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Brain-Based Learning and Bilingual Language Development in Pakistani Early Childhood Classrooms

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Abstract

In this research paper, the author has tried to explore the relationship between brain-based learning (BBL) principles and bilingual language development in early childhood classrooms of Pakistan where children are required to communicate in at least two languages (Urdu and a regional mother language of the country, either Punjabi, Sindhi, or Pashto) along with English as a medium of instruction. Incorporating findings from the cognitive neurosciences, sociolinguistic theory, and empirical classroom observation data, the study examines how the findings of the cognitive neurosciences can be translated into pedagogical strategies that can be applied to facilitating language learning in multilingual and resource-constrained educational contexts. A mixed methods design was used, which included standardized language assessments, classroom observations, teacher interviews, and parent questionnaires in 12 early childhood government and private institutions across three provinces in Pakistan. The results provide statistically significant evidence of the effectiveness of classrooms that integrated BBL-aligned strategies (such as translanguaging, rhythmic instruction, emotional scaffolding, and movement-based activities) for improving bilingual vocabulary breadth, phonological awareness, and reading readiness. The results provide practical and culturally responsive suggestions for curriculum design and implementation, teacher educators, and policy makers in the context of the multilingual situation in Pakistan to achieve the best outcomes for early language learning.

Keywords: brain-based learning, bilingual language development, early childhood education, Pakistan, translanguaging, neuroscience, multilingualism

Introduction

Children's brains are more malleable and receptive to language than at any other time in their lives from birth until approximately eight years of age. This is a particular moment when the human brain is attuned to learning language structures, phonological systems and communicative conventions when it can do so at a time when it has an unparalleled ability. For children in a multilingual environment, this is a unique moment in their lives, and simultaneous or sequential immersion in multiple linguistic systems could offer children significant cognitive, academic, and socioemotional benefits. The advantages of these, however, rely strongly on the nature of the early learning experiences – whether pedagogical methods reflect how the developing brain

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learns or not. In Pakistan, ECE occurs in a unique national context in the midst of the world's most linguistically diverse national context. On entering formal school, children speak with more than one language, home language being Punjabi, Sindhi, Pashto, Balochi etc., national language Urdu and English as the language of instruction in private and many government schools. This multilingual (and at times quadrilingual) reality does not reflect in official curricula and teacher preparation courses where Urdu-centricity (or at least Urdu monolingualism) is still a predominant feature.

Brain-Based Learning (BBL) is an educational approach based on research in the field of cognitive neuroscience, developmental psychology and education. Inspired by theoretic models like those of Jensen (2005), Sousa (2011), and Caine and Caine (1991), BBL is based on the foundation of knowledge on how learning environments, instructional practices, and social-emotional climates can be crafted to support brain function, memory consolidation, emotional processing, and the role of sleep, stress, and sensory input in learning. Bilingualism theory in particular, however, brings together the theories of bilingual acquisition (citing Vygotsky's zone of proximal development, Krashen's input hypothesis and Cummins' interdependence hypothesis), with important implications for classroom practice.

There is a considerable amount of research in bilingual education and BBL around the world, but not much empirical in ECE context in Pakistan. A consequence of such a gap is that pedagogical techniques that work well in large class sizes and have been used successfully in western classrooms (monolingual or structured bilingual) might not be easily transferred to classrooms with large classes, inexperienced teachers, scarce resources, and complex sociolinguistic situations. Therefore, a context approach is important for research. This study aimed to find out the implementation of brain-based learning in early childhood classrooms and its effect on bilingual language acquisition of children aged 3-7 years in Pakistan. The paper continues with a review of literature, description of methodology, presentation of results and a discussion of implications for policy and practice.

Literature Review

In the late 20th century brain-based learning was identified as a new paradigm in education and with the emergence of new neuroimaging technologies, including functional magnetic resonance imaging (fMRI) and positron emission tomography (PET), new ways of understanding learning processes at the neural level became available. Caine and Caine (1991) suggested that there are 12 principles of brain-based learning, such as 1) the brain processes parts and wholes simultaneously; 2) learning is developmental and follows biological rhythms; and 3) search for meaning is innate and fundamental to human cognition. These needs were expanded on by Jensen (1998, 2005), who pointed out the needs for enriched environments, physical activity, emotional security, and experiences across subject matter to promote long term learning.

A key idea of BBL in the context of language education is that of brain plasticity, or the ability of the brain to modify the neural pathways as a result of experiences. Kuhl (2010) found that infants' neural tuning is already language-specific in the first year of life, and the neural tuning for phonological contrasts is stable into adulthood. The finding supports the concept that early and copious language input is important, and that the quality of the language input, in the emotional tone, repetition, variation, and social context are as important as the quantity. The

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BBL approach is a learning approach that is intrinsically connected with emotion. There is an interaction between the amygdala, the hippocampus and the prefrontal cortex such that emotional states strongly influence memory encoding and retrieval (LeDoux, 2000). Classrooms that feel psychologically safe, have strong teacher-student relationships and provide relevant content that is engaging and meaningful are ideal learning environments, with higher levels of dopamine, norepinephrine, and acetylcholine. Chronic stress, on the other hand, increases cortisol, reduces function of the hippocampus, and impairs working memories, especially impacting language acquisition among young learners (Lupien et al., 2009).

There have been many changes in theories of bilingual acquisition within the last 40 years. While early models of deficit have been replaced by those that have documented the cognitive advantage of bilingualism such as those related to executive function, metalinguistic awareness and attentional flexibility (Bialystok, 2001; Adesope et al., 2010). The threshold hypothesis (Cummins, 1979) and its development, the interdependence hypothesis (Cummins, 1981), posited that some L2 skill acquisition depends on attainment of certain L1 skill levels and that L2 academic skills transfer to the L1 system, provided it is linguistically related.

Early models assumed there is a dichotomy between the two language systems of bilinguals, which has been called into question in more recent studies. Translanguaging is an idea introduced by Garcia and Wei (2014) on two fronts: as a communicative strategy employed by multilingual learners and as a pedagogical approach. Translanguaging pedagogy brings children's whole language repertoire to the forefront and makes it explicit in the teaching-learning process so that the process becomes a process that will help children understand their languages more deeply; in the teaching-learning process, the language process will be one that allows more authentic communication and more effective development of children's language.

In the Pakistani context, however, the language ecology of education has been documented by researchers like Rahman (2004), Mahboob and Cruz-Ferreira (2011) that L2 learners, whose home language is neither Urdu nor English, face English-medium education as 'submersion'. This is consistent with international evidence showing that a sudden change to a new mode of instruction (with no scaffolding or bridging to home language skills) can significantly hinder language development and learning of content (Thomas & Collier, 2002).

The neural overlap between L1 and L2 processing has been found to differ as a function of age of acquisition, proficiency and linguistic similarity, in line with the neuroscience of SLA. Neural representations are highly overlapping in sequential bilinguals (L2 learned after L1) compared to simultaneous bilinguals (L2 learned at the same time as L1) when L2 is learned simultaneously with L1 in both languages (L1 and L2) in the regions of Broca's area and LFG (Kim et al., 1997). Importantly, however, there has been neural evidence that native-like efficiency in neural processing is also possible in sequential bilinguals who acquired L2 early on in development, within the critical period for L2 acquisition (Pallier et al., 2003).

Pedagogically, neuroscience can also make contributions to other domains, e.g., in the domain of rhythm, music and prosody in language development. Evidence of strong relationships with rhythmic auditory processing, phonological awareness and acquisition of reading skills has been found by Goswami (2011) and Tierney and Kraus (2013), this indicates songs, chants and

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rhythmic teaching in the early language classroom. The findings of the present study are not only relevant in the context of Pakistan but there are also culturally relevant ways of teaching language through rhythm, which may be achieved through oral-poetic genres like ghazals, nasheeds, folk rhymes etc.

The ECE sector in Pakistan experienced tremendous growth in the past 20 years, from which the efforts of the Government of Pakistan (2009) and the Sindh Early Childhood Development (ECD) Curriculum can be highlighted. Children's participation in ECE programs numbers have grown, and so has the quality of the programs. ECE teachers in government schools are not well trained in any special areas like early childhood development, language acquisition theory and multilingual pedagogy. There are too many students in a class (more than 40) and there is a shortage of teaching materials in the regional language. In the context of the above, the application of evidence-based and brain-compatible strategies for teaching bilingual language is an intriguing possibility and a great challenge.

Methodology

Research Design

The design of this study was convergent mixed methods which combined quantitative pre test/post test assessment data with qualitative assessment data from classroom observations, semi structured interviews and focus group discussions. The mixed methods design was chosen to allow for measurement of outcomes and meaningful contextualization of how the outcomes were obtained. The study was carried out for a period of 8 months (from August 2025 to March 2026), in 12 early childhood institutions at three provinces of Pakistan; Punjab, Sindh and Khyber Pakhtunkhwa (KPK).

Participants

The study sample included 480 children between the ages of 3 and 7 years (Mean age = 5.2 years, SD = 0.87; 52% female) from 12 ECE participating institutions and 24 ECE classrooms. A purposive sampling of institutions was done to ensure inclusion of both government-run and private schools, urban and peri-urban schools, and locations where Punjabi, Sindhi or Pashto were the major home language, in addition to Urdu and English. Also, 24 female classroom teachers (Mean teaching experience = 6.3 years) and 240 parents/caregivers participated in complementary data collection. Two groups of classrooms were selected: 12 classrooms of 240 children were randomly assigned to the intervention group and continued with the BBL-aligned six-month bilingual instruction and 12 classrooms of 240 children were randomly assigned to the control group and went on with the usual instruction practices. Parents and institutional administrators provided informed consent, and institutional review board (IRB) approval was received.

Intervention

The research team developed the BBL-aligned bilingual intervention collaboratively based on existing BBL frameworks (Jensen, 2005; Sousa & Tomlinson, 2011) and adapting these to the linguistic and cultural context of Pakistani ECE. The main elements of the intervention were: (a) translanguaging activities which explicitly encouraged children to use their home languages in

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instruction; (b) rhythm-based language learning activities, which used traditional Pakistani folk rhymes and both current Urdu and English songs; (c) movement-integrated vocabulary learning activities, including Total Physical Response (TPR) techniques; (d) storytelling and narrative-based activities that related content to children's lived experiences; (e) emotionally safe classroom routines that aimed to reduce anxiety and encourage children to take risks in language use; and (f) play-based centers which provided structured opportunities for bilingual interaction.

The intervention group teachers participated in a two-week intensive professional development session before the intervention period and then in monthly coaching visits and cycles of peer observation throughout the study period. The teachers of the control group used the same methods they had been using previously and these were mostly memorization, reading of alphabets and numbers in Urdu and English, and teacher-centred recitation.

Data Collection Instruments

The language development was assessed by four validated instruments adapted in the context of Pakistan, where the child population speaks several languages.To assess language development, four validated instruments from other contexts were adapted for the context of Pakistan where children speak several languages. To measure vocabulary breadth in Urdu and regional language, Bilingual Vocabulary Assessment Measure (BVAM; Bedore et al., 2012) was adapted and administered individually at pre-test and post-test. For Urdu and English phonological awareness skills, the Phonological Awareness Literacy Screening–Early Childhood (PALS-EC; Invernizzi et al., 2004) was used. Print concepts, letter knowledge and early word recognition skills were assessed using an investigator-developed Reading Readiness Scale (RRS). Finally, a structured Language Use Observation Protocol (LUOP) was created to code the number, type, and variety of translanguaging events, teacher language use and child-initiated bilingual communication during classroom observations.

Qualitative data was gathered using 48 classroom observation sessions (two sessions per classroom), 24 individual teacher interviews and six parent focus group discussions (two per province). Observations were video-recorded and transcribed, while interviews and focus group were audio-recorded, transcribed and translated from Urdu/other local languages as required.

Data Analysis

IBM SPSS version 28 was used to analyze the quantitative data. Analysis of Covariance (ANCOVA) was used to compare post-test scores for the intervention group and the control group, with pre-test scores, child age, and school type as the covariates. Cohen's d was used as an index of the effect size. Paired-samples t-tests were used to make within-group pre-post comparisons. Data analysis was carried out in two phases: coding and collaborative theme development and done qualitatively following the method of thematic analysis (Braun & Clarke, 2006). To increase the credibility member checking and peer de-briefing were used

Results

The results of this study are presented in this chapter, both from the quantitative and qualitative strands. The equivalence of groups at pre-test is reported in Section 4.1. The main outcome data

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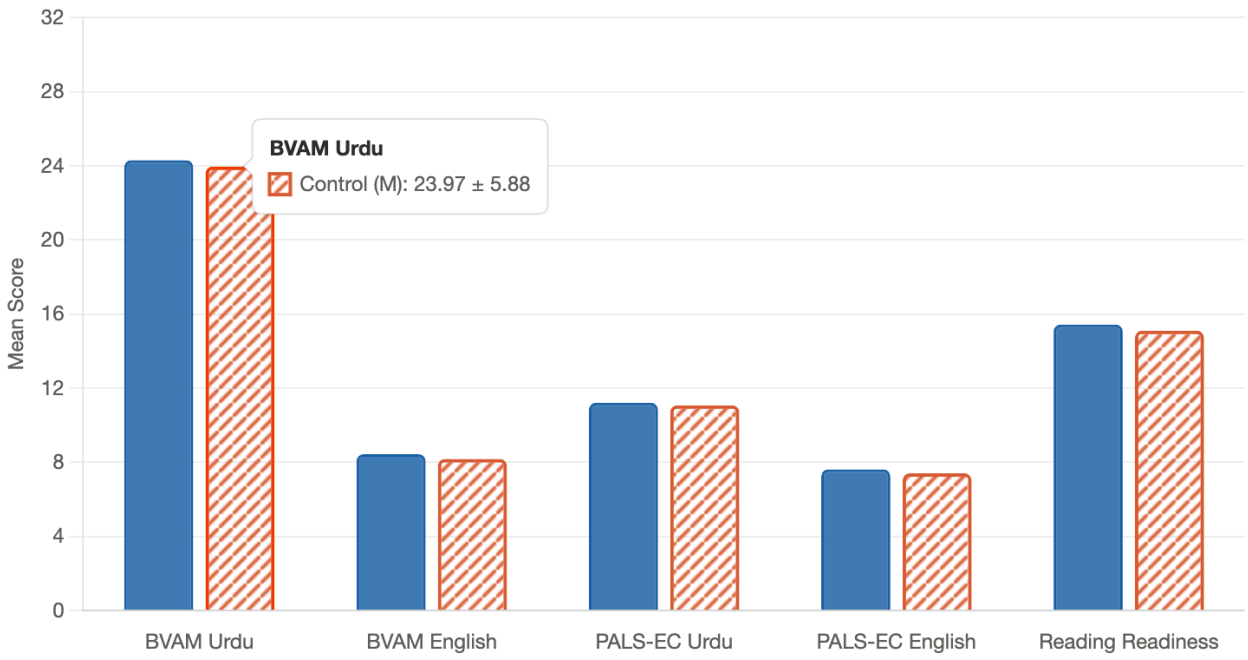
for each language development measure is presented in sections 4.2–4.5. Section 4.6 puts together qualitative data on classroom processes, teachers' perceptions, and families' perceptions.

Pre-Test Equivalence

Independent-samples t-tests showed that there were no significant pre-test differences between the intervention and control group on any language measure, thus providing baseline equivalency that allows for valid comparisons of post-test results. Pre-test mean and standard deviations are reported for both groups in Table 1.

Table 1: Pre-Test Language Assessment Scores by Group (N = 480)

Measure	Intervention (M ± SD)	Control (M ± SD)	t-value	p-value
BVAM – Urdu	24.31 ± 6.14	23.97 ± 5.88	0.62	.536
BVAM – English	8.45 ± 3.72	8.19 ± 3.61	0.78	.437
PALS-EC – Urdu	11.22 ± 4.01	11.08 ± 3.94	0.39	.698
PALS-EC – English	7.63 ± 3.15	7.41 ± 3.27	0.75	.453
Reading Readiness Scale	15.44 ± 5.23	15.11 ± 5.09	0.70	.483



Bilingual Vocabulary Development (BVAM)

ANCOVA results revealed that children in the intervention group demonstrated significantly greater gains in bilingual vocabulary across both Urdu and English compared to control group peers, after controlling for pre-test scores, age, and school type. For Urdu vocabulary, the intervention group attained a post-test mean of 34.87 (SD = 5.93) compared to 27.14 (SD = 6.21) in the control group, yielding a statistically significant group difference, $F(1, 477) = 98.43$, $p < .001$, partial $\eta^2 = .171$, Cohen's $d = 1.28$ (large effect). For English vocabulary, the intervention

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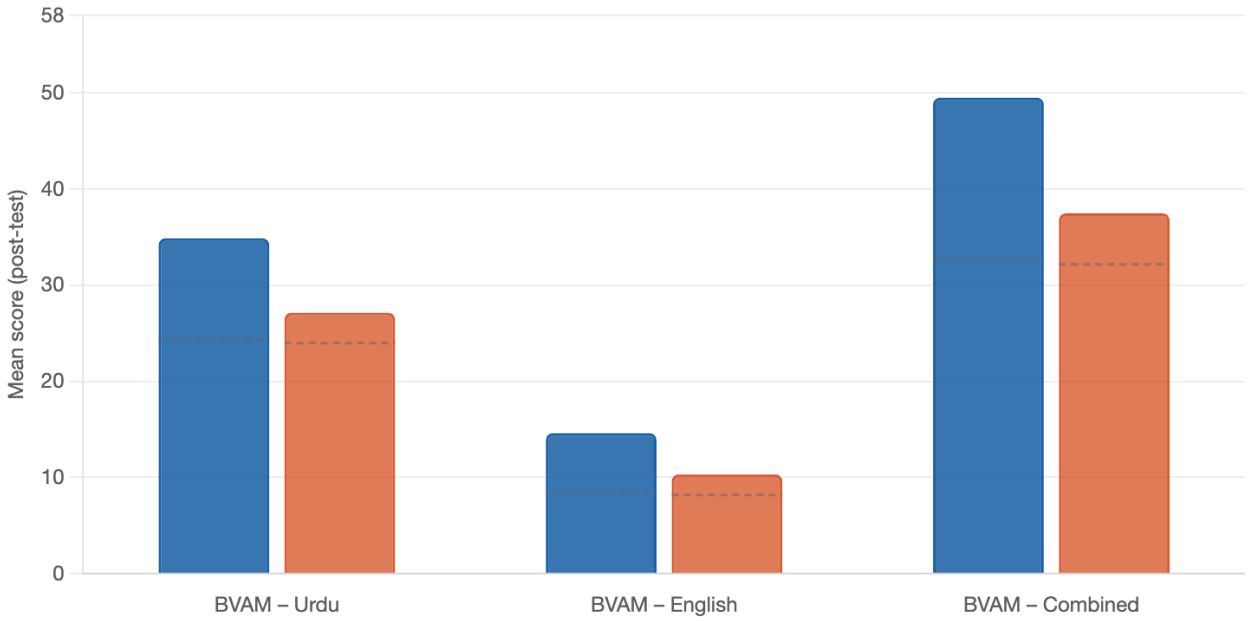
group post-test mean was 14.62 (SD = 3.84) versus 10.33 (SD = 3.47) in the control group, F (1, 477) = 112.67, p < .001, partial η^2 = .191, Cohen's d = 1.18 (large effect).

Notably, children in the intervention group also demonstrated broader concurrent vocabulary breadth—that is, higher combined scores when Urdu and English vocabulary were summed—suggesting that translanguaging-based instruction supported the development of a richer, integrated bilingual lexicon rather than merely redistributing lexical knowledge across languages. This finding is consistent with Cummins' (1981) interdependence hypothesis and with more recent translanguaging theory (Garcia & Wei, 2014).

Table 2: Post-Test BVAM Scores and ANCOVA Results by Language

Language	Int. Post-Test M (SD)	Control Post-Test M (SD)	F (1,477)	p	Cohen's d
Urdu	34.87 (5.93)	27.14 (6.21)	98.43	< .001	1.28
English	14.62 (3.84)	10.33 (3.47)	112.67	< .001	1.18
Combined	49.49 (8.61)	37.47 (8.85)	131.22	< .001	1.37



Phonological Awareness (PALS-EC)

Phonological awareness, widely recognized as a key predictor of early reading success, showed significant intervention-related gains in both languages. In Urdu, the intervention group's post-test mean reached 18.76 (SD = 3.82) compared to 13.94 (SD = 4.11) for controls, F(1, 477) = 113.48, p < .001, Cohen's d = 1.22. In English, the intervention group achieved a post-test mean of 13.28 (SD = 3.14) versus 9.07 (SD = 3.31) for controls, F(1, 477) = 142.37, p < .001, Cohen's d = 1.31.

Sub-scale analysis revealed that phoneme identification and rhyme awareness showed the largest between-group differences, consistent with the study's explicit incorporation of rhythm-based

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instructional activities including traditional Pakistani folk rhymes and contemporary song-based phonics instruction. Syllable segmentation also showed significant but smaller between-group differences, reflecting the greater reliance on natural exposure and developmental maturation for this skill.

Table 3: Post-Test PALS-EC Scores and ANCOVA Results

Sub-scale	Int. M (SD)	Control M (SD)	F (1,477)	p	d
Urdu- Rhyme Awareness	5.41 (1.12)	3.87 (1.34)	121.44	< .001	1.25
Urdu – Phoneme ID	4.93 (1.08)	3.42 (1.21)	134.67	< .001	1.31
Urdu – Syllable Seg.	4.19 (1.22)	3.64 (1.18)	19.87	< .001	0.46
English – Rhyme Aware.	4.88 (1.17)	3.14 (1.28)	149.23	< .001	1.43
English – Phoneme ID	4.72 (1.09)	3.21 (1.19)	141.88	< .001	1.33
English – Syllable Seg.	3.68 (1.11)	2.72 (1.24)	44.21	< .001	0.82

Reading Readiness

The Reading Readiness Scale, which assessed print concepts, letter knowledge (in both Urdu script and Roman script), and early word recognition, also demonstrated significant intervention-related gains. Intervention group children attained a post-test mean of 26.14 (SD = 5.11) on the RRS, compared to 18.93 (SD = 5.34) for control group peers, $F(1, 477) = 121.34$, $p < .001$, partial $\eta^2 = .203$, Cohen's $d = 1.38$. Print concept knowledge showed the largest relative gains in the intervention group, suggesting that the book-rich, storytelling-centered classroom environment established by the intervention effectively familiarized children with the conventions of written language in both Urdu and English.

Table 4: Reading Readiness Scale Post-Test Results

RRS Sub-scale	Int. M (SD)	Control M (SD)	Cohen's d	Significance
Print Concepts	9.12 (1.83)	6.24 (2.01)	1.51	p < .001
Urdu Letter Knowledge	8.74 (2.12)	6.43 (2.34)	1.04	p < .001
English Letter Knowledge	5.91 (1.74)	3.98 (1.81)	1.08	p < .001
Early Word Recognition	2.37 (1.02)	2.28 (0.97)	0.09	p = .391 (ns)
Total RRS Score	26.14 (5.11)	18.93 (5.34)	1.38	p < .001

Language Use Observation Protocol Findings

Observations of the classrooms, coded in the LUOP showed significant differences in the nature and quality of language use between intervention and control classrooms. On average, intervention classrooms had 18.4 discrete translanguaging instances during each observation time compared to 3.2 in control classrooms, which in most cases were not noticed or were implicitly discouraged (unless students were in the process of transitioning into the English language). Open-ended questioning, expansions of child utterances, and scaffolded

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narration/story retelling activities were higher for intervention teachers (M = 24.7, 31.2, and 11.4 per session, respectively) than for regular education teachers. One of the significant findings from the observation protocol was the link between teacher-initiated translanguaging and the child's bilingual risk-taking. Children were much more likely to volunteer extended utterances in classrooms in which teachers explicitly acknowledged the use of Punjabi, Sindhi or Pashto along with Urdu and English, and to try new vocabulary in more than one language, and to engage in peer-peer play in classrooms where teachers acknowledged the use of Punjabi, Sindhi or Pashto in addition to Urdu and English. This is in line with the BBL principle: in order to optimize language learning, the prefrontal cortex must be engaged, and the amygdala must not be.

Table 5: Language Use Observation Protocol: Key Indicators by Condition

LUOP Indicator	Intervention M	Control M	Effect
Translanguaging events/session	18.4	3.2	Large
Open-ended questions/session	24.7	8.3	Large
Child extended utterances/session	19.8	6.1	Large
Teacher expansions/session	31.2	11.4	Large
Rhythm/song-based activities/session	4.8	0.7	Large
Child bilingual peer interaction/session	22.3	5.9	Large

Qualitative Findings

Teacher Perspectives

The top four themes that arose from the data of the teacher interviews in the thematic analysis were: The first theme, Legitimizing the Home Language, reflected the teachers' thoughts on how teaching their students in the kids' home language has been transformed when they were given explicit training and authorization in the use of the home language in teaching. One of the teachers from Lahore said here: 'Earlier I thought that the problem of Punjabi was in my classroom. I see now that it's a resource. I always speak Punjabi with another child and then Urdu and English with the child. If a child is teaching another child in Punjabi, we teach in Urdu and English; then they understand better. Most of the 24 teachers interviewed (19) indicated a transformation of language from a problem to a resource point of view. Most of the teachers interviewed (19) spoke about their change of attitude in the problem to resource approach (Ruiz, 1984).

The second theme, Movement and Joy as Learning Tools, emphasized the first doubts and then the positive attitudes of the teachers for the implementation of movement integrated and rhythm-based learning strategies. Several teachers viewed these activities as non-academic, and noted that there was more engagement and retention in these activities. 'When we do the action songs, even the children who are usually very quiet—they participate. And the next day, they remember the words,' reported one KPK teacher. The third theme, Managing Structural Constraints, acknowledged the major implementation constraints resulting from the large classes, limited materials available and some unsupportive administrative cultures. Some teachers said the school administration forced them to return to a rote-learning method of instruction particularly in the context of standardized testing. The fourth theme, Growing Professional Confidence, was related to how coaching and collegiality positively influenced teacher professional identity and teaching effectiveness.

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Parent/Caregiver Perspectives

The results of the focus group discussions with parents indicated mainly positive perceptions about the impact of the intervention on the children's language development and engagement in school. Parents reported a general improvement in children's enthusiasm for going to school, confidence in speaking English and Urdu and—significantly—reported reduction in the reluctance of the children to attend school on a regular basis, for children participating in the interventions. In a number of focus groups, parents spontaneously reported their children teaching new words and songs to their families at home, indicating that learning was being transferred to the home environment. Initially some parents were not comfortable in using regional languages in formal education, as they felt that the mother tongues are not appropriate for education. There was a decrease in this concern during the study period after parents witnessed their children's literacy and language skills to become more concrete.

Discussion

The findings of this study offer strong support for the possibility of the use of BBL supported, translanguaging-informed instruction to greatly benefit bilingual language development of Pakistan's ECE children. High intercorrelation among the effect sizes of the vocabulary scores and the phonological awareness scores, and the correlations of the phonological awareness scores with reading readiness scores bring to light the strength of the congruence of the design of instruction and the way the brain learns.

These effects are likely due to the following mechanisms: Students' emotional safety gained in the environment of translanguaging, where all children's language repertoires were respected, rather than inhibited, was conducive to the development of the neurochemical conditions described by BBL theorists as optimal for learning. If children do not have to attend to linguistic shame or anxiety that they are not allowed to use their most fluent language, they will be able to shift their cognitive resources that they previously had to devote to language monitoring onto understanding content and acquiring new language.

Secondly, multiple neural systems were engaged simultaneously in the components of the intervention that were rhythm and movement based. Neuroscience studies reveal that neural networks related to sensorimotor, auditory and emotional processing encode information more deeply and this type of learning is more likely to be retained than learning through one of these processing modes (Sousa, 2011). Traditional folk songs and rhymes in Pakistan play a special role in culturally responsive BBL, on one hand they are most effective to memorize words and on the other hand they are culturally respectful.

Third, the open-ended questioning and narrative scaffolding provided by the intervention teachers suggest a focus on meaning making as a component of basic brain function in line with BBL. The episodic and semantic memory networks are involved in narrative and inquiry activities and the learning resulting from these activities can be more rich and transferable than that of drill activities, which tend to involve procedural memory systems (Jensen, 2005). The difference among groups was quite large for teacher use of open-ended questions and child production of extended utterances, showing that the intervention had an impact on the ecology of

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interactions in participating classrooms. The results are in line with, and build upon, the international literature available. The findings of the positive effects of translanguaging pedagogy on bilingual vocabulary development are similar to those found in New York City contexts (Garcia & Kleyn, 2016) and UK contexts for the study of Chinese heritage language (Wei, 2018), but are unique to a context as different as Pakistani ECE. The study findings also validate an observation of Goswami (2011), Tierney and Kraus (2013) that it is a very different phonological system and culture where rhythm-based teaching is being implemented.

The reading readiness results, in general, confirm the predicted outcomes, but there was one clear non-significant result: There was no significant difference between the groups on early word recognition. This may be associated with developmental appropriateness of the intervention, since word recognition is one of the last emergent literacy skills to develop in the ECE age range, and a 6-month intervention may have not been sufficient to provide meaningful group differences at this skill. Future studies with longer follow-up would be beneficial to determine if the results of vocabulary and phonological awareness gains observed in this study can be correlated with reading acquisition.

Conclusion

This study has demonstrated that brain-based learning principles, thoughtfully adapted to the linguistic, cultural, and material realities of Pakistani early childhood education, can produce substantial improvements in bilingual language development among children aged three to seven years. The convergence of neuroscientific evidence, bilingual acquisition theory, and empirical classroom data points toward a coherent and actionable vision for ECE language pedagogy in Pakistan: one grounded in emotional safety, linguistic inclusion, sensory richness, and the deep pedagogical wisdom embedded in Pakistan's own cultural traditions. The challenges of implementation—large class sizes, teacher preparation gaps, limited materials, and policy inertia—are real and should not be minimized. Yet the evidence from this study suggests that even within these constraints, teachers equipped with appropriate knowledge, skills, and collegial support can create classroom environments in which bilingual children's brains are engaged, respected, and challenged to their full remarkable potential.

Future research should examine the longitudinal effects of BBL-aligned bilingual ECE on reading acquisition, mathematics achievement, and socio-emotional development; explore the specific mechanisms through which translanguaging practices facilitate neurological learning; and investigate strategies for scaling effective ECE language programs within Pakistan's diverse and challenging educational landscape. The developing brain is, in its extraordinary plasticity and its insatiable drive toward meaning, a natural ally of good teaching. Pakistan's children deserve nothing less.

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