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AI-Enhanced Teacher Education and EFL Pre-Service Teachers' Professional Identity: A Quasi-Experimental Study

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ABSTRACT

Professional identity development during pre-service teacher education has emerged as a critical factor influencing teaching effectiveness, career satisfaction, and teacher retention. For English teachers, this process is further shaped by their language learning and teaching context. In countries such as China, where English is taught as a foreign language (EFL), pre-service teachers' professional identity formation involves not only pedagogical development but also the cultivation of language-related self-efficacy and cultural positioning within a non-English-speaking environment. This dual challenge distinguishes EFL pre-service teachers from their counterparts in ESL or native English-speaking contexts, where language proficiency is less of a concern. Concurrently, the rapid integration of artificial intelligence (AI) technologies in education presents both opportunities and challenges for teacher preparation programs worldwide. Although AI is increasingly used to support lesson planning, assessment, and reflection, empirical research examining its impact on EFL pre-service teachers' professional identity remains scarce. Understanding how AI integration interacts with the unique challenges of EFL contexts is essential for designing effective and context-sensitive teacher education programs. This study employs a single-group quasi-experimental design to explore associations between AI-enhanced teacher education and professional identity development, acknowledging that such exploratory research provides preliminary evidence necessary for informing future controlled experimental studies.

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Highlights:

- This study examines the impact of an AI-enhanced teacher education program on EFL pre-service teachers' professional identity in China.
- Findings reveal significant improvements in competence-related dimensions, especially self-efficacy.
- Results suggest that AI tools can act as scaffolds that strengthen pre-service teachers' professional identity in authentic teaching contexts.
- The study highlights both the potential and limitations of AI integration, underscoring the need for more rigorous controlled research.

Keywords: Artificial Intelligence; EFL Teacher Education; Professional Identity; Pre-Service Teachers; Quasi-Experimental Study

1. Introduction

Professional identity development during pre-service teacher education has emerged as a critical factor influencing teaching effectiveness, career satisfaction, and teacher retention^[1]. For English teachers, this process is particularly shaped by their language learning and teaching environment. In countries such as China, where English is taught as a foreign language (EFL), pre-service teachers' professional identity formation involves not only pedagogical skill development but also the cultivation of language-related self-efficacy and cultural positioning within a non-English-speaking context. This dual challenge distinguishes EFL pre-service teachers from their counterparts in ESL or native English-speaking settings, where language proficiency is less problematic^[2].

At the same time, the rapid integration of artificial intelligence (AI) technologies in education presents both opportunities and challenges for teacher preparation programs worldwide. AI tools are increasingly applied to support lesson planning, classroom observation, assessment, and reflective practice. While these applications demonstrate potential for enhancing teaching efficiency, empirical research examining their influence on EFL pre-service teachers' professional identity remains scarce. Most existing studies focus either on the technical performance of AI tools or their impact on student learning outcomes, rather than on how such tools may shape teachers' evolving professional self-conceptions^[3].

Professional identity encompasses teachers' sense of capability, beliefs, values, career commitment, and aspirations^[4]. For pre-service teachers, identity formation is particularly consequential, as it establishes foundational professional orientations that persist throughout their careers^[5]. The introduction

of AI tools in teacher education may reshape this process by providing new forms of cognitive scaffolding and altering the nature of pedagogical practice^[6,7]. However, little is known about how these effects manifest in EFL contexts, where self-efficacy and professional confidence are especially salient^[6].

This study addresses this research gap by examining the associations between participation in an AI-enhanced teacher education program and changes in EFL pre-service teachers' professional identity in China. As one of the first empirical investigations in this area, this study adopts an exploratory approach using a single-group quasi-experimental design. While acknowledging the limitations of causal inference inherent in such designs, we contend that exploratory research is essential for establishing proof-of-concept, estimating effect sizes, and identifying potential mechanisms before investing in more resource-intensive randomized controlled trials. Specifically, the study investigates whether overall professional identity and its core dimensions (self-efficacy, professional beliefs, career commitment, and future aspirations) improve following program participation. By focusing on an EFL teacher education context, this research contributes both theoretically and practically to understanding how AI integration intersects with professional identity development in pre-service teacher training.

2. Literature Review

2.1. Theoretical Perspectives on Teacher Professional Identity

Teacher professional identity (TPI) is widely understood as a dynamic and socially constructed phenomenon,

continuously negotiated through interactions with cultural, institutional, and interpersonal contexts^[1]. Grounded in sociocultural theory, identity is conceptualized not as an individual attribute but as a socially mediated process shaped by participation in meaningful practices. Vygotsky emphasized that learning and development are mediated by cultural tools and social interaction, highlighting the importance of context in shaping cognition and identity^[8]. Extending this view, Lave and Wenger proposed the notion of *legitimate peripheral participation*, through which newcomers gradually acquire competence and identity by engaging in communities of practice^[9]. Wenger further argued that identity formation occurs through participation, negotiation of meaning, and reification within these communities^[10].

Within teacher education, this sociocultural lens positions professional identity as something pre-service teachers construct by engaging with peers, mentors, and pedagogical innovations. Such a perspective underscores that identity is both individual and collective, shaped by self-perceptions and beliefs while also influenced by institutional expectations and cultural discourses^[2].

To operationalize this construct in the present study, four interrelated dimensions of TPI are emphasized: (1) Self-efficacy refers to teachers' beliefs in their ability to accomplish teaching tasks effectively. High self-efficacy supports persistence, innovation, and resilience, making constituting a critical element of professional identity^[11,12]. (2) Professional beliefs refer to teachers' assumptions about teaching, learning, and language, which fundamentally shape classroom practices and professional development. Beliefs form a foundation of identity because they influence how teachers interpret and enact their roles^[13]. (3) Career commitment concerns how teachers view the teaching profession in terms of value, stability, and personal meaning. Positive perceptions foster motivation and professional commitment, whereas negative views can hinder identity development^[14]. (4) Future aspirations capture teachers' long-term goals, aspirations, and envisioned career trajectories. A clear and positive future perspective can provide direction and sustainability in identity formation, especially for pre-service teachers preparing for professional entry^[15,16].

By integrating these dimensions within a sociocultural framework, this study conceptualizes teacher professional identity as a multifaceted yet coherent construct, allowing

for a comprehensive analysis of how pre-service teachers in the Chinese EFL context develop and reshape their professional identities in response to educational innovations, such as AI-enhanced teacher training.

2.2. Professional Identity in the Chinese EFL Context

The development of teacher professional identity (TPI) is particularly complex in the Chinese EFL (English as a Foreign Language) context, where pre-service teachers must negotiate their roles not only as future educators but also as non-native English speakers. Previous research indicates that language teachers' identity construction is deeply intertwined with broader sociocultural discourses and institutional contexts^[3,16]. For Chinese pre-service EFL teachers, this means navigating tensions between global discourses of English language teaching and local educational expectations.

First, the institutional context in China strongly shapes pre-service teachers' professional identities. Teacher education programs emphasize examination-oriented practices, while at the same time, there is increasing pressure to adopt communicative and student-centered pedagogies^[17]. Such contradictions often create identity conflicts for pre-service teachers, who must reconcile institutional demands with their own emerging beliefs and practices^[18].

Second, the non-native speaker status of Chinese pre-service teachers has been found to influence their confidence, legitimacy, and self-efficacy as future English teachers. Research indicates that many EFL teachers in China experience an "identity dilemma", balancing the authority of native-speaker norms with their own local strengths and resources^[19,20]. This often impacts their self-efficacy and perceptions of professional value.

Finally, recent innovations in teacher education, such as the integration of technology and AI tools, have added a new dimension to identity formation. Studies highlight that digital technologies can both empower pre-service teachers by offering new pedagogical possibilities and challenge them by disrupting traditional teaching beliefs^[21]. In China, this tension is particularly salient due to the nationwide push for educational digitalization.

Taken together, these factors suggest that Chinese pre-service EFL teachers' professional identity is shaped by a unique combination of institutional pressures, linguistic po-

sitioning, and pedagogical innovations. Recognizing this complexity is crucial for understanding how AI-enhanced teacher education interventions may facilitate identity development in this specific context.

2.3. AI and Teacher Professional Identity

The rapid advancement of Artificial Intelligence (AI) has introduced new opportunities and challenges in the field of teacher education. AI-powered tools, ranging from automated feedback systems to generative language models, are increasingly integrated into English language teaching and teacher training programs^[22,23]. These technologies are not merely technical add-ons but pedagogical mediators that can influence how pre-service teachers perceive their roles, competencies, and future trajectories as professionals.

From a sociocultural perspective, AI can be viewed as a mediational tool that supports teacher learning and identity development through interaction. For instance, intelligent tutoring systems can provide adaptive feedback that allows pre-service teachers to refine their pedagogical decisions^[24]. Similarly, AI-based virtual students and chatbots create opportunities for simulated teaching practice, enabling prospective teachers to experiment with questioning techniques, classroom management, and instructional scaffolding in a low-stakes environment^[25]. These forms of engagement help teachers construct professional identities by situating them in new contexts of practice and reflection.

At the same time, AI integration raises important questions about agency and professional legitimacy. Research has shown that while AI can enhance efficiency and support innovative pedagogy, it may also provoke identity tensions by challenging traditional beliefs about the teacher's role as sole knowledge provider^[26]. For pre-service teachers, navigating the balance between leveraging AI affordances and maintaining a sense of professional authority becomes a critical part of identity construction.

In the Chinese EFL context, where examination-driven traditions and rapid digitalization coexist, the use of AI in teacher education carries particular significance. It not only reshapes pre-service teachers' self-efficacy, professional beliefs, and career commitment, but also influences their future aspirations as English teachers in a technology-rich environment. Consequently, examining how AI-enhanced teacher education affects professional identity development is timely

and essential, especially for understanding the preparation of a new generation of language teachers.

2.4. Literature Review Summary

The literature reviewed above highlights three key insights. First, teacher professional identity (TPI) is best understood as a dynamic, socially constructed, and multidimensional phenomenon. Drawing on sociocultural and constructivist perspectives, identity development is shaped by teachers' participation in communities of practice, interaction with learners and peers, and personal reflection. Within this framework, the four dimensions of self-efficacy, professional beliefs, career commitment, and future aspirations provide a comprehensive lens to operationalize TPI in empirical studies^[1].

Second, research in the Chinese EFL context has emphasized the unique challenges pre-service teachers face, including exam-driven educational traditions, high social expectations, and increasing pressure to integrate technology into pedagogy. These contextual factors not only shape how professional identity is constructed but also highlight the need for teacher education programs that support identity development in culturally and institutionally specific ways^[27].

Third, the emergence of AI in education has created new opportunities for teacher training. AI tools have been shown to enhance pre-service teachers' reflection, adaptive teaching strategies, and pedagogical decision-making. However, research also indicates that AI integration can lead to identity tensions, as teachers negotiate their professional authority and redefine their roles in technology-rich environments. Despite these developments, few empirical studies have systematically examined how AI-enhanced teacher education impacts pre-service teachers' professional identity, particularly in the Chinese EFL context^[24].

Collectively, these gaps justify an exploratory approach that can provide preliminary evidence about the feasibility and potential effects of AI integration before proceeding to more rigorous experimental validation. By situating AI-enhanced training within a sociocultural framework and applying the four dimensions of TPI, this study seeks to provide new empirical evidence on how digital innovations shape the professional identity formation of Chinese EFL pre-service teachers.

3. Methodology

3.1. Research Design & Participants

This study adopted a single-group quasi-experimental pre-test and post-test design to explore associations between AI-enhanced teacher education and EFL pre-service teachers' professional identity development in China. While recognizing the limitations of causal inference inherent in single-group designs, this approach was selected for several reasons: (1) random assignment was not feasible within the authentic classroom context, (2) this study represents one of the first empirical investigations of AI's impact on teacher professional identity, making exploratory research appropriate, and (3) ethical considerations regarding withholding potentially beneficial training from a control group. The findings should therefore be interpreted as correlational evidence that requires validation through controlled experimental studies, rather than as definitive causal conclusions. The pre-post design was chosen because it provides a practical and effective way to capture changes in participants' professional identity within an authentic classroom setting, having been widely recognized as suitable for evaluating pedagogical interventions in higher education^[28].

The study was conducted at a Normal University (NNU), a provincial teacher education institution located in central China. NNU has a long history of preparing English teachers for primary and secondary schools in the region. Each year, hundreds of English-major undergraduates graduate from NNU and become frontline teachers in local schools, rendering it a representative site for exploring how teacher education in China fosters professional identity among future teachers. The participants were third-year undergraduates majoring in English education. This year level was intentionally chosen for the following reasons: First, by the third year, students have completed most foundation courses in English linguistics, literature, and pedagogy, providing them with the necessary academic background for engaging in

teaching-skill training; second, they are about to enter educational internships and teaching practicum in the following semester. This transitional stage is considered critical for identity formation, as students begin to envision themselves as future teachers^[1]; finally, compared with freshmen and sophomores, third-year students have stronger motivation to connect coursework with their career prospects, making them a particularly suitable group for an intervention focusing on professional identity.

A total of 197 students were enrolled in the compulsory English Teaching Methodology course in the spring semester. Ultimately, 190 participants provided complete data and were included in the final analysis. Seven participants were excluded due to incomplete responses ($n = 5$) or non-completion the full intervention program ($n = 2$). Analysis of the excluded participants revealed no significant differences in gender distribution or initial academic standing compared to the retained sample, indicating that the potential impact of missing data on the study's findings is minimal. The sample consisted of 171 female (90.0%) and 19 male (10.0%) participants. This gender distribution is consistent with the demographics of English teacher education programs in China, reflecting the female-dominated nature of the field. Their ages ranged from 20 to 22 years. All participants had maintained satisfactory academic progress, meeting the requirements for continued enrollment in the course.

Prior to the intervention, a comprehensive baseline survey was conducted to capture participants' technological background and AI-related experiences (see **Table 1**). Results indicated that 94.4% of participants had prior experience with AI tools, with moderate levels of AI knowledge and usage frequency. While most participants were familiar with general applications such as translation software and grammar checkers, very few had systematically applied AI in educational contexts. These baseline characteristics were later used to explore potential moderating factors in professional identity development.

Table 1. Participant Baseline Characteristics (N = 190).

Characteristic	n (%) or M (SD)
Demographics	
Female gender	171 (90.0%)
Male gender	19 (10.0%)
Age range	20-22 years

Table 1. *Cont.*

Characteristic	n (%) or M (SD)
Technology Background	
Prior AI tool experience	179 (94.4%)
AI knowledge level (1-5 scale)	3.06 (0.84)
AI usage frequency (1-5 scale)	2.63 (0.91)
Technology acceptance score (1-5 scale)	2.85 (0.72)
Educational Background	
Completed education technology courses	123 (64.5%)
Prior teaching practicum experience	37 (19.3%)
Academic GPA (4.0 scale)	3.58 (0.42)
AI Tool Familiarity	
Translation tools (e.g., DeepL)	168 (88.4%)
Grammar checkers	142 (74.7%)
Educational AI applications	23 (12.1%)
Lesson planning AI support	8 (4.2%)

3.2. Research Procedure, Intervention & Data Collection

A single-group design was employed for several reasons. First, the study was exploratory, aiming to investigate the potential of AI-supported teacher education in fostering professional identity within an intact cohort of pre-service teachers. Second, as the English Teaching Methodology course is a compulsory, cohort-based class, and institutional as well as curricular constraints made it infeasible to divide students into separate experimental and control groups. Splitting the cohort would have disrupted course integrity and created inequities in access to training, given that all students were expected to receive the same pedagogical opportunities. Third, the relatively small sample size within a single intact class limited the feasibility of meaningful subgroup comparisons. Given these pedagogical and ethical considerations, the single-group design was deemed both fairness

and feasibility, while still allowing for meaningful pre- and post-test comparisons.

To ensure implementation fidelity, several measures were implemented: attendance was tracked throughout the intervention (mean attendance rate: 97.9%), AI tool usage was documented through participant self-reports and platform analytics where applicable, and technical support was provided to address any barriers to participation. A total of 18 technical support incidents were recorded and resolved, affecting 9.5% of participants.

The overall procedure and integration of AI tools are summarized in **Figure 1**.

The figure illustrates the sequential structure of the research procedure, including five main phases. The timeline highlights the integration points of AI tools throughout the program, showing how they supported lesson planning, questioning techniques, observation, reflection, and classroom practice in a progressive and structured manner.

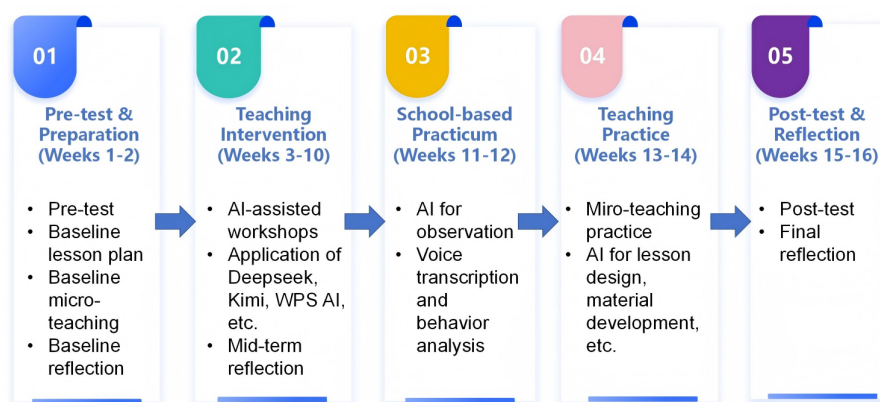


Figure 1. The research procedure and AI intervention timeline.

Weeks 1–2: Preparation, AI Usage Survey, and Pre-test

In the first two weeks, students were introduced to the overall course framework and completed a short survey about their prior experiences with AI tools in education (Appendix A). A professional identity pre-test questionnaire (Appendix B) was administered, followed by two baseline tasks: (a) the submission of an independent lesson plan, and (b) a three-minute micro-teaching video. These activities provided initial measures of pedagogical competence and identity-related perceptions.

Weeks 3–10: Teaching Intervention

During the next eight weeks, systematic training was provided, focusing on lesson planning, instructional questioning, and classroom management. Each week, a 90-minute intensive workshop was conducted with an emphasis on AI-assisted lesson planning and instructional optimization. Workshops included explicit training on AI prompt design for educational contexts, demonstrating participants how to query AI tools effectively for lesson content, teaching strategies, and feedback suggestions. Hands-on practice with tools such as DeepSeek, Kimi, and WPS AI formed the core of this stage, enabling participants to refine learning objectives, adjust instructional steps, and experiment with questioning techniques. This practical emphasis was designed to translate theoretical knowledge into classroom-ready skills, consistent with practice-based professional development models^[29–31]. The workshops also drew on research on optimizing human-AI interaction^[32], highlighting both the potential and challenges of using AI in education. In addition, participants were required to complete a mid-term reflection report, which provided qualitative data for subsequent analysis and offered insight into their evolving professional identity.

Weeks 11–12: School-based Practicum (Observation)

Participants engaged in a two-week school-based practicum, which mainly consisted of classroom observation and limited trial teaching. They were encouraged to use AI tools to adapt lesson plans and anticipate classroom challenges. Participants were tasked with utilizing AI tools (e.g., voice transcription and behavior analysis) to systematically document and analyze classroom instruction. This method is grounded in the principles of data-driven feedback^[33,34] offering objective grounds for reflection.

By capturing real-time interactions and generating detailed reports, AI-enhanced observation tools helped identify patterns in teaching practices and student engagement. These insights enable educators to align instructional strategies with evidence-based best practices, fostering continuous improvement and professional growth^[35,36].

Weeks 13–14: Teaching Practice

Participants were required to independently apply AI tools in lesson planning and material development, such as providing immediate feedback or assisting with classroom management. This phase required participants to integrate AI into their daily teaching routines more actively, demonstrating how technology could support the resolution of practical problems such as adjusting content difficulty, monitoring student participation, and refining assessment methods^[37,38].

Weeks 15–16: Post-test and Reflection

In the final two weeks, participants completed the post-test questionnaire, submitted a revised lesson plan, and delivered a five-minute micro-teaching video. Course review sessions and reflective activities were also carried out to consolidate learning. Although reflections were not included in the main quantitative analysis, they provided additional qualitative data that enriched the overall interpretation of results.

To better understand the intervention's impact, additional data were collected on participants' engagement with AI tools. Self-report data indicated that participants created an average of 2.4 AI-assisted lesson plans per week during the intensive training phase (weeks 3-10), and 87.4% of participants actively used the reflection tools during the practicum observation weeks. These engagement metrics were later used to explore dose-response relationships with professional identity outcomes.

The professional identity questionnaires, administered at the pre-test and post-test stages, served as the main source of quantitative data. Along with task submissions and reflective records, these data offered a comprehensive view of how AI-supported teacher training influenced both individual trajectories and group-level changes in professional identity.

3.3. Research Instrument

Professional identity was assessed using a 20-item Teacher Professional Identity Scale (Appendix A), an in-

strument adapted from the English Teacher Identity Measure (ETIM). The original ETIM was a 19-item scale validated for in-service English teachers in a Chinese EFL context^[29]. Developed following DeVellis's scale development guidelines^[30], the instrument was validated through exploratory factor analysis (N = 103) and confirmatory composite analysis (N = 331) with Chinese university EFL teachers. The ETIM comprises four dimensions: self-efficacy (9 items), professional beliefs (4 items), career commitment (3 items), and future aspirations (3 items). The scale demonstrated good psychometric properties with Cronbach's alpha values ranging from 0.798 to 0.953 across dimensions. To ensure the instrument's suitability and cultural appropriateness for pre-service teachers, we followed a rigorous adaptation process. Items were rephrased to reflect the perspectives of pre-service rather than in-service teachers. For instance, an item such as "I am an excellent teacher" was adapted to "I believe I will be an excellent teacher," to align with the developmental stage of pre-service teachers. Three educational researchers reviewed the adapted items for content validity, ensuring that all items effectively measured the intended constructs. A 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree) was used to capture the degree of participants' agreement with each statement.

An Exploratory Factor Analysis (EFA) was conducted on the adapted 20-item scale to validate its internal structure. The Kaiser-Meyer-Olkin (KMO) value was 0.89, and Bartlett's test of sphericity was statistically significant ($p < 0.001$), indicating the suitability of the data for factor analysis. The EFA results yielded an initial five-factor solution that explained 68.2% of the total variance. However, the fifth factor comprised only a small number of cross-loading items and was not theoretically interpretable. Therefore, based on theoretical justification and content validity, the scale was retained as a four-dimensional structure (self-efficacy, professional beliefs, career commitment, and future aspirations). Factor loadings ranged from 0.62 to 0.87, all exceeding the minimum acceptable standard of 0.40, indicating strong associations between items and their respective dimensions. Internal consistency reliability (Cronbach's α) for each dimension ranged from 0.77 to 0.89, all above the conventional threshold of 0.70, suggesting high reliability.

Based on the content analysis of the 20 items and theoretical considerations, the items were categorized into four

dimensions:

Self-Efficacy (8 items): Items 2-9 ($\alpha = 0.85$ pre, 0.88 post)

Professional Beliefs (4 items): Items 10-13 ($\alpha = 0.79$ pre, 0.82 post)

Career Commitment (5 items): Items 14-18 ($\alpha = 0.81$ pre, 0.84 post)

Future Aspirations (3 items): Items 19-21 ($\alpha = 0.77$ pre, 0.80 post)

3.4. Data Analysis

Data analysis was systematically conducted using IBM SPSS Statistics 30.0 and proceed a six-step process to ensure the rigor and reliability of the findings^[39,40]. Prior to formal analysis, all data were meticulously screened for missing values and outliers. A series of tests were then performed to evaluate key statistical assumptions, including normality, homogeneity of variance, and independence, to ensure the validity of subsequent parametric tests. Cronbach's α coefficient was used to assess the internal consistency reliability of the adapted professional identity scale and its four dimensions (self-efficacy, professional beliefs, career commitment, and future aspirations), thereby confirming the instrument's robustness in this study. To examine the potential impact of the intervention, paired-sample t-tests were conducted to compare pre-test and post-test data. This method is particularly suitable for assessing changes within the same group of participants over time, as it effectively controls for the influence of individual differences. Beyond statistical significance, we calculated the effect size for each dimension using Cohen's d , specifically by employing the pooled standard deviation. Effect size provides an objective measure of the magnitude of the intervention's effect, complementing the information provided by the p-value. Given that multiple t-tests were performed across the various dimensions of professional identity, we applied a conservative Bonferroni correction (by setting the significance level α to 0.01) to control for the cumulative probability of a Type I error. This helps ensure that the significant differences we observed were not due to chance. Finally, we calculated 95% confidence intervals for all effect sizes. This provides a range for the precision of our effect size estimates, thereby enhancing the interpretability and generalizability of the results.

Additional exploratory analyses were conducted to bet-

ter understand the intervention's mechanisms and individual variation in outcomes. Pearson correlations were computed between baseline characteristics (AI knowledge, usage frequency, technology course experience) and change scores to identify potential predictors of improvement. To explore dose-response relationships, we analyzed the correlation between self-reported AI tool engagement during the intervention and professional identity changes. Individual change patterns were examined using both statistical (> 0.5 SD change) and practical significance thresholds to understand the distribution of treatment effects across participants.

4. Results & Findings

Complete data were available for 190 of the 197 initial participants, yielding a high retention rate of 96.4%. To assess potential bias due to missing data, we compared the

demographic characteristics of the seven excluded participants with those of the retained sample. These statistical findings suggest that the data were missing at random and had no substantial impact on the representativeness of the sample. Therefore, we can reasonably conclude that the final sample used for analysis represents a valid representation of the initial participant pool, and the missing data were unlikely to compromise the validity of our findings.

4.1. Effects of AI-Integrated Training on Teacher Identity Dimensions

Table 2 presents the descriptive statistics and changes in teacher professional identity dimensions. A paired-samples t-test was conducted to examine changes in overall teacher professional identity following the AI-enhanced teacher education program.

Table 2. Descriptive Statistics and Changes for All Measures.

Dimension	Pre-Test M(SD)	Post-Test M(SD)	Change M(SD)	95% CI of Change	Cohen's d [95% CI]	t (189)	p
Total Scale	80.27 (7.51)	88.04 (9.34)	7.77 (12.00)	[6.05, 9.49]	0.918 [0.754, 1.082]	8.943	0.001
Self-Efficacy	3.20 (0.54)	3.86 (0.61)	0.66 (0.79)	[0.55, 0.77]	0.831 [0.680, 0.982]	11.46	0.001
Professional Beliefs	4.68 (0.46)	4.76 (0.50)	0.08 (0.63)	[-0.01, 0.17]	0.127 [-0.016, 0.270]	1.75	0.085
Career Commitment	4.43 (0.53)	4.68 (0.53)	0.25 (0.74)	[0.14, 0.36]	0.338 [0.177, 0.499]	4.66	< 0.001
Future Aspirations	4.13 (0.60)	4.48 (0.56)	0.35 (0.79)	[0.24, 0.46]	0.443 [0.280, 0.606]	6.11	< 0.001

Note: N = 190. Cohen's d values: 0.2 = small effect, 0.5 = medium effect, 0.8 = large effect.

Results demonstrated a statistically significant increase from pre-test (M = 80.27, SD = 7.51) to post-test (M = 88.04, SD = 9.34), with a mean difference of 7.77 points (SD = 12.00), $t(189) = 8.943$, $p < 0.001$, 95% CI [6.05, 9.49]. The effect size was large (Cohen's $d = 0.918$, 95% CI [0.754, 1.082]), suggesting that the intervention produced a meaningful and substantial improvement in participants' teacher professional identity development. To understand the mechanisms underlying the overall improvement, we conducted separate paired-samples t-tests for each dimension of teacher identity. The pattern of results revealed theoretically meaningful differential effects across the four dimensions.

Self-efficacy demonstrated the strongest response to the intervention, showing a significant increase of 0.66 points

(SD = 0.79), $t(189) = 11.46$, $p < 0.001$, 95% CI [0.55, 0.77], with a large effect size of $d = 0.831$, 95% CI [0.680, 0.982]. This dimension exhibited both the highest effect size and strongest statistical significance among all measured constructs. The magnitude of this effect is consistent with self-efficacy theory^[11], which posits that mastery experiences—such as successfully implementing AI tools in teaching contexts—serve as the most powerful source of efficacy beliefs. The large effect size suggests that the hands-on AI training provided participants with concrete evidence of their enhanced capabilities in both pedagogical skills and language proficiency.

Future aspirations showed a significant increase of 0.35 points (SD = 0.79), $t(189) = 6.11$, $p < 0.001$, 95% CI [0.24,

0.46], with a medium effect size of $d = 0.443$, 95% CI [0.280, 0.606]. This finding indicates that exposure to AI technologies expanded participants' conceptualization of their future professional roles and possibilities. The medium effect size is theoretically appropriate, as career aspirations typically require sustained experiences and reflection to undergo substantial modification. The significant improvement suggests that the AI integration effectively broadened participants' professional horizons without artificially inflating expectations.

Career commitment demonstrated a significant increase of 0.25 points ($SD = 0.74$), $t(189) = 4.66$, $p < 0.001$, 95% CI [0.14, 0.36], with a small-to-medium effect size of $d = 0.338$, 95% CI [0.177, 0.499]. This improvement indicates that the AI training strengthened participants' intention to remain in the teaching profession. The smaller but significant effect size is consistent with research indicating that career commitment represents a relatively stable professional attitude that requires sustained positive experiences to modify meaningfully^[35].

Professional beliefs showed a non-significant change of 0.08 points ($SD = 0.63$), $t(189) = 1.75$, $p = 0.085$, 95% CI [-0.01, 0.17], with a negligible effect size of $d = 0.127$, 95% CI [-0.016, 0.270]. The 95% confidence interval includes zero, confirming the absence of a meaningful treatment effect. This null finding is theoretically consistent and methodologically important. Professional beliefs represent deeply held philosophical orientations about teaching that typically develop over extended periods through diverse experiences^[13]. The stability of this dimension provides convergent validity for our measurement approach and suggests that the intervention targeted skill-based rather than belief-based aspects of professional development.

The observed effect sizes follow a theoretically coherent pattern: largest effects for skill-based competencies (Self-efficacy, $d = 0.831$), moderate effects for future-oriented cognitions (Future aspirations, $d = 0.443$), smaller effects for commitment attitudes (Career commitment, $d = 0.338$), and null effects for core beliefs (Professional beliefs, $d = 0.127$). This hierarchical pattern aligns with the Kirkpatrick model of training evaluation, where immediate skill acquisition and confidence gains (Level 2: Learning) precede broader attitudinal and behavioral changes (Level 3: Behavior). The large effect size for Self-efficacy ($d > 0.8$) meets Cohen's

criteria for practical significance and exceeds typical effect sizes reported in educational technology interventions (mean $d = 0.35$)^[36].

4.2. Individual Change Patterns and Moderating Factors

According to the data, 78.4% of participants showed positive changes in overall teacher professional identity (> 0.25 SD improvement), 12.1% showed minimal change (± 0.25 SD), while 9.5% showed negative changes (> 0.25 SD decline). When applying a more stringent criterion of meaningful change (> 0.5 SD improvement), 64.2% of participants still demonstrated substantial improvement in overall professional identity, suggesting that the benefits were both widespread and meaningful rather than marginal.

Beyond the significant mean changes, this study also examined the individual distribution of change scores for pre-service teachers' professional identity. The results indicate that a strong majority of participants experienced a positive shift. Specifically 78.4% of participants showed positive changes in their total professional identity, with an improvement of more than 0.25 standard deviations. This indicates that the AI integration program had a substantial positive impact on the majority of pre-service teachers. 12.1% of participants showed minimal change, within a range of ± 0.25 standard deviations, suggesting their professional identity remained relatively stable. A smaller group of 9.5% of participants experienced a negative change, with a decline greater than 0.25 standard deviations. While a minority, this finding suggests that some individuals may not have benefited from the program and may have even experienced a negative professional identity shift. A few short reflections illustrate these outcomes. One participant shared: "AI tools helped me design lesson plans more efficiently, which made me feel more confident as a future teacher." Another participant remarked: "I sometimes worried that relying too much on AI would weaken my own creativity in lesson design." These brief excerpts help contextualize the positive and negative trajectories observed in the quantitative data.

Among the four sub-dimensions, the largest improvements were observed in the competence-related dimensions, namely self-efficacy. This aligns with our expectations, as these dimensions directly reflect the tangible skills and practical experience gained with AI assistance, which in turn

appear to have enhanced their confidence. In contrast, professional beliefs were the most stable dimension, with 67% of participants showing only minimal change. This finding is consistent with existing research indicating that an individual's core belief system is relatively stable and typically requires a longer internalization process or deeper reflective experiences to change, beyond mere instrumental application.

4.3. Exploratory Analysis of Baseline Predictors and Engagement Effects

To better understand which participants benefited most from the AI-enhanced intervention, we examined relationships between baseline characteristics and teacher professional identity change scores. Participants' baseline AI knowledge level showed a moderate positive correlation with overall identity change ($r = 0.31, p < 0.001$), suggesting that those with greater initial familiarity with AI technologies were better positioned to benefit from the training. Similarly, prior experience with education technology courses was associated with larger improvements ($r = 0.24, p < 0.01$), indicating that some foundational technological understanding may facilitate AI integration in teacher education contexts.

Examination of engagement during the intervention revealed meaningful dose-response relationships. Participants who reported higher levels of AI tool usage during the intensive training weeks showed stronger improvements in self-efficacy ($r = 0.29, p < 0.001$) and future aspirations ($r = 0.22, p < 0.01$). This pattern supports the view that active engagement with AI tools, rather than passive exposure, was the main driver of professional identity development. Qualitative reflections also reinforce this trend. For example, a participant with high prior AI experience explained: "I already used AI tools before this course, but the workshops helped me apply them more effectively to lesson planning and questioning. I feel I can now design lessons with much more clarity."

Conversely, the 9.5% of participants who showed negative changes were characterized by significantly lower baseline technology acceptance ($M = 2.1$ vs. 3.2 for positive change group, $p < 0.001$) and reported more technical difficulties during the intervention. Qualitative feedback illustrated these challenges. One participant noted: "I often felt frustrated because I did not know how to use the AI tools

properly, and this made me anxious rather than confident." Another participant remarked: "I prefer traditional methods, because sometimes AI felt too complicated and disconnected from real classroom needs." These reflections highlight the reasons behind limited or negative changes.

These mixed-method findings suggest that both baseline readiness and active engagement strongly influenced the extent to which pre-service teachers benefited from AI integration. The qualitative excerpts provide concrete examples that complement the statistical patterns, illustrating how prior experience, engagement, and attitudes toward technology shaped individual outcomes.

4.4. Inter-Dimensional Relationships

To further validate the construct coherence and examine the relationships among the dimensions of teacher professional identity, a Pearson's product-moment correlation analysis was conducted on post-test data. The results revealed meaningful interconnections among all four dimensions, with correlations ranging from moderate to strong in magnitude.

The strongest relationship emerged between self-efficacy and future aspirations ($r = 0.67, p < 0.001$), reflecting the mutually reinforcing nature of confidence in teaching capabilities and long-term career goals. For English language teachers, confidence in teaching abilities and language proficiency represent interconnected components of their core professional competence. Self-efficacy also demonstrated a moderately strong association with career commitment ($r = 0.54, p < 0.001$), suggesting that greater confidence in one's teaching capabilities corresponds with stronger motivation to remain in the profession.

The motivational dimensions showed similarly robust interconnections. Career commitment and professional beliefs were moderately correlated ($r = 0.49, p < 0.001$), indicating that stronger foundational beliefs about the teaching profession align with greater long-term commitment to the field. Additionally, future aspirations and career commitment showed a significant positive relationship ($r = 0.43, p < 0.001$), demonstrating that optimistic career expectations are closely linked to psychological attachment and sustained investment in the profession.

The pattern of positive and statistically significant correlations across all dimensional pairs provides strong em-

pirical support for conceptualizing professional identity as a multidimensional yet coherent construct. These findings validate the internal consistency and structural integrity of the measurement framework while highlighting the interconnected nature of self-efficacy, professional beliefs, career commitment, and future aspirations in shaping pre-service teachers' professional identity development.

4.5. Reliability Analysis

Table 3 presents the internal consistency reliability across all dimensions and time points. The results indicate that Cronbach's α values were adequate to good, supporting the reliability of the measurement across both pre-test and post-test phases.

Table 3. Internal Consistency Reliability.

Dimension	Pre-Test α	Post-Test α	Items
Teaching Efficacy	0.85	0.88	8
Professional Beliefs	0.79	0.82	4
Career Commitment	0.81	0.84	5
Future Aspirations	0.77	0.80	3
Total Scale	0.86	0.89	20

At pre-test, the α values for all dimensions ranged from 0.77 to 0.86, meeting conventional psychometric standards for reliability^[34]. At post-test, the reliability coefficients for all dimensions showed a slight increase, ranging from 0.80 to 0.89. The Total Scale reliability increased from $\alpha = 0.86$ at pre-test to $\alpha = 0.89$ at post-test, reflecting very strong internal consistency for the entire instrument. The self-efficacy dimension showed a high reliability, with an increase from $\alpha = 0.85$ to $\alpha = 0.88$. The career commitment dimension also demonstrated stable reliability, increasing from $\alpha = 0.81$ to $\alpha = 0.84$. The professional beliefs and future aspirations dimensions both maintained adequate to good reliability levels, with minor increases at post-test. The general increase in reliability coefficients at post-test may suggest

that participants' understanding of the measured constructs deepened during the intervention, or that the intervention itself enhanced the internal consistency of these constructs in the participants' minds. Collectively, these results provide strong evidence that the scale used in this study possessed robust internal consistency at both time points, making its measurements reliable and stable.

4.6. Exploratory Correlation Analysis

To further understand the relationships between baseline characteristics, intervention engagement, and teacher professional identity outcomes, correlation analyses were conducted. The results are presented in **Table 4**.

Table 4. Correlations Between Baseline Characteristics and Professional Identity Changes.

Variable						
1. Baseline AI Knowledge	—					
2. AI Usage Frequency	0.42**	—				
3. Technology Course Experience	0.28**	0.19*	—			
4. Total Identity Change	0.31**	0.18*	0.24**	—		
5. Self-Efficacy Change	0.35**	0.22**	0.29**	0.87**	—	
6. Future Aspirations Change	0.21**	0.16*	0.18*	0.72**	0.58**	—

Note: N = 190. * $p < 0.05$, ** $p < 0.01$.

The correlation analysis revealed several meaningful patterns. Baseline AI knowledge showed the strongest relationship with teacher professional identity improvement ($r = 0.31$, $p < 0.01$), suggesting that participants with greater initial familiarity with AI technologies were more likely to benefit from the intervention. Educational technology course

experience was also significantly associated with identity change ($r = 0.24$, $p < 0.01$), indicating that some foundational technological understanding facilitated AI integration. Among the teacher professional identity dimensions, self-efficacy change showed the strongest correlations with baseline predictors, particularly AI knowledge ($r = 0.35$, $p < 0.01$)

and educational technology course experience ($r = 0.29, p < 0.01$). This pattern supports the theoretical proposition that self-efficacy, as a competence-related aspect of identity, is most responsive to skill-based interventions.

5. Discussion

5.1. Principal Findings and Interpretive Cautions

An important finding from our baseline survey reveals that while 94.4% of participants had prior AI tool experience, this familiarity was predominantly limited to basic consumer-level applications such as translation software (88.4%) and grammar checkers (74.7%). Only 12.1% had used AI in educational contexts, and merely 4.2% had applied AI tools for lesson planning or teaching design. This suggests a significant gap between general AI awareness and pedagogical AI application. Our intervention targeted this specific gap by providing systematic, professionally-guided training in AI-enhanced teaching practices rather than basic tool familiarization. The observed improvements in teacher professional identity may therefore reflect participants' transition from passive AI consumers to active pedagogical innovators—a qualitatively different level of engagement that requires structured professional development.

This study provides preliminary evidence suggesting that participation in a comprehensive AI-enhanced teacher education program is associated with improvements in specific aspects of pre-service teachers' professional identity. The large overall effect size ($d = 0.92$) and the finding that 78.4% of participants experienced positive changes suggest meaningful improvement occurred during the intervention period. The dose-response relationships between AI tool engagement and identity improvements provide additional support for the potential role of AI in facilitating professional development. This finding supports our central hypothesis that AI, as a new cultural tool, can facilitate the development of professional identity by reshaping pedagogical practices.

However, interpreting these findings requires significant caution due to the study's exploratory nature and methodological limitations^[41]. A critical limitation of this study is its single-group design, which prevents us from drawing definitive conclusions about AI-specific effects.

The observed changes may result from multiple concurrent factors, including traditional practicum experiences, general coursework, natural developmental processes, and potential selection effects among participants who completed the full program. The 16-week study period coincided with a critical developmental phase for third-year pre-service teachers, making it difficult to separate intervention effects from natural maturation. While the dose-response relationships between AI usage and identity improvements provide some support for a causal pathway, alternative explanations—such as more motivated participants both using AI tools more frequently and experiencing greater professional growth—cannot be ruled out. Therefore, we cannot directly attribute all observed positive changes to the integration of AI alone, and the findings should be interpreted as correlational evidence requiring validation through controlled experimental studies.

Despite this, the observed pattern of differential effects across dimensions offers valuable insights into the potential mechanisms underlying these associations. For example, the significant changes in competence-related dimensions (e.g., self-efficacy) compared to the stability in core belief dimensions (e.g., professional beliefs) suggest that the impact of AI integration may be tiered. It appears to first improve tangible skills and self-efficacy by providing concrete and perceptible scaffolds—a relatively direct impact. Changes to deeper beliefs and values, however, may require a longer period of time and more profound practical internalization.

Several factors beyond AI integration could account for the observed improvements. The teaching observation and practice components (weeks 11-14) themselves represent powerful professional development experiences that independently promote professional identity development. Research consistently demonstrates that authentic teaching experiences are among the most significant factors in teacher identity formation^[9]. The comprehensive nature of the intervention makes it impossible to disentangle the independent effects of AI training from traditional coursework and authentic teaching experiences. Additionally, participants who completed the full program may represent a self-selected group with higher motivation and commitment, which could contribute to an overestimation of the intervention's effects.

5.2. Theoretical Interpretation Within Limitations

Despite methodological limitations, this study's findings can be interpreted through a sociocultural theory lens, offering initial insights into how AI integration may influence pre-service teachers' professional identity. The largest improvements in self-efficacy align well with sociocultural theory's emphasis on tool-mediated activity. AI tools may have functioned as cultural mediators, providing cognitive and emotional "scaffolds" that expanded participants' Zone of Proximal Development (ZPD). These tools enabled participants to achieve higher levels of performance on authentic teaching tasks; for example, AI-assisted lesson planning helped them generate more sophisticated plans than they could produce alone, while AI-powered language practice boosted confidence in their proficiency. Through this tool-mediated success, participants' professional self-concept was positively reshaped^[9]. However, it is important to acknowledge that traditional tools and experiences, such as mentor guidance and peer collaboration, likely contributed equally to this expansion of the ZPD^[8]. The finding that competence-related dimensions (self-efficacy) showed larger improvements than value-based dimensions (professional beliefs) provides a key insight into the mechanisms of professional identity development. This pattern supports the core sociocultural view that identity development occurs through changing participation in professional practices rather than through direct attitude change^[10]. AI tools, as new forms of practice, first altered how participants, which in turn influenced their perception of who they are. The minimal change in professional beliefs may reflect the relatively stable nature of these deep-seated convictions, or, alternatively, the need for longer exposure periods or different intervention approaches that directly challenge and reconstruct their core pedagogical philosophy, rather than simply providing instrumental support.

5.3. Practical Implications with Appropriate Caveats

The findings of this study provide several practical implications for teacher education programs seeking to integrate AI into training. Importantly, the results indicate that the four dimensions of teacher professional identity—

self-efficacy, professional beliefs, career commitment, and future aspirations—can be meaningfully supported through targeted uses of AI tools.

First, self-efficacy showed the largest gains. Qualitative reflections confirmed that AI support in lesson planning and instructional questioning enhanced participants' confidence. For example, one participant noted that AI-assisted design made lesson preparation "faster and more systematic," which directly reinforced their sense of competence. This aligns with existing evidence that technology-enhanced practice opportunities can significantly boost teachers' confidence in handling instructional tasks.

Second, professional beliefs remained the most stable dimension. Many participants valued AI for practical efficiency but emphasized the need to balance its use with authentic teacher judgment. This indicates that while AI can support instructional processes, identity aspects tied to core beliefs may require longer-term reflective practices, mentorship, and classroom experience to change. Prior studies also highlight that teachers' core professional beliefs are relatively resistant to change in the short term. Thus, AI should be seen as a complement rather than a replacement for deeper professional socialization.

Third, career commitment was positively influenced by the visibility of AI's practical applications in authentic classroom settings. For instance, participants reported that integrating AI into practicum observation and feedback helped them envision themselves as teachers who can competently handle technology-rich classrooms. This suggests that AI integration may not only enhance skills but also strengthen long-term career commitment, echoing findings from earlier research on the relationship between professional competence and career perception.

Finally, future aspirations benefited from active engagement with AI tools. Students who experimented more intensively with AI often expressed greater motivation to explore innovative teaching strategies in their future careers. As one reflection stated: "I see AI as something that will be part of education in the future, and I want to be prepared to use it responsibly." This perspective resonates with the literature on technology acceptance, which notes that hands-on engagement fosters more positive attitudes toward future adoption.

While acknowledging the limitations regarding causal

inference, the findings of this study offer several important practical implications for teacher education program developers and administrators. The high program completion rate (96.4%) and the observed positive associations suggest that integrating AI tools within a comprehensive teacher education program is both feasible and potentially beneficial. This finding provides strong preliminary evidence for educational institutions that may be cautious about incorporating emerging technologies into their curriculum^[37]. The strongest effects were observed in the domain of self-efficacy, while professional beliefs remained largely stable. This finding suggests that AI tools may be particularly valuable for supporting the development of practical, tangible skills and for building confidence among pre-service teachers. Future curriculum designs can strategically leverage AI to provide personalized skill practice and immediate feedback, which directly enhances professional competence^[38]. The results imply that integrating AI tools with traditional experiences, such as classroom observations and practicum, may be more effective than isolated technology training. This comprehensive approach not only provides the tools but also offers pre-service teachers opportunities to use and internalize them within an authentic context, thereby fostering identity development within a community of practice^[10]. However, this implication requires further investigation through controlled studies that can isolate the specific contributions of AI integration as compared to traditional training components.

Overall, the combination of quantitative gains and qualitative insights suggests that AI can effectively support different facets of teacher professional identity when used thoughtfully. However, it also underscores the need for structured guidance to ensure that pre-service teachers develop both technical competence and professional judgment. Teacher education programs should therefore integrate AI not as a stand-alone tool, but as part of a broader pedagogical framework that balances innovation with reflective practice.

5.4. Methodological Reflections and Limitations

This study provides valuable preliminary insights into the role of AI in teacher education, but its findings must be interpreted in light of several key methodological limitations. As an exploratory study using a single-group design, the primary limitation is the inability to establish causal relationships between AI integration and the observed improve-

ments in professional identity. Thus, the results should be considered correlational rather than causal, serving as initial proof-of-concept evidence.

The single-group design constitutes a primary limitation. Without a control group, we cannot definitively attribute the observed improvements in professional identity to AI integration alone, as we cannot rule out the influence of other concurrent factors. Thus, the findings should be understood as correlational rather than causal evidence. Variables such as traditional practicum experiences, ongoing coursework, and natural developmental processes represent potential confounding factors that could have influenced professional identity. Future research should therefore employ more rigorous experimental or quasi-experimental designs, such as Randomized Controlled Trials (RCTs) or designs with control groups, to better isolate the independent effect of AI^[39]. The 16-week study period coincided with the natural professional development trajectory of pre-service teachers. This temporal confounding poses challenges in distinguishing between the effects of the intervention and the natural maturation process. Although no demographic differences were found, participants who completed the full program may represent a self-selected group with higher motivation and commitment, which could lead to an overestimation of the observed effects.

Several methodological considerations warrant attention in interpreting these findings. The professional identity scale, while expertly reviewed, was adapted from an instrument originally validated for in-service teachers, and its psychometric properties in a pre-service context require further empirical validation^[30]. Although our exploratory factor analysis and reliability analyses provided support for the adapted instrument's psychometric properties, confirmatory validation with an independent sample would strengthen confidence in the measurement approach. The reliance on self-report measures introduces potential social desirability bias, as participants may respond in ways they perceive as more favorable rather than reflecting their authentic experiences. Although participant anonymity helped mitigate this concern, complete elimination of such bias remains challenging. Additionally, the two-week interval between intervention completion and post-test measurement, while designed to balance experience consolidation with memory decay, may not adequately capture longer-term developmental effects.

Extended follow-up assessments are therefore recommended to evaluate the sustainability of observed changes^[40].

The study's scope presents several constraints on the broader applicability of findings. Participant recruitment from a single Chinese university limits transferability across different cultural contexts, educational systems, and pedagogical traditions. The mandatory nature of program participation may not accurately reflect voluntary AI adoption scenarios typical in professional practice settings, potentially affecting the ecological validity of results. Furthermore, the focus on specific AI tools constrains generalization to other artificial intelligence applications or models that may function differently or offer distinct capabilities. The concentration on English teacher preparation similarly restricts applicability to other subject areas such as science or mathematics, where discipline-specific factors may influence professional identity development patterns.

5.5. Future Research Directions

The findings of this study provide a valuable foundation for understanding the role of AI in pre-service teacher professional identity development. Based on the identified limitations, future research should be deepened and expanded across several critical dimensions to strengthen both theoretical understanding and practical applications.

The most pressing need involves employing more rigorous experimental designs, particularly Randomized Controlled Trials (RCTs), to isolate the specific effects of AI from other program components. Component analyses that compare AI-only groups, traditional-only groups, and combined intervention groups would help clarify each element's contribution. Wait-list control designs could also provide an ethical and practical comparison while ensuring all participants benefit. Additionally, multi-site implementation across different institutions and cultural contexts would significantly enhance generalizability and external validity, while longitudinal studies with extended follow-up periods could assess the persistence of changes and their impact on actual teaching practice and long-term career outcomes.

Beyond experimental design improvements, future investigations should move beyond single self-report measures toward more comprehensive measurement approaches. This includes employing fully validated, multi-item instruments for all professional identity dimensions specifically validated

for pre-service contexts, and incorporating behavioral indicators such as classroom practice observations, teaching portfolio analyses, and coded teaching behaviors rather than relying solely on self-reported perceptions. Mixed-methods designs combining quantitative findings with in-depth qualitative exploration through interviews, reflective journals, and focus groups would provide richer, more nuanced understanding of the developmental process. Long-term career tracking could reveal whether AI training influences actual career choices and professional trajectories beyond immediate teacher professional identity perceptions.

Given the dose-response relationships observed in this study, future research should also examine optimal levels and patterns of AI exposure to maximize benefits while avoiding potential negative effects of over-reliance on technology. The baseline characteristics that predicted positive outcomes (AI knowledge, technology course experience) suggest that future studies should investigate how to best prepare participants for AI-enhanced training. These directions would not only strengthen the evidence base for AI-enhanced teacher preparation but also inform educational practice and policy with greater precision.

6. Conclusions

This study provides encouraging preliminary evidence for the integration of AI in teacher education. We found that pre-service teachers participating in an AI-enhanced program showed significant gains in professional identity, particularly in key dimensions such as self-efficacy. The large effect sizes ($d = 0.92$ for overall identity, $d = 0.83$ for self-efficacy) and the finding that 78.4% of participants experienced positive changes suggest that meaningful improvements occurred during the intervention period. The dose-response relationships between AI tool usage and identity improvements provide additional support for the potential role of AI in facilitating professional development. Importantly, this study is among the first empirical investigations of AI's impact on the professional identity of Chinese EFL pre-service teachers, which highlights its unique contribution to the emerging field of AI in teacher education. This aligns with the theory of communities of practice^[10], wherein identity formation occurs through evolving participation in professional practices.

Nevertheless, the findings should be interpreted with caution. They represent correlational rather than causal evidence and require further validation through more controlled experimental studies. The comprehensive nature of our intervention, while practically necessary, makes it difficult to separate AI-specific effects from traditional training components. Future studies should therefore employ randomized controlled trials, quasi-experiments with control groups, and longitudinal tracking to better establish causal relationships and explore the mechanisms through which AI integration may influence professional identity development.

The research also sheds light on the practical feasibility and challenges of AI integration. The high completion rate of 96.4% attests to its operability, while participant feedback underscores AI's role in boosting efficiency and confidence. However, implementation challenges must be addressed, such as the need for robust technical and pedagogical support^[41] and the importance of balancing AI assistance with independent judgment. The finding that participants with technical difficulties and lower technology acceptance were more likely to experience negative outcomes highlights the importance of ensuring adequate infrastructure and support systems before implementing AI-enhanced programs.

In conclusion, while limited by its single-group design, this study offers proof-of-concept evidence that warrants further investment in rigorous experimental validation. Longitudinal studies are also needed to determine whether these positive changes translate into sustained teaching practices and long-term career outcomes. By providing effect size estimates and identifying potential mechanisms, this research contributes to the growing body of literature on technology integration in teacher education and lays a foundation for deeper exploration of AI's role in shaping the professional identity of future educators.

Author Contributions

Conceptualization, M.Z.; methodology, M.Z.; software, M.Z.; validation, H.H. and S.H.; formal analysis, M.Z.; investigation, M.Z.; resources, H.H.; data curation, H.H.; writing—original draft preparation, M.Z.; writing—review and editing, H.H. and S.H.; visualization, H.H.; supervision, H.H. and S.H.; project administration, M.Z.; funding acquisi-

tion, M.Z. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Nanyang Normal University (NNU).

This study was conducted in accordance with the ethical standards of the institutional research committee of a comprehensive university in China. Ethical approval was obtained prior to data collection. Written informed consent was obtained from all participants, and their responses were anonymized to ensure confidentiality. Participation was voluntary, and participants retained the right to withdraw from the study at any stage without penalty.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data supporting the findings of this study were collected from pre-service English teachers enrolled in a teacher education program at a normal university in China. Due to institutional regulations and privacy concerns, the dataset is not publicly available. However, de-identified data may be obtained from the corresponding author upon reasonable request and with appropriate institutional permission.

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Conflicts of Interest

The authors declare no conflict of interest.

Appendix A. Survey Questionnaire (AI Tools Application in English Teacher Education)

Dear Student:

To optimize our English teacher education curriculum and explore how AI technology can enhance teaching skills training, we are conducting this research study. Your authentic feedback will directly influence future curriculum design and help the college develop more practical AI training modules to improve core competencies such as lesson planning and classroom management.

Confidentiality Commitment: This questionnaire is completely anonymous. All data will be used solely for academic research purposes and will not be linked to individual grades or evaluations. You may withdraw from the survey at any time without any concerns. Thank you for contributing to the innovation of teacher education!

Section I: Demographic Information

1. What is your gender?
 - ☐ Male.
 - ☐ Female.
2. What is your age group?
 - ☐ 18-20 years old.
 - ☐ 21-23 years old.
 - ☐ 24 years old and above.
3. Have you ever taken courses related to educational technology?
 - ☐ Yes.
 - ☐ No.
4. Do you have experience in primary or secondary English teaching practicum?
 - ☐ Yes.
 - ☐ No.

Section II: AI Tool Familiarity and Usage

5. What is your level of understanding of AI tools?
 - ☐ No understanding at all.
 - ☐ Have heard of them but never used them.
 - ☐ Occasionally use basic functions.

- ☐ Proficiently use multiple functions.
6. How frequently do you use AI tools?
 - ☐ Never used.
 - ☐ Occasionally use.
 - ☐ Use several times per week.
 - ☐ Use almost daily.
7. Which AI tools do you use most frequently?
 - ☐ DeepSeek.
 - ☐ ChatGPT.
 - ☐ Doubao (豆包).
 - ☐ Wenxin Yiyan (文心一言).
 - ☐ Kimi.
 - ☐ iFlytek Spark (讯飞星火).
 - ☐ Others (please specify): _____
8. What are the main scenarios where you use AI tools? [Multiple Choice]
 - ☐ Lesson planning/courseware design and other teaching exercises.
 - ☐ English grammar/writing assignment assistance and revision.
 - ☐ Learning material retrieval.
 - ☐ Basic skills practice (listening, speaking, reading, writing).
 - ☐ Daily entertainment (such as chatting, creative activities).
 - ☐ Others (please specify): _____

Section III: Barriers and Attitudes

9. What are the main factors that hinder your use of AI tools? [Multiple Choice]
 - ☐ Complex operation, high technical barriers.
 - ☐ Network lag/device incompatibility.
 - ☐ Academic integrity and ethical concerns.
 - ☐ Data privacy and security issues.
 - ☐ Unreliable effectiveness.
 - ☐ Lack of guidance from school/teachers.
 - ☐ Others (please specify): _____
10. What is the attitude of teachers in other courses toward AI tools?
 - ☐ Clearly encourage use.
 - ☐ Allow but do not actively mention.
 - ☐ Prohibit use (e.g., consider it cheating).

- Have not mentioned relevant policies.
 - I am not sure.
11. What role or impact do you think AI tools have on the professional development of English teacher education students? [Multiple Choice]
- Gain inspiration, improve lesson preparation efficiency, unleash creativity.
 - Assist in student situation analysis, achieve precision teaching.
 - Alleviate classroom management pressure.
 - May weaken basic teaching abilities.
 - Intensify professional competition pressure.
 - No clear impact yet.
12. Are you concerned that AI technology will replace the teaching profession in the future?
- Very concerned.
 - Somewhat concerned.
 - Not concerned.
 - I believe AI cannot replace teachers.
13. What is your overall attitude toward using AI tools to assist English teaching?
- Very negative.
 - Somewhat negative.
 - Neutral.
 - Somewhat positive.
 - Very positive.

Section IV: AI Integration Preferences and Expectations

14. Do you prefer using a single AI tool or combining multiple AI tools for teaching practice?
- Single tool (e.g., only DeepSeek).
 - Multiple tools combined (e.g., DeepSeek + WPS AI).
15. In which teaching practice areas would you like AI tools to provide support for English teacher education students? [Multiple Choice]
- In-depth understanding and practice of teaching theories.
 - Generate differentiated learning objectives.
 - Analysis of key and difficult points in teaching materials.

- Instructional design.
 - Classroom activity design.
 - Assessment and evaluation design.
 - Assist in teaching reflection.
 - Simulate classroom interaction or management.
 - Others (please specify): _____
16. Through using AI to assist in teaching skills training, what goals do you hope to achieve? [Multiple Choice]
- Improve instructional design capabilities.
 - Enhance classroom management confidence.
 - Master communication skills with students, parents, and colleagues.
 - Improve teaching performance in microteaching.
 - Gain new understanding of future teacher identity and career choices.
 - Others (please specify): _____

Appendix B. English Teacher Professional Identity Questionnaire for EFL Pre-Service Teachers

Dear Participant,

Thank you for participating in this research on English teacher education students' teacher professional identity. To better understand how you perceive and shape your teacher identity during your learning and teaching process, we have designed this questionnaire. Please respond based on your genuine feelings. Your answers will provide valuable data support for our research.

Research Purpose:

This study aims to explore the formation and development of English teacher professional identity, particularly teachers' identity perception and self-positioning in teaching practice. Through analyzing your responses, we hope to understand the changes in teacher professional identity across different teaching stages and the influencing factors, providing more targeted suggestions for teacher education and training.

Confidentiality:

Your personal information and questionnaire content will be strictly confidential. All data will be used solely for research analysis, and no personal identity information will be disclosed in reports. Your responses will be processed anonymously to ensure your privacy is protected.

Voluntary Participation:

Participation in this research is entirely voluntary. You have the right to withdraw from the questionnaire at any time. Completing the questionnaire will not cause any adverse effects. If you choose to withdraw, all completed content will be completely deleted and will not be used for any analysis.

Rating Method:

This questionnaire uses a 5-point rating scale. Please select the most appropriate option based on your genuine thoughts or feelings. The specific rating criteria are as follows:

- Strongly Disagree - You completely disagree with the statement.

- Disagree - You disagree with the statement in most situations.

- Neutral - You have no clear attitude toward the statement, or you think it applies in some situations.

- Agree - You agree with the statement in most situations.

- Strongly Agree - You completely agree with the statement.

Completion Time:

The estimated time to complete this questionnaire is 5-8 minutes. Please complete it carefully in a quiet environment to ensure the accuracy of the results.

Thank you for your participation and support! If you have any questions, please feel free to contact us.

1. Your student ID is: _____ (Please fill in your student ID to ensure consistency between pre- and post-tests for data matching. Information will be strictly confidential)
2. I am confident that I can effectively allocate time in actual teaching activities.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
3. I am confident in establishing classroom management systems and managing students well in actual teaching.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
4. I am confident that I can answer relatively difficult English questions raised by students in teaching.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
5. I am confident in setting clear and specific teaching objectives and outcomes in lesson planning.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
6. My written English ability can support me in designing

lesson plans.

- Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
7. I am confident in proposing good guiding questions in instructional design.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
8. I am confident in creating a good classroom environment and organizing students for collaborative activities in actual teaching.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
9. My spoken English is fluent.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
10. As a future English teacher, I should continuously update my professional knowledge.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
11. After becoming a real teacher, I should utilize various training opportunities to improve my teaching level.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
12. I believe that future English teachers should possess certain information technology application abilities to meet the new requirements for English teaching.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
13. I believe that teachers should ensure their teaching is effective.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
14. I believe that the teaching profession is one of the most important professions in social division of labor.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
15. I believe that the role of English teachers is crucial in the educational environment.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
16. I believe that teachers' work plays an important role in human social development.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
17. I believe that teachers' work is important for promoting students' growth and development.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
18. I will strive to become a future English teacher with strong research capabilities.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
19. I believe that the English teaching profession will allow me to live a satisfying life in the future.
Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree
20. I will strive to become an English teacher that students like.

Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree

21. I will strive to continuously improve my teaching level through teaching practice.

Strongly Disagree ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 Strongly Agree

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