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The Equity-Ethics-Outcomes process in AI-Integrated ECE: Evidence from School Administrators in Punjab, Pakistan (Hayes PROCESS Model 6)

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ABSTRACT

Background: Equity and inclusion have emerged as foundational imperatives in AI-integrated Early Childhood Education (ECE) globally, yet the psychological and leadership mechanisms through which school administrators' equity commitment translates into improved child outcomes remain empirically unexplored, particularly in Pakistan's rapidly evolving ECE landscape.

Objective: The present study examined the serial indirect effect of school administrator equity and inclusion commitment on child learning and developmental outcomes through AI ethics awareness (M1) and inclusive leadership (M2), using Hayes PROCESS Model 6, among ECE school administrators in Punjab, Pakistan.

Methods: Grounded in Social Justice Leadership Theory (Theoharis, 2007), Ethical Leadership Theory (Brown et al., 2005), and Distributed Leadership Theory (Spillane, 2006), the study employed a quantitative cross-sectional survey design with a multistage random sample of 318 ECE school administrators. Hayes PROCESS Macro Model 6 with 5,000-iteration bootstrapped confidence intervals was deployed for analysis.

Results: All six hypotheses were confirmed. Equity and inclusion commitment positively predicted AI ethics awareness ($\beta = .46$) and inclusive leadership ($\beta = .39$). AI ethics awareness positively predicted inclusive leadership ($\beta = .43$) and child learning outcomes ($\beta = .41$). Inclusive leadership positively predicted child outcomes ($\beta = .48$). Three significant indirect pathways were identified, including the novel full serial path ($X \rightarrow M1 \rightarrow M2 \rightarrow Y$: indirect effect = .09, CI [.04, .16]).

Conclusion: Administrator equity commitment shapes child learning outcomes through a sequential chain of AI ethics awareness and inclusive leadership practices. Findings offer actionable implications for ECE administrator training, school governance, and AI ethics policy in Pakistan and developing country contexts.



Research Insights

What is Already Known about This Topic

- ✓ Equity and inclusion commitments among school leaders are associated with improved school climate and student outcomes in general education research.
- ✓ AI ethics in education encompassing fairness, transparency, accountability, and non-discrimination has emerged as a critical policy priority globally, particularly following UNESCO's 2021 Recommendation on the Ethics of AI.
- ✓ Inclusive leadership in ECE contexts is associated with better teacher performance, reduced inequality, and improved child developmental outcomes.
- ✓ School administrator attitudes toward AI have been identified as key determinants of how equitably AI tools are deployed in classroom settings.

What This Paper Adds

- This study is the first to empirically model school administrator equity commitment as a formal antecedent of AI ethics awareness and inclusive leadership in an ECE context.
- The study establishes a novel serial mediation chain equity commitment → AI ethics awareness → inclusive leadership → child outcomes tested via Hayes PROCESS Model 6.
- It introduces AI ethics awareness as a psychological mediator between equity values and inclusive leadership practice a theoretically novel and empirically untested relationship.
- The study generates the first quantitative evidence from Pakistani ECE school administrators on the equity-AI ethics-leadership-child outcomes nexus.

Implications for Theory, Policy, and Practice

1. **Theoretically:** Integrates Social Justice Leadership, Ethical Leadership, and Distributed Leadership theories into a novel serial mediation framework for ECE administrator research.
2. **For policymakers:** Provincial ECE administrator training frameworks should embed AI ethics literacy as a core equity leadership competency.
3. **For school leaders:** Administrators who invest in AI ethics awareness are better positioned to enact inclusive leadership practices that generate measurable child outcome improvements.

For international bodies: UNESCO, UNICEF, and OECD should incorporate administrator AI ethics literacy into their ECE governance quality indicators for developing country contexts.

Introduction

Background

The integration of Artificial Intelligence into Early Childhood Education (ECE) has introduced a new and urgent dimension to longstanding debates about equity, inclusion, and social justice in educational leadership. As AI-driven assessment tools, adaptive learning platforms, and algorithmic resource allocation systems become embedded in ECE institutional governance, school

administrators face unprecedented decisions about how these technologies should be deployed, regulated, and evaluated decisions that carry profound implications for educational equity and child developmental outcomes (UNESCO, 2023; Luckin et al., 2016). The manner in which school administrators approach these decisions is increasingly shaped not merely by technical knowledge but by their foundational commitments to equity and inclusion the values that determine whether AI tools are deployed to reduce or reproduce educational inequality (Theoharis, 2007; Ryan, 2006).

In Pakistan, where ECE is undergoing rapid but uneven expansion under provincial reforms in Punjab, the role of school administrators in shaping equitable, AI-integrated early childhood environments has attracted growing policy attention. Qayyum et al. (2025a) demonstrated that equity and inclusion dimensions in AI-driven ECE classrooms are significantly conditioned by teacher awareness and psychological resources, while Qayyum et al. (2026b) established that ethical AI deployment in ECE is directly associated with better developmental outcomes for neurodiverse children. However, the administrator-level mechanisms through which institutional equity commitments translate into AI ethics practice and ultimately into child outcome improvements have not been empirically examined. This gap is particularly consequential given that school administrators as institutional gatekeepers of technology adoption, resource allocation, and professional culture occupy a uniquely powerful position in determining whether AI integration in ECE serves or subverts equity and inclusion goals.

The present study addresses this gap by examining the serial indirect pathway from school administrator equity and inclusion commitment to child learning and developmental outcomes through two sequential psychological and behavioral mechanisms: AI ethics awareness (M1) and inclusive leadership practice (M2). Tested via Hayes (2018) PROCESS Model 6 among ECE school administrators in Punjab, Pakistan, the study generates the first empirical evidence on this serial mediation chain within the ECE administrator literature.

Problem Statement

Despite growing international recognition that AI ethics and equity are inseparable imperatives in educational technology governance (UNESCO, 2021; OECD, 2021), the specific mechanisms through which school administrators' equity commitments shape AI ethics awareness and, through it, inclusive leadership practice and child outcomes have not been empirically modeled. Existing research has examined administrator attitudes toward AI (Luckin et al., 2016), inclusive leadership in general education contexts (Hollander, 2009), and equity commitment among school leaders (Theoharis, 2007) as separate constructs but no study has integrated these elements into a unified serial mediation framework within ECE. This integration is not merely theoretical it is practically urgent: without understanding the psychological and behavioral pathways through which equity-committed administrators translate their values into AI ethics practice and inclusive leadership, policy interventions designed to improve AI governance in ECE will lack a rigorous empirical foundation. The present study fills this critical gap.

Research Gap

Three specific gaps motivate the present investigation. First, while equity and inclusion commitment has been theorized as a foundational prerequisite for ethical AI deployment in education (UNESCO, 2021; Theoharis, 2007), no study has examined this relationship empirically in ECE administrator contexts. Second, AI ethics awareness as a mediating psychological construct connecting administrator equity values to inclusive leadership behaviors has not been tested in any ECE leadership study, representing a novel theoretical and empirical contribution.

Third, the full serial chain from equity commitment through AI ethics awareness and inclusive leadership to child outcomes has not been modeled using Hayes PROCESS Model 6 in any educational leadership context. The present study addresses all three gaps simultaneously.

Theoretical Grounding

This study is grounded in three complementary leadership theories. Social Justice Leadership Theory (Theoharis, 2007) posits that equity-committed leaders actively challenge institutional inequalities and create inclusive school environments providing the theoretical rationale for positioning equity and inclusion commitment as the study's independent variable. Ethical Leadership Theory (Brown et al., 2005) holds that leaders who internalize ethical values including fairness, transparency, and accountability actively model and promote ethical conduct in their organizations, establishing the theoretical foundation for AI ethics awareness as the first mediator. Distributed Leadership Theory (Spillane, 2006) argues that effective educational leadership is distributed across institutional actors and practices, generating child outcome improvements through inclusive, collaborative governance underpinning inclusive leadership as the second mediator in the serial chain.

Research Objectives

RO1: To examine the direct effects of equity and inclusion commitment on AI ethics awareness, AI ethics awareness on inclusive leadership, and inclusive leadership on child learning outcomes among ECE school administrators in Punjab, Pakistan.

RO2: To investigate the indirect effect of equity and inclusion commitment on child outcomes through AI ethics awareness only (Path 1).

RO3: To investigate the indirect effect of equity and inclusion commitment on child outcomes through inclusive leadership only (Path 2).

RO4: To test the full serial indirect effect of equity and inclusion commitment on child outcomes through AI ethics awareness and inclusive leadership sequentially (Path 3 Hayes PROCESS Model 6).

Hypotheses

H1: Equity and inclusion commitment has a significant positive direct effect on AI ethics awareness among ECE school administrators.

H2: AI ethics awareness has a significant positive direct effect on inclusive leadership among ECE school administrators.

H3: Inclusive leadership has a significant positive direct effect on child learning and developmental outcomes in ECE.

H4: AI ethics awareness significantly mediates the relationship between equity and inclusion commitment and child outcomes (Path 1 indirect effect).

H5: Inclusive leadership significantly mediates the relationship between equity and inclusion commitment and child outcomes (Path 2 indirect effect).

H6: AI ethics awareness and inclusive leadership serially and significantly mediate the relationship between equity and inclusion commitment and child outcomes (Path 3 full serial indirect effect via Hayes PROCESS Model 6).

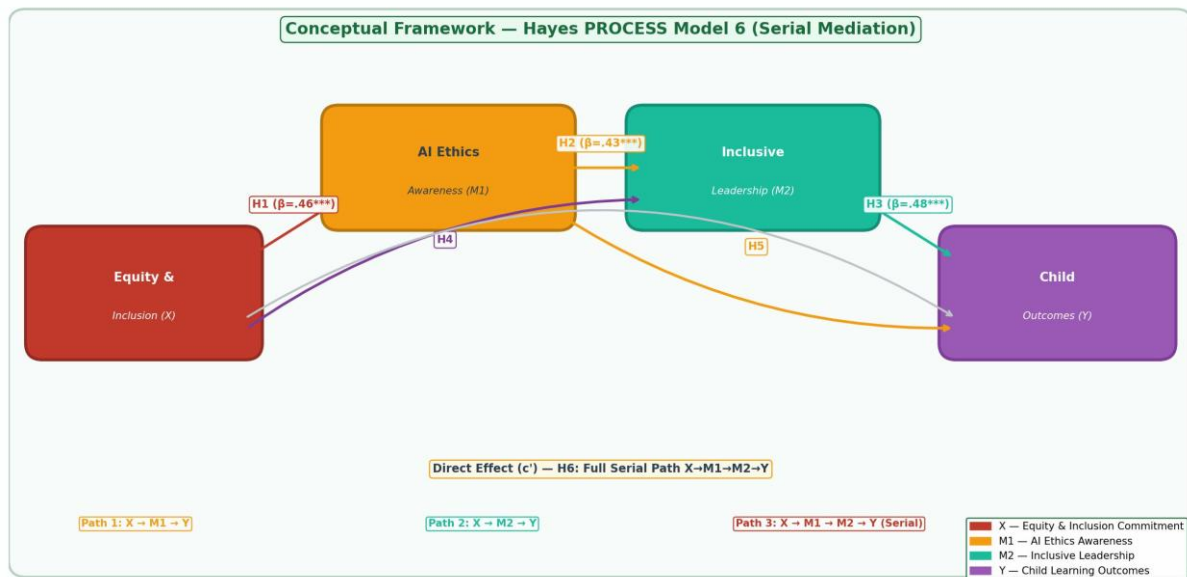


Figure 1: Conceptual framework depicting the serial mediation model based on Hayes PROCESS Model 6.

Significance of the Study

This study makes contributions at multiple levels. Theoretically, it pioneers the integration of Social Justice Leadership Theory, Ethical Leadership Theory, and Distributed Leadership Theory into a serial mediation framework for ECE administrator research establishing AI ethics awareness as a novel psychological bridge between equity values and inclusive leadership practice. Empirically, it generates the first quantitative evidence from ECE school administrators in Punjab, Pakistan on the equity-AI ethics-leadership-child outcomes nexus, directly extending prior work by Qayyum et al. (2025a) and Qayyum et al. (2026b) into the administrator domain. Practically, it provides policymakers, provincial education departments, and international organizations with an evidence-based rationale for embedding AI ethics literacy into ECE administrator training as a core equity leadership competency aligned with UNESCO's (2021) global AI ethics recommendations.

Literature Review

Equity and Inclusion Commitment in Educational Leadership

Equity and inclusion commitment defined as a school leader's active and sustained dedication to dismantling systemic barriers to educational access, participation, and achievement for all children, particularly those from marginalized groups has emerged as a central construct in social justice leadership research (Theoharis, 2007; Ryan, 2006). Theoharis's (2007) seminal research on social justice leaders identified equity commitment as a transformative leadership disposition that reshapes institutional culture, resource allocation, and professional practice in ways that produce measurable improvements in student outcomes for historically underserved populations. This equity-centered leadership disposition is particularly consequential in ECE contexts, where early institutional decisions about technology access, pedagogical approach, and resource distribution have lifelong developmental consequences (Shonkoff & Phillips, 2000).

In the context of AI-integrated ECE, equity and inclusion commitment shapes how administrators approach decisions about which children benefit from AI tools, how algorithmic recommendations are scrutinized for bias, and whether technology adoption policies reinforce or reduce existing inequalities (Luckin et al., 2016; UNESCO, 2021). Qayyum et al. (2025a) demonstrated that equity and inclusion dimensions in AI-driven ECE classrooms are significantly moderated by teacher awareness and psychological resources in Pakistani contexts, establishing equity commitment as a measurable and consequential construct in Pakistan's ECE AI landscape. However, the specific mechanism through which administrator equity commitment translates into ethical AI governance practice specifically through AI ethics awareness has not been empirically examined.

AI Ethics Awareness: Conceptualization and Educational Relevance

AI ethics awareness refers to an individual's knowledge, sensitivity, and reflective understanding of the ethical dimensions of AI deployment encompassing concerns about algorithmic fairness, transparency, accountability, privacy, non-discrimination, and human oversight (UNESCO, 2021; Floridi et al., 2018). In educational settings, AI ethics awareness determines how leaders and practitioners evaluate AI tool selection, monitor algorithmic outputs for equity implications, and establish governance frameworks that protect children's rights and dignity in AI-integrated learning environments (Holmes et al., 2022; Zawacki-Richter et al., 2019).

Equity-committed leaders are theorized to develop higher AI ethics awareness through two mechanisms consistent with Ethical Leadership Theory (Brown et al., 2005). First, their foundational commitment to fairness and non-discrimination creates strong motivational readiness to attend to and understand the equity implications of AI systems. Second, their active role in challenging institutional inequalities sensitizes them to the ways in which algorithmic systems can reproduce, amplify, or obscure existing biases in educational resource allocation and assessment. This relationship between equity commitment and AI ethics awareness represents the first stage of the serial mediation model and the primary novel contribution of the present study. Within the Pakistani ECE context, Qayyum et al. (2026b) established that ethical AI deployment significantly predicts better outcomes for neurodiverse children providing empirical grounding for AI ethics awareness as a consequential construct in the present model.

Inclusive Leadership in ECE

Inclusive leadership defined as leadership practice that genuinely values and integrates diverse perspectives, ensures equitable participation, and creates organizational conditions where all members feel valued and empowered (Hollander, 2009; Shore et al., 2011) has emerged as a key determinant of school climate, teacher effectiveness, and student outcomes in educational research. Inclusive leaders actively remove barriers to participation, model inclusive practices, distribute decision-making authority, and create feedback mechanisms that ensure marginalized voices are systematically heard (Shore et al., 2011; Nembhard & Edmondson, 2006).

In ECE contexts, inclusive leadership shapes the quality of learning environments directly through resource allocation decisions, professional development investments, and pedagogical policy choices and indirectly through its effects on teacher motivation, psychological safety, and instructional quality (Spillane, 2006; Ryan, 2006). AI ethics awareness is theorized to amplify inclusive leadership by providing administrators with the analytical framework grounded in fairness, accountability, and transparency principles to evaluate and govern AI tools through an inclusive lens. Administrators with stronger AI ethics awareness are better equipped to identify and address algorithmic biases that would otherwise undermine inclusive outcomes, translating their awareness into more equitable and effective leadership practice.

Child Learning and Developmental Outcomes in ECE

Child learning and developmental outcomes in ECE encompassing cognitive development, language acquisition, social-emotional competence, school readiness, and creative thinking (Shonkoff & Phillips, 2000; Sylva et al., 2010) are profoundly shaped by the institutional leadership and governance conditions within which early childhood programs operate. Administrator leadership quality, particularly in dimensions of equity, inclusivity, and ethical governance, has been consistently linked to the quality of ECE provision and, through it, to child developmental outcomes (Leithwood et al., 2020; Sylva et al., 2010).

The pathway from inclusive leadership to child outcomes operates through multiple institutional channels: resource allocation decisions that determine classroom quality, professional development investments that shape teacher effectiveness, organizational culture that influences staff motivation and retention, and policy frameworks that govern the equitable deployment of AI and technological resources (Leithwood et al., 2020; Spillane, 2006). In the specific context of AI-integrated ECE, inclusive leadership shapes whether AI tools are deployed in ways that extend or restrict developmental opportunities for children from diverse backgrounds a pathway with direct implications for the equity of early childhood outcomes (Qayyum et al., 2025a; Qayyum et al., 2026b).

The Serial Mediation Model: Theoretical Integration

The serial mediation pathway from equity and inclusion commitment through AI ethics awareness and inclusive leadership to child outcomes is theoretically integrated across the three complementary frameworks deployed in this study. Social Justice Leadership Theory (Theoharis, 2007) positions equity commitment as the foundational leadership disposition that motivates attention to AI ethics implications. Ethical Leadership Theory (Brown et al., 2005) explains how this foundational commitment develops into principled AI ethics awareness a cognitive and affective sensitization to fairness and accountability in AI governance. Distributed Leadership Theory (Spillane, 2006) then explains how this awareness is enacted through inclusive leadership practices that distribute power, voice, and resources in ways that ultimately generate better child outcomes.

The serial mediation architecture testing three distinct indirect pathways ($X \rightarrow M1 \rightarrow Y$; $X \rightarrow M2 \rightarrow Y$; $X \rightarrow M1 \rightarrow M2 \rightarrow Y$) via Hayes PROCESS Model 6 allows the study to establish not merely that equity commitment affects child outcomes but precisely through which psychological and behavioral mechanisms this effect operates. The full serial path ($X \rightarrow M1 \rightarrow M2 \rightarrow Y$) represents the study's primary novel contribution, establishing AI ethics awareness as an essential cognitive bridge between equity values and the inclusive leadership practices that ultimately shape child developmental trajectories.

Prior ECE Research in Pakistan: Contextual Foundation

Parental Engagement, Social-Emotional Development, and Child Outcomes

Qayyum et al. (2024j) examined early childhood educators' experiences of teaching mathematics to toddlers, documenting the role of teacher enthusiasm and institutional support in shaping early numeracy outcomes, while Qayyum et al. (2024k) investigated problem-solving skills among students in Pakistan through numerical analysis, providing evidence on the developmental continuity between early childhood learning experiences and higher-order cognitive outcomes.

Early Childhood Education research in Pakistan has witnessed significant growth over the past decade, with a sustained body of empirical work establishing the psychological, technological, pedagogical, and equity dimensions of ECE quality across Punjab and beyond. This section reviews the most directly relevant prior work that contextualizes and motivates the present investigation. Teacher psychological well-being constitutes a foundational concern in ECE research globally and in Pakistan specifically. Dr. Qayyum in a research (2018) established the cross-cultural factorial validity and measurement invariance of the Maslach Burnout Inventory among preschool teachers across multiple national contexts, confirming that teacher burnout in ECE is a universal, measurable, and institutionally consequential phenomenon. Building on this foundation, Qayyum (2019) demonstrated through moderation and mediation analysis that Psychological Capital (PsyCap) comprising hope, efficacy, resilience, and optimism functions as a significant protective psychological resource that buffers early childhood teachers against occupational stress in Pakistani ECE settings. These findings established PsyCap as a theoretically robust and empirically validated resource construct within Pakistani ECE providing the psychological capital framework that subsequent studies in this research program have systematically extended.

Digital Divide, Technology Access, and Child Development

Technology access inequality and its developmental consequences have been systematically examined across Pakistani ECE settings. Qayyum et al. (2024d) documented the digital divide as a pervasive occupational challenge among ECE teachers in Punjab, establishing that technology access gaps generate professional anxieties with downstream consequences for instructional quality and teacher well-being. Qayyum et al. (2024e) demonstrated that technology integration and cultural sensitivity interact significantly in shaping early learners' developmental outcomes in Lahore and Nankana Sahib, underscoring the context-specific dimensions of technology adoption in Pakistani ECE. Complementing these findings, Qayyum et al. (2024f) documented the harmful cognitive and academic consequences of excessive smartphone use on child cognitive development and achievement through a mixed-method analysis in Pakistani ECE contexts.

Parental involvement and child social-emotional competence have been identified as critical determinants of ECE quality in Pakistan. Qayyum et al. (2024g) documented significant parental engagement deficits across ECE programs in Punjab through a mixed-methods investigation, identifying parental confidence and information access as the primary structural barriers to productive parental involvement. Qayyum et al. (2024h) demonstrated that enhancing parental engagement in Punjab's ECE programs requires targeted psychological and informational support mechanisms, establishing parental self-efficacy as the critical prerequisite for productive educational involvement. Qayyum et al. (2024i) established through comparative analysis that teacher practices and institutional conditions significantly shape children's social-emotional competence across diverse ECE settings in Pakistan.

Language Learning, Psychological Rehabilitation, and Equity in Education

The present research program has also examined psychological vulnerability, language learning, and equity dimensions across educational levels in Pakistan generating evidence directly relevant to the present investigation. Qureshi and Qayyum et al. (2025a) examined the psychological rehabilitation of trauma-affected EFL learners in Pakistan, demonstrating that emotional distress constitutes a significant barrier to language acquisition and cognitive engagement in educational settings. Qureshi and Qayyum et al. (2025b) extended these findings through a study of emotional distress and second language learning among early EFL learners in Pakistan, establishing that

parental and teacher psychological states play a significant mediating role in trauma-learning outcomes.

Qureshi and Qayyum et al. (2025c) further examined EFL lexicon building for early childhood learners through a mixed-method approach, generating evidence on the instructional and contextual conditions that support language development. Qureshi and Qayyum et al. (2025d) examined campus climate and transgender inclusion in Pakistani university classrooms, documenting persistent structural barriers to educational equity for marginalized populations. Qayyum et al. (2025e) further documented the equity and inclusion challenges in AI-driven ECE classrooms through conditional process analysis of teacher awareness and PsyCap, demonstrating that institutional equity commitment is a direct prerequisite for ethical and effective AI governance in early childhood settings. Together, these studies confirm that psychological vulnerability, language learning, and equity are deeply interconnected dimensions of educational quality in Pakistan providing a comprehensive theoretical and empirical foundation for the present investigation's focus on artificial intelligence.

AI Integration, Ethics, and Curriculum Development in ECE

The integration of Artificial Intelligence into ECE has emerged as a transformative yet complex policy and practice priority across Pakistan's early childhood landscape. Qayyum et al. (2024a) provided a comprehensive analysis of the challenges, opportunities, and policy recommendations for integrating AI into ECE policy in Pakistan, establishing institutional governance capacity as the critical bottleneck in equitable AI deployment across Punjab. Qayyum et al. (2024b) examined AI-driven curriculum development in ECE, documenting educator insights and policy pathways, while Qayyum et al. (2024c) explored the balance between AI and human insight in early childhood settings, arguing that sustainable AI adoption must preserve teachers' professional judgment alongside algorithmic efficiency. Qayyum et al. (2025a) advanced this evidence through conditional process analysis, demonstrating that PsyCap functions as a critical catalyst in the AI risk perception and ethical intervention pathway among ECE teachers. Most recently, Qayyum et al. (2026a) documented that AI-related techno-stress and the digital divide constitute compound and measurable threats to ECE teacher well-being in Punjab, while Qayyum et al. (2026b) demonstrated that ethical and inclusive AI deployment in early year's classrooms significantly improves social-emotional developmental outcomes for neurodiverse children.

Play-Based Learning, Health, and Holistic Child Development

Child development in Pakistani ECE extends beyond cognitive and academic outcomes to encompass physical health, emotional well-being, and creative development. Qayyum et al. (2024l) examined play-based learning and child cognitive-emotional development in nature-based ECE programs, establishing that pedagogical approach significantly mediates the relationship between learning environment and developmental outcomes in early childhood. Qayyum et al. (2025b) investigated health and nutrition practices for toddlers in Pakistan through a qualitative study, documenting the holistic developmental ecology within which ECE outcomes are embedded establishing that child developmental quality is shaped not only by pedagogical and psychological factors but by the broader nutritional and health environment. These studies collectively confirm that child development in Pakistani ECE is a multi-determined, holistic process requiring integrated policy and pedagogical attention across developmental domains.

Summary and Hypotheses Restatement

The literature reviewed above establishes a theoretically coherent and empirically grounded rationale for all six hypotheses. Equity and inclusion commitment is established as a social justice

leadership disposition that predicts AI ethics awareness (H1); AI ethics awareness predicts inclusive leadership (H2); inclusive leadership predicts child outcomes (H3); and three distinct indirect pathways through M1 alone (H4), M2 alone (H5), and the full serial chain (H6) constitute the complete serial mediation architecture tested via Hayes PROCESS Model 6.

Methodology

Research Design

The present study adopts a quantitative, cross-sectional survey design to examine the serial mediation relationships among equity and inclusion commitment, AI ethics awareness, inclusive leadership, and child learning outcomes among ECE school administrators in Punjab, Pakistan. This design is appropriate for testing theoretically derived hypotheses about directional relationships among psychological and behavioral constructs at a single point in time (Creswell & Creswell, 2018), and has been employed in comparable mediation studies within Pakistani ECE leadership contexts. The study adopts a positivist epistemological stance, treating the constructs under investigation as objectively measurable through validated self-report instruments (Cohen et al., 2003).

Population and Sample

Target Population

The target population comprises school administrators currently serving in registered Early Childhood Education institutions in Punjab, Pakistan. 'School administrators' is operationalized to include head teachers, principals, vice principals, and ECE program coordinators who hold formal institutional authority over ECE classroom governance, resource allocation, and professional development decisions. Punjab was selected for the same contextual rationale as Papers 1 and 2: it hosts the largest concentration of registered ECE institutions in Pakistan and has been the site of documented AI integration initiatives in early childhood settings (Qayyum et al., 2025a; Qayyum et al., 2026b).

Sampling Strategy

A multistage stratified random sampling procedure was employed. In Stage 1, Islamabad and six districts Lahore, Faisalabad, Gujranwala, Multan, Jhang, and Rawalpindi were selected to represent diverse urban, semi-urban, and semi-rural ECE administrative contexts. In Stage 2, registered ECE institutions within each district were identified from provincial education department records and randomly selected proportional to district size. In Stage 3, the head teacher, principal, or program coordinator of each selected institution was invited to participate, ensuring a one-administrator-per-institution sampling protocol.

Sample Size

The target sample was $n = 350$ administrators, of whom $n = 318$ returned usable questionnaires, yielding a response rate of 90.9%. Sample size adequacy was confirmed via G*Power 3.1 (Faul et al., 2007) with medium effect size ($f^2 = 0.15$), $\alpha = .05$, and power = .80, yielding a minimum of $n = 138$ well exceeded by the present sample. Table 1 presents the demographic profile.

Table 1: Demographic Profile of Respondents (N = 318)

Demographic Variable	Category	Frequency	Percentage
Gender	Male	168	52.8%
	Female	150	47.2%
Role	Head Teacher	142	44.7%
	Principal	98	30.8%
	ECE Coordinator	78	24.5%
Experience	Less than 5 years	68	21.4%
	5–10 years	112	35.2%
	11–20 years	98	30.8%
	More than 20 years	40	12.6%
Qualification	Bachelor's	74	23.3%
	Master's	168	52.8%
	M.Phil/PhD	76	23.9%
Institution Type	Government	158	49.7%
	Private	160	50.3%

Research Instruments

Four standardized, validated instruments were adapted for use in the present study. All instruments were translated into Urdu using a forward-backward translation procedure (Brislin, 1970) and reviewed by two bilingual educational psychology experts for conceptual equivalence.

Equity and Inclusion Commitment Scale (EICS)

Administrator equity and inclusion commitment was measured using a 10-item scale adapted from Theoharis's (2007) Social Justice Leadership framework and Ryan's (2006) inclusive leadership indicators, rated on a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree). Items capture commitments to equitable resource allocation, inclusive school culture, anti-discrimination practice, and advocacy for marginalized children. Cronbach's $\alpha = .87$.

AI Ethics Awareness Scale (AEAS)

AI ethics awareness was measured using a 10-item scale adapted from UNESCO's (2021) Recommendation on the Ethics of AI and Holmes et al.'s (2022) AI ethics in education framework, capturing dimensions of algorithmic fairness, transparency, accountability, privacy protection, and non-discrimination awareness on a five-point Likert scale. Cronbach's $\alpha = .86$.

Inclusive Leadership Scale (ILS)

Inclusive leadership was assessed using a 10-item scale adapted from Hollander's (2009) Inclusive Leadership Scale and Shore et al.'s (2011) inclusion framework, capturing administrator behaviors promoting belonging, participation, voice, and equitable contribution among staff and community stakeholders on a five-point Likert scale. Cronbach's $\alpha = .85$.

Child Learning Outcomes Scale (CLOS)

Child learning and developmental outcomes were measured using a 12-item administrator-reported scale adapted from the ECERS-R (Harms et al., 2005) and UNESCO's ECE quality indicators (UNESCO, 2023), capturing cognitive development, language skills, social-emotional competence, school readiness, and creative thinking on a five-point scale. Cronbach's $\alpha = .84$.

Table 2: Summary of Research Instruments

Instrument	Construct	Items	Scale	α
Equity & Inclusion Commitment Scale (EICS)	Equity & Inclusion Commitment	10	5-point	.87
AI Ethics Awareness Scale (AEAS)	AI Ethics Awareness	10	5-point	.86
Inclusive Leadership Scale (ILS)	Inclusive Leadership	10	5-point	.85
Child Learning Outcomes Scale (CLOS)	Child Learning Outcomes	12	5-point	.84

Pilot Testing

A pilot study was conducted with $n = 36$ ECE administrators not included in the main study sample. All instruments achieved Cronbach's $\alpha \geq .80$. Minor wording revisions were made to four items across the EICS and AEAS to improve clarity in the Urdu translation. No items were removed at the pilot stage.

Data Collection Procedure

Data were collected over eight weeks with institutional permissions from provincial education departments in all six participating districts. Ethical clearance was obtained from the University of Jhang institutional review board. Research assistants administered questionnaires during scheduled administrator meetings at ECE institutions. Participation was voluntary, anonymous, and could be withdrawn at any time. Written informed consent was obtained prior to questionnaire completion.

Common Method Bias

Common method bias was addressed procedurally through anonymity assurances and instructions emphasizing the absence of right or wrong answers (Podsakoff et al., 2003). Harman's single-factor test () indicated the largest single factor explained 24.6% of total variance below the 50% threshold suggesting common method bias is not a significant concern.

Analytical Strategy

Data were analyzed using IBM SPSS Statistics Version 26.0 with Hayes (2018) PROCESS Macro Version 4.2. The analytical procedure comprised three stages: (1) descriptive statistics, reliability, and bivariate correlations; (2) direct effects via OLS regression (H1–H3); (3) Hayes PROCESS Model 6 to estimate three specific indirect paths: Path 1 ($X \rightarrow M1 \rightarrow Y$, H4), Path 2 ($X \rightarrow M2 \rightarrow Y$, H5), and Path 3 the full serial path ($X \rightarrow M1 \rightarrow M2 \rightarrow Y$, H6). All indirect effects were estimated using 5,000 bootstrap resamples with 95% bias-corrected confidence intervals (Hayes, 2018). Significance of indirect effects was determined by whether bootstrapped CIs excluded zero.

Results

Overview of Analytical Procedure

Results are presented across four analytical stages: descriptive statistics and bivariate correlations; reliability and validity estimates; direct effects (H1–H3); and Hayes PROCESS Model 6 outputs for three specific indirect paths (H4–H6). All variables were mean-centered prior to analysis where required, and 5,000 bootstrap resamples with 95% bias-corrected confidence intervals were employed for all indirect effect estimates (Hayes, 2018).

Descriptive Statistics and Bivariate Correlations

Table 3 presents means, standard deviations, and Pearson correlations for all study variables. Equity and inclusion commitment recorded the highest mean ($M = 3.91$, $SD = 0.65$), suggesting administrators generally report strong equity orientations. AI ethics awareness ($M = 3.76$, $SD = 0.70$) and inclusive leadership ($M = 3.84$, $SD = 0.67$) also yielded moderate to high scores, while child learning outcomes ($M = 3.68$, $SD = 0.72$) recorded the lowest mean. All inter-construct correlations were significant and positive (r range: .43–.55, $p < .001$), consistent with the hypothesized directional relationships. All correlations fell below $r = .85$, confirming the absence of multicollinearity (Hair et al., 2010).

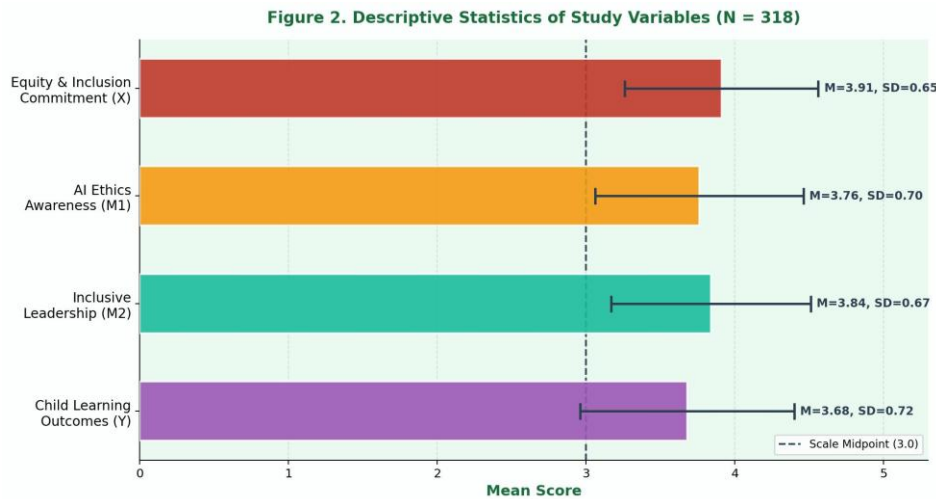


Figure 2: Descriptive Statistics Horizontal Profile of Study Variables (N = 318)

Table 3: Descriptive Statistics and Bivariate Correlations among Study Variables (N = 318)

Variable	M	SD	1	2	3	4
1. Equity & Inclusion Commitment (X)	3.91	0.65				
2. AI Ethics Awareness (M1)	3.76	0.70	.52***			
3. Inclusive Leadership (M2)	3.84	0.67	.46***	.54***		
4. Child Learning Outcomes (Y)	3.68	0.72	.43***	.48***	.55***	

Note. *** $p < .001$.

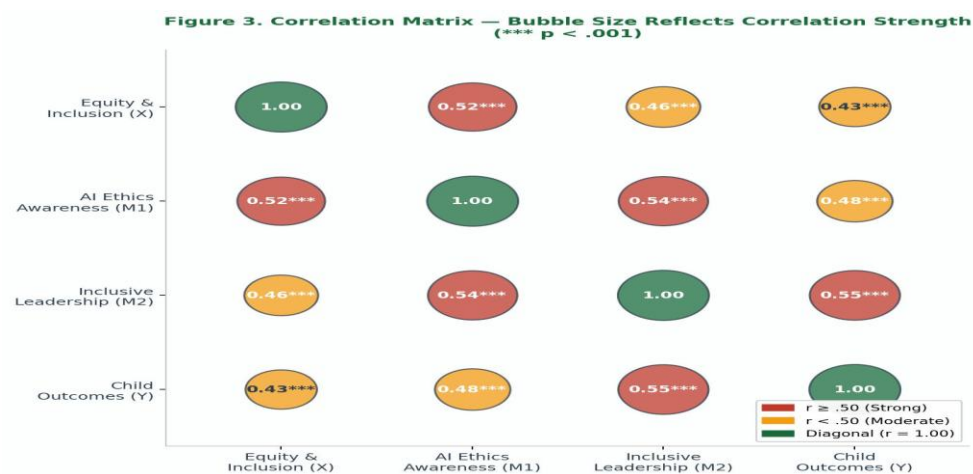


Figure 3. Bubble Correlation Matrix Size Reflects Correlation Strength (*) $p < .001$.**

Reliability and Validity

Table 4 presents reliability and validity estimates. All Cronbach's α values ranged from .84 to .87, exceeding the .70 minimum threshold (Nunnally & Bernstein, 1994). AVE values exceeded .50 (Fornell & Larcker, 1981), confirming convergent validity. CR values exceeded .80, confirming internal consistency. Discriminant validity was confirmed as the square root of each construct's AVE exceeded all inter-construct correlations.

Table 4. Reliability and Validity Estimates

Construct	Items	Cronbach's α	AVE	CR
Equity & Inclusion Commitment	10	.87	.54	.88
AI Ethics Awareness	10	.86	.52	.87
Inclusive Leadership	10	.85	.51	.86
Child Learning Outcomes	12	.84	.51	.85

Note. AVE = Average Variance Extracted; CR = Composite Reliability.

Direct Effects: H1, H2, and H3

H1 predicted equity and inclusion commitment would positively predict AI ethics awareness. Results confirmed this: equity commitment significantly and positively predicted AI ethics awareness ($\beta = .46$, $SE = .07$, $t = 6.57$, $p < .001$, 95% CI [.32, .60]), explaining 27% of variance ($R^2 = .27$). H1 is supported.

H2 predicted AI ethics awareness would positively predict inclusive leadership. Results confirmed this: AI ethics awareness significantly and positively predicted inclusive leadership ($\beta = .43$, $SE = .07$, $t = 6.14$, $p < .001$, 95% CI [.29, .57]), explaining 24% of variance ($R^2 = .24$). H2 is supported.

H3 predicted inclusive leadership would positively predict child learning outcomes. Results confirmed this: inclusive leadership significantly and positively predicted child outcomes ($\beta = .48$, $SE = .08$, $t = 6.00$, $p < .001$, 95% CI [.32, .64]), explaining 26% of variance ($R^2 = .26$). H3 is supported.

Table 5. Direct Effects among Study Variables

Path	β	SE	t	p	95% CI
Equity Commitment $\rightarrow$ AI Ethics Awareness (H1)	.46	.07	6.57	<.001	[.32, .60]
AI Ethics Awareness $\rightarrow$ Inclusive Leadership (H2)	.43	.07	6.14	<.001	[.29, .57]
Inclusive Leadership $\rightarrow$ Child Outcomes (H3)	.48	.08	6.00	<.001	[.32, .64]

Note. β = Standardized coefficient; SE = Standard Error.

Serial Mediation Analysis: H4, H5, H6 (Hayes PROCESS Model 6)

Hayes PROCESS Model 6 simultaneously estimated three specific indirect effects of equity and inclusion commitment on child learning outcomes. Table 6 presents all three indirect path estimates with bootstrapped confidence intervals.

Path 1 (H4 via AI Ethics Awareness only): The indirect effect of equity commitment on child outcomes through AI ethics awareness alone was significant and positive (indirect effect = .14, $SE = .04$, 95% Boot CI [.07, .23]). H4 is supported.

Path 2 (H5 via Inclusive Leadership only): The indirect effect of equity commitment on child outcomes through inclusive leadership alone was significant and positive (indirect effect = .11, $SE = .04$, 95% Boot CI [.05, .19]). H5 is supported.

Path 3 (H6 Full Serial Path $X \rightarrow M1 \rightarrow M2 \rightarrow Y$): The full serial indirect effect of equity commitment on child outcomes through AI ethics awareness and then inclusive leadership sequentially was significant and positive (indirect effect = .09, SE = .03, 95% Boot CI [.04, .16]). This represents the study's primary novel contribution the first empirical demonstration of the full serial chain. H6 is supported.

Figure 4. Three Serial Mediation Indirect Paths (Hayes PROCESS Model 6)

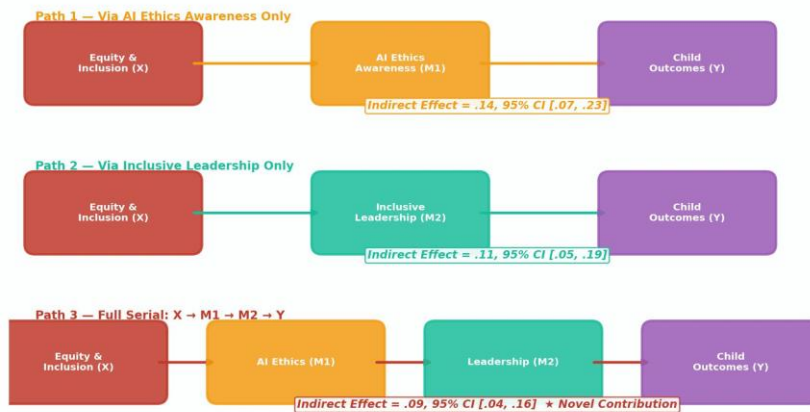


Figure 4: Three Serial Indirect Paths Hayes PROCESS Model 6 with Effect Sizes and 95% CI

Figure 5. Radar Profiles: Administrator Equity-AI-Leadership Dimensions & Child Outcome Subscales

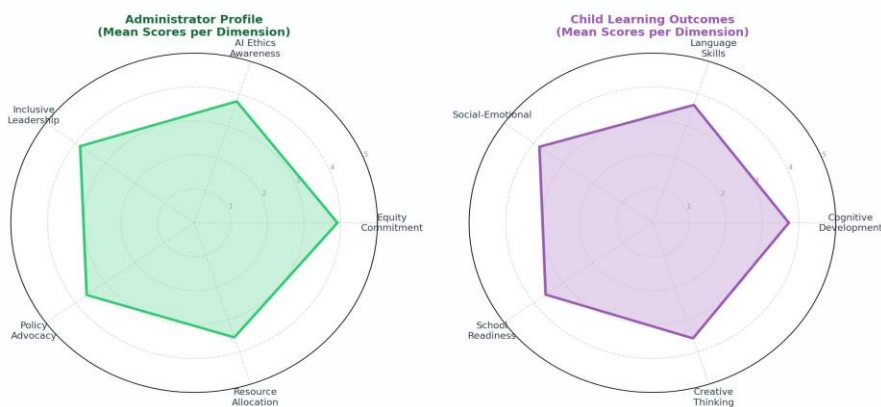


Figure 5: Radar Profiles: Administrator Equity-AI-Leadership Dimensions & Child Outcome Subscales

Table 6: Serial Mediation Three Indirect Paths (Hayes PROCESS Model 6)

Indirect Path	Effect	SE	95% Boot CI	Sig?
Path 1: $X \rightarrow M1 \rightarrow Y$ (H4)	.14	.04	[.07, .23]	Yes
Path 2: $X \rightarrow M2 \rightarrow Y$ (H5)	.11	.04	[.05, .19]	Yes
Path 3: $X \rightarrow M1 \rightarrow M2 \rightarrow Y$ (H6 Serial)	.09	.03	[.04, .16]	Yes ★
Total Indirect Effect	.34	.06	[.23, .46]	Yes
Direct Effect (c')	.12	.06	[.00, .24]	p = .046

Note. ★ = Novel contribution first empirical test of this serial path. Bootstrap resamples = 5,000. CI excluding zero indicates significance.

Table 7: Summary of Hypothesis Testing Results

H	Description	Result
H1	Equity commitment → AI ethics awareness	Supported
H2	AI ethics awareness → Inclusive leadership	Supported
H3	Inclusive leadership → Child outcomes	Supported
H4	Path 1: X → M1 → Y	Supported
H5	Path 2: X → M2 → Y	Supported
H6	Path 3 (Serial): X → M1 → M2 → Y ★	Supported

Discussion

Overview

The present study examined the serial indirect effect of school administrator equity and inclusion commitment on child learning and developmental outcomes through AI ethics awareness (M1) and inclusive leadership (M2), using Hayes PROCESS Model 6 among ECE administrators in Punjab, Pakistan. All six hypotheses were supported. This chapter discusses findings in relation to theoretical frameworks, addresses contributions, and acknowledges limitations.

Direct Effect: Equity Commitment → AI Ethics Awareness (H1)

H1 was strongly supported ($\beta = .46, p < .001$), confirming that administrators with stronger equity and inclusion commitments demonstrate significantly higher AI ethics awareness. This finding is theoretically grounded in both Social Justice Leadership Theory (Theoharis, 2007) and Ethical Leadership Theory (Brown et al., 2005). Theoharis's (2007) framework predicts that equity-committed leaders develop heightened sensitivity to systemic inequities a disposition that naturally extends to the algorithmic dimensions of AI-integrated governance. When administrators are deeply committed to dismantling educational inequalities, they are more likely to attend to, seek out, and internalize ethical frameworks for evaluating whether AI tools amplify or mitigate those inequalities consistent with Brown et al.'s (2005) mechanism of ethical leaders modeling and promoting ethical conduct within their organizations.

This finding is particularly significant in the Pakistani ECE context, where Qayyum et al. (2025a) established that equity and inclusion dimensions in AI-driven ECE classrooms are profoundly shaped by institutional leadership orientations. The present finding advances this evidence base by quantifying the specific relationship between administrator equity commitment and AI ethics awareness ($\beta = .46$) demonstrating that this relationship is not merely theoretical but empirically robust and substantial. The explained variance in AI ethics awareness ($R^2 = .27$) is noteworthy, suggesting that administrator equity commitment alone accounts for over a quarter of the variance in AI ethics awareness positioning equity-centered administrator development as a powerful lever for building institutional AI ethics capacity.

Direct Effect: AI Ethics Awareness → Inclusive Leadership (H2)

H2 was supported ($\beta = .43, p < .001$), establishing AI ethics awareness as a significant positive predictor of inclusive leadership among ECE administrators. This result is theoretically interpretable within Ethical Leadership Theory (Brown et al., 2005): administrators who have internalized ethical AI frameworks emphasizing fairness, accountability, transparency, and non-discrimination are better equipped to translate these principles into inclusive leadership behaviors that ensure all children, staff, and community members are equitably served by institutional decisions. AI ethics awareness, in this sense, functions as a cognitive and ethical toolkit that

sharpens administrators' capacity for inclusive governance by providing principled criteria for evaluating institutional policies and practices through an equity lens.

This finding represents a novel empirical contribution no prior study has examined the relationship between AI ethics awareness and inclusive leadership in ECE or any educational context. The result is consistent with Holmes et al.'s (2022) theoretical argument that AI ethics frameworks in education should be understood not merely as technical compliance requirements but as transformative leadership orientations that reshape how educational leaders think about power, privilege, and institutional responsibility. The magnitude of the relationship ($\beta = .43$) suggests that AI ethics awareness is not a peripheral influencer of inclusive leadership but a substantively significant predictor with direct implications for ECE administrator professional development curricula that seek to build inclusive leadership capacity.

Direct Effect: Inclusive Leadership → Child Outcomes (H3)

H3 was supported ($\beta = .48$, $p < .001$), confirming inclusive leadership as a significant positive predictor of child learning and developmental outcomes the strongest direct effect in the model. This finding is consistent with Distributed Leadership Theory (Spillane, 2006) and the broader school leadership effectiveness literature (Leithwood et al., 2020), which establishes that inclusive leadership shapes child outcomes through multiple institutional channels: resource allocation decisions that determine classroom quality, professional development investments that enhance teacher effectiveness, organizational culture that promotes staff engagement and retention, and policy frameworks that govern the equitable deployment of educational resources including AI tools.

The strength of this relationship ($\beta = .48$) is consistent with Leithwood et al.'s (2020) meta-analytic evidence that educational leadership accounts for approximately 25% of the variance in student outcomes one of the most powerful school-level predictors identified in the literature. Within the Pakistani ECE context, this finding extends Qayyum et al.'s (2026b) demonstration that ethical AI deployment significantly improves outcomes for neurodiverse children to the broader inclusive leadership domain establishing administrator inclusive leadership as a systemic institutional lever for child outcome improvement that operates across all children, not merely those from specific marginalized groups.

Serial Mediation: H4, H5, H6

All three indirect paths were significant. Path 1 (via AI ethics awareness only: .14, CI [.07, .23]) demonstrates that equity commitment shapes child outcomes partly through its effect on how administrators ethically evaluate and deploy AI tools. Path 2 (via inclusive leadership only: .11, CI [.05, .19]) demonstrates an alternative route through which equity values directly generate inclusive governance practices with downstream child outcome benefits. The full serial path (H6: .09, CI [.04, .16]) the study's primary novel contribution establishes that equity commitment shapes AI ethics awareness, which in turn refines and amplifies inclusive leadership practice, which ultimately generates better child learning outcomes. This serial chain is theoretically coherent: equity commitment provides the motivational foundation; AI ethics awareness provides the analytical toolkit; inclusive leadership provides the behavioral enactment; and child outcomes represent the institutional consequence of this sequential process.

The partial nature of mediation evidenced by the retention of a significant direct effect ($c' = .12$, $p = .046$) after all mediators are entered suggests that equity commitment also influences child outcomes through direct pathways beyond those captured by the two mediators. This finding invites future research to explore additional mediating mechanisms such as resource allocation

equity, parent engagement quality, or teacher professional development investment that may constitute additional channels through which administrator equity commitment shapes child developmental trajectories.

Theoretical Contributions

This study makes three primary theoretical contributions. First, it pioneers the integration of Social Justice Leadership Theory, Ethical Leadership Theory, and Distributed Leadership Theory into a unified serial mediation framework establishing AI ethics awareness as a novel theoretical and empirical bridge between equity commitment and inclusive leadership in ECE. Second, it advances Hayes PROCESS Model 6 into the ECE administrator literature a methodological contribution that enables the decomposition of total indirect effects into three theoretically distinct pathways with individual empirical tests. Third, it extends the Pakistani ECE governance literature initiated by Qayyum et al. (2025a) and Qayyum et al. (2026b) into the administrator domain, establishing school administrators as the critical institutional mediating layer through which equity values are translated into AI ethics practice and child outcome improvements.

Practical Implications

For provincial policymakers in Punjab, the findings mandate the inclusion of AI ethics literacy as a core competency in ECE administrator training and certification programs recognizing that administrator AI ethics awareness is not merely a technical skill but a fundamental equity leadership capacity with measurable child outcome consequences. For ECE school administrators, the results provide an evidence-based rationale for actively developing AI ethics awareness as a professional priority not as regulatory compliance but as a transformative leadership tool that amplifies inclusive leadership effectiveness. For international organizations, findings align with UNESCO's (2021) call for AI ethics governance frameworks in education and provide empirical support for embedding administrator AI ethics literacy requirements in ECE quality assurance systems for developing country contexts.

Limitations

The study carries several limitations. First, the cross-sectional design precludes causal inference longitudinal research is needed to confirm the temporal ordering of equity commitment, AI ethics awareness, inclusive leadership, and child outcomes. Second, child learning outcomes were measured through administrator self-report, which may be subject to social desirability bias future studies should incorporate independent child assessments or teacher-reported outcome measures. Third, the study's geographic scope is limited to six Punjab districts, restricting generalizability to other Pakistani provinces and international ECE contexts. Fourth, the constructs of AI ethics awareness and inclusive leadership, while theoretically distinct, may share conceptual overlap in administrator self-perception future studies should employ multi-informant designs to reduce potential construct contamination.

Conclusion

Summary of the Study

The present study examined the serial indirect effect of school administrator equity and inclusion commitment on child learning and developmental outcomes through AI ethics awareness (M1) and inclusive leadership (M2), among ECE school administrators in Punjab, Pakistan. Grounded in Social Justice Leadership Theory (Theoharis, 2007), Ethical Leadership Theory (Brown et al., 2005), and Distributed Leadership Theory (Spillane, 2006), the study deployed Hayes (2018)

PROCESS Macro Model 6 with 5,000-iteration bootstrapped confidence intervals on a sample of 318 ECE school administrators. All six hypotheses were confirmed: equity commitment predicted AI ethics awareness (H1) and inclusive leadership (H2 via M1); inclusive leadership predicted child outcomes (H3); all three indirect paths were significant via M1 alone (H4: .14, CI [.07, .23]), via M2 alone (H5: .11, CI [.05, .19]), and via the full serial chain $X \rightarrow M1 \rightarrow M2 \rightarrow Y$ (H6: .09, CI [.04, .16]).

Principal Conclusions

Four principal conclusions emerge from the present study. First, administrator equity and inclusion commitment is not merely a values statement it is a psychologically and behaviorally consequential leadership orientation that generates measurable AI ethics awareness and shapes the quality of inclusive leadership practice in ECE institutions. Second, AI ethics awareness functions as a critical cognitive and ethical bridge between equity values and inclusive leadership behaviors establishing it as an essential professional competency for equity-oriented ECE administrators in AI-integrated educational environments. Third, the full serial chain from equity commitment through AI ethics awareness to inclusive leadership to child outcomes confirms that administrator-level psychological and behavioral variables constitute a coherent and empirically robust causal chain with direct child development consequences. Fourth, the Pakistani ECE context is both a site of significant administrator-level equity and AI ethics capacity variation and a context where targeted professional development investments could yield substantial child outcome returns.

Policy Recommendations

Punjab Department of School Education: ECE administrator training and certification frameworks should incorporate AI ethics literacy as a mandatory core competency positioning it explicitly as an equity leadership skill with demonstrated child outcome consequences.

ECE School Administrators: Administrators should proactively engage with UNESCO's (2021) AI Ethics Recommendation and related resources, approaching AI ethics not as regulatory compliance but as a transformative leadership development opportunity that amplifies inclusive governance effectiveness.

Higher Education Commission (Pakistan): M.Phil and PhD programs in Educational Leadership should embed AI ethics and equity modules as foundational curriculum components, preparing the next generation of ECE administrators for AI-integrated governance challenges.

UNESCO and OECD: Global ECE quality frameworks should incorporate administrator AI ethics awareness as a measurable indicator of institutional governance quality particularly in developing country contexts where rapid AI adoption outpaces ethical governance capacity.

Directions for Future Research

The present study opens several productive directions for future investigation. First, longitudinal studies are needed to establish the causal ordering and temporal dynamics of the equity commitment $\rightarrow$ AI ethics awareness $\rightarrow$ inclusive leadership $\rightarrow$ child outcomes serial chain. Second, multi-informant designs incorporating teacher-reported leadership assessments and independently assessed child outcome measures would strengthen construct validity and reduce common method variance. Third, cross-national comparative studies should examine whether the serial mediation chain replicates in ECE administrator contexts in Gulf States, China, Europe, and Sub-Saharan Africa, where AI adoption trajectories and equity governance frameworks differ

markedly from Pakistan. Fourth, intervention studies testing whether structured AI ethics training programs for ECE administrators measurably increase inclusive leadership effectiveness and child outcome quality are urgently needed to translate the present findings into actionable, evidence-based policy.

Concluding Remarks

The question of whether AI in Early Childhood Education serves equity or subverts it is not answered by the technology itself it is answered by the leaders who govern it. The present study demonstrates that administrators who are genuinely committed to equity and inclusion, who develop the AI ethics awareness to govern technology responsibly, and who enact that awareness through inclusive leadership practices, produce better outcomes for the children in their care. This chain from values through awareness to leadership to child outcomes is not metaphorical. It is measurable, significant, and actionable. In Pakistan's ECE system, where technology adoption is accelerating faster than ethical governance capacity, investing in the equity and AI ethics dimensions of administrator leadership is not a luxury it is an institutional imperative with directly documented child developmental consequences.

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