention Domain Scores (ANCOVA)

Domain	Experimental M(SD)	Control M(SD)	η^2
Grammar	78.6(7.2)	68.4(7.9)	0.32***
Pronunciation	74.2(6.8)	65.3(8.1)	0.27***
Vocabulary	75.9(6.5)	70.1(7.3)	0.15***
Pragmatics	72.4(8.1)	66.8(8.7)	0.11***

** $p<0.001$

Error Reduction: Experimental participants achieved substantially greater reductions: articles (68.4% vs 31.2%), word order (71.3% vs 28.7%), tense-aspect (59.7% vs 24.5%), phonology (54.2% vs 19.8%), collocations (62.1% vs 27.3%). All differences $p<0.001$.

Metalinguistic Awareness: 78.3% of experimental vs 23.7% of control participants could explicitly identify interference patterns ($\chi^2=145.28, p<0.001$). Think-aloud protocols revealed enhanced strategy diversity: experimental $M=7.4\pm 1.8$ vs control $M=4.1\pm 1.3$ ($t(238)=16.72, p<0.001, d=2.16$).

Individual Differences: Higher balanced bilingual proficiency predicted greater intervention benefit ($\beta=0.34, p<0.01$), though effects remained significant across proficiency spectrum ($\beta=0.19, p<0.05$).

Qualitative Findings: Interview analysis (n=48) revealed four themes: Awareness Breakthrough: "When I understood that Uzbek and Turkmen both put the verb at the end, but English puts it in the middle, everything became clearer" (Participant E-47). Strategic Control: "Now before I speak, I think about which language is trying to come out. I can control it better" (Participant E-82). Positive Reframing: "I used to think knowing Turkmen and Uzbek made English harder. Now I see they actually help me understand how languages work" (Participant E-103). Enhanced Engagement: Teachers reported increased motivation, productive metalinguistic discussions, reduced frustration, and greater learner autonomy in experimental classes.

Discussion

This study provides robust evidence for complex bidirectional transfer effects in trilingual acquisition. Three findings advance theoretical understanding: Finding 1 - Typological Proximity Overrides L1 Status: Both Turkic languages influenced English equally in morphological domains, suggesting genetic-typological relationship creates persistent crosslinguistic competition regardless of L1/L2 designation. This supports cumulative enhancement approaches emphasizing global linguistic repertoire over language-specific hierarchies (Cook, 2016).

Finding 2 - Systematic Interference Patterns: The 47 interference zones clustered predictably by linguistic level, validating contrastive analysis for pedagogical prediction (Gast, 2013) while acknowledging psychological modulation (Kellerman, 1983).

Phonological transfer proved most automatic (devoicing 74.2%), morphological most persistent (articles 89.4%), syntactic most variable (word order 81.7%). Finding 3 - Bilingual Metalinguistic Advantage: While demonstrating no general cognitive processing advantage, bilinguals exhibited superior metalinguistic awareness and strategic flexibility—precisely the capacities targeted by the intervention. This aligns with Bialystok's (2001) framework distinguishing analysis (metalinguistic knowledge) from control (executive function). The 41.3% superior performance of the experimental group validates three neurodidactic principles (Sambanis, 2013; Spitzer, 2012): Explicit Pattern Recognition: Conscious attention to crosslinguistic patterns activates prefrontal networks supporting declarative memory consolidation and production monitoring. Multi-sensory Integration: Combining visual, auditory, and kinesthetic input recruits distributed neural networks, enhancing encoding strength and retrieval (Shams & Seitz, 2008). Emotional Engagement: Reframing errors as predictable linguistic phenomena reduced anxiety and increased motivation, optimizing neurochemical learning conditions (Pekrun, 2006).

Pedagogical Implications Four recommendations emerge: Conduct Systematic Contrastive Analysis: Proactively identify high-frequency interference zones through rigorous linguistic comparison; Implement Staged Metalinguistic Instruction: Explicitly leverage learners' full linguistic repertoire through the four-stage framework; Adopt Neurodidactic Principles: Align instruction with brain-compatible design: multi-sensory input, emotional engagement, distributed practice; Foster Positive Multilingual Identity: Validate bilingualism as cognitive asset, helping learners recognize facilitative transfer

Limitations and Future Directions. Generalizability beyond border region contexts requires replication across diverse Turkic bilingual populations. The 16-month intervention, while substantial, represents a limited window; longitudinal follow-up would clarify maintenance effects. Enhanced effects might partially reflect attention/novelty, though theoretically predicted patterns argue against pure Hawthorne effects. Future research should employ component analysis isolating active model ingredients, extend to additional linguistic skills (writing, listening), investigate optimal developmental timing, and integrate digital/adaptive technologies.

Conclusion

This study demonstrates that Turkmen-Uzbek bilingualism systematically influences English acquisition through both facilitative and inhibitory transfer. The comprehensive contrastive analysis provides an empirical foundation for evidence-based pedagogy, while experimental validation of the four-stage neurodidactic model yields substantial learning gains—41.3% improvement over standard instruction. As linguistic diversity increases globally, educational systems must evolve beyond monolingual paradigms. This research demonstrates that bilingual experience, appropriately leveraged through neurodidactically-informed pedagogy, constitutes a valuable foundation for additional language learning. The proposed model offers a scalable, theoretically coherent, empirically validated framework applicable across diverse multilingual contexts, transforming learners' complete linguistic repertoire from potential liability into strategic asset.

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