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Impact of a university–school collaboration model on pre-service teacher leadership development

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ABSTRACT

The purpose of this study was to examine the impact of an innovative university–school collaboration model on leadership development (LD), operationalized through leadership competencies (LCs), among pre-service teachers (PTs) enrolled in teacher education programs (TEPs), and to explore the relationship between LCs and teaching self-efficacy. Specifically, the study investigated whether participation in the university–school collaboration model led to statistically significant improvements in key LCs within the Kazakhstani teacher education context. A quantitative quasi-experimental pretest–posttest control group design was employed, involving 120 PTs from Abai Kazakh National Pedagogical University in Almaty, Kazakhstan. The findings indicate that participation in the university–school collaboration model was associated with significant improvements in LCs across multiple dimensions. In addition, strong positive relationships were observed between LCs and teaching self-efficacy, suggesting that leadership-oriented learning experiences support broader aspects of professional confidence among PTs. No subject-specific differences in LD outcomes were identified, indicating the discipline-general applicability of the model. Overall, the study provides empirical evidence supporting multidimensional LD through structured university–school collaboration. The findings extend existing research on teacher leadership and offer practical guidance for designing scalable, experiential leadership components within initial TEPs.

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1. INTRODUCTION

The rapid transformation of educational systems worldwide has increased the demand for teachers who are not only subject-matter experts but also effective leaders capable of managing complex school environments. Contemporary schools require professionals with strategic thinking, collaborative decision-making, and organizational leadership skills to navigate educational reforms, accountability pressures, and innovation-driven change [1]. Consequently, the development of leadership competencies (LCs) among pre-service teachers (PTs) has become a critical priority in teacher education programs (TEPs) [2].

Traditionally, leadership preparation has been associated with in-service professional development or specialized training for school administrators [3]. Recent research, however, emphasizes that LCs should

begin during initial teacher education (ITE) [4]. PTs who develops leadership skills early are better prepared to assume expanded professional roles, contribute to school improvement, and potentially transition into school leadership positions, including that of principal. Despite this recognition, many TEPs continue to prioritize pedagogical and disciplinary knowledge over leadership preparation, leaving leadership development (LD) insufficiently integrated [5].

One promising approach is the implementation of university–school (U-S) collaboration models [6]. These structured partnerships between higher education institutions and schools provide PTs with authentic, practice-oriented experiences that foster leadership growth [7]. Through collaborative projects, mentoring by school leaders, and participation in school-based decision-making, PTs develop essential leadership skills in real educational contexts. Innovative U-S collaboration models thus bridge theory and practice, supporting the holistic professional development of future teachers [8].

Although U-S partnerships are widely discussed, empirical evidence on their effectiveness in developing LD among PTs remains limited, particularly in quantitative studies. Existing research often focuses on general professional competencies (PC) rather than explicitly measuring leadership outcomes. This gap highlights the need for systematic investigations of how U-S collaboration models influence leadership skills in TEPs [9]. In response, the present study examines the impact of an innovative U-S collaboration model on PTs' LD within ITE. Using a quantitative design, the study assesses changes in key LCs before and after participation in the program.

Despite growing expectations for teachers to contribute to school leadership, many ITE programs provide limited structured opportunities for PTs to develop LCs in authentic school settings. As a result, graduates often enter the profession without the skills, experience, or confidence to engage in school leadership or support institutional improvement. In Kazakhstan, these challenges are amplified by a centralized, hierarchical educational system that limits teacher autonomy, shared decision-making, and leadership opportunities beyond the classroom. Teacher leadership is rarely practiced, and many educators lack the experience or confidence to implement instructional improvements, curriculum innovations, or collaborative problem-solving [10]–[13]. The country also faces a shortage of school leaders: as of the mid-2020s, approximately 740 leadership positions remain unfilled, and only 9% of principals hold advanced professional qualifications. Most school leaders have limited formal preparation, and professional development is often generic, centrally assigned, and not tailored to required competencies [14]–[16]. Workforce issues, including up to 35% attrition of talented teachers, further reduce the pool of potential leaders [17]–[20].

Taken together, these factors indicate that ITE in Kazakhstan does not sufficiently integrate LD into curricula or experiential learning. Some initiatives, such as national leadership programs and collaborative projects, exist, but quantitative evidence of their effectiveness is scarce. In addition, few studies have demonstrated the causal impact of university–school partnerships on leadership competency development among PTs. This study addresses this gap by examining the impact of a structured university–school collaboration model on PTs' LD. The purpose of this study is to evaluate the impact of an innovative U–S collaboration model on LD, operationalized through LCs among PTs enrolled in TEPs, and to explore the relationship between LCs and teachers' sense of efficacy scale (TSES). Specifically, the study examines whether participation in the U–S collaboration model leads to statistically significant improvements in key LCs, thereby supporting the preparation of potential school leaders within the Kazakhstani educational context. This study addresses the following research questions:

- Does participation in the U–S collaboration model significantly enhance the overall LCs of PTs in TEPs? (RQ1)
- Which LCs dimensions demonstrate the most pronounced improvement in the experimental group (EG) compared to the control group (CG) following participation in the U–S collaboration model? (RQ2)
- Are there differences in LD outcomes among PTs from different subject-specific TEPs? (RQ3)
- Is there a significant relationship between LCs (measured using the teacher leadership scale (TLS)) and TSES among PTs? (RQ4)

In addition, the research hypotheses are: i) participation in the U–S collaboration model leads to a statistically significant improvement in the overall LCs of PTs in TEPs (H1); ii) participation in the U–S collaboration model leads to statistically significant improvements across LCs dimensions, as evidenced by significant time×group interaction effects (H2); iii) LD outcomes, operationalized through LCs, differ across subject-specific TEPs (H3); and iv) LCs measured with the TLS are positively and significantly associated with TSES among PTs (H4).

This study provides empirical evidence that structured U–S collaboration significantly enhances LCs among PTs. Using a quasi-experimental design, it examines LD at the pre-service stage and explores its relationship with teaching self-efficacy. The findings offer a scalable model for integrating leadership-oriented activities into TEPs through university–school partnerships. This approach addresses long-term shortages of

qualified school leaders and informs curriculum design, professional practice, and policy. The study is particularly relevant in Kazakhstan, supporting ongoing educational reforms and proposing an early, systematic approach to preparing future school leaders.

2. CONCEPTUAL FRAMEWORK

In this study, LD is conceptualized as an outcome of participation in an innovative U–S collaboration model. LD is operationalized through measurable LCs, which include initiative and responsibility (IR), collaboration and influence (CI), communication and decision-making (CD), and professional growth orientation (PGO) [21]. LD is therefore understood not as an abstract process but as a set of observable and quantifiable competencies assessed using the TLS. This approach extends teacher leadership theory by framing LD as competencies that can be systematically developed during the pre-service stage through structured experiential learning within ITE. The conceptual framework illustrates how structured participation in the U–S collaboration model influences LD outcomes, as shown in Figure 1. The model consists of three interrelated components: input, process, and output.

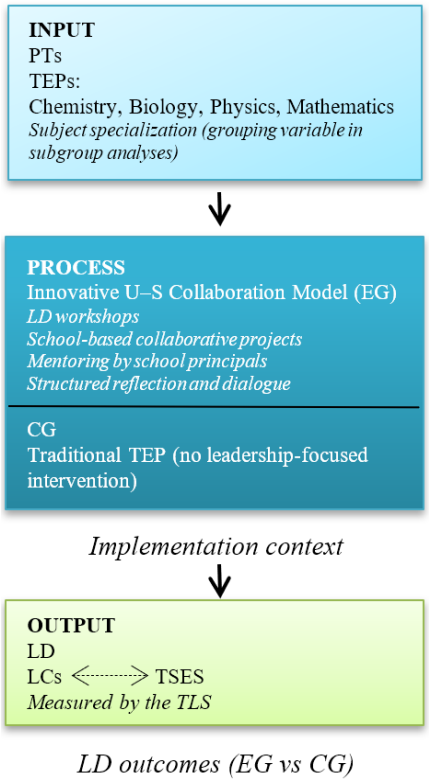

Figure 1. Conceptual framework of LD through a U–S collaboration model

2.1. Input

Participants are PTs enrolled in subject-specific TEPs in chemistry, biology, mathematics, and physics. At this stage, participants in both the EG and CG possess comparable levels of pedagogical and subject-specific knowledge. Subject specialization is treated as a grouping variable for subgroup analyses. However, participants generally have limited prior exposure to formal leadership roles or school management practices [22].

2.2. Process

The EG participates in an innovative U–S collaboration model that integrates multiple leadership-oriented experiences into ITE. These include LD workshops to develop leadership knowledge and reflective skills, school-based collaborative projects that provide opportunities for practical leadership enactment, mentoring by school principals to model effective leadership behaviors, and structured reflection and dialogue to consolidate learning. Together, these components create authentic, practice-oriented experiences

through which PTs systematically develop their LCs. These components create a mechanism through which PTs apply leadership knowledge in authentic school contexts, develop PC, and internalize leadership behaviors. The CG follows the traditional TEP curriculum without targeted LD interventions, serving as a comparison to isolate the effect of the U–S model [23].

2.3. Output

LD outcomes are measured via pre-test and post-test scores of LCs using the TLS. Expected outcomes include improvements in communication, decision-making, organizational skills, initiative, and readiness for future leadership roles [24]. Differences between EG and CG post-test scores evaluate the causal impact of the U–S model, while subgroup comparisons assess subject-specific variation. Additionally, TSES is examined as an associated construct to explore its relationship with LCs, without being treated as a dependent or mediating variable. This framework makes explicit how structured, practice-oriented U–S collaboration serves as the independent variable that systematically develops LCs (dependent variables) through experiential activities, mentoring, and reflection. By linking input-process-output, the framework clarifies the mechanism by which participation in the intervention enhances LCs among PTs.

3. METHOD

3.1. Study design

This study employed a quantitative quasi-experimental pretest–posttest control group design [25] to examine the impact of an innovative U–S collaboration model on the LD of PTs. The design included the EG and the CG, with LCs measured at two time points: prior to the intervention (pre-test) and after the completion of the intervention (post-test). The EG participated in the innovative U–S collaboration model, while the CG followed the traditional teacher education curriculum without targeted LD interventions. This design enabled systematic comparisons of changes in LCs between groups over time and supported a robust examination of the intervention's effects. LD was operationalized through measurable LCs and assessed using the TLS. The inclusion of a control group and repeated measurements enhanced internal validity by reducing the influence of maturation effects and other extraneous variables.

3.2. Participants

The participants of the study were 120 PTs enrolled in bachelor's degree TEPs at Abai Kazakh National Pedagogical University. Participants were initially selected using purposive sampling, targeting students enrolled in programs directly involved in the implementation of the U–S collaboration model. To ensure comparability between groups, a stratified matching procedure was applied, whereby participants were matched based on year of study and prior academic performance before being assigned to the EG (n=60) or CG (n=60). This combined approach ensured that both groups were balanced on key baseline characteristics while still focusing on the relevant population. Pre-test comparisons confirmed that both groups were comparable across all leadership competency dimensions before the intervention. Table 1 presents the demographic characteristics of the participants.

Table 1. Characteristics of study participants

Variable	Category	n	%
Gender	Female	78	65.0
	Male	42	35.0
Age	18–19 years	28	23.3
	20–21 years	54	45.0
	22–23 years	30	25.0
	24 years and above	8	6.7
Year of study	2nd year	32	26.7
	3rd year	56	46.7
	4th year	32	26.7
TEP	Chemistry (6B01510)	30	25.0
	Biology (6B01513)	30	25.0
	Mathematics (6B01501)	30	25.0
	Physics (6B01504)	30	25.0
Group assignment	EG	60	50.0
	CG	60	50.0
Prior LE	Yes	18	15.0
	No	102	85.0

3.3. Procedure

The study was conducted between September and December 2025 at Abai Kazakh National Pedagogical University in collaboration with partner secondary schools. Prior to data collection, formal permission to conduct the research was obtained from the university administration and the administrations of the participating schools. All institutional requirements for conducting educational research were met before the start of the study. At the initial stage of the research, participants were informed about the purpose of the study, the procedures involved, and the voluntary nature of their participation. Written informed consent was obtained from all participants. The intervention was implemented over a 12-week period. The pre-test and post-test data were collected under comparable conditions to ensure consistency and reliability of measurement. All collected data were anonymized prior to analysis and stored securely. The research procedure was designed to ensure ethical compliance, data integrity, and methodological rigor throughout all stages of the study.

3.4. Intervention

Prior to the intervention, university instructors and school-based mentors (experienced school principals and senior teachers) were briefed on the objectives, structure, and expected outcomes of the collaboration model. This preparatory phase ensured a shared understanding of LD goals and consistency in the implementation of learning activities across university and school contexts. The intervention integrated leadership-oriented modules delivered through a combination of university-based instruction and school-based experiential learning, which were not part of the traditional teacher education curriculum followed by the CG. Activities included leadership workshops, collaborative school projects, mentoring sessions with experienced school principals, and structured reflection. These components provided authentic leadership experiences and opportunities for PTs to develop measurable LCs in ways that were not available in the standard curriculum, as shown in Table 2.

Table 2. Structure of the intervention: training modules by week

Week	Module focus	Targeted LCs
1	Introduction to educational leadership	Leadership awareness; professional identity
2	Self-leadership and professional values	Self-regulation; responsibility
3	Communication and teamwork	Communication skills; collaboration
4	Decision-making in educational contexts	Analytical thinking; decision-making
5	Organizational and time management	Organizational skills; time management
6	Instructional leadership	Instructional leadership; feedback skills
7	School-based project planning	Strategic planning; initiative
8	Mentoring and leadership support	Mentoring skills; leadership modeling
9	Conflict management and ethical leadership	Conflict resolution; ethical decision-making
10	Collaborative school improvement	Team leadership; collaboration
11	Reflective leadership practice	Reflective thinking; self-evaluation
12	Evaluation and future leadership pathways	Leadership readiness; professional growth

3.5. Instruments

PTs' LCs were measured using an adapted version of the TLS originally developed by Katzenmeyer and Moller [26]. The scale was selected due to its strong theoretical foundation in TL research and its extensive use in educational studies. For the purposes of the present study, the instrument was linguistically and contextually adapted to reflect the experiences and professional roles of PTs rather than in-service educators, with careful attention to maintaining the conceptual meaning of each item. The scale assesses leadership across four core dimensions: IR, CI, CD, and PGO. Participants responded to the items using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating higher perceived LCs.

TSES was measured using a modified version of the teachers' sense of efficacy scale developed by Tschannen-Moran and Hoy [27], which assesses PTs' beliefs in their future teaching effectiveness. The instrument comprises three subscales: efficacy for instructional strategies (IS), classroom management (CM), and student engagement (SE). Responses were recorded on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Previous research has reported high internal consistency for this scale, with Cronbach's alpha coefficients ranging from .86 to .90. In the present study, reliability analyses also indicated strong internal consistency across all subscales.

All instruments were translated into the language of instruction using a forward–backward translation procedure. Construct validity was further considered by examining the factor structure of the adapted scales and ensuring that item wording remained appropriate for PTs. A pilot study ($n \approx 20–30$) was conducted to ensure the clarity, contextual appropriateness, and face validity of the items. Feedback from the

pilot study was incorporated to refine item wording and response options. Reliability analyses of the pilot data indicated acceptable internal consistency, supporting the suitability of the instruments for the main study.

3.6. Data analysis

All statistical analyses were conducted using SPSS version 29 (IBM Corp., Armonk, NY, USA). Data were screened for accuracy, missing values, and outliers, with missing data (<5%) handled using mean imputation. Assumptions of normality, homogeneity, and sphericity were examined and met prior to analysis. Reliability of the TLS and TSES instruments was confirmed using Cronbach's alpha ($\alpha \geq 0.70$). Repeated-measures ANOVA, one-way ANCOVA, paired-samples t-tests, and Pearson correlations were conducted to test the study hypotheses, as shown in Table 3.

Table 3. Data analysis methods

Research objective/hypothesis	Statistical method
Preliminary checks	Descriptive statistics; Shapiro–Wilk test; Levene's test; Cronbach's alpha
H1	Repeated-measures ANOVA (time×group); effect size (partial η^2); supplementary paired-samples t-tests
H2	Repeated-measures ANOVA (time × group × dimension); effect size (partial η^2)
H3	One-way ANCOVA (post-test as dependent variable, pre-test as covariate); post hoc comparisons (Tukey HSD)
H4	Pearson product–moment correlation

4. RESULTS

Prior to testing the main hypotheses, the reliability and descriptive statistics of the instruments were examined to ensure suitability for subsequent analyses. Cronbach's alpha values indicated acceptable internal consistency for both the TLS and the TSES ($\alpha \geq 0.79$). Baseline comparisons revealed no statistically significant differences between the EG and the CG, supporting initial group equivalence. Updated reliability coefficients and descriptive statistics are presented in Table 4.

Paired-samples t-tests indicated a statistically significant increase in overall LCs for the EG, whereas the CG showed a non-significant change. Independent-samples t-test at post-test confirmed that the EG outperformed the CG. These analyses confirm the effectiveness of the U–S collaboration model in enhancing total TLS. The small but statistically significant increase observed in the CG may reflect natural developmental progression associated with ongoing teacher education and repeated measurement effects; however, the substantially larger effect size in the EG confirms the added value of the U–S collaboration model. Detailed results are provided in Tables 5 and 6.

Table 4. Reliability and descriptive statistics for TLS and TSES

Instrument	Subscale/total	Cronbach's α	EG mean (SD)	CG mean (SD)
TLS	IR	0.82	3.22 (0.58)	3.18 (0.60)
	CI	0.79	3.12 (0.62)	3.08 (0.61)
	CD	0.81	3.06 (0.65)	3.02 (0.63)
	PGO	0.84	3.16 (0.60)	3.12 (0.59)
	Total	0.88	3.14 (0.57)	3.10 (0.58)
TSES	IS	0.87	3.31 (0.52)	3.28 (0.50)
	CM	0.86	3.26 (0.55)	3.24 (0.54)
	SE	0.88	3.29 (0.53)	3.26 (0.55)
	Total	0.90	3.29 (0.53)	3.26 (0.53)

Table 5. Pre-test and post-test TLS total scores and paired comparisons (H1)

Group	Pre-test mean (SD)	Post-test mean (SD)	*t*	*p*	Cohen's d
EG	3.14 (0.57)	4.02 (0.48)	11.74	<0.001	1.60
CG	3.10 (0.58)	3.25 (0.55)	2.33	0.02	0.21

Table 6. Independent-samples t-test post-test EG vs CG

Group	Post-test mean (SD)	*t*	*p*	Cohen's d
EG	4.02 (0.48)	8.17	<0.001	1.49
CG	3.25 (0.55)	-	-	-

Repeated-measures ANOVA revealed significant time×group interactions for all TLS subscales ($p<0.001$), with partial eta squared (η^2) values ranging from 0.21 to 0.25. This indicates that the intervention produced consistent improvements across initiative, collaboration, communication, and professional growth dimensions, while modest variations in effect sizes across subscales suggest slight differential impacts, as shown in Table 7. ANCOVA on post-test TLS scores, controlling for pre-test scores, revealed no statistically significant differences across TEPs. Adjusted post-test means varied slightly between programs, reflecting natural variability, and Tukey HSD pairwise comparisons confirmed the absence of significant differences. These findings indicate that the intervention was equally effective for PSTs across all subject-specific programs, as shown in Table 8. Pearson correlation analyses were conducted to examine associations between TLS and TSES. Strong positive correlations were observed across total scores and subscales, indicating that higher TLS correspond with greater TSES, as seen in Table 9.

Table 7. Repeated-measures ANOVA for TLS subscales (H2)

TLS subscale	Time×group F	*p*	Partial η^2
IR	32.5	<0.001	0.25
CI	30.2	<0.001	0.23
CD	28.0	<0.001	0.21
PGO	31.0	<0.001	0.24

Table 8. ANCOVA of TLS post-test by TEP (H3)

TEP	Adjusted post-test mean	Tukey HSD	*p*
Chemistry	3.98	a	0.85
Biology	4.05	a	0.91
Mathematics	4.00	a	0.88
Physics	4.02	a	0.89

*Groups sharing the same letter do not differ significantly at $p<0.05$ according to Tukey HSD post hoc tests

Table 9. Pearson correlations between TLS and TSES (H4)

Variable	TSES total	IS	CM	SE
TLS total	0.72**	0.70**	0.68**	0.69**
IR	0.65**	0.62**	0.60**	0.63**
CI	0.68**	0.66**	0.63**	0.65**
CD	0.66**	0.64**	0.61**	0.62**
PGO	0.70**	0.68**	0.65**	0.67**

Note*:* $p<0.001$.

5. DISCUSSION

The present study demonstrates that a structured U–S collaboration model effectively fosters LD among PTs enrolled in TEPs. The findings indicate that LD is a multidimensional construct, encompassing IR, CI, CD, and PGO. This supports conceptualizations of teacher leadership as a holistic phenomenon integrating personal agency, interpersonal influence, and continuous professional learning [28], [29].

The observed multidimensional development aligns with earlier research emphasizing experiential and practice-oriented approaches to leadership preparation. Cunningham *et al*. [30] argue that leadership capacity develops best when theoretical knowledge is combined with authentic, school-based experiences. The U–S collaboration model embeds leadership learning within real institutional contexts through mentoring, collaborative projects, and structured reflection. This approach moves beyond isolated skill acquisition and supports the internalization of leadership roles and the formation of professional identity—dimensions often insufficiently addressed in traditional coursework-based teacher education [31].

An important contribution of this study is the absence of subject-specific differences in LD outcomes. While previous research reported variation in leadership engagement across disciplines [32], [33], our findings suggest that LCs can be developed in a discipline-general manner. Organizing learning around shared professional practices rather than subject-specific content supports the view that LD is a core component of ITE.

The strong positive association between LCs and teaching self-efficacy further highlights the interconnected nature of these constructs. From a social-cognitive perspective [34], authentic leadership experiences in the U–S collaboration model serve as mastery experiences, enabling PTs to successfully engage in leadership tasks. These experiences enhance practical competencies, reinforce leadership identity, and strengthen teaching self-efficacy. Consistent with social-cognitive perspectives on teacher development

[35]–[37], enhanced leadership capacities are associated with greater confidence in IS, CM, and SE. These findings align with recent evidence showing that leadership-oriented learning improves both leadership readiness and broader professional competence among PTs [38], [39].

Overall, this study extends existing research on teacher leadership by providing empirical support for a scalable, collaboration-based model of LD within ITE. Unlike prior studies focusing on in-service teachers, our study shows that structured leadership preparation at the pre-service stage can systematically enhance multidimensional LCs. The quasi-experimental design allowed us to measure changes in LC and their association with teaching self-efficacy, providing robust evidence of causal effects. Situating the study in the Kazakhstani context also addresses practical challenges of leadership shortages and ongoing educational reforms, demonstrating how pre-service teacher programs can develop future school leaders.

5.1. Implications for teacher education

The findings of this study highlight the pedagogical value of systematically integrating U–S collaboration models into TEPs. Embedding LD within authentic school contexts enables PTs to meaningfully connect theoretical knowledge with professional practice, thereby strengthening reflective capacity, collaborative competence, and readiness to assume leadership-related responsibilities in future professional roles. The results suggest that leadership-oriented learning experiences can be effectively incorporated into ITE without displacing core instructional priorities. Instead, such models appear to complement instructional preparation by fostering broader PC that support instructional decision-making, collaboration, and professional growth. For TEIs, the findings offer practical guidance for curriculum design aimed at preparing adaptable, reflective, and leadership-ready graduates. Specifically, structured partnerships with schools—incorporating mentoring, collaborative projects, and guided reflection—may provide scalable mechanisms for embedding LD across subject-specific programs. Such approaches support the preparation of teachers who are not only instructional practitioners but also active contributors to school improvement and professional communities.

5.2. Limitation

Several limitations of the present study should be acknowledged. First, the quasi-experimental design limits the strength of causal inferences, despite the inclusion of a control group and confirmation of baseline equivalence between groups. Second, the intervention captured only short-term developmental outcomes, leaving questions about the sustainability and long-term trajectory of LD after program completion.

The use of a single-institution sample restricts the generalizability of findings to other institutional and cultural contexts. While validated self-report instruments were employed, reliance on self-reports may not fully capture enacted leadership practices in authentic school settings. Although the TLS and TSES showed acceptable reliability, confirmatory factor analysis was not conducted after adaptation. This limits the ability to fully establish the construct validity of the instruments for PTs. Future research should address these limitations by using longitudinal designs, incorporating multi-institutional and cross-contextual samples, and integrating observational or performance-based measures of leadership practice. Such approaches would strengthen the evidence base for U–S collaboration models and provide deeper insight into how LCs develop and are enacted over time in diverse educational contexts.

6. CONCLUSION

This study examined the impact of an innovative U–S collaboration model on the LD of PTs in TEPs. Participation in the structured, practice-oriented model significantly improved key LCs and supported teaching self-efficacy. LD was fostered through experiential learning combining theoretical instruction, school-based mentoring, collaborative projects, and structured reflection. No subject-specific differences were observed, suggesting LCs can develop in a discipline-general manner. These findings highlight the potential of U–S collaboration models as scalable approaches across TEPs. Future research should examine long-term outcomes, include multiple institutional contexts, and use observational measures to capture enacted leadership practices.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
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R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The corresponding author may provide study data upon reasonable request.

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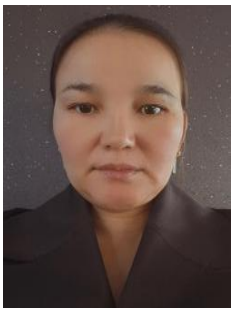

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