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Examining the Interaction Between Leadership Styles and Managers' Self-Efficacy on Teachers' Psychological Empowerment and Creativity: A Neural Network Approach

Abbas Mohammadi*[1], Esmat Pasdar[2]

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Abstract

The purpose of this research is to investigate the interaction between leadership styles and managers' self-efficacy on teachers' psychological empowerment and creativity using a neural network approach. This research is applied in terms of purpose and is considered a descriptive-correlational study. The statistical population of the study included all teachers in Iranshahr city in the academic year 2024-2025, totaling 1800 individuals. Based on Krejcie and Morgan's table, a sample size of 317 individuals was estimated and selected using simple random sampling. Ultimately, after distributing and collecting data, 310 questionnaires were used for analysis. Four questionnaires were used to measure the variables: Leadership Style (Bass and Avolio, 1969), Managers' Self-Efficacy (Bandura, 1986), Psychological Empowerment (Spreitzer, 1995), and Creativity (Amabile, 2001). Validity was confirmed based on expert opinions, and reliability was assessed using Cronbach's alpha, which was found to be 0.92, 0.83, 0.77, and 0.79, respectively. Statistical methods used for hypothesis testing included variance-based structural equation modeling and multi-layer perceptron neural network, which were implemented in SMARTPLS 0.4 and SPSS27 software, respectively. The neural network model consisted of three input layers, one hidden layer with two units, and two output layers (two dependent variables). The function used to determine the hidden layers was hyperbolic tangent. The error in the train model was 0.19 and, in the test, sample was 0.07. While confirming the impact of leadership styles and managers' self-efficacy variables on teachers' psychological empowerment and creativity, the coefficient of determination of the model was 63%, which indicates the explanation of the creativity variable under the influence of independent and mediating variables. The role of the mediating variable of self-efficacy was fully confirmed as a mediator.

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[1] Assistant Professor, Department of Educational Sciences, Payame Noor University, Tehran, Iran.
*Corresponding Author Email: A_mohammadi@pnu.ac.ir
[2] MD in Educational Management, Payame Noor University, Tehran, Iran.

INTRODUCTION

In recent decades, rapid and extensive transformations in educational systems, coupled with the complex and dynamic demands of the twenty-first century, have posed multifaceted and significant challenges for educational leaders. These changes have not only imposed environmental pressures and technological shifts on schools but also necessitate that educational systems respond effectively to the needs of a new generation-students who enter learning environments with skills and competencies that differ markedly from previous cohorts, requiring innovative teaching and management approaches **(Purohit & Dutt, 2024; Sagdiyev, 2025).** Consequently, educational systems demand leaders who can not only manage human resources efficiently but also cultivate a creative, empowering, and motivational environment for teachers, enabling them to apply their skills and creativity in the teaching–learning process and thereby enhance educational quality **(Celik, Sari, & Karagozoglu, 2025).** Within this context, teachers' psychological empowerment and creativity serve as two fundamental components of educational performance, playing a pivotal role in achieving transformative school objectives; teachers who experience a sense of competence, self-confidence, and autonomy are more likely to engage in innovative practices, employ creative teaching methods, and improve instructional effectiveness. Therefore, identifying the factors that can enhance these two critical variables has emerged as a central concern for researchers in educational leadership and management.

Teachers' psychological empowerment constitutes a key factor in enhancing instructional effectiveness and improving teaching quality. This multidimensional construct refers to an individual's perception of meaning, competence, self-determination, and impact within the work environment, enabling teachers to play an active role in educational decision-making and to experience a greater sense of value and control over their professional activities **(Ashraf, Amir, & Ratan, 2025).** When teachers perceive themselves as influential in the teaching-learning process and recognize the meaningfulness of their work, they exhibit higher levels of intrinsic motivation, creativity, and professional commitment. Recent studies have demonstrated that psychological empowerment is not only directly associated with teachers' performance and innovation but also serves as a critical mediator between individual and organizational factors, such that the relationship between emotional intelligence and work engagement can be explained through self-efficacy and psychological empowerment **(Hameli, Ukaj, & Çollaku, 2025).**

Recent studies further indicate that this form of psychological empowerment can function as a protective buffer against occupational burnout, enhancing teachers' resilience and sense of efficacy, thereby enabling them to better cope with professional pressures **(Xue et al., 2024).** From this perspective, psychological empowerment is not merely a managerial tool but constitutes a fundamental mechanism for cultivating teachers who are creative, self-directed, and committed to educational transformation.

One of the key factors in achieving the objectives of educational systems is the leadership style of school administrators and their level of self-efficacy, as these two components can directly and indirectly influence teachers' psychological empowerment and creativity. Research indicates that effective leadership styles, particularly transformational and ethical leadership, are capable of fostering supportive, trust-building, and participatory environments that enhance teachers' capacity for innovation and creativity in the teaching–learning process, while significantly improving their motivation, job satisfaction, and overall performance **(Northouse, 2018; Wu et al., 2022; Marlia, Fahmy, Lucite, & Games, 2025).**

Moreover, administrators' self-efficacy plays a decisive role in the quality of decision-making, the management of human resources, and the creation of empowering environments. Leaders with higher self-efficacy possess greater confidence in their ability to confront challenges and can enhance teachers' sense of competence, autonomy, and impact, thereby boosting their intrinsic motivation. Such an environment enables teachers to leverage innovative ideas and methods to create richer and more effective learning experiences for students **(Supendi, Rosa, Fahrurozi, & Gaffar, 2025).**

A management approach grounded in effective leadership styles and high self-efficacy not only enhances teachers' job performance and instructional quality but also fosters a participatory and creative organizational culture while strengthening their professional commitment. This dual impact underscores the pivotal role of school leaders in promoting teachers' psychological empowerment and

creativity, highlighting that attention to leadership style and managerial self-efficacy is strategically essential for improving educational quality.

Extensive research indicates that various leadership styles, particularly transformational leadership, can serve as effective mediating factors in enhancing teachers' self-efficacy and psychological empowerment. These effects manifest through the creation of supportive and motivational environments, improvement of job performance, and elevation of the teaching–learning process quality **(Moradi et al., 2017).** Transformational leadership, by encouraging teacher autonomy in decision-making, providing continuous emotional support, and motivating adherence to a shared vision, not only increases teachers' sense of meaning and competence but also strengthens their self-determination and influence in daily professional activities, thereby fostering greater motivation and commitment to their responsibilities **(Nguyen & Nguyen, 2021).** Furthermore, this leadership style significantly enhances teachers' job satisfaction by cultivating an empathetic and trust-based environment, which in turn boosts their productivity and creativity in teaching and provides opportunities for teachers to implement innovative ideas in the classroom and create more effective learning experiences for students **(Salehi et al., 2019; Hassanzadeh, 2018).** Thus, transformational leadership, by balancing support and autonomy, plays a crucial role in enhancing intrinsic motivation, job satisfaction, and professional innovation, and can be considered a powerful tool for fostering a participatory and creative organizational culture within schools.

In addition to transformational leadership, research has shown that ethical leadership plays a significant role in enhancing teachers' job satisfaction and psychological empowerment, as this leadership style is grounded in principles of fairness, honesty, and transparency, guiding leaders' actions within these values **(Brown & Treviño, 2006; Riadi, Riani, Sunarsi, & Munna, 2025).** Ethical leaders, by emphasizing moral values and fostering supportive, trustworthy, and participatory environments, create conditions in which teachers feel greater responsibility, competence, and capability in their professional duties and can participate effectively in decision-making and instructional processes. This leadership style not only increases teachers' intrinsic motivation and professional commitment but also provides a framework for them to implement innovative ideas and methods in the classroom, thereby creating more creative and effective learning experiences for students **(Nikparast et al., 2022).** Furthermore, emphasis on professional ethics and organizational principles grounded in Islamic values can enhance job satisfaction and organizational commitment among teachers and faculty members, while reinforcing a participatory and supportive organizational culture **(Riadi et al., 2025).** Accordingly, administrators who employ ethical leadership can simultaneously strengthen teachers' psychological empowerment and creativity, contributing substantially to improving educational quality in schools.

Moreover, principals' self-efficacy plays a pivotal role in shaping leadership behaviors and guiding staff, functioning as a key factor in creating empowering and creative environments for teachers. Leaders with high levels of self-efficacy exhibit greater confidence in their ability to navigate complex challenges and situations, enabling them to adopt more effective leadership approaches that enhance both teacher motivation and commitment, while simultaneously fostering creativity and innovation within schools **(Tschannen-Moran & Gareis, 2001; Farahmand et al., 2021; Arastaman et al., 2024).** Recent studies indicate that self-efficacy is not merely an individual attribute of leaders but serves as a critical mediating factor between organizational variables and performance outcomes, directly and indirectly influencing participatory behaviors, professional creativity, and teachers' psychological empowerment **(Zainal & Mohd Matore, 2021).** Indeed, principals' self-efficacy is considered a key predictor of the development of creative, empowering, and supportive school environments, where leaders who trust in their capabilities can make strategic decisions and establish supportive structures that facilitate teacher innovation and professional growth, ultimately enhancing the quality of instruction and student learning outcomes **(Yilmaz & Tore, 2025).**

A study titled "The Relationship between Principals' Self-Efficacy and Teacher Performance" demonstrated that principals who trust in their managerial capabilities can create a safe and supportive environment for teachers, where feelings of security, trust, and motivation for creativity and innovation are enhanced. Consequently, teachers are able to approach their professional responsibilities with greater confidence and apply their innovative ideas in the teaching process, which directly improves instructional quality and increases job satisfaction

(Noori et al., 2017). Furthermore, teacher self-efficacy is also of critical importance, as educators with higher levels of self-efficacy are better equipped to manage classrooms, engage effectively with students, and employ creative teaching methods, which in turn strengthens their psychological empowerment and fosters active participation in the teaching–learning process with a sense of motivation and ownership. Moreover, in contemporary educational systems, teachers' roles in nurturing student creativity and psychological empowerment have become increasingly significant, and enhancing teachers' creativity and psychological empowerment not only elevates teaching and learning quality but also contributes to the overall development of the educational system and the empowerment of future generations **(Ozdogru et al., 2025).**

Teacher creativity, as another fundamental component in contemporary education, refers to the ability to generate innovative and practical ideas within the teaching process and is undeniably crucial for enhancing student learning outcomes. This concept encompasses the capacity to design innovative instructional activities, present content through diverse approaches, and solve educational challenges creatively, enabling teachers to make the teaching–learning process more engaging, interactive, and effective. Consequently, student motivation, participation, and learning are significantly enhanced **(Brauer, Ormiston, & Beausaert, 2025).**

Empirical evidence indicates that teacher creativity extends beyond an innate trait or individual skill and is shaped by various psychological, social, and organizational factors, exerting broad effects on learning processes. Creative teachers are able to employ innovative teaching methods to foster a dynamic and stimulating learning environment, in which students engage with educational activities with greater motivation and interest and express their individual capabilities more effectively (**Albay & Eisma, 2025; Soeharto, Singh, & Afriyanti, 2024).**

Multiple studies, including **Abbasi et al. (2019) and Maleki et al. (2020),** have demonstrated that teacher creativity is directly associated with teaching quality, students' academic performance, and the development of learning skills. Creative teachers employ innovative ideas and methods to make the learning process more engaging for students, thereby enhancing their motivation and interest. Furthermore, recent research indicates that teacher creativity plays a pivotal role in fostering interactive learning experiences and improving students' problem-solving skills, and it can exert both direct and indirect effects on their academic success **(Brauer, Ormiston, & Beausaert, 2025).**

Given the critical role of creativity in teaching, it can be regarded not only as an individual skill for teachers but also as a strategic factor in the development of modern educational systems and the enhancement of learning environments. This perspective has garnered significant attention from researchers and educational planners, who consider teacher creativity as one of the key objectives of contemporary education **(Brauer, Ormiston, & Beausaert, 2025; Albay & Eisma, 2025).**

However, the relationships among leadership styles, managerial self-efficacy, teachers' psychological empowerment, and creativity are inherently complex, dynamic, and often nonlinear, making them difficult to analyze using traditional linear statistical models **(Fan & Zhang, 2008).** Most prior studies have examined these relationships through linear and causal approaches, whereas organizational and educational evidence indicates that interactions among these variables are multifaceted, involving direct, indirect, mediating, and simultaneous effects. Consequently, more advanced analytical methods are required. In this context, the use of sophisticated models such as artificial neural networks (ANNs) offers an efficient and scientifically robust solution. Neural networks, with their adaptive learning capabilities and ability to identify complex patterns in data, enable the analysis and prediction of nonlinear relationships and multivariable interactions **(Goodfellow, Bengio, & Courville, 2016).** These capabilities not only facilitate the extraction of direct and indirect effects of leadership styles and self-efficacy on teachers' empowerment and creativity but also uncover hidden interactions and complex structures among these variables, potentially leading to deeper insights and the design of more effective managerial strategies in educational settings **(LeCun, Bengio, & Hinton, 2015).**

Therefore, teachers' psychological empowerment and creativity are key factors in enhancing instructional quality and student performance, as teachers-being the backbone of the educational system-require an environment in which they feel competent, autonomous, and influential, and where they can apply their skills and innovative capabilities in the teaching-learning process. Leadership styles and managerial

self-efficacy play a critical role in creating such environments and can exert both direct and indirect effects on teachers' psychological empowerment and creativity.

However, most studies have examined these factors separately, and few have analyzed their simultaneous interactions. This gap represents a significant knowledge deficiency, highlighting the need for research that explores the complex and nonlinear relationships among leadership styles, managerial self-efficacy, teachers' psychological empowerment, and creativity. Rapid changes in education and the demand for innovation in teaching, along with challenges such as limited teacher participation in decision-making, further underscore the importance of investigating these interactions.

Accordingly, the primary research question of this study is: Can the interaction between leadership style and managerial self-efficacy predict teachers' creativity through psychological empowerment, and can an artificial neural network model provide a more precise representation of these interactions compared to traditional models?

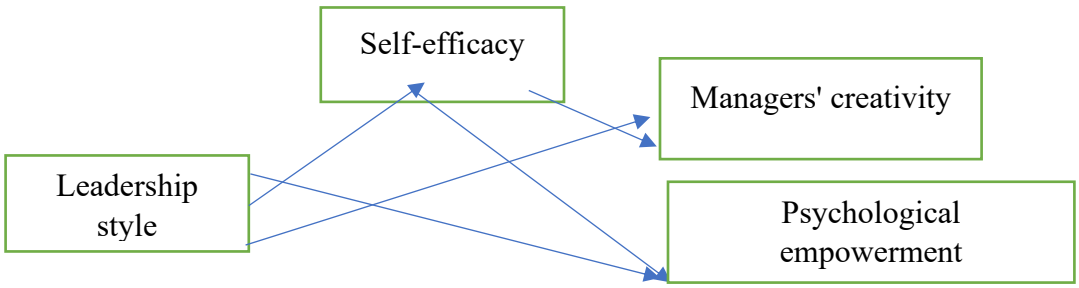

Fig.1. Theoretical Foundations Generalized model of Khoo et al., (2024)

METHODOLOGY

The present research is applied in terms of purpose and descriptive-correlational in terms of data collection. The statistical population of the study included all teachers in Iranshahr city in the academic year 2024-2025, totaling 1800 people. Using the Krejcie and Morgan table (1970), a sample size of 317 people was estimated and selected using simple random sampling. Finally, after distributing and collecting the data, 310 questionnaires were used for analysis. To measure the variables, four questionnaires were used: Leadership Style **(Bass and Avolio, 1969**), Managers' Self-Efficacy **(Bandura, 1986),** Psychological Empowerment **(Spreitzer, 1995), and Creativity (Amabile, 2001).** The face and content validity of all four questionnaires were confirmed by consulting with 5 experts, and their reliability was confirmed using Cronbach's alpha, which was estimated to be 0.92, 0.83, 0.77, and 0.79, respectively. Statistical methods for testing hypotheses included variance-based structural equation modeling and multilayer perceptron neural network, which were implemented in SMARTPLS 4.0 and SPSS 27 software, respectively. The neural network model included three input layers, one hidden layer with two units, and two output layers (two dependent variables). Descriptive statistics (mean and standard deviation) and inferential statistics (multilayer perceptron neural network) were used to analyze the data, using SPSS-27 and Smartpls4.0.1.9 software.

RESEARCH FINDINGS

According to the descriptive analyses, the highest frequency in terms of age was in the 35-40 age group, with 69.8%. The mean of self-efficacy was higher than all other variables. The assumption of univariate normality for the research constructs was not confirmed by the Kolmogorov-Smirnov test. Therefore, the variance-based structural equation modeling (PLS) method and the multilayer perceptron neural network were used to test the hypotheses, which will be interpreted. The results of the mean and standard deviation of the research variables are shown in Tables 1.

Table 1. Descriptive Findings Related to Research Variables

	N	SD	M	Sig.
Psychological empowerment	384	.571	3.036	٠/٠٠٠
Leadership style	384	.579	3.079	٠/٠٠٠
Principal's Creativity	384	.621	3.040	٠/٠٠٠
Principal's Self-efficacy	384	.632	3.109	٠/٠٠٠

As the results in Table 1 show, according to the normality criterion, the research variables all have a significance level less than 0.05, and therefore, a deviation from the normality of the data is observable. In the inferential statistics section, the research model is tested, which is evaluated using the variance-based structural equation modeling method with a partial least squares (PLS) approach, analyzed and interpreted in two stages. First, the measurement model and then the structural model are analyzed and interpreted. In fitting the measurement model, the construct validity of the model is examined, for which two criteria of convergent validity and discriminant validity are used.

To evaluate convergent validity, factor loadings, average variance extracted (AVE), composite reliability (CR), and correlation between constructs are used. An AVE value greater than 0.5, a factor loading above 0.4, and a CR greater than 0.7 are the basis for confirming convergent validity (Le & Le., 2023). Discriminant validity indices are Fornell-Larcker criterion, cross-loadings, and HTMT. In the Fornell-Larcker criterion, discriminant validity is confirmed if the square root of the AVE of each construct is greater than the correlation of that construct with other constructs (Fornell & Larcker, 1981).

Table 2: Convergent validity results for questionnaire dimensions

Sig.	T	Factorial	Factor /Items
0.000	37.677	0.779	KH1 <- Creativity
0.000	59.229	0.817	KH10 <- Creativity
0.000	45.485	0.805	KH11 <- Creativity
0.000	48.213	0.797	KH12 <- Creativity
0.000	35.444	0.777	KH13 <- Creativity
0.000	39.767	0.737	KH14 <- Creativity
0.000	29.32	0.71	KH15 <- Creativity
0.000	33.891	0.758	KH2 <- Creativity
0.000	46.524	0.813	KH3 <- Creativity
0.000	42.886	0.789	KH4 <- Creativity
0.000	38.11	0.738	KH5 <- Creativity
0.000	35.305	0.732	KH6 <- Creativity
0.000	47.065	0.799	KH7 <- Creativity

Sig.	T	Factorial	Factor /Items
0.000	49.402	0.831	KH8 <- Creativity
0.000	39.047	0.764	KH9 <- Creativity
0.000	42.492	0.771	KHDM1 <- Self-efficacy
0.000	5.712	0.307	KHDM10 <- Self-efficacy
0.000	54.693	0.808	KHDM2 <- Self-efficacy
0.000	47.202	0.789	KHDM3 <- Self-efficacy
0.000	50.448	0.811	KHDM4 <- Self-efficacy
0.000	42.929	0.789	KHDM5 <- Self-efficacy
0.000	43.994	0.797	KHDM6 <- Self-efficacy
0.000	45.981	0.807	KHDM7 <- Self-efficacy
0.000	49.399	0.812	KHDM8 <- Self-efficacy
0.000	26.068	0.706	KHDM9 <- Self-efficacy

As observed in Table 2 below, considering that the Average Variance Extracted (AVE) and Cronbach's alpha composite for all research variables are higher than 0.5 and 0.7, respectively, it can be stated that the research instrument possesses acceptable convergent validity. All items are significant at a confidence level of 0.95. The significance of the items is indicated by a significance value greater than ±1.96. Therefore, based on the obtained values, it can be said that the convergent validity of the measurement instrument is confirmed.

Table 3. Discriminant validity based on Fornell-Larcker criterion

Psychological empowerment	Leadership style	Principal's Creativity	Principal's Self-efficacy	**Variables**
			0.82	Psychological empowerment
		0.777	0.796	Leadership style
	0.754	0.426	0.521	Principal's Creativity
0.887	0.775	0.419	0.633	Principal's Self-efficacy

According to Table 3, the square root of AVE for each variable is greater than the correlation of that construct with other constructs; therefore, the research instrument possesses adequate discriminant validity based on the Fornell-Larcker criterion.

Considering the confirmed acceptability of the convergent validity, discriminant validity, and goodness-of-fit indices, the measurement model of the research is confirmed.

After analyzing and examining the fit of the measurement model, this section examines the fit of the structural model. In effect, the second stage in the procedures involves utilizing path analysis, the coefficient of determination, and the model fit index. In path analysis, the relationships between variables flow in one direction and are considered as distinct paths (Westland, 2025). Figures 1 and 2 show the structural equation model and the path diagram of the research model, along with the significance values and path coefficients.

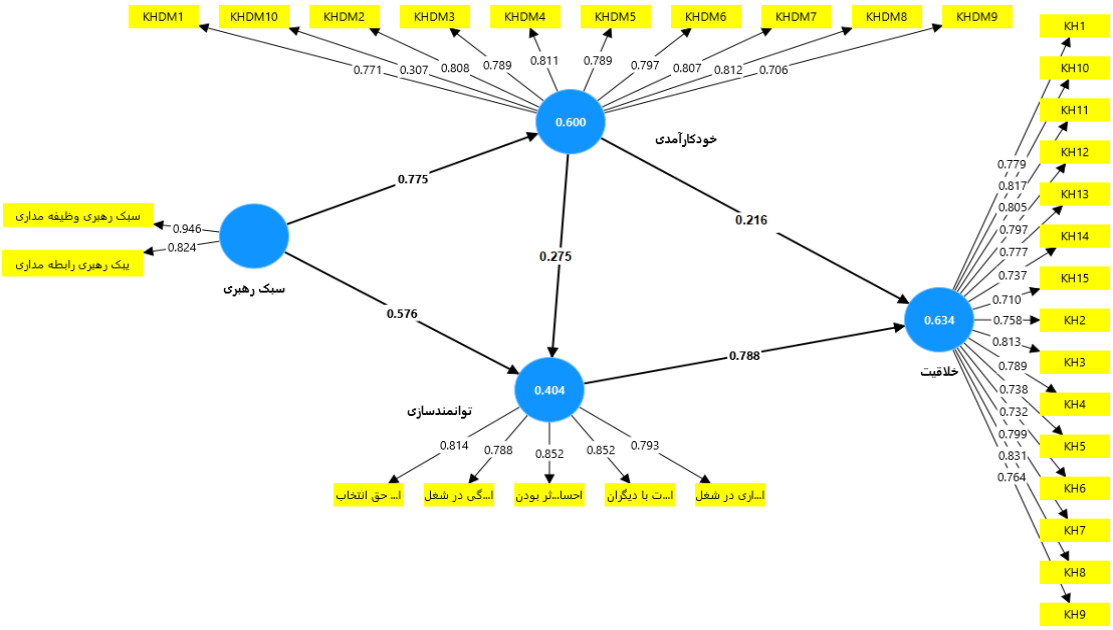

Figure 2: Fitted structural model between research constructs with standardized factor loadings

According to Figures 1 and 2, the coefficient of determination for the fitted research model, considering its significant variables, is 0.41, 0.63, and 0.6, respectively, for the variables of empowerment, creativity, and self-efficacy. Accordingly, approximately 41%, 63%, and 60% of the changes in the variables of empowerment, creativity, and self-efficacy are explained by the independent and mediating variables.

To assess the predictive power of the model for the dependent variables, the Q^2 criterion introduced by Stone (1974) and Geisser (1975) is used. If the Q^2 value for an endogenous construct achieves the three values of 0.02, 0.15, and 0.35, it indicates a weak, medium, and strong predictive power of the exogenous construct(s) related to it, respectively (Hair *et al.,* 2022). According to Table 4, the Q^2 values for the variables of empowerment, creativity, and self-efficacy are 0.4, 0.63, and 0.6, respectively, indicating that the structural model of the research has strong predictive power.

To assess the overall model fit, the Goodness of Fit (GOF) index is used, which is derived from the geometric mean of the coefficient of determination and the square root of the Average Variance Extracted (AVE). Given the three values of 0.01, 0.25, and 0.36, which are introduced as weak, moderate, and strong values for the GOF index, and the obtained value of 0.777 according to Table 5, a very suitable fit of the overall model is confirmed. According to the GOF calculation based on the outputs of SMARTPLS software, the model has a good fit (Shehata et al., 2021). Based on Figures 1 and 2, technological competence has a direct impact on job satisfaction, and its effect size is 0.39 (Sig = 0.000, T-Value = 13.241). On the other hand, technological competence has a direct impact on organizational performance, and its effect size is 0.44 (Sig = 0.000, T-Value = 11.581). In SmartPLS, the results of the PLS-SEM algorithm use a bootstrapping approach that includes direct effect, total indirect effect, specific indirect effects, and total effect. These results, available in SmartPLS results reports, allow for a mediation analysis (Hair et al., 2022). The results in Table 5 show that knowledge sharing between technological competence and job satisfaction has a complete mediating role according to the bootstrap test (Sig = 0.000, T-Value = 7.898), since the direct path is significant (technological competence → job satisfaction). On the other hand, knowledge sharing between technological competence and organizational performance has a complete mediating role according to the bootstrap test (Sig = 0.000, T-Value = 4.619).

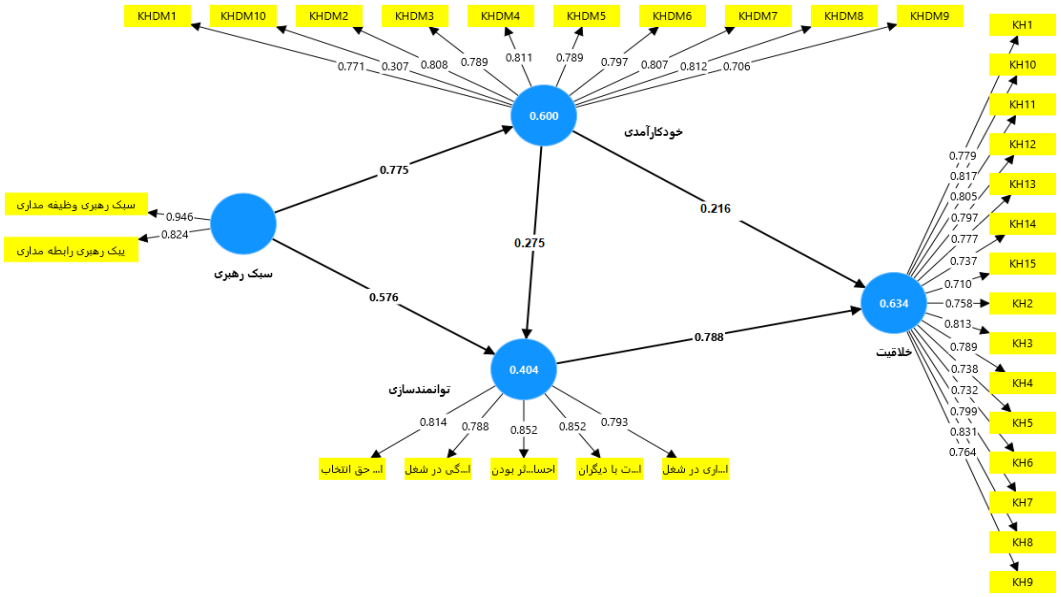

Figure 3: Fitted structural model between research constructs with significant numbers

Empowering and Creative Multilayer Perceptron Neural Network Model Fitting. Before starting the analysis, data processing steps were performed, including identifying outlier, inconsistent, and missing data, followed by normalization and standardization. Finally, the database was prepared for analysis.

Table 4. Coefficient of Determination and Stone-Geisser Criterion

Construct	R^2	Q^2
Psychological empowerment	0.404	0.399
Principal's Creativity	0.643	0.169
Principal's Self-efficacy	0.6	0.598

Inconsistent Data: If inconsistencies exist in some records within the data file, corrections can be made by considering the main dependent variable in the fields of each record, which was done in this project.

Missing Data: If a value is not entered for a field in a series of records, it is considered missing data. Records with fields lacking sufficient information were deleted.

Outlier Data: Box plot diagrams were used as descriptive summarization methods to obtain a comprehensive picture of the data and identify outliers. If outliers are not an important part of the problem statement, they can be removed after consulting with experts in the same industry.

Table 5: GOF Index Calculation

Construct	AVE	Coefficient of determination
Psychological empowerment	0.820	0.404
Principal's Creativity	0.777	0.634
Principal's Self-efficacy	0.754	0.6
Leadership style	0.887	
M	0.810	0.546

Data Normalization: Through normalization, the scale of the data was changed so that it was mapped to a small and specific range [0, 1]. Normalization was performed because when the data are used to measure distance, data with a large scale do not skew the result. For this purpose, the Min-Max normalization method was used. This method performs a linear transformation on the original data; therefore, the relationship between the values of the original data is preserved in this method. Suppose (min) A and (max) A are the minimum and maximum values of a feature, respectively. A Min-Max normalization maps a value V from A to a value V′ in the interval new (min) A, new (max) A as follows: V^′=(V-(min)_A)/(max)_A-(min)_A) (new (max)_A-new (min)_A) +new (min)_A

Finally, SPSS27 software was used to standardize the data. The resulting neural network, as shown in Figure 2, consists of 3 input layers, 1 hidden layer with 2 units, and 2 output layers (dependent variable). The performance function used in the hidden layer is the hyperbolic tangent function, and the error function used is the sum of squares. It should be noted that 72 percent of the data, equivalent to 278 data points, were used as training samples, and 28 percent of the data, equivalent to 106 data points, were used as testing samples.

Table 6: Results of Bootstrap Test for Examining Indirect Effects

Path consistent with hypotheses	Sig.	t	Path coefficient	Results
Leadership style <- Principal's Self-efficacy <- Psychological empowerment	۰,۰۲۰	۲,۲۹	۰,۵۸	Confirmed
Leadership style <- Principal's Self-efficacy <- Creativity	۰,۰۰۳	۲,٤٥	۰,۳۱۲	Confirmed
Principal's Self-efficacy <- Psychological empowerment <- Creativity	۰,۰۲۰	۲,۲۹٤	۰,٥٥۹	Confirmed
Leadership style <- Psychological empowerment <- Creativity	۰,۰۰۰	۱۱,۲۰۳	۰,٤٥٤	Confirmed

The amount of error obtained from fitting this model is 187 in the training sample and the amount of error obtained in the testing sample is 75. Since the amount of error obtained in the testing sample is less than the training sample, the model fit is acceptable. According to Figure 2, it is concluded that the percentage of correct prediction in the testing sample is higher than the training sample, and therefore the validity of the model is confirmed. The order of importance of independent variables in the neural network structure model is in Figure 3.

Discussion and Conclusion

The present study aimed to examine the effect of the interaction between leadership styles and managerial self-efficacy on teachers' psychological empowerment and creativity, utilizing advanced data

analysis models. The findings indicated that effective leadership styles, particularly transformational and ethical leadership, exert a direct and significant influence on teachers' psychological empowerment. These results align with previous research on leadership and the creation of supportive and motivating environments for teachers (Northouse, 2021; Wu et al., 2022; Marlia, Fahmy, Lucite, & Games, 2025). Transformational leadership, by providing a shared vision, encouraging innovation, and offering continuous support, establishes a meaningful space for the expression of teachers' professional competencies. Similarly, ethical leadership, emphasizing principles of justice, integrity, and transparency, fosters a trustworthy and participatory environment that strengthens teachers' sense of responsibility and competence (Brown & Treviño, 2024; Riadi, Riani, Sunarsi, & Munna, 2025; Nikparast et al., 2022).

Within this framework, managerial self-efficacy—defined as managers' belief in their ability to plan, guide, and oversee educational processes—exerts both direct and indirect effects on teachers' psychological empowerment and creativity (Tschannen-Moran & Gareis, 2020; Farahmand et al., 2021; Arastaman et al., 2024; Guo et al., 2021). Managers with high self-efficacy are capable of creating a supportive, flexible, and motivating environment in which teachers experience autonomy, competence, and a sense of impact, allowing them to apply their skills and innovative ideas in teaching (Supendi, Rosa, Fahrurozi, & Gaffar, 2025; Noori et al., 2017). Such an environment fosters the development of psychological empowerment, as teachers who perceive their work as meaningful, have control over their activities, and can make an impact, demonstrate higher intrinsic motivation and commitment (Ashraf, Amir & Ratan, 2025; Hameli, Ukaj & Çollaku, 2025; Xue et al., 2024).

In this study, psychological empowerment emerged as a primary predictor of teachers' creativity. Psychologically empowered and proactive teachers cultivate a creative learning environment in which students engage with higher motivation and participation in the learning process (Celik, Sari, & Karagozoglu, 2025; Amabile, 1996; Brauer, Ormiston, & Beausaert, 2025). These findings indicate that psychological empowerment serves as a key mediator between leadership styles and teachers' creativity, such that the impact of leadership on educational innovation largely occurs through enhancing teachers' sense of competence, autonomy, and influence (Ozdogru et al., 2025; Albay & Eisma, 2025; Soeharto, Singh, & Afriyanti, 2024).

Furthermore, the interaction between leadership styles and managerial self-efficacy demonstrated that managers' self-efficacy facilitates the effectiveness of leadership approaches. In other words, managers who have confidence in their capabilities can implement transformational and ethical leadership strategies to create an environment that enhances teachers' psychological empowerment and more effectively fosters their creativity. These findings indicate that managerial self-efficacy functions as an enabling factor, playing a crucial role in realizing the positive interaction between leadership and psychological empowerment (Purohit & Dutt, 2024; Sagdiyev, 2025; Celik, Sari, & Karagozoglu, 2025).

Overall, the present study demonstrates that teachers' creativity emerges from a complex interaction among leadership styles, managerial self-efficacy, and psychological empowerment. Effective and ethical leadership styles, by creating supportive and motivating environments, directly and indirectly—through enhancing managerial self-efficacy—strengthen teachers' psychological empowerment and ultimately foster their creativity. These findings highlight that, for improving the quality of teaching and student learning, simultaneous attention to developing leadership skills, reinforcing managerial self-efficacy, and establishing psychologically empowering conditions for teachers is strategically essential (Supendi, Rosa, Fahrurozi, & Gaffar, 2025; Northouse, 2021; Hameli, Ukaj & Çollaku, 2025).

Consequently, this study provides a coherent framework of relationships among managerial and psychological variables that can guide practical and strategic planning in schools to enhance teacher empowerment and creativity. It emphasizes that the real impact of school management on fostering innovation and educational quality is achieved only through the alignment of effective leadership, high managerial self-efficacy, and teachers' psychological empowerment.

Based on the research results, the following practical suggestions are offered:

- Professional development courses should be designed to enhance managers' self-efficacy;
- Transformational and participatory leadership approaches should be institutionalized in school management;
- Evaluation and reward systems should be revised in accordance with indicators of teachers' creativity;
- Macro policies of the Ministry of Education should be rebuilt around the psychological empowerment of teachers.

Based on the results of this research and in order to expand theoretical and practical knowledge in the field of educational leadership, psychological empowerment, and teacher creativity, the following items are suggested:

- Future studies can use multi-level modeling methods to simultaneously analyze the impact of principals' leadership styles on teachers' creativity and psychological empowerment at the school, regional, and provincial levels.
- It is suggested that future research use in-depth interviews, thematic analysis, and narrative research to examine the lived experiences of teachers in the face of transformational and participatory leadership styles.
- Examining factors such as school organizational culture, teachers' psychological capital, gender, or work experience as moderating variables in the relationships between leadership style, self-efficacy, and creativity can provide a deeper understanding of the influential contexts.
- It is suggested that a comparative study be conducted between schools with high and low educational performance to determine the differences in the leadership styles of principals in these two categories and how these styles are related to teachers' creativity and their psychological empowerment.
- Given the successful application of the multilayer perceptron neural network in this research, it is suggested that future research utilize more advanced algorithms such as decision trees, logistic regression, convolutional networks, or hybrid algorithms to predict organizational behaviors.
- Conducting longitudinal studies to examine the stability of the effect of leadership styles and principals' self-efficacy on teachers' empowerment and creativity over several consecutive years can help understand the dynamics of these relationships over time.
- It is suggested that in future research, the indirect impact of managerial and psychological variables on students' educational outcomes (such as academic performance, satisfaction, learning motivation, and student creativity) be evaluated.
- Finally, designing and evaluating the effectiveness of intervention programs to promote principals' self-efficacy and analyzing its impact on supportive behaviors can be highly valuable in the field of educational leaders' professional development.

Limitations

Despite the researchers' efforts to adhere to scientific principles and rigorous methodology, this study, like other humanities studies, faced limitations:

- The research population was limited to managers and teachers in a specific region/city, which makes generalizing the results to other regions problematic.
- The use of questionnaires (especially in assessing leadership style, self-efficacy, and creativity) may be subject to response bias, reducing the accuracy of the data.
- Although neural networks are powerful tools for analyzing complex data, they require more data and high accuracy in parameter tuning. Also, interpreting the results of these models may be difficult for non-technical users.
- The present study was conducted over a specific period, and the long-term effects of the interaction between variables have not been

investigated. Future research could use longitudinal designs.

- Extraneous variables such as cultural conditions, educational policies, and work experience may affect the research variables, which were not controlled in this study.

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Name: Abbas Mohammadi*

Email: A_mohammadi@pnu.ac.ir

Assistant Professor, Department of Educational Sciences, Payame Noor University, Tehran, Iran.

Name: Esmat Pasdar

Email: esamtpasdar1@gmail.com

MD in Educational Management, Payame Noor University, Tehran, Iran.