



Bridging Leadership and Educational Neuroscience: The Predictive Influence of Instructional Leadership on Teacher Efficacy and Brain-Based Pedagogy in Primary Schools

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Abstract

The link between instructional leaders' practices, teacher self-efficacy and classroom application of brain-based pedagogy has been studied in government primary schools in district Wazirabad. The study focused on the relationship among the instructional leadership of principals, teacher confidence, and the actual instructional change, based on the instructional leadership model of Bandura's social cognitive theory and Caine and Caine's brain-based learning theory. A quantitative approach, specifically a correlational research design, was used. A representative sample of 300 primary school teachers (120 male teachers and 180 female teachers) was randomly selected from a target population of 1,330 teachers in 227 schools using Cochran's formula. A self-developed, valid and reliable 30-item Likert questionnaire, with an overall reliability of $\alpha = 0.989$, was used to collect data. Descriptive results showed that perceived instructional leadership ($M = 4.12$, $SD = 1.19$), teacher self-efficacy ($M = 4.09$, $SD = 1.19$) and brain-based pedagogy implementation ($M = 4.22$, $SD = 1.14$) were all relatively high. Pearson correlation analysis indicated that there were strong positive correlations between all three variables ($r = 0.848$, 0.873 and 0.877 , all $p < 0.01$ with the highest correlation between teacher self-efficacy and classroom implementation, $r = 0.877$, $p < 0.01$). Simple linear regression results revealed that the instructional leadership is a highly significant predictor with 73.4% variance accounted for in teacher self-efficacy ($R^2 = 0.734$, $Beta = 0.857$, $p < 0.001$) and 71.9% variance accounted for in brain-based pedagogy implementation ($R^2 = 0.719$, $Beta = 0.848$, $p < 0.001$). The conclusions highlight the impact of instructional leadership as a force that can increase teacher confidence and align cognitive neuroscience to classroom practice in developing contexts.

Keywords:

Instructional Leadership, Teacher Self-Efficacy, Brain-Based Pedagogy, Primary Education.

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Introduction

Primary education is a basic level in which basic cognitive, social and emotional skills are developed and influence the learning path a child that will take throughout his life. Education systems around the world have come under pressure in the 21st Century to shift from traditional, passive teaching methods to learning-oriented, active and engaging approaches that enable students for dynamic societies (Ali et al., 2019). The pedagogical change is now guided by cognitive neuroscience and this has given rise to the concept of brain-based pedagogy. Brain-based pedagogy is a way of instruction that closely matches the natural functioning of the brain to maximize cognitive engagement, attention, memory and retention. It views learning as an active process of meaning-making rather than a passive receiving of information, and considers the physical, social, and emotional contexts (Ali and Saleh, 2020). Brain-based learning has been signaled as a way to transform the quality of teaching, yet the successful application of brain-based learning is dependent upon two factors: teacher self-efficacy and instructional leadership. Teacher self-efficacy is an educator's confidence in their ability to plan and implement activities that will have a meaningful effect on student learning, affecting how receptive they are to innovation, how willing they are to try new things in the classroom, and how resilient they are when faced with classroom challenges.

The low-efficacy teachers are less likely to embrace brain-based pedagogy or other student-centered approaches, and more likely to stick to traditional teacher-centered methods. But, a lot of teacher self-efficacy is determined by what goes on in the school. Teaching leadership, as opposed to administration leadership, is directly involved in the development of curricula, supervision of teachers, professional coaching, and the establishment of teaching conditions that are supportive and collaborative. The facilitators in art of pedagogy transformation, the school head is the instructional leader who shares a vision for the academic program, provides constructive feedback, and demonstrates innovative pedagogy. Leaders' attitudes to having a supportive school climate have a direct impact on teachers' psychological safety and confidence, which in turn affects their teaching effectiveness. However, even if there are some clear conceptual connections, academic leadership is often limited to the governance and administration of the school, and not to pedagogical processes. Although literature highlights the role of leadership in improving school outcomes, there is a paucity of empirical research that examines the inter-relatedness of instructional leadership, teacher efficacy, and the implementation of brain-based pedagogy in the classroom in a single conceptual framework (Ali et al., 2020). This study aims to fill this void by investigating the predicting role of instructional leadership practices with respect to teacher self-efficacy and classroom practices on brain-based pedagogy in government primary schools of District Wazirabad in Pakistan. This research has two implications. In theory it connects cognitive neuroscience (brain-based learning), with educational leadership (instructional leadership models) and behavioral psychology (self-efficacy theory). From a practical perspective, the results provide information for teacher training, school leaders and policy makers on how effective instructional leadership

behaviors can help to create a very effective teaching force with the ability to implement cutting-edge, brain compatible pedagogies in developing contexts.

Objectives of the Study

This study is directed toward two primary, closely related research objectives:

1. To explore the relationship between Instructional Leadership Practices, Teacher self-efficacy and Classroom implementation of brain-based pedagogy in primary schools
2. To examine the extent to which instructional leadership practices predict primary school teachers' self-efficacy and the extent to which they implement brain-based pedagogy in their classrooms.

Research Hypotheses

To address these objectives, the researchers formulated the hypotheses:

- H₁ Instructional leadership practices have a significant positive predictive effect on primary school teachers' self-efficacy in applying brain-based pedagogy.
- H₂ Instructional leadership practices have a significant positive predictive effect on the actual classroom implementation of brain-based pedagogy by primary school teachers.
- H₃ There are strong, positive, and statistically significant relationships among instructional leadership practices, teacher self-efficacy, and the implementation of brain-based pedagogy.

Review of Related Literature

Instructional leadership came into the world in the late 70s and early 80s, and school principals went from being administrative managers to mentors and facilitators for teaching learning process. The instructional leadership model has (Hallinger and Murphy, 1985) three dimensions that define the schools' mission, manage the instructional program, and promote a positive school learning climate. These dimensions make it clear that good school leaders articulate learning expectations, plan and oversee the curriculum, safeguard instructional time, and promote professional development.

Instructional leadership is distinctively classroom based with other models, like Transformational Leadership (Burns 1978; Bass 1985), providing motivation and inspiration through vision and intellectual stimulation; and Distributed Leadership (Spillane 2006; Harris 2013) models allowing for distributed responsibilities among stakeholders. It is centered in direct instructional improvement, observations, positive feedback and linking professional development to pedagogical goals. The research shows that transformational and distributed leadership improve school climate and teacher commitment while instructional leadership has the direct effect on pedagogical practices at the classroom level (Kashif, 2020).

The teacher efficacy is based on Bandura's (1977, 1997) social cognitive theory that considers self-efficacy as the confidence in one's ability to carry out a sequence of acts to attain a level of performance. Teacher self-efficacy is also defined as the confidence educators have in their teaching abilities, i.e. they plan, manage and deliver curriculum and motivate students who

have lost their interest, and adjust their teaching style to address the various students' needs in cognitive and emotional disciplines.

Bandura believes self-efficacy is a dynamic belief system that is influenced by four major sources: mastery experiences (one's own successes), vicarious experiences (observing peers), social/verbal persuasion, and physiological states (feelings of security and support in the work environment). All four sources are directly impacted by instructional leadership behaviors. Principals who coach in the classroom and give explicit pedagogical feedback support effective teaching. Leaders who implement professional learning communities (PLCs) provide intentional time for teacher observations. In addition, when instructional leaders are empathetic and give constructive feedback, this will be a powerful verbal persuasion and create a positive school climate, which will maximize the emotional state of the teachers.

Brain-based pedagogy, also known as brain-compatible learning, is an instructional model based on the research of the human brain and cognitive psychology that creates learning activities to fit with the natural way the brain works. This perspective, much influenced by Caine and Caine (1990), considers learning as an active biological process that is mediated by the continuous reorganization of the brain through experiential stimuli (neuroplasticity). They described some key principles of brain-compatible instruction, including brain is a parallel processor and the brain naturally looks for meaning, patterns and relationships, and that the brain relates new input with existing schemas. Some of the key principles are;

1. Emotional Safety: Emotional Safety - Positive emotional states support attention, motivation and memory, while stress or anxiety triggers the defensive amygdala response which cognitively affects problem-solving and information processing.
2. Patterning and meaning-making: The brain dislikes unconnected facts. Conceptual maps, thematic units, and analogies are effective tools for organizing information into meaningful patterns, for relating content to real-life applications, and for teaching effective instruction.
3. Active and Experiential Learning: Students who collaborate and engage in dialogue, experiments, and problem solving activate multiple neural pathways, and the learning is better remembered than when the students listen to a lecture and have information passively "inserted" into their minds.
4. Relaxed Alertness: An optimal level of cognitive challenge with emotional support that frees students from the fear of failing and encourages them to take risks with their thinking.

These three domains are all intertwined and create a robust conceptual triad. Within this model, Instructional Leadership is the key, external, and exogenous catalyst. Leaders activate teachers' self-efficacy beliefs directly, by developing the structural and psychological environments for teachers through vision building, curriculum support and instructional guidance, which in turn activate the four pathways of Bandura's theory. Moreover, teacher self-efficacy serves as one of the key psychological mediators as teachers who have committed self-efficacy in their teaching practices are more likely to engage in pedagogical risks, professional transformation, and implementation of the multifaceted practices of brain-based pedagogy. Although this triad

of integration is a sensible idea, there is a definite research gap there. Most of the prior research focuses on the dyadic aspect alone. In addition, most of the studies take place in the developed countries of the West. There is little empirical evidence of the interaction of these variables in the context of developing South Asia, in this case primary schools in Pakistan. The classrooms found there are marked by high pupil/teacher ratios, a focus on centralization of education, and old-fashioned rote learning. This study fills this gap by presenting an empirical study of this combined triad in District Wazirabad, Pakistan.

Methods and Procedures

The researchers used quantitative research with survey approach that was correlational characteristics. It motivates the researchers to explore the natural relationship between the existing variables of the study without any manipulations. The target population was all Primary School Teachers (PSTs) of Government Primary School in District Wazirabad, Punjab, Pakistan. The total population is 1330 PSTs in 227 schools in two tehsils namely Wazirabad ($n = 732$) and Ali Pur Chatha ($n = 598$). Using Cochran's formula at 95% level of confidence with 5% level of error, a sample of 300 teachers was arrived at to represent the population. The researchers used simple random sampling technique for the selection of the participants, which gave all the teachers equal and independent probability of selection in the district. Finally, the sample comprised 120 male teachers (40%) and 180 female teachers (60%) which was the same as gender distribution of primary school teachers in Wazirabad District.

The researchers used a self-developed research tool for data collection that comprised of close-ended items. The questionnaire comprised 30 items in three scales (10 items each):

1. Instructional Leadership Practices Scale (10 items): Assessed how teachers perceived their school leaders regarding academic vision, monitoring of classroom, feedback to teachers, and support for instruction.
2. Teacher Self-Efficacy Scale (10 items): measured teacher confidence to manage classroom, engage diverse learner, use active learning, and adapt instruction.
3. Brain-Based Pedagogy Implementation Scale (10 items): Assessed the degree of teacher implementation of brain-based pedagogy including multisensory, emotional safety, social collaboration, and active learning.

Expert review was used to determine face and content validity. The first version of the questionnaire was assessed by the research supervisor and a group of experts in the fields of educational leadership, teacher education and cognitive neuroscience. Feedback from them was used to adjust the wording of the items for their context and appropriateness for primary schools in Pakistan. After validation, a pilot testing was done with 30 Primary school teachers who were not included in the final sample. Ambiguities of the items were removed based on the feedback obtained from the pilot test. The pilot data were analyzed with SPSS to check the internal consistency with Cronbach's Alpha. Pilot coefficients on all subscales showed high reliability: Instructional Leadership Practices ($\alpha = 0.89$), Teacher Self-Efficacy ($\alpha = 0.91$), and Brain-Based Pedagogy Implementation ($\alpha = 0.88$). Reliability coefficients on the Cronbach's Alpha of the instruments were very high in the final administration ($N = 300$) with Instructional Leadership Scale ($\alpha = 0.976$), Teacher Self-Efficacy Scale ($\alpha =$

0.979), and Brain-Based Pedagogy Scale ($\alpha = 0.981$) and overall instrument reliability ($\alpha = 0.989$).

The researcher personally collected the data from all selected government primary schools of District Wazirabad. The consent of the participants was always obtained, written informed consent was obtained, and confidentiality of the data was always respected. Collected data were coded and analyzed by SPSS (Version 26.0). To determine the demographics and the extent of leadership, efficacy, and pedagogy, descriptive statistics (frequencies, percentages, means, and standard deviations) were computed. Pearson's Product-Moment Correlation (r) was used to analyze bivariate relationships. Two simple linear regression analyses were used to examine the predictive relationships, with the independent variable being instructional leadership practices, and the dependent variables being teacher self-efficacy and brain-based pedagogy implementation.

Data Analysis

Table 1 reveals the distributive profile of demographic variables of the 300 primary school teachers who participated. The sample is represented to the staffing of government primary schools in District Wazirabad.

Table 1: *Demographic variables (N = 300).*

Demographic Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	120	40.0%
	Female	180	60.0%
	Total	300	100.0%
Age	25 to 30 yrs	143	47.7%
	30 to 35 yrs	73	24.3%
	35 to 40 yrs	45	15.0%
	>40 yrs	39	13.0%
	Total	300	100.0%

As shown in Table 1, most of the respondents are females (60.0%) and this reflects the good representation of females in primary education as per official provincial distributions. As for age, almost half of the teaching staff are in the early stage of their teaching career, that is, early-career stage (25-30 years: 47.7%) and a substantial fraction of the teaching staff are aged 30-35 years (24.3%). This youthful profile indicates that teachers are very open to modern and innovative pedagogical approaches and responsive to professional development programs in cognitive neuroscience.

Descriptive statistics were used for assessing teachers' perceptions of ILP, their self-efficacy beliefs (TSE), and their actual implementation of BBP. A general description of the overall variables, and the items with the highest and lowest scores on each scale, is presented in Table 2.

Table 2: *Descriptive statistics of the variables (N = 300).*

Construct / Item Identifier	Core Statements	Mean (M)	Std. Deviation (SD)
Instructional Leadership (ILP)	Overall Variable Mean	4.12	1.19
ILP1 (Highest)	Clearly communicates the school's academic mission to teachers	4.27	1.26
ILP2 (Average)	Emphasizes improvement in teaching and learning over administrative tasks	4.23	1.29
ILP10 (Lowest)	Involves teachers in decision-making related to curriculum planning	4.01	1.38
Teacher Self-Efficacy (TSE)	Overall Variable Mean	4.09	1.19
TSE1 (Highest)	Confident in using effective instructional strategies for diverse learners	4.16	1.25
TSE2 (Average)	Confident in successfully engaging students in active learning activities	4.13	1.27
TSE9 (Lowest)	Confident using technology-enhanced strategies to support learning	4.04	1.30
Brain-Based Pedagogy (BBP)	Overall Variable Mean	4.22	1.14
BBP1 (Highest)	Uses multisensory teaching strategies to enhance student learning	4.32	1.15
BBP2 (Average)	Creates a classroom environment that supports emotional safety	4.28	1.17
BBP10 (Lowest)	Stimulates critical thinking and problem-solving based on how brain learns	4.17	1.21

According to the descriptive results, the government primary school teachers of District Wazirabad have a high perception of instructional leadership in their schools ($M = 4.12$, $SD = 1.19$). Communicating the academic mission ($M = 4.27$, $SD = 1.26$) is rated the highest and shows that school heads are good at communicating clear academic goals. The lower mean for involving teachers in decision-making ($M = 4.01$, $SD = 1.38$), however, indicates that while there is strong evidence of school heads' providing strong direction, there is an opportunity to improve evidence of participative, distributed leadership behaviour.

The overall mean ($M = 4.09$, $SD = 1.19$) for teacher self-efficacy indicates that the participants have high levels of self-efficacy in their pedagogical skills. They feel best able to tackle diverse learners ($M = 4.16$, $SD = 1.25$) and encourage students to be active learners ($M = 4.13$, $SD = 1.27$). They were least confident in employing technology enhanced strategies ($M = 4.04$, $SD = 1.30$).

The highest overall mean was found in the construct of brain-based pedagogy with implementation of brain-based pedagogy ($M = 4.22$, $SD = 1.14$). Teachers' practices in using multisensory teaching ($M = 4.32$, $SD = 1.15$) and creating emotionally safe environments ($M = 4.28$, $SD = 1.17$) show that they are employing basic brain-compatible strategies. This shows a significantly high level of congruence between the theoretical underpinnings of neuroscience-informed teaching and what is taught in the primary school in government schools.

Pearson product-moment correlation coefficients (r) were employed to analyze the bivariate relationships of the three constructs. The correlation matrix is shown in Table 3.

Table 3: *Pearson correlation matrix ($N = 300$).*

Variable	Instructional Leadership	Teacher Self-Efficacy	Brain-Based Pedagogy
Instructional Leadership (ILP)	1.000		
Teacher Self-Efficacy (TSE)	0.857**	1.000	
Brain-Based Pedagogy (BBP)	0.848**	0.877**	1.000

** $p < 0.01$ (2-tailed)

In table 3 the correlation matrix analysis describes that there are strong and positive correlation between the variables which are statistically significant ($p < 0.01$). First, there is a very high positive correlation between instructional leadership practices and teacher self-efficacy ($r = 0.857$, $p < 0.01$), meaning that supportive leadership practices and highly confident teachers co-occur. Secondly, there is a strong correlation between instructional leadership and actual classroom implementation of brain-based pedagogy ($r = 0.848$, $p < 0.01$), indicating that pedagogical supervision is effective, and innovative classroom environments are associated with it. Third, self-efficacy had the greatest correlation with the implementation of brain-based pedagogy ($r = 0.877$, $p < 0.01$). This robust relationship supports the theoretical stance that teachers' psychological beliefs and confidence is the most proximal process of implementing complex, neuroscience informed classroom practices.

Two simple linear regression analyses were used to calculate the predictive effects of instructional leadership practices on teacher self-efficacy, and on the actual implementation of brain-based pedagogy. The statistical results are presented in Table 4.

Table 4: *Linear regression analyses ($N = 300$).*

Dependent Variable	Model Predictor	R	R ²	Adj. R ²	F	Constant (B)	Coefficient (B)	Std. Error (SE)	Beta (beta)	t	p-value
Teacher Self-Efficacy (TSE)	(Constant)	0.857	0.734	0.733	821.85**	0.377	—	0.054	—	6.94	<
	Instructional Leadership (ILP)					 —	0.815	 0.028	 0.857	 28.67	 0.001
Brain-Based Pedagogy (BBP)	(Constant)	0.848	0.719	0.718	762.39**	0.352	—	0.053	—	6.62	<
	Instructional Leadership (ILP)					 —	0.763	 0.028	 0.848	 27.61	 0.001

** $p < 0.001$; Dependent Variables: Teacher Self-Efficacy and Brain-Based Pedagogy Implementation respectively

For the first regression model, instructional leadership practices were used as the predicting variables, and teacher self-efficacy was the outcome variable. Results indicated that these instructional leadership practices explained 73.4% of the variance in teacher self-efficacy ($R^2 = 0.734$, Adjusted $R^2 = 0.733$) and was highly significant, $F(1, 298) = 821.85$, $p < 0.001$. A strong positive predictive association is also demonstrated by the regression coefficient ($\beta = 0.857$, $t = 28.67$, $p < 0.001$). Thus, for every 1-unit increase in instructional leadership practices, there is a 0.857-unit increase in teacher self-efficacy. This indicates that school leaders are very critical actors in developing teachers' confidence.

The second regression model assessed the extent to which instructional leadership practices predict the extent to which brain-based pedagogy is implemented in the classroom. The analysis results showed a significant relationship with $F(1, 298) = 762.39$, $p < 0.001$, the determination coefficient of the relation was $R^2 = 0.719$, Adjusted $R^2 = 0.718$ which indicated the relationship between both variables was high. The regression coefficient ($\beta = 0.848$, $t = 27.61$, $p < 0.001$) indicates that a one-unit increase in the teachers' instructional leadership behaviors is associated with a 0.848-unit increase in teachers' use of brain-compatible strategies.

Hypothesis H_1 , H_2 , and H_3 were all supported by the regression models presented in this study, which were statistically sound. The high predictive power (over 70% variance accounted for in the two endogenous variables) shows that instructional leadership in primary education is not merely an administrative role but a potent force which can drive teacher growth and classroom transformation.

Findings

Strong Positive Bivariate Correlations: All three primary variables of this study, instructional leadership practices, teacher self-efficacy, and classroom implementation of brain-based pedagogy, have strong and positive relationships that were statistically significant.

Primacy of Teacher Confidence: The highest bivariate correlation is between teacher self-efficacy and the real-world application of brain-based teaching. This validates that self-efficacy of the teacher in his/her own instructional skills is the most direct psychological predecessor to innovative, neuroscience-informed classroom practices.

High Level of Pedagogical Implementation: Government primary school teachers report high levels of brain-based pedagogy implementation. They have a special strength in their ability to use multisensory approaches (including visual representation and movement) and to create emotionally safe learning environments in the classroom where children feel intellectually supported and without anxiety.

Strong Instructional Leadership Perceptions: Principals are viewed as being extremely effective instructional leaders. They are very good at conveying the school's academic purpose and at focusing on enhancing teaching and learning rather than on day-to-day management.

Simple linear regression analyses indicate that instructional leadership practices are powerful and highly significant positive predictors of teacher self-efficacy. Nearly three-quarters of the variance in teachers' confidence can be attributed to heads' pedagogical actions. This indicates that effective leadership behaviour have a direct impact in developing teachers' self-confidence in their skills.

Instructional leadership practices are significant and positive predictors of actual implementation of brain-based pedagogy. A significant majority of the variation in the

implementation of brain compatible classroom strategies is explained by school heads' guidance.

Empirical Support for Hypotheses: The statistical results show that the three research hypotheses (H_1 , H_2 , H_3) are supported by solid empirical evidence, which supports the integrated conceptual framework used in the study in the context of government primary schools.

Conclusion

The present study was a success in exploring the predictive effect of instructional leadership practices on teacher self-efficacy and brain-based pedagogy implementation in government primary schools, district Wazirabad, Pakistan. The empirical results support the transformative role of the school head as to teachers' psychological confidence and the reality of classroom pedagogy. Instructional leaders support the implementation of brain compatible, student-centered instruction by directly impacting teacher's self-efficacy through academic missions, classroom observations, and subsequent feedback. This study is a valuable contribution to international educational literature because it brings together the concepts of instructional leadership models, Bandura's social cognitive theory, and neuroscience informed pedagogy in a triad, unique and unified in conceptualization. Importantly, it offers some of the first empirical research into the functioning of these variables in a developing, South Asian public school system. Large classes and limited resources illustrate how effective pedagogical leadership can help to bridge the gap between cognitive neuroscience and classroom practices.

Limitations and Future Research

The current study has some limitations. First, it was restricted to the government primary schools of a single district (District Wazirabad, Pakistan) and the results may not be applicable to private schools or other geographical areas. Second, the data was self-reported via questionnaires and can be subject to the effect of social desirability. Third, the correlational survey design does not allow causal relationships to be definitively determined over time. Future studies need to overcome these drawbacks by using qualitative, observation-based approaches (e.g., direct classroom audits) to complement and verify the self-reported pedagogical practices. Longitudinal research is also suggested to explore the consistency of the leadership impact on teacher behaviour over the time.

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