



Innovative Leadership and Educational Innovation in Agricultural and Biological Sciences Education: Evidence from Secondary Schools in Saraburi, Thailand

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Abstract

Innovative leadership provides an organizational foundation for encouraging teachers to develop and implement new educational practices; however, different leadership dimensions may not contribute equally to teachers' educational innovativeness. This study examined the levels of school administrators' innovative leadership and teachers' educational innovativeness and identified the leadership dimensions that significantly predicted teachers' educational innovativeness under the Secondary Educational Service Area Office Saraburi, Thailand. A quantitative cross-sectional survey was conducted with 297 teachers selected through stratified random sampling according to school size from a population of 1,265 teachers. Data were collected using a five-point questionnaire. Content validity was evaluated by five experts, with all retained items obtaining an item-objective congruence value of 1.00. A pilot test with 30 teachers yielded an overall Cronbach's alpha coefficient of .862. Data were analyzed using frequency, percentage, mean, standard deviation, and stepwise multiple regression. School administrators' innovative leadership was high overall ($M = 4.19$, $SD = .46$), with creative thinking receiving the highest mean. Teachers' educational innovativeness was also high ($M = 4.21$, $SD = .45$), with technology use receiving the highest mean. The final regression model was statistically significant, $F(4, 292) = 62.688$, $p < .001$, and explained 46.20% of the variance in teachers' educational innovativeness ($R = .680$, $R^2 = .462$, adjusted $R^2 = .455$). Creative thinking was the strongest predictor ($\beta = .310$), followed by vision for change ($\beta = .260$), use of technology and information ($\beta = .210$), and teamwork ($\beta = .170$). Systems and networking did not make a significant additional contribution ($\beta = .058$, $p = .237$). The main hypothesis and four of the five subsidiary hypotheses were supported. The findings suggest that leadership development should prioritize creative problem solving, a shared direction for change, evidence-informed technology use, and professional teamwork. Potential applications extend to agricultural, biological, and environmental science education; however, discipline-specific conclusions require samples that explicitly identify teachers' subject assignments. Because the study used cross-sectional self-reported data, the reported relationships should be interpreted as statistical prediction rather than causality.

Keywords

Innovative leadership; educational innovativeness; school administrators; teachers; secondary education.

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1. Introduction

Rapid technological advancement has transformed the organization of teaching and learning as well as the responsibilities of school administrators and teachers. Educational institutions are increasingly

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expected to integrate digital technologies use information in decision making and develop students' capacities for creativity problem solving and adaptation. Thailand's Thirteenth National Economic and Social Development Plan identifies human capital development digital competence innovation and lifelong learning as essential foundations for national competitiveness and sustainable development (Office of the National Economic and Social Development Council, 2023). At the international level educational leadership has also been recognized as an important mechanism for improving teaching quality strengthening organizational learning and enabling schools to respond to technological and societal change (UNESCO, 2024). Consequently, schools must move beyond conventional knowledge transmission and establish organizational conditions that support experimentation professional collaboration and the development of educational innovations.

The need for innovation is particularly relevant to agricultural biological and environmental science education because these fields require learners to connect scientific knowledge with authentic problems involving food production ecosystems natural resources and sustainable development. Emerging agricultural technologies can provide meaningful contexts for integrating science technology engineering and mathematics although their successful adoption depends on teachers' instructional competence and schools' technological readiness (Manning et al., 2022). Agricultural-based STEM curricula can also strengthen students' problem-solving collaboration and twenty-first-century learning skills through activities connected with local agricultural contexts (Sawangmek et al., 2023). Partnerships among schools, universities, communities and agricultural education organizations further expand teachers' access to specialized knowledge and resources for interdisciplinary teaching (Charoenmuang et al., 2024). However, the availability of technologies curricula or external partnerships does not automatically produce educational innovation because their value depends on whether school administrators and teachers can transform these resources into appropriate instructional practices.

Innovative leadership among school administrators represents an important organizational mechanism for converting educational resources and reform directions into sustained professional practices. Innovative leadership involves establishing a vision for change encouraging creative thinking applying technology and information developing organizational systems and networks and promoting teamwork. Educational transformation requires coherence between institutional direction collaborative culture professional learning and responsibility for student outcomes (Fullan & Quinn, 2023). Knowledge-oriented leadership can further enhance innovation by supporting the acquisition exchange and application of knowledge within an organization (Chaithanapat et al., 2022). Therefore, innovative leadership should not be interpreted merely as an administrator's personal creativity or willingness to adopt new technology. It represents a multidimensional organizational capability through which administrators establish direction allocate resources coordinate professional relationships and create opportunities for teachers to develop and implement new approaches to teaching and learning.

Teachers' educational innovativeness represents the professional capacity to identify instructional problems generate and test alternative solutions use appropriate technologies develop innovative teaching methods and adapt professional practices to changing learner needs. Evidence from Thai secondary schools indicates that administrators' innovative leadership is positively related to teachers' innovativeness because leadership practices influence professional support participation and opportunities for instructional experimentation (Chanasongkram et al., 2024). Inquiry-based instruction illustrates how teachers can move from conventional knowledge delivery toward learning activities that involve investigation evidence-based reasoning and active student participation (Nelson et al., 2022). Effective technology integration also requires teachers to combine technological pedagogical and content knowledge rather than using technological tools without clear instructional purposes (Aumann et al., 2023). These findings suggest that teachers' educational innovativeness is determined not only by individual competence but also by organizational conditions that support professional autonomy collaboration access to information and continuous improvement.

Despite the growing recognition of innovative leadership and teacher innovativeness three related gaps remain. First previous studies have often examined innovative leadership as an overall leadership characteristic without identifying which specific dimensions contribute most strongly to teachers' educational innovativeness. Second empirical evidence remains limited regarding the comparative predictive effects of vision for change creative thinking use of technology and information systems and networking and teamwork within a single analytical model. Third limited evidence is available from schools under the Secondary Educational Service Area Office Saraburi where schools must respond to technological change diverse learner needs and locally relevant educational priorities. The present study therefore examines the levels of school administrators' innovative leadership and teachers' educational innovativeness and determines which dimensions of innovative leadership significantly predict teacher

innovativeness. The study contributes by separating the five leadership dimensions within a predictive model and by generating evidence that can inform leadership development school innovation planning and the improvement of instructional practices including potential applications in agricultural biological and environmental science education.

Research Objectives

This study had three objectives:

1. To study the level of innovative leadership among school administrators under the Secondary Educational Service Area Office Saraburi.
2. To study the level of teachers' educational innovativeness under the Secondary Educational Service Area Office Saraburi.
3. To examine the dimensions of school administrators' innovative leadership that significantly predict teachers' educational innovativeness under the Secondary Educational Service Area Office Saraburi.

Research Hypotheses

H1: School administrators' innovative leadership significantly predicts teachers' educational innovativeness under the Secondary Educational Service Area Office Saraburi.

H1a: School administrators' vision for change significantly predicts teachers' educational innovativeness.

H1b: School administrators' creative thinking significantly predicts teachers' educational innovativeness.

H1c: School administrators' use of technology and information significantly predicts teachers' educational innovativeness.

H1d: School administrators' development of systems and networking significantly predicts teachers' educational innovativeness.

H1e: School administrators' promotion of teamwork significantly predicts teachers' educational innovativeness.

2. Literature Review

2.1 Innovative Leadership of School Administrators

Innovative leadership refers to the capacity of leaders to establish directions for change and create organizational conditions through which personnel can generate evaluate and implement new ideas. In educational organizations innovative leadership extends beyond the acquisition of new technologies because it also encompasses the transformation of organizational values decision-making processes professional relationships and instructional support systems. Sustainable educational change requires administrators to connect a clearly communicated direction with collaborative professional learning and shared responsibility (Fullan & Quinn, 2023). Research on innovative leadership in Thai educational settings similarly identifies vision creativity technology utilization organizational development and participation as important leadership components (Tangsiripattana & Phetmalaikul, 2022). Innovative leadership should therefore be understood as a combination of leadership behaviors and organizational arrangements that enable teachers to transform professional knowledge into improved educational practices.

The present study conceptualizes innovative leadership through five dimensions. Vision for change refers to the administrator's capacity to anticipate educational developments formulate attainable directions and communicate those directions to organizational members. Creative thinking concerns openness to diverse perspectives and the development of alternative approaches to administrative and instructional problems. Use of technology and information refers to the purposeful application of digital tools and relevant evidence in communication planning monitoring and decision making. Systems and networking involve the coordination of internal structures and external partnerships to expand organizational knowledge and resources. Teamwork refers to the development of shared responsibility mutual learning and coordinated action among school personnel. These dimensions are conceptually distinguishable but operationally interdependent because vision without implementation mechanisms may not produce change while technology and networking without collaborative participation may remain disconnected from classroom practice.

Vision for change and creative thinking provide the strategic and cognitive foundations of innovative leadership. A clearly communicated vision enables teachers to understand the purpose of organizational change and align their professional practices with school priorities. Creative thinking enables administrators to question routine procedures consider alternative solutions and respond to complex

educational problems. Research indicates that transformational leadership can strengthen teachers' commitment and innovative practices particularly when teachers trust their administrators and understand the rationale for organizational change (Kılınç et al., 2024). Nevertheless, creative leadership should not be interpreted as unrestricted experimentation because educational innovations must remain consistent with curriculum requirements ethical responsibilities available resources and student learning needs.

Technology information systems networking and teamwork provide the organizational infrastructure required to implement innovative ideas. Technology and information allow administrators to examine educational performance identify emerging problems and communicate with relevant stakeholders. Systems and networks connect schools with external knowledge professional expertise and supplementary resources. Teamwork enables teachers to discuss instructional challenges refine ideas and coordinate the implementation of new practices. Distributed leadership can contribute to teacher innovativeness by strengthening professional autonomy and collaboration (Lin, 2022). Collective teacher innovativeness is also supported when leadership promotes professional collaboration and favorable working conditions instead of concentrating decision-making authority exclusively at the administrative level (Büyükgöze et al., 2024). Innovative leadership therefore depends on how effectively administrators distribute opportunities information responsibilities and resources across the school organization.

2.2 Teachers' Educational Innovativeness

Teachers' educational innovativeness refers to their capacity and willingness to generate evaluate apply and improve new ideas in professional practice. It differs from general creativity because innovativeness includes the implementation and refinement of an idea rather than only its initial generation. In the present study educational innovativeness comprises problem solving experimentation technology use innovative teaching methods and adaptability. Problem solving concerns the systematic examination of instructional difficulties and the development of contextually appropriate responses. Experimentation involves testing a new practice on a manageable scale and evaluating its consequences. Technology use refers to the purposeful integration of digital resources into instruction and professional work. Innovative teaching methods involve the development or adaptation of pedagogical approaches that enhance learning while adaptability concerns the modification of professional practices in response to changes in learners' curricula technologies and organizational conditions.

These five dimensions form a connected professional process. Teachers initially recognize an instructional problem or an opportunity for improvement and then generate possible solutions. Selected ideas are subsequently tested and evaluated using evidence from classroom implementation. Technology may facilitate this process by providing access to instructional resources communication platforms simulations and learner information. However, technology use should not be treated as synonymous with educational innovativeness because technologically sophisticated instruction may remain pedagogically ineffective when it lacks alignment with learning objectives. Inquiry-oriented teaching demonstrates that innovation involves the redesign of learning activities to enable students to investigate questions collect evidence and construct explanations (Nelson et al., 2022). Similarly enacted technological pedagogical content knowledge requires teachers to integrate technology with disciplinary content and appropriate pedagogical strategies (Aumann et al., 2023). Teacher education that develops these integrated capabilities can consequently strengthen teachers' readiness to design and implement innovative instruction (Wollmann & Lange-Schubert, 2022).

Educational innovativeness has particular significance in agricultural biological and environmental science education. These disciplines require learners to observe natural phenomena conduct investigations interpret evidence and apply scientific knowledge to practical and societal problems. Inquiry-based molecular biology instruction can promote students' situational interest by actively involving them in scientific processes (Röllke et al., 2021). Structured learning models that combine group investigation research simulation and communication can also strengthen science process skills and biology learning outcomes (Senisum et al., 2022; . Katangchol et al., 2023). The integration of emerging agricultural technologies into classroom learning further provides opportunities to connect scientific principles with agricultural production sustainability and local economic activities (Manning et al., 2022). Nevertheless, an instructional approach should not be classified as innovative solely because it is new or technology-based. It must also demonstrate relevance to the identified instructional problem systematic implementation and educational value for learners.

2.3 Relationship Between Innovative Leadership and Teachers' Educational Innovativeness

Innovative leadership is expected to influence teachers' educational innovativeness by shaping the organizational conditions in which professional experimentation occurs. Vision for change provides a shared direction and explains why instructional improvement is necessary. Creative thinking legitimizes

the consideration of alternatives to established routines. Technology and information provide resources and evidence for planning and evaluating instructional innovations. Systems and networking expand access to knowledge and external expertise while teamwork supports the collective refinement and implementation of new ideas (Channuwong, 2018). These mechanisms suggest that leadership does not produce teacher innovativeness solely through administrative authority. Its influence also operates through professional autonomy trust collaboration access to resources and opportunities for learning. Empirical evidence supports the proposed relationship while indicating that different leadership dimensions may not exert equal predictive influence. Transformational leadership can strengthen teachers' commitment and innovative practices when organizational relationships are characterized by trust (Kılınç et al., 2024). Distributed leadership can contribute to teacher innovativeness through teacher autonomy and professional collaboration (Lin, 2022). Collective teacher innovativeness is similarly associated with leadership arrangements that facilitate job satisfaction and collaborative work (Büyükgöze et al., 2024). Evidence from Thai secondary schools also demonstrates a positive association between administrators' innovative leadership and teachers' innovativeness (Chanasongkram et al., 2024). However, these findings cannot determine in advance which leadership dimensions will be statistically significant in the Saraburi context. The relative contributions of the five dimensions must therefore be examined empirically.

2.4 Synthesis of the Constructs and Dimensions

The literature indicates that innovative leadership functions as an organizational antecedent whereas teachers' educational innovativeness represents the professional outcome expected to emerge under supportive leadership and organizational conditions. The two constructs must remain conceptually separate because administrators create direction resources and working conditions while teachers perform the professional actions involved in problem solving experimentation technology integration instructional innovation and adaptation. Table 1 summarizes the definitions and operational dimensions adopted in the present study.

2.5 Conceptual Framework

The conceptual framework was developed from the synthesis of literature concerning innovative leadership and teachers' educational innovativeness. Innovative leadership is conceptualized as a multidimensional organizational characteristic through which school administrators establish strategic direction support creative problem solving apply technology and information coordinate organizational networks and promote collaborative work. Prior research indicates that transformational and distributed leadership practices can strengthen teachers' commitment (Kılınç et al., 2024) professional autonomy collaboration (Lin, 2022) and willingness to undertake innovative practices (Büyükgöze et al., 2024). Evidence from Thai secondary schools also suggests that school administrators' innovative leadership is positively associated with teachers' innovativeness (Chanasongkram et al., 2024). Nevertheless, the relative contribution of each leadership dimension may vary according to organizational and contextual conditions. The present study therefore does not treat innovative leadership solely as a single composite predictor. Instead its five dimensions are examined separately to determine which dimensions make statistically significant contributions to teachers' educational innovativeness.

The framework specifies five predictor variables consisting of vision for change creative thinking use of technology and information systems and networking and teamwork. Teachers' educational innovativeness is specified as the outcome variable and is reflected through problem solving experimentation technology use innovative teaching methods and adaptability. Vision for change is expected to provide a shared direction for instructional improvement. Creative thinking is expected to encourage the development of alternative solutions to educational problems. The use of technology and information is expected to provide teachers with resources evidence and communication mechanisms for improving instructional practices. Systems and networking are expected to expand access to knowledge professional expertise and external support. Teamwork is expected to facilitate knowledge exchange collective problem solving and the implementation of new practices. The proposed relationships are presented in Figure 1.

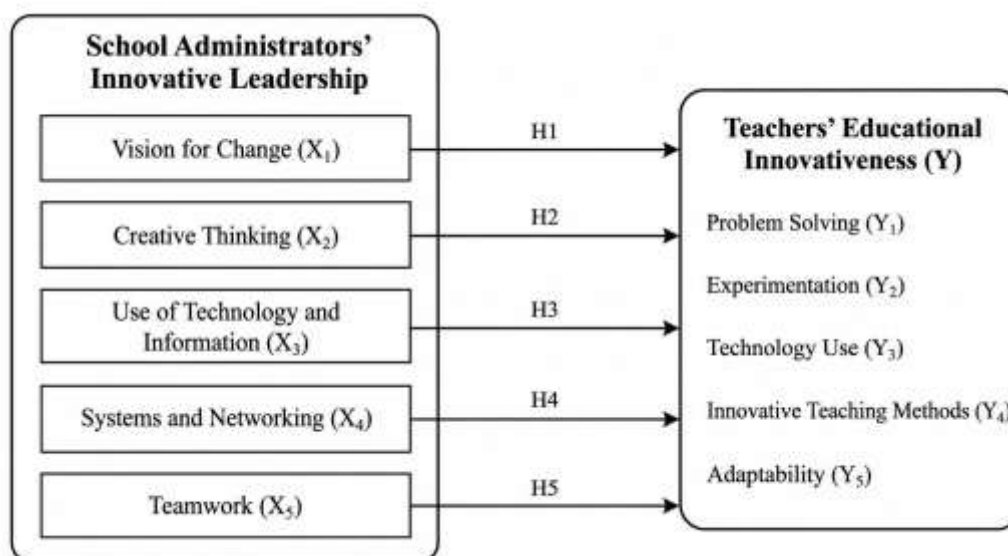


Figure 1. Conceptual framework of school administrators' innovative leadership predicting teachers' educational innovativeness

3. Research Methodology

3.1 Research Design

This study employed a quantitative cross-sectional survey design to investigate school administrators' innovative leadership and teachers' educational innovativeness under the Secondary Educational Service Area Office Saraburi. The design was appropriate because the study sought to measure the levels of the two principal constructs and examine the extent to which five dimensions of administrators' innovative leadership statistically predicted teachers' educational innovativeness. The unit of analysis was the individual teacher. The predictor variables consisted of vision for change creative thinking use of technology and information systems and networking and teamwork. The outcome variable was teachers' overall educational innovativeness comprising problem solving experimentation technology use innovative teaching methods and adaptability. Because data were collected at one point in time the statistical relationships were interpreted as predictive associations rather than confirmed causal effects.

3.2 Population and Sample

The target population consisted of 1,265 teachers employed in schools under the Secondary Educational Service Area Office Saraburi during the period covered by the study. The required sample size was determined using the sample-size table developed by Krejcie and Morgan (1970). Based on a population of 1,265 teachers the study required a sample of 297 participants. Stratified random sampling was subsequently employed using school size as the stratification criterion. The number of participants selected from each stratum was allocated in relation to the distribution of teachers across the school-size categories. Teachers were then selected from the respective strata according to the sampling procedure established by the researchers. A total of 297 completed questionnaires were included in the statistical analysis.

3.3 Research Variables

The independent variable was school administrators' innovative leadership. The construct was operationalized through five predictor dimensions consisting of vision for change creative thinking use of technology and information systems and networking and teamwork. These dimensions reflected leadership practices related to strategic direction organizational creativity evidence-informed administration external and internal coordination and professional collaboration. The specification of the leadership construct was informed by educational leadership literature (Tangsiripattana & Phetmalaikul, 2022) and previous studies of innovative leadership in Thai school settings (Chanasongkram et al., 2024).

The dependent variable was teachers' educational innovativeness. It was operationalized through five dimensions consisting of problem-solving experimentation technology use innovative teaching methods and adaptability. These dimensions represented teachers' ability to identify and resolve instructional problems test and refine new ideas apply relevant technologies develop or adapt pedagogical approaches and modify their professional practices in response to changing educational conditions. For the regression analysis teachers' educational innovativeness was treated as the overall outcome score

while the five dimensions of administrators' innovative leadership were entered as separate predictor variables.

3.4 Research Instrument

Data were collected using a structured questionnaire developed from the conceptual definitions research framework and relevant studies concerning innovative leadership (Tangsiripattana & Phetmalaikul, 2022) and teachers' innovativeness (Chanasongkram et al., 2024). The questionnaire consisted of items measuring respondents' general characteristics school administrators' innovative leadership and teachers' educational innovativeness. The substantive items were measured using a five-point rating scale. Higher scores represented higher perceived levels of innovative leadership or educational innovativeness according to the construct being measured.

The innovative leadership section measured five dimensions comprising vision for change creative thinking use of technology and information systems and networking and teamwork. The teachers' educational innovativeness section measured five dimensions comprising problem solving experimentation technology use innovative teaching methods and adaptability. The original information available for the study does not specify the number of items assigned to each dimension. These item counts must therefore be obtained from the original questionnaire and reported before the article is submitted for publication.

3.5 Instrument Validity and Reliability

Content validity was evaluated by five experts with relevant knowledge of educational administration research methodology or the substantive constructs included in the study. The experts assessed the congruence between each questionnaire item and its intended objective or construct. The Index of Item–Objective Congruence was used to summarize their evaluations. The original report stated that all questionnaire items obtained an IOC value of 1.00. This result indicates complete agreement among the five experts that the retained items were congruent with their intended measurement objectives.

The revised questionnaire was pilot-tested with 30 teachers who possessed characteristics comparable to those of the target population but were not included in the final sample. Internal consistency reliability was assessed using Cronbach's alpha coefficient. The questionnaire yielded an overall reliability coefficient of .862. This value indicated satisfactory internal consistency for the instrument as a whole. Nevertheless, an overall coefficient alone does not demonstrate the reliability of every dimension. If the original analysis contains separate Cronbach's alpha coefficients for the five innovative leadership dimensions and the five educational innovativeness dimensions those coefficients should also be reported because the regression model analyzes the leadership dimensions as separate predictors.

3.6 Data Collection

Following completion of the instrument validation and pilot testing procedures the questionnaire was administered to teachers selected through the stratified random sampling process. The researchers coordinated questionnaire distribution and collection within schools under the Secondary Educational Service Area Office Saraburi. The returned questionnaires were screened for completeness before data entry. A total of 297 usable questionnaires were retained for analysis. The available manuscript does not specify the dates of data collection the number of questionnaires distributed the number returned or the response rate. These details must be added from the original data-collection records because the statement that 297 questionnaires were analyzed does not by itself establish the response rate.

3.7 Data Analysis

Descriptive statistics were used to summarize the respondents' characteristics and the observed levels of the research variables. Frequency and percentage were used for categorical demographic information. Mean and standard deviation were used to summarize school administrators' innovative leadership teachers' educational innovativeness and their respective dimensions.

Stepwise multiple regression analysis was used to determine which dimensions of school administrators' innovative leadership significantly predicted teachers' educational innovativeness. The five candidate predictors were vision for change (X1), creative thinking (X2), use of technology and information (X3), systems and networking (X4), and teamwork (X5), with teachers' educational innovativeness specified as the outcome variable (Y).

The general regression model was expressed as follows:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \varepsilon$$

where β_0 represents the regression constant, β_1 to β_5 represent the regression coefficients for the five predictor variables, and ε represents the residual term. The analysis reported R, R^2 , Adjusted R^2 , unstandardized coefficients (B), standardized coefficients (β), standard errors, t-values, and p-values. Statistical significance was evaluated at the .05 and .01 levels. Before the regression findings are interpreted the final manuscript should report diagnostic evidence concerning linearity independence of residuals normality of residuals homoscedasticity and multicollinearity. At minimum tolerance and

variance inflation factor values should be presented for the retained predictors. The absence of these diagnostic results would weaken the credibility of the regression conclusions because statistically significant coefficients alone do not demonstrate that the assumptions of multiple regression were satisfied.

4. Results

The results are presented according to the three research objectives. The first section reports the level of school administrators' innovative leadership. The second section reports the level of teachers' educational innovativeness. The third section presents the results of the stepwise multiple regression analysis used to identify the dimensions of innovative leadership that significantly predicted teachers' educational innovativeness.

4.1 Results for Research Objective 1

The first research objective was to investigate the level of school administrators' innovative leadership under the Secondary Educational Service Area Office Saraburi. As presented in Table 5 the overall level of innovative leadership was high ($M=4.19$, $SD=0.46$). When the five dimensions were considered separately creative thinking obtained the highest mean ($M=4.31$, $SD=0.48$) followed by vision for change ($M=4.25$, $SD=0.52$) use of technology and information ($M=4.19$, $SD=0.54$) and teamwork ($M=4.14$, $SD=0.56$). Systems and networking obtained the lowest mean ($M=4.07$, $SD=0.58$). All five dimensions were interpreted as being at a high level.

Table 1. Means standard deviations and levels of school administrators' innovative leadership

Rank	Innovative leadership dimension	Mean (M)	Standard deviation (SD)	Interpretation
1	Creative thinking	4.31	0.48	High
2	Vision for change	4.25	0.52	High
3	Use of technology and information	4.19	0.54	High
4	Teamwork	4.14	0.56	High
5	Systems and networking	4.07	0.58	High
	Overall innovative leadership	4.19	0.46	High

The results demonstrate that teachers generally perceived their school administrators as displaying a high level of innovative leadership. The overall mean of 4.19 indicates that innovative leadership behaviors were perceived to occur frequently across the participating schools. The overall standard deviation of 0.46 shows that the respondents' perceptions were relatively concentrated around the mean and that there was no substantial dispersion in their assessments.

Creative thinking was ranked first with a mean of 4.31. Its standard deviation of 0.48 indicates relatively consistent perceptions among the participating teachers. The result suggests that administrators were particularly capable of considering different perspectives developing alternative solutions and encouraging new approaches to organizational and instructional problems. Vision for change was ranked second with a mean of 4.25 and a standard deviation of 0.52. This indicates that administrators were perceived as establishing and communicating directions for school development while preparing teachers to respond to educational change.

Use of technology and information was ranked third with a mean of 4.19 and a standard deviation of 0.54. This result indicates that administrators regularly applied digital technologies and relevant information to communication planning and decision making. Teamwork was ranked fourth with a mean of 4.14 and a standard deviation of 0.56. Although the dimension remained at a high level its lower position suggests that collaborative decision making and shared professional responsibility may not have been implemented as consistently as administrators' creative thinking or vision for change.

Systems and networking obtained the lowest mean of 4.07 with a standard deviation of 0.58. The score remained within the high-level range but showed the largest dispersion among the five dimensions. This finding indicates greater variation among schools in their development of internal systems external partnerships and professional networks. The difference between the highest and lowest means was 0.24 points. Although the difference was not large it identifies systems and networking as the dimension with the greatest opportunity for further development.

4.2 Results for Research Objective 2

The second research objective was to investigate the level of teachers' educational innovativeness under the Secondary Educational Service Area Office Saraburi. As presented in Table 2 teachers' educational

innovativeness was high overall ($M=4.21$, $SD=0.45$). Technology use obtained the highest mean ($M=4.34$, $SD=0.47$) followed by experimentation ($M=4.27$, $SD=0.50$) problem solving ($M=4.21$, $SD=0.52$) and adaptability ($M=4.16$, $SD=0.55$). Innovative teaching methods obtained the lowest mean ($M=4.08$, $SD=0.57$). All five dimensions were interpreted as being at a high level.

Table 2. Means standard deviations and levels of teachers' educational innovativeness

Rank	Educational innovativeness dimension	Mean (M)	Standard deviation (SD)	Interpretation
1	Technology use	4.34	0.47	High
2	Experimentation	4.27	0.50	High
3	Problem solving	4.21	0.52	High
4	Adaptability	4.16	0.55	High
5	Innovative teaching methods	4.08	0.57	High
	Overall educational innovativeness	4.21	0.45	High

The overall mean of 4.21 indicates that teachers frequently demonstrated behaviors associated with educational innovativeness. The overall standard deviation of 0.45 suggests that the respondents' scores were relatively concentrated and that teachers generally reported similar levels of educational innovativeness. The dimension means ranged from 4.08 to 4.34 and all remained within the high-level range.

Technology use obtained the highest mean of 4.34 with a standard deviation of 0.47. This indicates that teachers frequently applied digital technologies and electronic resources in their instructional and professional activities. The relatively small standard deviation also suggests that technology use was consistently perceived across the sample. Experimentation was ranked second with a mean of 4.27 and a standard deviation of 0.50. This result indicates that teachers were willing to test new approaches and adjust their practices based on classroom experience.

Problem solving was ranked third with a mean of 4.21 and a standard deviation of 0.52. The result demonstrates that teachers were generally able to identify instructional problems analyze relevant conditions and develop appropriate responses. Adaptability was ranked fourth with a mean of 4.16 and a standard deviation of 0.55. Although the dimension remained at a high level the greater dispersion indicates some variation in teachers' abilities to modify their practices in response to changes in learners' curricula technologies and organizational expectations.

Innovative teaching methods obtained the lowest mean of 4.08 with a standard deviation of 0.57. The score remained at a high level but was 0.26 points lower than technology use. This difference indicates that teachers' frequent use of technology did not necessarily correspond with an equally high level of pedagogical redesign. Teachers may have used digital tools to support existing instructional practices without consistently developing fundamentally new teaching approaches. The comparatively larger standard deviation also suggests that the implementation of innovative teaching methods differed more noticeably among participating teachers.

4.3 Results for Research Objective 3

Stepwise multiple regression analysis was used to identify the dimensions of school administrators' innovative leadership that significantly predicted teachers' educational innovativeness. The candidate predictors were vision for change (X1), creative thinking (X2), use of technology and information (X3), systems and networking (X4), and teamwork (X5). Diagnostic statistics indicated no serious multicollinearity, with tolerance values ranging from 0.715 to 0.836 and VIF values from 1.196 to 1.399. The Durbin-Watson statistic was 1.921.

Table 3. Multiple regression coefficients for dimensions of innovative leadership predicting teachers' educational innovativeness

Predictor	B	S.E.	β	t	p-value	Tolerance	VIF
Constant	1.020	0.176	—	5.795	< .001	—	—
Creative thinking (X2)	0.280	0.047	0.310	5.957	< .001	0.742	1.348
Vision for change (X1)	0.230	0.045	0.260	5.111	< .001	0.715	1.399
Use of technology and information (X3)	0.190	0.043	0.210	4.419	< .001	0.803	1.245
Teamwork (X5)	0.150	0.050	0.170	3.000	0.003	0.836	1.196

$R = 0.680$, $R^2 = 0.462$, Adjusted $R^2 = 0.455$, $SE = 0.310$, $F(4, 292) = 62.688$, $p < 0.001$, Durbin–Watson = 1.921

As shown in Table 3, the regression model was statistically significant, $F(4, 292) = 62.688$, $p < 0.001$, and explained 46.20% of the variance in teachers' educational innovativeness. Creative thinking had the largest predictive contribution, $\beta = 0.310$, followed by vision for change, $\beta = 0.260$, use of technology and information, $\beta = .210$, and teamwork, $\beta = 0.170$. All four predictors were statistically significant. Systems and networking were not retained in the final model because its additional contribution was not significant, $\beta = 0.058$, $t = 1.184$, $p = 0.237$.

Systems and networking (X4) were not retained in the final regression model because its additional contribution was not statistically significant after the other predictors were considered, $\beta = 0.058$, $t = 1.184$, $p = 0.237$. Therefore, H4 was not supported.

The raw-score prediction equation was:

$$Y = 1.020 + 0.280X_2 + 0.230X_1 + 0.190X_3 + 0.150X_5$$

The standardized prediction equation was:

$$Z(Y) = 0.310Z(X_2) + 0.260Z(X_1) + 0.210Z(X_3) + 0.170Z(X_5)$$

The standardized coefficients showed that creative thinking had the largest predictive contribution, followed by vision for change, use of technology and information, and teamwork.

4.3.1 Results of Main and Subsidiary Hypothesis Testing

The main hypothesis proposed that school administrators' innovative leadership significantly predicted teachers' educational innovativeness. The overall regression model was statistically significant, $F(4, 292) = 62.688$, $p < 0.001$, and explained 46.20% of the variance in teachers' educational innovativeness. Therefore, the main hypothesis was supported.

Table 4. Summary of hypothesis-testing results

Hypothesis	Proposed relationship	Statistical result	Decision
H1	Innovative leadership predicts teachers' educational innovativeness	$R = 0.680$, $R^2 = 0.462$, $F(4, 292) = 62.688$, $p < 0.001$	Supported
H1a	Vision for change predicts teachers' educational innovativeness	$\beta = 0.260$, $t = 5.111$, $p < 0.001$	Supported
H1b	Creative thinking predicts teachers' educational innovativeness	$\beta = 0.310$, $t = 5.957$, $p < 0.001$	Supported
H1c	Use of technology and information predicts teachers' educational innovativeness	$\beta = 0.210$, $t = 4.419$, $p < 0.001$	Supported
H1d	Systems and networking predict teachers' educational innovativeness	$\beta = 0.058$, $t = 1.184$, $p = 0.237$	Not supported
H1e	Teamwork predicts teachers' educational innovativeness	$\beta = 0.170$, $t = 3.000$, $p = 0.003$	Supported

Four of the five subsidiary hypotheses were supported. Vision for change, creative thinking, use of technology and information, and teamwork significantly predicted teachers' educational innovativeness, whereas systems and networking did not make a significant additional contribution to the final model.

5. Discussion

The findings are discussed according to the three research objectives. Particular attention is given to the dimensions of innovative leadership that significantly predicted teachers' educational innovativeness and to the implications of the supported and unsupported hypotheses.

5.1 Discussion of Research Objective 1

The first objective examined the level of school administrators' innovative leadership. The overall high level indicates that teachers generally perceived their administrators as demonstrating leadership practices that supported educational development and adaptation to change. This finding is consistent with the view that effective educational leadership requires a clear organizational direction and sustained professional learning (Fullan & Quinn, 2023). It is also consistent with evidence from Thai educational settings showing that innovative leadership includes vision creativity technology utilization organizational development and participation (Tangsiripattana & Phetmalaikul, 2022; Channuwong et al., 2026).

Creative thinking obtained the highest mean among the five dimensions. This finding suggests that administrators were particularly strong in considering alternative approaches and responding flexibly to educational and organizational problems. Such leadership may be especially important in environments where schools must respond to changing technologies learner needs and administrative demands. Knowledge-oriented leadership can support innovation by encouraging the acquisition exchange and application of new knowledge within organizations (Chaithanapat et al., 2022; Photchanachan et al., 2026).

Systems and networking obtained the lowest mean although the level remained high. One possible explanation is that internal leadership practices are more visible to teachers than external networking activities. In addition, the existence of formal partnerships does not necessarily mean that teachers receive useful knowledge resources or professional support from those networks. This result therefore suggests that the quality and practical value of school networks may be more important than the number of formal partnerships.

5.2 Discussion of Research Objective 2

The second objective examined teachers' educational innovativeness. The overall high level indicates that teachers perceived themselves as capable of solving instructional problems experimenting with new practices using technology adapting to change and developing innovative approaches to teaching. This finding is consistent with evidence from Thai secondary schools showing that supportive innovative leadership is associated with teachers' engagement in innovation (Chanasongkram et al., 2024).

Technology use obtained the highest mean. This result may reflect the increasing integration of digital tools and electronic resources into teaching and professional work. However frequent technology use should not automatically be interpreted as educational innovation. Effective technology integration requires teachers to connect technological knowledge with pedagogical and disciplinary knowledge (Aumann et al., 2023). Teacher development should therefore focus not only on the ability to use digital tools but also on the ability to employ those tools in ways that improve learning design and instructional quality (Wollmann & Lange-Schubert, 2022; Sirathanakul et al., 2023).

Innovative teaching methods obtained the lowest mean. This result may indicate that teachers are more comfortable adopting digital tools than redesigning pedagogical practices. Teachers may use technology to support existing instructional methods without substantially changing the structure of teaching and learning. The finding suggests that professional development should place greater emphasis on pedagogical experimentation and the design of learning activities rather than technology adoption alone.

5.3 Discussion of Research Objective 3 and Hypothesis Testing

The third objective examined the predictive contribution of five dimensions of school administrators' innovative leadership to teachers' educational innovativeness. The final regression model explained 46.20% of the variance in teachers' educational innovativeness. This result supported the main hypothesis and indicates that innovative leadership has meaningful predictive value. However, the remaining unexplained variance also shows that teachers' innovativeness is likely to be associated with additional factors such as motivation self-efficacy professional knowledge workload school resources and organizational climate. Because the study employed a cross-sectional design the results should be interpreted as predictive associations rather than causal effects. Innovative Leadership of School...

5.3.1 Vision for Change

H1a was supported because vision for change significantly predicted teachers' educational innovativeness ($\beta = .260, p < .01$). A clearly communicated vision may help teachers understand the purpose of change and connect their professional practices with school priorities. Transformational leadership research indicates that meaningful organizational direction can strengthen teachers' commitment and innovative practices when trust in leadership is present (Kılınç et al., 2024). The present finding therefore suggests that vision is most useful when it is translated into understandable and attainable priorities for teaching and learning.

5.3.2 Creative Thinking

H1b was supported and creative thinking showed the largest predictive contribution ($\beta = .310, p < .01$). Administrators who consider different perspectives and encourage alternative solutions may create conditions in which teachers are more willing to experiment with new practices. This finding is consistent with research showing that leadership can strengthen innovation by supporting the creation and application of organizational knowledge (Chaithanapat et al., 2022).

The result is also important because creative thinking obtained the highest mean in Research Objective 1 and the largest standardized regression coefficient in Research Objective 3. This pattern suggests that creative thinking was both strongly perceived and statistically relevant within the present sample.

Nevertheless, the finding should not be interpreted as proof that creative thinking causes teacher innovativeness because reciprocal or indirect relationships remain possible.

5.3.3 Use of Technology and Information

H1c was supported because use of technology and information significantly predicted teachers' educational innovativeness ($\beta = .210, p < .01$). Administrators who use technology and information effectively may support teachers through improved communication access to resources and more informed decision making. However, the value of technology depends on how it is integrated with educational goals. Effective technology use requires alignment among technological pedagogical and content knowledge (Aumann et al., 2023).

This finding is consistent with the descriptive result that technology use was the highest-rated dimension of teachers' educational innovativeness. Together these findings suggest that technology is an important element of the innovation environment but should be treated as a means of supporting instructional improvement rather than as an indicator of innovation by itself.

5.3.4 Systems and Networking

H1d was not supported because systems and networking did not make a statistically significant additional contribution after the other leadership dimensions were included in the model. This result should not be interpreted as evidence that networking is unimportant. Rather it indicates that systems and networking did not explain unique additional variance beyond the contribution of the other predictors.

One possible explanation is that networking overlaps with teamwork technology use or access to information. Another possibility is that some school networks exist formally but do not provide teachers with resources or expertise that directly influence classroom practice. Research on school partnerships suggests that networks are most useful when they provide authentic professional knowledge and opportunities for collaboration (Charoenmuang et al., 2024). Future studies should therefore examine the quality and usefulness of networks rather than only their existence.

5.3.5 Teamwork

H1e was supported because teamwork significantly predicted teachers' educational innovativeness ($\beta = .170, p < .05$). Professional collaboration may enable teachers to exchange knowledge discuss instructional problems share resources and refine new practices. Distributed leadership has been associated with teacher innovativeness through professional autonomy and collaboration (Lin, 2022). Collective teacher innovativeness has also been linked with organizational conditions that support collaborative work (Büyükgöze et al., 2024).

Although teamwork had the smallest standardized coefficient among the significant predictors its contribution remained statistically significant. This finding suggests that collaboration should not be evaluated only by the frequency of meetings or committee participation but by the extent to which professional interaction contributes to instructional improvement and experimentation.

Overall the main hypothesis was supported and four of the five subsidiary hypotheses were supported. Creative thinking showed the largest predictive contribution followed by vision for change use of technology and information and teamwork. Systems and networking did not make a statistically significant additional contribution after the other predictors were controlled. These results demonstrate that the dimensions of innovative leadership do not contribute equally to teachers' educational innovativeness. The overall model should therefore be interpreted together with the individual regression coefficients rather than assuming that all leadership dimensions have the same predictive role.

6. Conclusion Recommendations and Limitations

6.1 Conclusion

This study examined school administrators' innovative leadership, teachers' educational innovativeness, and the leadership dimensions that predicted teachers' educational innovativeness under the Secondary Educational Service Area Office Saraburi.

School administrators' innovative leadership was high overall ($M = 4.19, SD = 0.46$). Creative thinking obtained the highest mean ($M = 4.31, SD = .48$), whereas systems and networking obtained the lowest ($M = 4.07, SD = 0.58$). These findings indicate that administrators demonstrated strong innovative leadership, particularly in creative problem solving, while systems and networking remained an area for further development.

Teachers' educational innovativeness was also high overall ($M = 4.21, SD = 0.45$). Technology use obtained the highest mean ($M = 4.34, SD = 0.47$), while innovative teaching methods obtained the lowest ($M = 4.08, SD = 0.57$). This suggests that teachers were confident in using technology and

experimenting with new practices, although technology use was not always accompanied by substantial pedagogical redesign.

The regression model was statistically significant, $F(4, 292) = 62.688$, $p < 0.001$, and explained 46.20% of the variance in teachers' educational innovativeness ($R = 0.680$, $R^2 = .462$, Adjusted $R^2 = 0.455$). Creative thinking made the largest predictive contribution ($\beta = .310$), followed by vision for change ($\beta = 0.260$), use of technology and information ($\beta = 0.210$), and teamwork ($\beta = 0.170$). Systems and networking did not make a significant additional contribution ($\beta = .058$, $p = 0.237$). The main hypothesis and four of the five subsidiary hypotheses were therefore supported.

Overall, the findings indicate that teachers' educational innovativeness is associated with leadership practices that encourage creative problem solving, provide clear direction for change, use technology and information purposefully, and promote professional collaboration. Because the study employed a cross-sectional design, these findings should be interpreted as predictive relationships rather than causal effects.

6.2 Recommendations

6.2.1 Recommendations for Educational Practice

School administrators should prioritize creative thinking by encouraging problem solving, experimentation, and the development of alternative instructional approaches. Vision for change should be translated into clear instructional priorities and measurable outcomes, with teachers actively involved in implementation.

Technology and information should be used to improve teaching quality rather than simply increase access to digital tools. Schools should also strengthen teamwork through professional learning communities, peer coaching, lesson study, and collaborative action research. Although systems and networking were not a significant independent predictor, schools should continue to develop partnerships that provide teachers with useful knowledge, expertise, resources, and opportunities for professional learning.

6.2.2 Recommendations for the Secondary Educational Service Area Office Saraburi

The Secondary Educational Service Area Office Saraburi should develop leadership-development programs emphasizing creative thinking, vision for change, technology and information use, and teamwork. Training should be combined with professional coaching, school-based innovation projects, and evidence-based evaluation.

The area office should also provide consultation, technical support, and resources for instructional innovation and encourage schools to document and share effective practices. Evaluation indicators should distinguish between technology adoption and genuine educational innovation, particularly improvements in instructional design, learner participation, assessment, and learning outcomes.

6.2.3 Recommendations for Agricultural Biological and Environmental Science Education

For agricultural, biological, and environmental science education, schools may apply the findings through inquiry-based learning, field investigation, data collection, simulation, and problem-based projects related to local conditions. Partnerships with universities, farms, enterprises, and environmental agencies may provide authentic learning resources and specialist knowledge.

However, these recommendations should be treated as potential applications rather than direct findings because teachers' subject assignments were not identified in the present study. Future research should therefore examine whether the relationships differ across subject areas.

6.3 Limitations

Several limitations should be considered. First, the study was conducted within a single secondary educational service area office, which limits generalization to other educational contexts. Second, the cross-sectional design does not establish temporal or causal relationships. Third, the use of teacher self-report data may introduce social desirability and common-method bias.

Fourth, stepwise regression is sensitive to sample characteristics and correlations among predictors. The exclusion of systems and networking should therefore not be interpreted as definitive evidence that this dimension is unimportant. Future studies should consider theoretically specified models, hierarchical regression, structural equation modeling, or cross-validation.

Fifth, the model explained 46.20% of the variance in teachers' educational innovativeness, leaving 53.80% unexplained. Future research should examine additional teacher-level and school-level factors such as motivation, self-efficacy, professional knowledge, workload, resources, professional autonomy, and innovation climate.

Finally, the available instrument information reported only an overall Cronbach's alpha of .862 and did not provide reliability coefficients for individual dimensions or confirmatory factor analysis. Future studies should report dimension-specific reliability and stronger evidence of construct validity. The

absence of information on teachers' subject assignments also means that conclusions specific to agricultural, biological, or environmental science teachers cannot be drawn from the present data.

Declarations

Acknowledgement: Not applicable.

Conflicts of Interest: The authors declare that they have no conflicts of interest related to this study.

Data Availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request. Access may be subject to appropriate ethical and confidentiality considerations.

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