

From Cradle to Classroom: Early Childhood Teachers' Understanding and Integration Regarding the ABCs of Brain-Based Learning

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Abstract

Early Childhood Education (ECE) teachers serve as the architects for a child's educational journey, nurturing their cognitive, emotional, and social development during the early years. In this study, the researchers aimed to investigate ECE teachers' understanding of Brain-Based Learning (BBL) and its integration into their teaching practices. The research design of the current quantitative research was a cross-sectional survey, and the data were collected from 602 ECE teachers using a self-reported questionnaire. The results revealed that ECE teachers better understand and integrate BBL. Male and professionally more qualified teachers showed a higher understanding of BBL than their counterparts. Moreover, ECE teachers' understanding of BBL significantly predicts their integration into teaching practices. Mediation analysis revealed that gender ($\beta = .03$, $SE = .01$, 95 % $CI [.0157, .0461]$, $p = .000$) and professional qualification ($\beta = -.02$, $SE = .01$, 95 % $CI [-.0416, -.0032]$, $p = .000$) are significant, and academic qualification ($\beta = -.01$, $SE = .01$, 95 % $CI [-.0190, -.0304]$, $p = .230$) is an insignificant mediator in the relationship between understanding and integration of BBL. Based on the present study results, ECE teachers are suggested to design and use BBL-based interventions to improve ECE students' cognitive functions.

Keywords: *Brain-based learning, brain development, ECE teachers, demographic variables, integration of BBL, understanding of BBL*

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Introduction

With broader implications, Neuroscience is the foundation of Brain-Based Learning (BBL), representing a more student-centered pedagogy that combines Neuroscience principles into teaching for better student development (Rodgers & Hales, 2021). It helps educators identify students' potential and brain capacity, helping them design lessons according to students' needs and interests (Reddy et al., 2021). BBL covers different aspects of human development, including emotional states, eating habits, physical activity, and overall well-being, which contribute to the learning process (Reddy et al., 2021). The idea of BBL came in the 1990s and got attention due to its broader implications in education and child development (Haddad & Hashimi, 2024; Jang et al., 2022). It focuses on students' experiences across all age groups by including BBL principles for mobility, stress mitigation, increasing practice, and providing effective teaching (Febriansyah et al., 2023; Korkmaz, 2024). Educators can attain a more learning-conducive and interactive classroom environment by implementing BBL principles (Tompkins, 2007).

Teachers are the key stakeholders in planning classroom teaching activities (Jaworski & Huang, 2014; Kieran et al., 2012). The researchers have found evidence in the literature that by implementing BBL, teachers significantly improve students' performance (Lagoudakis et al., 2022). For the effective use of BBL, teachers design activities, including coloring, to enhance students' visual processing and provide frequent breaks to improve students' focus and attention (Shad et al., 2023). It has also been seen that BBL is beneficial in retaining students in classrooms because it provides an opportunity to learn in a fun way that suits younger students. By adopting BBL, teachers can improve students' engagement by providing an environment suitable for cognitive and physical involvement (Funa et al., 2024). It is also evident from the literature that when novel ideas or techniques are deployed in classrooms, they attract students' interest and contribute to their learning (Jamil et al., 2023). Teachers who provide visual and auditory support can return their attention to lessons (Nakahara et al., 2023). In such a situation, the current study was planned to examine teachers' awareness and understanding of the level of BBL that should be implemented in the classrooms.

Developing a positive classroom climate fosters an environment conducive to learning. Teachers' mindfulness and stress-reduction techniques equip students with valuable tools for managing their cognitive states (Amjad et al., 2022). Incorporating bodily movement into lessons can further enhance learning outcomes. Differentiating guidance to accommodate diverse learning needs ensures that all students can effectively understand the material (Tzenios, 2020). Allocating time for students to engage in discussions, such as through “turn and talk” activities, facilitates comprehension and knowledge sharing (Clark, 2024). BBL emphasizes that breaking complex concepts into manageable chunks enhances concept clarity and understanding. Furthermore, incorporating practical learning activities actively engages students in learning. Teachers can use these BBL principles to maximize students' performance by implementing how the brain processes and stores information efficiently.

Multiple researchers deployed BBL in Pakistan to improve students' learning outcomes in different subjects and levels. Various studies were conducted to enhance students' performance and motivation in mathematics at the elementary level (Amjad & Tabbasam, 2024; Noureen et al., 2017; Shahzadi et al., 2024) and the secondary level (Rehman, 2011). Few studies have been carried out on English subjects at the elementary level (Ali et al., 2019) and the secondary level (Shahzadi et al., 2024; Shahzadi et al., 2022). Fatima (2017) conducted a study investigating university teachers' attitudes toward students' achievement and motivation in the context of BBL integration. However, as far as the researchers know, none of the studies have yet been carried out to explore teachers' preparation for applying BBL in the context of Early Childhood Education (ECE). This gap reveals a conflicting scenario where BBL is widely promoted and adopted at higher education and secondary levels, yet foundational levels such as ECE remain largely overlooked. Such inconsistency may reflect a systemic disconnect in policy implementation or teacher training priorities, which this study seeks to investigate and clarify. Considering the research gap, the present study was designed to explore the knowledge and understanding of ECE teachers regarding BBL principles, their integration at the ECE level, and how their demographic variables mediate their relationship.

Research Model

The focus of the study was to explore ECE teachers' understanding and integration of BBL to improve ECE students' performance and experience. Considering the educational implications of Social Cognitive Theory (SCT) of Bandura, the researchers followed it in this study to examine how ECE teachers can integrate BBL in their classrooms. SCT guided the authors in examining ECE teachers' understanding of and integration of BBL into ECE classrooms by applying the social elements of the classrooms. SCT principles were followed to explore ECE teachers' beliefs, attitudes, and self-efficacy to understand and integrate BBL principles in their respective classrooms. In this way, the SCT-guided process was used to explore the nature and level of BBL readiness and integration by ECE teachers. In this regard, SCT helped to understand how teachers opt for and make decisions for BBL-based teaching. If teachers design interventions and techniques to support ECE students in creating interactive and learning-friendly environments, they can be trained in a better way to face future challenges (Kayır, 2020). Based on SCT, the following research model was designed to guide the study's processes (Figure 1).

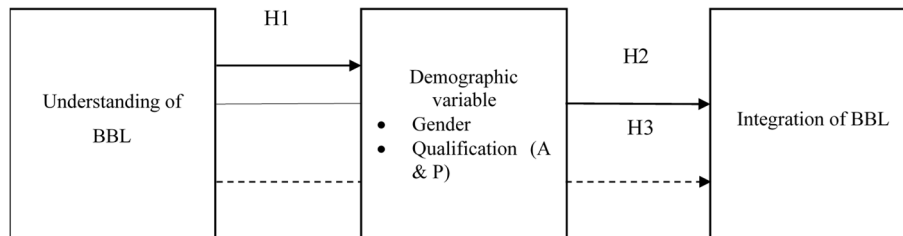


Figure 1. Research Model

Research Objective

In the context of SCT, the present study was designed to explore ECE teachers' understanding and integration of BBL principles, their level of integration in their teaching, and whether their gender and qualifications (academic and professional) mediate the relationship between their understanding and integration of BBL principles.

Research Questions and Hypotheses

To get answers to the above-narrated research objective, the following research questions and directional hypotheses were formulated to guide the study.

RQ1: To what level do ECE teachers understand the BBL principles?

RQ2: What is the ECE teachers' integration level of BBL principles into their ECE classrooms?

H1: ECE teachers' understanding significantly differs in context from their qualifications (academic and professional) and gender.

H2: ECE teachers' understanding of brain-based learning principles positively contributes to their instructional strategies for classroom implementation.

H3: ECE teachers' gender and qualifications (academic and professional) positively mediate the relationship between their understanding and integration of BBL.

Literature Review

Caine and Caine were the founders of BBL. They gave 12 principles for aligning the teaching-learning process with the brain's potential and ability (Amjad et al., 2022). By adopting those principles, ECE teachers can develop a more learning-conducive, welcoming, and inclusive environment for young students (Amjad et al., 2025). They can also modify their teaching styles to reach the potential of ECE students by exploring their interests and ideas (Beaudry & Gould, 2024). It is also evident from the literature that ECE teachers who adopt BBL principles are more capable of engaging students with activities such as gaming, culinary projects, hands-on learning, and problem-solving skills (Misra, 2021). Moreover, teachers familiar with BBL principles can enhance students' performance by praising them, developing a sense of community within the class, and using encouraging and supportive language. Figure 2 provides these 12 principles.

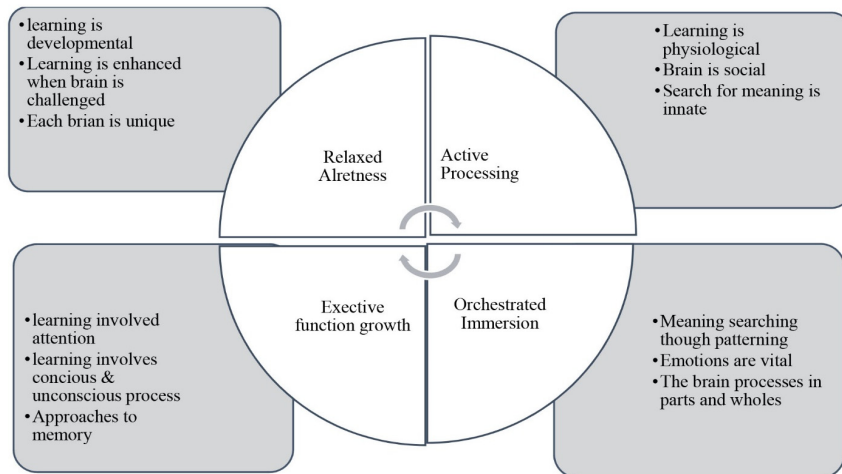


Figure 2. BBL Strategies and Principles

The literature also demonstrates that teachers who follow BBL strategies and principles have students who remember learning concepts for longer (Jang et al., 2022). Although no significant literature is found in the context of ECE, the researchers have found that developing activities that require skill, time, and energy and aligning them with BBL principles is more demanding. However, teachers who engage their students mentally and physically get better class results (Anierobi et al., 2025; Tabassum et al., 2025). They engage them in physical and mental activities to keep them fresh and energized, to learn new concepts and things (Shahzadi et al., 2024).

Devi (2020) conducted a study in India to explore primary teachers' knowledge of BBL. She collected data using a survey and found that 67 % of teachers (40 out of 60) had poor knowledge of BBL. Only four teachers had higher knowledge of BBL. She found no significant correlation between teachers' demographic variables (gender, age, locality, teaching experience, religion, and qualification) and their knowledge. Similarly, Letina and Perković (2021) studied 207 primary teachers in Croatia to explore their knowledge and understanding of BBL for primary students. They found that teachers did not integrate BBL in teaching science, but they had satisfactory knowledge of BBL. They also found that teachers who had master's degrees had significantly higher knowledge than those who held bachelor's degrees. They also revealed a positive correlation between teachers' knowledge

and implementation of BBL in primary-level science teaching. Most of them believed they could have applied BBL better if they had been allowed more time in class.

Alanazi (2020) designed an experimental study on Saudi 7th-grade science teachers to explore their perceptions of BBL and its impact on students' performance. His study revealed that BBL integrations significantly enhanced students' learning outcomes. However, he did not witness any significant correlation between elementary teachers' qualifications and teaching experience in the context of the BBL integration. Bada (2022) studied the integration of BBL among Nigerian Physics teachers. After collecting data through two different surveys, they revealed that BBL integrations are very effective and significantly affect students' learning in heat energy. He found that most of the secondary teachers were inclined to integrate BBL into their classrooms.

Method

The researchers explored ECE teachers' understanding and integration of BBL in their ECE rooms with the guidance of SCT. SCT by Albert Bandura emphasizes the reciprocal interaction between personal factors, behaviors, and environmental influences. It highlights how individuals learn by observing others, and how self-efficacy plays a critical role in behavioral change and learning. The literature reveals that positivism's research philosophy is considered the most suitable for comprehending the knowledge and implications of BBL on a larger scale (Baškarada & Koronios, 2018). Adopting positivist implications of objectivity and generalizability helped to explore reliable evidence for ECE teachers' perceptions and policy decisions regarding integrating BBL in ECE rooms. Thus, quantitative methods were deployed in the present paper on various data collection and analysis stages.

Research Design

In the present quantitative study, the authors followed the steps and stages of a cross-sectional survey research design. It was argued in the literature that a cross-sectional research design is preferred for investigating the perceptions and practices of teachers at a single point

in time (Romero-Tena et al., 2020; Tuma et al., 2021) This research design helped to understand and reveal ECE teachers' understanding and integration of BBL practices to identify the existing patterns and trends across different demographic variables of ECE teachers. Furthermore, this design helped to collect data from a larger sample to gain different insights into ECE teachers' perceptions and practices regarding BBL.

Context and Participants

As mentioned in the Punjab Early Childhood Education Policy 2017, the Government of Punjab (GOP) established 1225 ECE classrooms during the years 2013-15, 900 ECE classrooms were developed during 2015-16, 1400 ECE classrooms were established during 2016-17, GOP further planned to develop 10000 more ECE classrooms till April 2018. Since 2018, the GOP has consistently increased the number of ECE classrooms throughout the province. The GOP established ECE classrooms throughout the province and trained teachers. The ultimate goal is to equip ECE teachers with the modern teaching skills and pedagogies appropriate for ECE teachers (Government of Punjab, 2017).

The target population of the present study was the ECE teachers working in Punjab, but the accessible population consisted of the ECE teachers working in the district of Kasur. In the Kasur district, there are 1359 schools (Government of the Punjab, n.d.). All of the schools now have ECE classrooms and teachers. Thus, the total population of the study was 1357 ECE teachers. A sample of 650 (almost half of the population) ECE teachers were selected using simple random sampling and stratified sampling techniques. Typically, for descriptive research, a sample of more than 400 is considered appropriate (Wallen & Fraenkel, 2013). Overall, 602 ECE teachers responded to the questionnaire, with a response rate of 92.62 %. There were 315 (52 %) female and 287 (48 %) male teachers..

Measure

The researchers developed the questionnaire to measure participants' responses against the present study's variables. The authors reviewed the literature and tried to find a suitable questionnaire to measure ECE teachers' understanding and integration of BBL into ECE. On

failure, after an extensive literature review on the study variables, a questionnaire was developed (Alanazi, 2020; Bada, 2022; Devi, 2020; Letina & Perković, 2021). Initially, it had 22 items, which were reduced after the expert opinion and pilot testing. The final questionnaire had four demographic variables (gender, age, and academic and professional qualifications) and 20 scale items, with options 1 (strongly disagree) to 5 (strongly agree). The scale's reliability was .88 Cronbach's alpha, which was far better than the value of .70, which is usually considered an accepted criterion of the scale in social sciences.

Furthermore, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted to establish the construct validity of the newly developed scale. Bartlett's Test of Sphericity was significant, $\chi^2(190) = 5125, p < .001$, and the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was .89, confirming the suitability of the data for factor analysis.

The initial CFA model did not demonstrate acceptable fit ($RMSEA = .137$, 90% CI [.132, .143]; $TLI = .562$). Based on modification indices and standardised factor loadings, items with poor loadings ($< .40$) or high cross-loadings were removed step by step. The respecified model with 17 items yielded significantly improved fit indices ($\chi^2(224) = 512.41, p < .001$; $RMSEA = .051$, 90% CI [.044, .058]; $CFI = .947$; $TLI = .936$; $SRMR = .046$). These indices fall within the recommended thresholds, supporting the adequacy of the final model.

Composite reliability values for each construct ranged from .78 to .86, and average variance extracted (AVE) values ranged from .52 to .61, demonstrating convergent validity. Discriminant validity was established as the square root of AVE for each construct exceeded the inter-construct correlations. Collectively, these results provide evidence of the scale's construct validity and reliability.

Data Collection

After formulating the questionnaire, a Google Form was generated. The Google Form links were shared with the selected participants via School WhatsApp groups and direct messages. After sharing the links, the respondents were given two reminders with a gap of one week. The data were collected during February 2024. After collecting the data, it was stored with the password option.

Data Analysis

After collecting data, it was analyzed using descriptive and inferential statistics. The researchers used the data analysis software Jamovi (version 2.4.14) and SPSS (version 26). Initially, the assumptions of parametric statistics (normality, homogeneity, independence, randomization, absence of outliers) were tested, and they were all satisfied (Table 1). Then, the researchers used frequency, percentage, mean, and standard deviation to investigate ECE teachers' understanding and integration of BBL. The authors deployed an independent sample *t*-test, simple linear regression, and mediation analysis to test the study's hypotheses.

Table 1. *Assumption Check*

Assumption	Test Used	Test Statistics	p-value	Interpretation
Normality	Shapiro-Wilk Test	$W = .963$	$p = .117$	Data is normally distributed ($p > .05$)
Homogeneity of variance	Levene's Test	$F = 1.213$	$p = .231$	Equal variance assumed ($p > .05$)
Linearity	Scatterplot	Linear pattern observed	-	Assumption met
Absence of outliers	boxplot	No extreme outliers detected	-	Assumption satisfied

Research Ethics

In the present study, the research ethics were followed to maintain the ECE teachers' dignity and rights. Participants' consent was obtained using the willingness to take part option in the questionnaire. To ensure the ECE teachers' confidentiality and anonymity, their names, school names, and personal information were not asked. They were assured that their data would only be used in the present study. No potential harms were involved as the respondents completed the survey at their own ease. They were allowed to withdraw from the study if they felt any hazard to themselves.

Results

The study focused on exploring ECE teachers' understanding and integration of BBL into

their ECE classrooms in Punjab. To respond to the research objective, the researchers designed two research questions and three hypotheses. The data were analyzed to answer these research questions and test hypotheses.

ECE Teachers' Understanding of BBL Principles

To answer the first research question, the authors collected data using a questionnaire on ECE teachers' understanding of BBL principles. Their understanding was examined by applying descriptive statistics (frequency, percentage, mean, and standard deviation), and the results are presented in Table 2.

Table 2. *ECE Teachers' Understanding of BBL (N= 602)*

Sr No	Statement	SD (%)	D (%)	N (%)	A (%)	SA (%)	M	SD
1	I am familiar with the basic principles of brain-based learning.	4	0	10	63	23	4.02	.81
2	I understand the concept of brain-based learning and its relevance to early childhood education.	4	0	6	67	23	4.07	.76
3	I can explain how brain development in early childhood impacts learning processes.	5	0	9	49	37	4.14	.93
4	I am knowledgeable about the role of sensory experiences in brain-based learning.	6	2	15	59	17	3.80	.95
5	According to brain-based learning, I can describe the significance of emotions and their impact on learning.	1	3	8	54	34	4.15	.80
6	I understand the concept of cognitive load and its implications for instructional design in brain-based learning.	2	2	20	57	19	3.87	.82
7	I am familiar with strategies for promoting engagement and attention in the classroom based on brain-based learning.	3	0	7	61	29	4.12	.81
8	I stay updated on current research and developments in brain-based learning through professional development and reading.	2	9	19	55	15	3.71	.91
9	I know different learning styles and how they relate to brain-based learning principles.	2	2	16	54	26	3.98	.85
10	I understand the importance of movement and physical activity in facilitating brain development and learning.	0	1	9	54	36	4.24	.66

Table 2 reveals the analysis of ECE teachers' understanding of BBL principles for the first research question. It shows that overall, ECE teachers' understanding of BBL principles was on the higher side. Thus, it was concluded that ECE teachers' understanding of BBL principles was high enough to provide the grounding for its implementation. The last item shows that participants had the highest understanding ($M = 4.24$, $SD = .66$). It shows that an overwhelming majority of ECE teachers (90 %) believed that they were very much aware of the importance of bodily movements. This was aligned with the BBL principle, which focuses on the physical movements in the physiology of learning. The analysis further revealed that ECE teachers' understanding of BBL principles, like emotions, is critical patterning ($M = 4.15$, $SD = .80$). In contrast, a significant majority of the participants (88 %) believed that they could describe the importance of emotions and their impact on learning. It strongly implies that students can learn much better when emotionally attached or attracted. The results also revealed that ECE teachers understand the principle of learning and that the brain is developmental ($M = 4.14$, $SD = .93$), whereas 88 % of the ECE teachers understand and know the brain and child's development.

ECE Teachers' Integration of BBL Principles

The researchers also collected data to answer the second research question. ECE teachers' integration of BBL principles into their classrooms was explored using frequency, percentage, mean, and standard deviation, and the results are presented in Table 3.

Table 3 provides the analysis for the second research question concerned with the ECE teachers' levels and methods of integration of BBL principles. The analysis revealed that overall, teachers' integration of BBL principles into their ECE classrooms was higher, so ECE teachers may benefit from integrating BBL for class retention, engagement, and motivation. ECE teachers had the highest integration ($M = 4.27$, $SD = .72$). This shows that an overwhelming majority (92 %) of the respondents argued that they regularly provide feedback and adjust students' needs and preferences. It was followed by the third item ($M = 4.23$, $SD = .82$), where 86 % of the teachers believed that they prepare lessons to provide opportunities for students to apply critical thinking and problem-solving skills. It was followed by the 5th ($M = 4.21$, $SD = .80$) and eighth ($M = 4.21$, $SD = .80$) statements, whereas

87 % and 92 % of the ECE teachers believe that they use storytelling and narrative-based learning approaches to stimulate students' imagination and creativity. ECE teachers encourage collaborative learning activities that promote social interaction and peer learning.

Table 3. *ECE Teachers' Integration of BBL (N= 602)*

Sr No	Statement	SD (%)	D (%)	N (%)	A (%)	SA (%)	M	SD
1	I incorporate multisensory activities into my lessons to engage students in active learning experiences.	1	5	9	58	27	4.05	.81
2	I regularly incorporate movement and physical activity into classroom lessons to enhance students' cognitive engagement.	1	7	13	48	31	4.01	.91
3	I design lessons that provide opportunities for students to apply critical thinking and problem-solving skills.	1	2	11	44	42	4.23	.82
4	I scaffold learning experiences to support students with varying levels of ability and understanding.	1	3	13	56	27	4.03	.80
5	I use storytelling and narrative-based learning approaches to stimulate students' imagination and creativity.	0	4	9	47	40	4.21	.80
6	I incorporate brain breaks and mindfulness activities to help students regulate their emotions and maintain focus.	0	7	9	55	29	4.06	.81
7	I provide opportunities for students to reflect on their learning and make connections to real-life experiences.	1	1	9	56	33	4.17	.74
8	I encourage collaborative learning activities that promote social interaction and peer learning.	3	0	5	56	36	4.21	.82
9	I use technology tools and resources to enhance learning experiences and cater to diverse learning styles.	1	5	12	48	34	4.08	.87
10	I actively seek student feedback and adjust instructional strategies based on their needs and preferences.	1	1	6	54	38	4.27	.72

Demographic-Based Difference in BBL Understanding

The first hypothesis was designed to explore ECE teachers' understanding, which may significantly differ in context, based on their qualifications (academic and professional) and

gender. An independent sample t-test was applied to test the hypothesis, and the results are provided in Table 4.

Table 4. *Demographics and ECE Teachers' Understanding of BBL*

Variable	Category	<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i> (2-tailed)
Gender	Male	287	4.09	.34	3.62	600	.000
	Female	315	3.94	.58			
Academic qualification	BA or equal	55	4.12	.38	1.77	600	.077
	MA or equal	547	4.00	.50			
Professional qualification	B.Ed	504	3.96	.49	-6.87	600	.000
	M.Ed	98	4.26	.38			

Table 4 indicates that male teachers had a higher understanding of BBL ($M = 4.09$, $SD = .34$) than female teachers ($M = 3.94$, $SD = .58$). This difference in understanding was statistically significant at $t(600) = 3.62$, $p = .000$. Although male and female ECE teachers had similar qualification and training why female teachers had the lesser level of BBL understanding need further attention to be studied. Regarding their academic qualification, it was found that although bachelor-level ECE teachers had a higher understanding ($M = 4.12$, $SD = .38$) of BBL than master-level ($M = 4.00$, $SD = .50$) academic qualifications, this difference was not statistically significant at $t(600) = 1.77$, $p = .077 > .001$. However, in the context of their professional qualification, it was found that ECE teachers who had higher professional qualifications (M.Ed) had a higher understanding of BBL ($M = 4.26$, $SD = .38$) than ECE teachers with B.Ed as their professional qualification ($M = 3.96$, $SD = .49$), and this difference was statistically significant at $t(600)$, $p = .000$. This implies that higher professional qualification is very crucial for getting better and advance level understanding of BBL.

Contribution of Understanding to Integration

The second hypothesis was formulated to examine the contribution of understanding BBL to ECE teachers' integration. It was tested using simple linear regression on Jamovi software,

and the results are presented in Table 5.

In Table 5, the results of the regression analysis are provided. It was found that ECE teachers' understanding of BBL positively contributes to their integration ($\beta = .66$, $SE = .03$, $t = 19.5$, $p = .000$). It revealed that a one-unit improvement in understanding of BBL will enhance .66 units of integration of BBL into ECE teachers' instructional strategies. It was also found that the intercept showcasing the integration of BBL, when understating was zero, was estimated at 1.50 ($SE = .14$, $t = 11.1$, $p = .000$). F-test ($F[1,600] = 382$, $p = .000$) suggests the model fitness for a significant proportion of variance in the integration of BBL ($R = .624$, $R^2 = .389$). These findings support the second hypothesis that ECE teachers' understanding of BBL is a strong predictor and contributor to integrating BBL into their instructional practices.

Table 5. *Contribution of Understanding to Integration*

Predictor	Estimate	SE	t	p
Intercept	1.50	.14	11.1	.000
Understanding of BBL	.66	.03	19.5	.000
$R (.624)$, $R^2 (.389)$, $F(1,600) = 382$, $p = .000$				

Dependent variable: Integration of BBL

Mediation Effect of Demographic Variables

The third hypothesis was designed to examine the mediational effect of demographic variables (gender, academic, and professional qualification) on the relationship between understanding and integration of BBL in ECE teachers' instructional practices. The researchers tested the hypothesis using the mediation analysis option from Jamovi, and the results are presented in Table 6.

Table 6 provides the analysis for the third hypothesis. It was revealed that gender ($\beta = .03$, $SE = .01$, 95 % $CI [.0157, .0461]$, $p = .000$) and professional qualification ($\beta = -.02$, $SE = .01$, 95 % $CI [-.0416, -.0032]$, $p = .000$) have a significant indirect effect, academic qualification ($\beta = -.01$, $SE = .01$, 95 % $CI [-.0190, -.0304]$, $p = .230$) did not have significant indirect effect on the relationship between ECE teachers' understating and integration of BBL in teaching

practices. These findings reveal that gender and professional qualifications indirectly affect the integration of BBL, while gender and professional qualifications explain only 4.61 % and 3.09 % of the total mediation effect. However, the direct effect of all these demographic variables was significant for gender ($\beta = .63, SE = .04, 95\% CI [.5460, .6967], p = .000$), for academic qualification ($\beta = .66, SE = .04, 95\% CI [.5872, .7280], p = .000$), and professional qualification ($\beta = .68, SE = .04, 95\% CI [.5932, .7468], p = .000$) all are positively associated with ECE teachers' integration of BBL to their instructional practices. Overall, these findings support the third hypothesis for the case of gender and professional qualification, but not for academic qualification.

Table 6. *Mediational Effect of Demographic Variables between Understanding and Integration*

Mediator	Effect	Estimate	SE	95 % CI		Z	P	Mediation (%)
				Lower	Upper			
Gender	Indirect	.03	.01	.0157	.0461	3.70	.000	4.61
	Direct	.63	.04	.5460	.6967	16.64	.000	95.39
	Total	.66	.04	.5743	.7266	16.88	.000	100
Academic qualification	Indirect	-.01	.01	-.0190	-.0304	-1.20	.230	.87
	Direct	.66	.04	.5872	.7280	17.84	.000	99.13
	Total	.66	.04	.5769	.7240	17.10	.000	100
Professional qualification	Indirect	-.02	.01	-.0416	-.0032	-2.23	.026	3.09
	Direct	.68	.04	.5932	.7468	17.38	.000	96.91
	Total	.66	.04	.5740	.7284	16.87	.000	100

Discussion

The first question of the study was designed to explore ECE teachers' understanding of BBL principles and interventions. Based on Bandura's SCT, this study's findings provide insight into how ECE teachers understand and employ BBL principles. These findings have significance for enhancing children's educational experiences. The analysis reveals a significant alignment between the ECE teachers' understanding of BBL principles and their

preparedness to implement them. The majority of ECE teachers demonstrate a higher-level understanding of the essential components of BBL. Understanding the importance of bodily movements and emotions in learning is especially significant as it aligns with BBL's emphasis on physiological and affective components. This contrasts with previous studies conducted by Devi (2020) and Letina and Perković (2021), which pointed to limitations in understanding elementary teachers' understanding of BBL in various educational settings. Although these studies highlighted difficulties in integrating BBL and identified characteristics such as academic achievement, the findings indicate a more positive situation in the ECE, possibly suggesting a stronger connection between ECE teaching methods and BBL concepts. However, additional research is needed to investigate the particular factors that influence the application of BBL and develop interventions that are compatible with the concepts of SCT. These interventions should aim to enhance the effectiveness and competence of ECE teachers in integrating BBL into their teaching practices.

The analysis conducted for the second research question, which is based on Bandura's SCT and focuses on ECE teachers' integration of BBL principles into their instructional practices, reveals positive trends that suggest a significant adoption of BBL practices among ECE teachers. The findings highlight a higher level of integration across several aspects of BBL, indicating a promising approach to improving class retention, interaction, and motivation in ECE contexts. ECE teachers are dedicated to customising their teaching methods to accommodate their pupils' varied requirements and preferences. This is evident through their consistent offer of input and adjustments to facilitate diverse learning needs. Furthermore, the extensive utilisation of narrative-based learning methodologies and collaborative tasks highlights the efforts of ECE teachers to foster the development of creative thinking, imagination, and social skills in ECE students. The results align with previous studies by Alanazi (2020) and Bada (2022), which emphasized the effectiveness of integrating BBL in improving student learning outcomes in various educational settings. Contrary to previous studies, the research shows no significant relationship between teachers' qualifications and their integration of BBL practices. This suggests that effective strategies for implementing BBL can be universally applied and adapted in the field of ECE. In the future, researchers should focus on studying the precise mechanisms contributing to

integrating BBL ECE classrooms.

The first hypothesis's findings concern the relationship between ECE teachers' knowledge of BBL principles and their qualifications, gender. These results provide fascinating insights into the multiple variables influencing understanding of BBL in the ECE. The results indicate a significant difference in BBL understanding between male and female ECE teachers, with male teachers demonstrating a higher level of understanding than their female colleagues. The existence of this gender difference, even when individuals possess comparable education and training, necessitates a further examination of possible underlying factors that affect BBL understanding among different gender populations. In addition, there was no significant difference in BBL understanding between ECE teachers with bachelor's and master's degrees. However, there was a significant difference in terms of professional qualifications. ECE teachers with higher professional qualifications (M.Ed) exhibited a superior understanding of BBL than their counterparts with B.Ed qualifications. This emphasizes the significance of improved professional qualifications in promoting a deeper understanding of BBL concepts among ECE educators. The results of this study align with previous research conducted by Devi (2020), Letina and Perković (2021), Alanazi (2020), and Bada (2022), which emphasizes the complex relationship between teachers' qualifications, gender, and comprehension of BBL. These findings underscore the importance of implementing focused interventions based on the SCT to improve understanding and integration of BBL in ECE settings.

The results of hypothesis H2, investigating the association between ECE teachers' understanding of BBL principles and their teaching methods for classroom application, provide valuable insights into the critical role of understanding BBL in shaping and enhancing instructional practices in the ECE. The regression analysis reveals a statistically significant positive correlation between ECE teachers' understanding of BBL principles and their incorporation into instructional techniques. A higher understanding of BBL principles corresponds to a stronger integration of these ideas into teaching methodologies. This relationship highlights the effectiveness of BBL principles in designing educational approaches that correspond with the brain's natural learning processes, as Caine and Caine recommended. Furthermore, the model's strength, demonstrated by a large amount of variance explained in BBL integration, emphasizes the importance of SCT in understanding

the cognitive processes that influence teachers' decision-making in BBL-based instruction. These findings support previous research highlighting the significant effect of BBL principles on learning outcomes (Amir, 2021). They also emphasize the potential of integrating BBL to improve ECE students' cognitive, emotional, and social development. This aligns with the objectives of SCT and the broader goals of ECE pedagogy.

The findings of hypothesis H3 explore the influence of demographic variables (gender, academic, and professional qualifications) on the relationship between ECE teachers' understanding and integration of BBL principles. These results provide valuable insights into the intricate relationship between personal characteristics and teaching methods in the ECE sector. The analysis uncovers an in-depth view where gender and professional qualification play a crucial role as mediators, indirectly impacting the integration of BBL into instructional practices. However, they only explain a small portion of the overall mediation effect. These findings support previous research that emphasizes the significance of customizing teaching methods to match the brain's natural learning processes, as emphasized by Jang et al. (2022) and Shahzadi et al. (2024), who highlight the effectiveness of various BBL strategies in maximizing learning outcomes and promoting student engagement and retention. Interestingly, despite what was expected, academic qualification did not significantly influence how well ECE teachers understood and applied BBL principles. This emphasizes the necessity of conducting additional research to understand how demographic factors impact the integration of BBL in ECE.

Conclusions

In the current study, the authors found ECE teachers' understanding and integration level for deploying BBL principles to improve student outcomes and inclusivity. After collecting data, it was analyzed using descriptive and inferential statistics to answer the current study's research questions and test hypotheses. In response to the first research question, the researchers found that teachers had a higher level of understanding of BBL principles, particularly in connection with students' physical movements and the role of students' emotions in being ready to attain knowledge. In response to the second research question, the

authors found that teachers' integration level is also higher when incorporating BBL in ECE. A higher level of understanding and integration can set a foundation for implementing BBL principles in ECE. The researchers also found that ECE teachers' demographics, like gender and qualifications (academic and professional), had a positive and statistically significant effect on their understanding and integrations. The researchers tested the second hypothesis and found a positive and statistically significant correlation between ECE teachers' understanding and integration of BBL principles into ECE classrooms. The authors analyzed data for the third hypothesis and found that ECE teachers' gender and qualifications significantly mediate the relationship between their understanding and integration of BBL in ECE classrooms.

Recommendations

Based on the study's results, the researchers had some practical and future research-related recommendations. They suggest that ECE teachers should incorporate BBL principles in their teaching methodologies, considering their broader educational implications for ECE students. Teachers' training institutions are suggested to train ECE teachers to regulate young students' emotions, engagement, and brain development. Considering the gender gaps in implementing BBL, the researchers suggest introducing BBL-based programs in their teacher training. They may also become more aware by participating in seminars and conferences on neuroscientific integration into education. To improve inclusivity, the authors suggest that stakeholders, including policy-makers and school education officers, incorporate BBL-based teaching strategies and a manual for classroom planning. As the present study used only quantitative data with a cross-sectional research design, future studies may deploy longitudinal and mixed-methods studies to improve the current study's generalizability.

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