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From Reflection to Re-Reflection: ChatGPT and Transformative Learning in Preservice Elementary Science Education

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Abstract. Reflective practice is essential in teacher education, yet traditional journaling often falls short in encouraging transformation. With artificial intelligence (AI) gaining prominence in education, there is a growing need to explore the use of generative AI to facilitate deeper reflection and professional identity development in preservice teachers. This study explores the impact of ChatGPT-based reflective writing on preservice elementary teachers' transformative learning. Grounded in Mezirow's transformative learning theory, Kolb's experiential learning cycle, and the Onion Model of Reflection, the study employed a qualitative within-subjects design with 20 female preservice teachers undergoing practicum. Purposive sampling ensured authentic classroom engagement. Participants experienced both traditional journaling and AI-supported re-reflection using ChatGPT. Sources of data were reflective journals, AI interaction logs and semi-structured interviews. Depth-based and thematic analyses using an inductive coding approach with inter-coder reliability (Cohen's kappa = 0.84), revealed that ChatGPT facilitated more concentrated, deeper and clearer reflections. Reflections demonstrated higher pedagogical insight, instructional reasoning and professional identity development. Generative AI was seen to act as a reflective scaffold that prompted critical analysis and eased identity shifts in accordance with principles of transformative learning. These findings highlight the potential of AI integration into teacher preparation to assist in deep reflective practice and identity formation. The study addresses a critical gap in the literature by positioning AI as a tool for deepening reflective learning in elementary teacher preparation. It is recommended that teacher education programs incorporate AI-enhanced tools in combination with journaling to enhance reasoning, promote identity growth and maintain transformative learning.

Keywords: ChatGPT; transformative learning; preservice teachers; Onion Model; reflective practice; reflection; re-reflection

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1. Introduction

Numerous educators and scholars have investigated specialized curricular approaches aimed at promoting transformative learning. Most initiatives focus on professional education, promoting individual growth and advancing the profession through cultural awareness, social responsibility, and critical reflection (Taylor, Cranton, & Associates, 2012).

Reflective practice— defined as the conscious and systematic exploration of one's professional beliefs and actions with the aim to enhance teaching effectiveness and professional awareness (Farrell, 2019)—plays an essential role in increasing preservice teachers' awareness of their profession. This newfound awareness supports their professional development through reassessing the responsibilities and factors that shape teaching.

Over the years, reflection has become the central theme for many studies of the teaching profession (Brookfield, 2017; Clarke, 1995; Körkkö et al., 2016; Lunenberg & Korthagen, 2009), thus has become a crucial part of teaching practice (Dewey, 1933/1998; Schön, 1987). Drawing on Kolb (1984), LaBoskey (1993), and Zeichner (1981, 1987), reflection can range from superficial to profound in analyzing learning contexts and personal responses. Therefore, reflection affects all those who participate in the teaching-learning process, including both practitioners and preservice teachers, especially as they confront the consequences of their professional actions (Rodgers, 2002).

Classroom teaching practice based on reflective methods greatly impacts preservice teachers' instructional development (Kılıç, 2022). Science teacher trainees have demonstrated enhanced reflective abilities by maintaining reflective journals, assessing problem-based learning (PBL) lessons through self, peer, and mentor evaluations, and engaging with constructive feedback (Bonney et al., 2024). Moreover, practicum experiences in remote areas have been linked to transformative learning methods among preservice teachers (Sari et al., 2022). School-based practicums are crucial for introducing preservice teachers to the realities of the profession and for developing their proficiency as educators (Foncha et al., 2015),

This is particularly relevant for preservice elementary science teachers, whose professional identities are still in formation. New studies suggest that text-based ChatGPT is a valuable bridge connecting the theories and practice in teacher education, promotes preservice teachers' own self-efficacy in addressing classroom challenges substantially and shows the potency of AI tools in connecting academic theories with concrete classroom contexts (Kim et al., 2025).

In light of these foundations, focus is now shifting to how emerging technological tools, especially AI-based systems, intersect with reflective teaching. In this research, reflection is taken further to re-reflection, which emphasizes revisiting and deepening initial reflections to reconstruct meaning and strengthen professional identity. AI technologies like ChatGPT offer the possibility of scaffolding this re-reflection, provoking preservice teachers to go beyond surface

descriptions to more transformative insights. The findings of this research have implications for educational policy, curriculum development and the overall quality of science education. Through the incorporation of technology-supported reflective practices in teacher education, this research points to ideas for research and makes a contribution to innovation in teacher preparation for the challenges of 21st-century classrooms.

2. Literature Review

Previous empirical studies have consistently highlighted the role of reflection in teacher education, particularly in practicum settings. For example, research shows that preservice teachers can develop pedagogical reasoning and professional awareness through reflective journaling, peer feedback, and problem-based learning activities (Bonney et al., 2024; Kılıç, 2022; Rodgers, 2002). Practicum experiences in diverse contexts have also been linked to transformative learning and identity development (Foncha et al., 2015; Sari et al., 2022). The implementation of technology-enhanced reflective tools, such as reflective journals and guided prompts, has also been suggested to stimulate stronger metacognitive activity (Runnel et al., 2013).

Despite these developments, the mainstream literature has focused mainly on traditional journaling or computer-based models, with little empirical research into whether or how generative AI might benefit reflective processes. Although recent research has begun to highlight this potential (Abualrob, 2025; Choi, 2025), there are few systematic analyses of AI-augmented reflective practices in preservice teacher education.

This study therefore contributes by addressing this gap, examining how ChatGPT-assisted re-reflection can deepen preservice teachers' insights, strengthen instructional decision-making, and support professional identity formation in elementary practicum contexts, including science teaching. The present study therefore builds on this literature by empirically exploring how both traditional and AI-assisted reflection contribute to transformative learning and professional identity development in elementary teacher education, with a focus on science teaching.

2.1 Theoretical Framework

Although previous research has highlighted the use of reflective practice and transformative learning, little is known about how generative AI can facilitate those processes in preservice teacher education particularly within elementary practicum contexts that include science teaching. This observed gap calls for a deeper investigation into how different modes of reflection, both traditional and AI-assisted, might bring about shifts in belief systems, professional identity development and instructional agency during practicum experiences.

A reference reflection framework has been suggested to ensure deeper, guided and meaningful reflection during field experiences, ultimately enhancing initial teacher education (García-Lázaro & Reyes-de-Cózar, 2024). One theoretical framework for examining the benefits of teaching practice is transformative

learning (TL), which is rooted in experiential learning (Polyzoi & Magro, 2015). TL is the process through which individuals transform their pre-existent perspectives into new ones when the former no longer align with their current environments or are deemed inadequate (Mezirow, 1991). Hoggan (2016) describes TL as a process that involves changes in how learners interpret their experiences, stemming from transformed meaning perspectives (Mezirow, 1978).

Through these transformed perspectives, learning becomes holistic, stimulating the cognitive, emotional, and social aspects (Taylor, 2009). TL therefore leads to comprehensive personal development contributing to increased self-awareness, enhanced capabilities, and other significant personal changes (Hoggan, 2016). These developments ultimately support both personal (D'Amato & Krasny, 2011; Dorsett et al., 2017) and professional growth (Polyzoi & Magro, 2015).

At the heart of this theory, reflection is more than a mere technical tool for improvement; it is an intimate social process that reshapes individuals' understanding of themselves and their roles within the educational context. Key triggers for this transformation include reflective journaling, dialogue mentoring and ethical decision-making, all of which are core activities in the teaching practicum. In science education, reflection is explained as a metacognitive process that relates theoretical content to personal experience by describing, justifying, evaluating and discussing learning activities. Runnel et al. (2013) have proposed a technology-enhanced model that uses tools like reflective diaries, prompts and guiding questions to facilitate and enhance student reflection.

Furthermore, Kolb's experiential learning cycle (1984) complements Mezirow's framework by highlighting the iterative nature of learning through experience, reflection, conceptualization and experimentation. Given these theoretical lenses, the integration of AI into reflective practices presents a timely and necessary area of inquiry. From these theoretical foundations, recent literature has started to explore how generative AI, in particular ChatGPT, can prompt reflective thinking in lesson planning. This case reveals that suggestions by ChatGPT encouraged the participants to revise and reflect on their teaching practices. By doing so, the AI tool not only indicated missed content or logical inconsistencies but also assisted with reflective thinking (Choi, 2025).

Although AI-supported tools like ChatGPT are promising in facilitating reflective teaching, their limitations should also be considered. As Jho and Ha (2024) noted, the study illuminated AI's promise for educational applications as well as its limitations, such as the greater prevalence of incorrect element identification when accuracy was low. This would indicate that although generative AI can aid surface-level reflection, its utility for facilitating deeper pedagogical reasoning should be accompanied by careful human monitoring and critical engagement.

These theoretical underpinnings pose questions regarding the impact of reflective journaling—whether deployed through traditional methodologies or powered by generative AI technologies—on preservice teachers' instructional reasoning, pedagogical decision-making and construction of their professional identities in

authentic classroom settings. Current literature addresses how teachers might integrate AI into teaching, and how AI might be utilized to enhance the learning environment (Chiu et al., 2023; Su & Yang, 2023; Veletsianos et al., 2024; Younis, 2024).

While AI technologies are increasinglybeing integrated into fields of instructional design, formative assessment, and adaptive learning environments (Holmes et al., 2022), their implications for education—particularly the development of reflective thinking, instructional agency and professional identity in teacher education—are still understudied. Recent studies have only started to reveal the reflective potential of generative AI technologies in teacher education courses. Abualrob (2025) found that preservice elementary teachers used AI-aided planning tools not only to create instructional materials but also to reflect deeply on their practice through journaling and focus groups.

These results suggest that generative AI may serve not only as a planning assistant but also as a catalyst for deeper pedagogical reflection; however, this area of inquiry still requires further empirical exploration. On the other hand, existing studies have been predominantly interested in determining the scientific quality of AI-generated content or measuring user attitudes without examining the processual and reflective qualities of teacher engagement with AI (Ishmuradova et al., 2025; Powell & Courchesne, 2024).

This study addresses a critical gap by exploring how preservice teachers employ both traditional and AI-assisted reflection to manage identity development, instructional reasoning and decision-making in actual practicum environments. Based on the newness of generative AI within reflective practice, this research provides novel empirical understanding of how these sorts of technologies reformulate teacher thinking.

Grounded in Mezirow's transformative learning theory and Kolb's experiential learning cycle, the research adopts a theoretical framework that emphasizes the critical roles of reflective thinking, experiential engagement and the reconstruction of meaning in teacher education practice. The Onion Model of Reflection, originally introduced by Korthagen (2001), has been adapted by García-Lázaro & Reyes-de-Cózar (2024) to describe layered reflection, from surface behaviors to core beliefs and professional identity. This study innovatively applies the model to compare AI-assisted and traditional reflective practices, enhancing our understanding of reflection depth. The figure below summarizes this integrated framework.

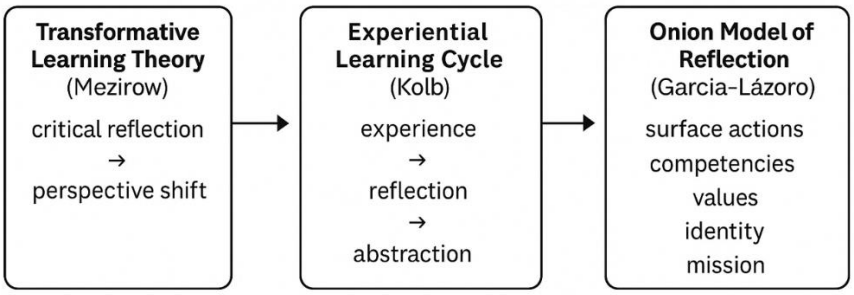

Figure 1: Integrated theoretical model guiding reflective practice analysis
(Adapted From Mezirow, 1991; Kolb, 1984; Korthagen, 2001; and García-Lázaro & Reyes-de-Cózar, 2024)

This visual synthesis supported the study's interpretation of how preservice teachers, through both traditional and AI-augmented reflection, progressed from surface-level descriptions to deeper pedagogical insight and identity awareness.

In this study, these theoretical frameworks are applied to preservice elementary teachers, with a focus on science teaching. Their practicum experiences provide solid grounds for exploring how reflective practices contribute to transformative learning, particularly as they begin to reassess their roles, beliefs and teaching approaches within diverse classroom settings.

Accordingly, this study addresses the following research questions:
1. How do preservice elementary teachers' traditional reflections reveal their instructional practices and professional thinking during elementary science teaching practicum?
2. How does ChatGPT-assisted reflective writing influence the depth, clarity and focus of preservice elementary teachers' reflections during science teaching practicum?
3. What differences emerge between traditional and AI-assisted reflections in terms of pedagogical insights, instructional decision-making and professional identity development among preservice elementary teachers?

This study is grounded in transformative learning theory (TLT) by Jack Mezirow (1991) which focuses on how adults revise and reinterpret their experiences to develop new perspectives and identities. Mezirow states that TL involves a "disorienting dilemma", critical reflection and rational discourse causing a shift in one's frame of reference. In teacher education, such dilemmas often stem from real-life classroom experiences that challenge preservice teachers' existing beliefs about instruction, authority and the student-teacher relationship.

An integration of Mezirow's TLT and Kolb's Experiential Learning Cycle results in a rich framework for understanding reflective methodologies being used by preservice teachers, regardless of whether these methodologies are traditional or AI -facilitated (Mezirow, 1991; Kolb, 1984). Although reflective journaling's value for teacher identity and pedagogy is well established (Kılıç, 2022; Rodgers, 2002; Zeichner, 1981), few empirical studies examine how generative AI tools like ChatGPT support deeper reflection.

3. Research Methodology

3.1 Research Design

This study employed a qualitative research design grounded in both narrative and thematic analysis. The research approach adopted was as an interpretive qualitative approach considered most fitting to illuminate the preservice teachers' subjective perceptions, along with their development of professional identities and reflective practices in real practicum settings. This model was chosen to capture both the descriptive and interpretive dimensions of preservice teachers' reflective experience to enable an in-depth understanding of TL processes.

In addition, the research had a within-subject comparative element by exploring two different periods of reflection—specifically, traditional and AI-augmented—allowing for an exploration of the possible mechanisms by which generative AI tools could increase the complexity and depth of reflective thinking. The comparative approach countered variability by allowing each student to serve as their own control, ensuring that the differences observed in the depth of reflection were attributed to the AI-supported phase and not to individual differences.

The analysis followed three stages: (1) thematic analysis (Creswell, 2013); (2) depth analysis via the Onion Model (García-Lázaro & Reyes-de-Cózar, 2024); and (3) transformative synthesis guided by Mezirow (1991) and Kolb (1984). At each of these phases, coding protocols and analytic choices were recorded to ensure transparency and reproducibility.

3.2 Study Context and Participants

3.2.1 Study Population

The population of the study comprised preservice elementary teachers enrolled in teacher education programs at the AAUP Faculty of Education. The total population of students enrolled in the program during the study semester was 55. These individuals were registered in practicum courses during the second semester of the 2024/2025 academic year. The course was centered on the pedagogy of science and classroom application of teaching strategies, so it provided a suitable setting for exploring reflective practice and professional development.

3.2.2 Study Sample

The study sample consisted of 20 female preservice teachers taking student teaching at public schools, meeting the requirements needed for the degree program. The rationale for selecting these participants lay in the fact that they represent a critical stage in teacher education, where professional identity was being constructed, and reflective practice supported the development of pedagogical thinking and teaching autonomy.

This gender representation reflected the actual enrollment rate in the program, where over 90% of students were female. Participants were selected through purposeful sampling, focusing on participants who were both engaged in authentic classroom instruction and capable of expressing their reflective insights on their teaching and professional growth.

All participants were fourth-year preservice teachers enrolled in the elementary education program, whose academic preparation included a strong focus on science content and pedagogy relevant to teaching science at the elementary level. The same participants engaged in both traditional and AI-supported reflection phases, enabling a controlled within-subject comparison.

To determine the sample's appropriateness, inclusion criteria were: (a) enrollment in a teaching practicum course; (b) active engagement in school-based teaching placements; and (c) both the ability and willingness to take part in both stages of reflection. Participants had no prior formal exposure to AI tools for reflective writing, thus ensuring the intervention's novelty and integrity.

Informed consent was obtained prior to participation, and ethical approval was obtained from the institutional review board. Participants were informed about the objectives of the study, confidentiality measures and their right to withdraw at any point.

3.3 Data Collection Instruments and Phases

A variety of data were gathered during the design process, such as traditional reflective journals, ChatGPT interaction logs and semi-structured interviews. Only after students had finished their traditional journaling was the AI-supported reflection stage presented. Students were explicitly instructed to enter their journal entries through ChatGPT and utilize it to enhance their reflections. The identical open-ended questions employed in the conventional journal were utilized in the AI-supported stage. Extra "probing questions," however, were suggested—e.g., "On what principles were your decisions based?" or "In what ways might your students view this strategy?"—to facilitate more depth and conceptual clarity.

To ensure consistency and comparability across both stages of reflection, all participants responded to the same core set of five open-ended questions at each stage. Questions were adapted from widely accepted models of reflective practice and focused on key instructional elements, such as lesson goals, pedagogical approaches, student engagement, classroom challenges and personal growth.

An overview of the data collection tools is given below to increase transparency:

Table 1: Overview of Data Collection Instruments, Purposes and Timeline

Instrument	Purpose	Timing	Data Volume/Type
Reflective Journals	Capture participants' traditional reflections	Week 3–6	100 entries (5 per participant × 20 participants)
ChatGPT Interaction Logs	Observe AI-augmented reflective processes	Week 7–9	100 logs (1 per journal × 20 participants)
Revised Reflections	Analyze changes prompted by ChatGPT dialogue	Week 7–9	100 revised entries

Instrument	Purpose	Timing	Data Volume/Type
Semi-Structured Interviews	Elicit deeper insights and validate journal findings	Week 10–11	20 transcripts (~30–40 minutes each)
Meta-Reflection Feedback	Capture participants' experiences with ChatGPT	Week 11	20 short written feedback reports

All data were gathered in Arabic, the native language of the participants, and subsequently translated into English for analysis and reporting. Back-translation procedures were used to provide fidelity and accuracy of meaning.

3.3.1 Reflective Journals
Maintained throughout the practicum, the journals recorded reflections on participants' shifting perceptions, instructional practices and professional identity development.

The reflective journal was the main instrument used in this study, containing a series of open-ended questions designed to prompt critical reflection. The reflective prompts focused on several key dimensions:

- A description of each science lesson delivered
- Instructional strategies employed
- Challenges encountered in the classroom
- Significant learning outcomes
- Evolved understanding of their role and identity as teachers

Apart from describing strategies and challenges, the participants were asked to outline the objectives that the specific science lesson was supposed to attain, the identified needs of their learners, and an estimated time length for the lesson. This ensured that the reflections were placed within an actual teaching context.
Candidates were asked to reflect following every practicum session and turn in entries on a weekly basis. Questions were open-ended yet focused to draw out multilayered answers.

3.3.2 ChatGPT Interaction Logs
These consisted of archived logs of participants' interactions with ChatGPT throughout the AI-supported reflection session. They were utilized to monitor the extent to which preservice teachers engaged in dialogic thinking and expanded on their earlier reflections. Interaction data were analyzed using the same framework of reflective depth (from descriptive to mission-level reflection) as outlined in the Onion Model.

The logs contained the participants' initial reflective entries, the feedback that ChatGPT produced, and the subsequent participant revisions or clarifications. These logs recorded responses for at least three turns of dialogue and were automatically timestamped, thus enabling the analysis of both content

development and the temporal order of interactions. The participants were encouraged to have a minimum of three turns of dialogue for each entry to facilitate depth. The responses of ChatGPT were not evaluated for accuracy but for their ability to stimulate deeper pedagogical reflection.

3.3.3 Semi-Structured Interviews

After completing both reflection periods, the interviews were held to deepen the understanding of the participants' experiences and validate the patterns that emerged from the journal data and ChatGPT data. An interview protocol was created to address themes including perceived changes in reflection depth, instructional decision-making, professional identity and experiences with AI use. Interviews were recorded, transcribed word-for-word and anonymized.

3.3.4 Meta-Reflection Feedback

During the final phase, the participants were requested to produce brief written reports on feedback that summed up their overall reflection experiences mediated by ChatGPT. Typically ranging from one to two pages long, the reports included the participants' reflections on the benefits, challenges and limitations involved with the use of AI when it comes to re-reflection. The purpose of this instrument was to triangulate findings from journals, interaction logs and interviews by documenting participants' metacognitive evaluations of the reflective process itself. The reports were an appraisal on the reflective process mediated by AI that considered supposed benefits, challenges and ethical considerations. The tool was an authentication mechanism devised to add supplementary findings drawn from the other three approaches.

3.4 Research Procedures

The study followed a structured timeline of 10 weeks, divided into distinct phases:

- Weeks 1–2: Participant recruitment, informed consent and training session on ethical AI use.
- Weeks 3–6: Traditional journaling phase; participants submitted one journal entry per week.
- Week 7: ChatGPT reflection orientation; participants uploaded their previous reflections into ChatGPT.
- Weeks 7–9: AI-supported journaling and editing phase. Students edited reflections iteratively in response to prompts from ChatGPT.
- Week 10–11: Submission of meta-reflection feedback and individual semi-structured interviews.

The rationale behind authorizing the beginning of the traditional journaling stage was to have an initial set of authentic, independent reflections before AI facilitation was introduced. This strategy allowed for a clear demarcation of reflections that were generated independently generated from those that were generated with the interaction of AI technologies. The next stage was then delineated clearly: the traditional stage required independent weekly reflections, while the ChatGPT-assisted stage comprised the upload, clarification of and augmentation of prior reflections through an interactive dialogue with the AI system.

In the orientation sessions, students were familiarized with major concepts in AI-generated content, such as authorship concerns, intellectual independence and sensitivity to bias. They were told not to take ChatGPT responses at face value but as provocations to further thought and personal improvement. During the process, the participants' activity was overseen by a reflection facilitator who ensured uniformity of use of the tool and ethical conduct. The same facilitator offered technical assistance and reminded the participants to store and archive their ChatGPT activities for review. By ordering traditional and AI-assisted stages with deliberate pacing, the protocols ensured that any noted difference in reflection depth could reasonably be linked to the intervention.

3.5 Data Analysis

The qualitative data collected in this study were analyzed according to a three-component framework:

3.5.1 Traditional Thematic Analysis (Creswell's Approach):

The initial analysis involved open coding and inductive theme generation from traditional journaling entries founded on Creswell's (2013) qualitative interpretation model, supported by Braun and Clarke's (2006) six-step process. The themes that emerged were instructional strategies, classroom challenges, values in teaching and student engagement.

Coding was done manually and was supported by qualitative analysis software (NVivo 14) to enhance traceability and organization. A preliminary list of 74 open codes was generated and subsequently was grouped into 12 axial groups, from which four core themes were identified. Coding was conducted independently by two researchers with an inter-coder agreement rate of 87%. Discrepancies that occurred were resolved through consensus.

3.5.2 In-Depth Analysis with the Onion Model:

Reflected revisions through ChatGPT were analyzed using García-Lázaro and Reyes-de-Cózar's (2024) Onion Model, with established levels of reflection serving as the coding framework. For analytical clarity, the six nested levels of Korthagen's Onion Model (environment, behavior, competencies, beliefs, identity and mission) were operationalized into five coded categories: description/justification (aligned with environment & behavior), principles (aligned with competencies), beliefs, identity, and educational purpose (aligned with mission).

A comparative matrix mapped individual shifts in reflective depth, with indications of increasing complexity and alignment with professional values and identity. Each journal entry, original and revised, was assigned a reflection depth code based on particular indicators, such as the use of pedagogical rationale, mention of student needs or articulation of teaching philosophy. The coders were trained in the Onion Model framework and used a clearly defined rubric to enhance consistency. The rubric delineated indicators for each level of reflection: descriptive statements (surface), pedagogical justification (principles), articulation of teaching beliefs, identity-level statements and mission-oriented reflections. Reflective changes were monitored on five levels per participant

through the utilization of a scoring matrix. This enabled the researchers to identify intra-individual development as well as cross-case trends. A check for reliability resulted in a Cohen's kappa of 0.84 between coders for depth-level classification. This model, placed in the theoretical framework, provided a systematic view for tracking transitions from descriptive to identity-level reflection.

3.5.3 Transformative Synthesis Analysis:
The results derived from both stages were integrated through a meta-thematic technique to ascertain:

- TL shifts across both phases
- Professional identity formation patterns
- Better pedagogical thinking linked to AI use

This synthesis used constant comparison and cross-tabulation techniques in NVivo to triangulate findings in journals, ChatGPT logs and interview transcripts. A matrix of several cases was developed to track recurrent themes in identity language (e.g., "I see myself as a guide," "I had to rethink my role") in relation to pedagogical positions. These findings were interpreted through the lens of Mezirow's TLT and Kolb's experiential learning cycle with the intent of assessing the presence of disorienting dilemmas, perspective change and evidence of reflective reconstruction. Analytic memos were composed in every stage to record interpretations, emerging hypotheses and confirmatory disconfirming evidence.

3.6 Trustworthiness and Rigor
To ensure the integrity and comprehensiveness of the study, several validation strategies were employed:

- Peer debriefing was employed to neutralize bias when developing themes.
- The process of member checking involved returning the interpretations to the selected participants.
- Triangulation was achieved by combining traditional reflection, AI-supported reflection, semi-structured interview data, and participants' meta-feedback.
- Thick description was used to enable transferability.

Along with these strategies, the research followed Lincoln and Guba's (1985) standards for qualitative rigor, which are credibility, reliability, confirmability and transferability.

- Credibility: Was established through extended interaction with participants across a 10-week period, repetitive coding by several researchers, and member checking of thematic interpretations.
- Reliability: An external audit trail was kept, recording all methodological choices, coding schemes and analytic memos.
- Confirmability: Reflexive diaries were maintained by the principal researchers to bracket presumptions and recognize positionality. All sources of data were archived in a systematic manner to enable independent verification.
- Transferability: Rich contextual and demographic data were provided, along with exemplar quotes from different participants, which were used to support key themes and allow readers to assess transferability to other contexts.

Additionally, the inter-coder reliability was assessed and documented at each analytical phase, exhibiting values between 84% and 88%. Moreover, a systematic peer validation procedure was implemented involving two external qualitative researchers to ensure the impartiality and consistency of the findings. Ethical considerations were emphasized, particularly concerning the use of ChatGPT. Participants were taught the appropriate use of AI, were cautioned against problems of authorship and originality, and were encouraged to assess critically the results of the AI. Usage of ChatGPT was monitored to ensure that it was used as a reflective tool and not a substitute for the professional judgment of participants.

4. Research Results

This section presents the findings of a qualitative investigation that examined the impact of ChatGPT-facilitated reflective writing on the professional cognition and identity transformation of preservice elementary teachers during their practicum, with a focus on science teaching. The results are organized thematically in alignment with the three research questions, addressing instructional practices, depth and clarity of reflection, and pedagogical/identity development.

The findings are presented in three parts:

- The first examines traditional reflections through Creswell's (2013) and Braun and Clarke's (2006) models, determining patterns within teaching strategies, challenges and core values.
- The second dimension explores reflections facilitated by ChatGPT through the Onion Model (Korthagen, 2001; García-Lázaro & Reyes-de-Cózar, 2024) focusing on deeper levels of reflection and shifts with regards to identity and educational purpose.
- The third stage integrates Mezirow and Kolb's perspectives to explore transformation learning, professional identity construction, and AI's facilitative role in developing reflective practice.

In sum, findings revealed how AI-backed reflection paved the way for more focused, meaningful and professionally grounded results.

4.1 Findings on Instructional Practices in Traditional Reflections

The findings for Research Question 1 showcase how preservice teachers' reflections demonstrate changing instructional practices in teaching science. The reflections centered on six major themes that reflect changes in the way participants plan, teach and reflect on science lessons.

4.1.1 Theme 1: Emphasis on Active Learning and Sensory Observation

Some teachers, such as (P1) and (P2), documented their adoption of active learning strategies in their lessons.

(P1) described a direct visual experiment in which students observed changes in two pieces of paper without being provided any information directly, encouraging observation and inference. Similarly, (P2) used a flashlight as a demonstration tool, within the same experiment and asked students to track the

changes themselves. (P3) began her lesson with a rubbing experiment and posed an open-ended question to stimulate student thinking.

These reflections demonstrate a shift toward interactive teaching methods that rely on sensory exploration rather than lecturing, indicating a move toward active learning practices.

4.1.2 Theme 2: Integration of Play and Learning
Reflections from (P4), (P5), and (P6) revealed an increased recognition of play as an effective entry point to learning.

(P4) used flash cards with positive and negative signs to review a lesson on electricity, increasing the levels of engagement and excitement in the session. (P5) employed the "Everyone Participates" strategy to encourage group participation.

(P6) integrated playful learning with technology, presenting scientific concepts in an enjoyable and clear manner.

These reflections illustrate a shift in perspective: viewing play not merely as entertainment, but as a key component that enhances student understanding and engagement.

4.1.3 Theme 3: Use of Technology as a Learning Enhancer
Teachers (P7), (P8), and (P9) emphasized the value of technology in enhancing students' understanding of scientific concepts, especially those that are abstract or difficult to demonstrate.

(P7) used videos to show molecular motion during wave propagation, helping students visualize the complex concept. (P8) deemed educational videos to be essential for topics that couldn't be physically demonstrated. (P9) found that utilizing technology for interactive presentations in the classroom created a more effective learning environment.

These reflections demonstrate a shift toward the integration of digital media as central teaching tools to facilitate deep learning.

4.1.4 Theme 4: Awareness of Learner-Centered Instructional Design
Reflections from (P10), (P11), and (P12) showed an increased recognition of the importance of tailoring class activities to students' backgrounds and needs.

(P10) emphasized the value of experiments that relate to students' daily lives, as they make scientific content more accessible. (P11) stressed that science lessons should be interactive and observation-based rather than focused on rote memorization. (P12) used a flashlight to demonstrate methods of charging objects, aligning the activity with students' cognitive sequence.

These reflections indicate a shift toward more flexible lesson planning informed off student backgrounds, enhancing instructional effectiveness.

4.1.5 Theme 5: Connecting Theoretical knowledge to Practical Application
(P13), (P14), and (P15) emphasized the importance of linking theoretical knowledge with practical classroom application.

(P13) used a tuning fork to illustrate sound and resonance in a tangible way. (P14) started the lesson with a rubbing experiment as a gateway for discussing electric charge, promoting understanding through observation. (P15) relied on simple tools like colored markers and a whiteboard to explain the outcomes of the experiment, strengthening visual comprehension.

These reflections show a shift toward more hands-on teaching methods for science concepts, improving understanding and learning retention.

4.1.6 Theme 6: Classroom Decision-Making Based on Values and Professional Awareness
(P16) described a situation where she felt hesitant while teaching but chose to act independently without relying on school administration, driven by her desire for direct educational engagement with students. She expressed a strong sense of responsibility in managing the classroom independently. (P17) shared a similar ethical decision based on personal values rather than administrative rules.

These reflections suggest growing professional awareness and a newfound ability to make educational decisions based on pedagogical and ethical considerations, indicating a maturing teaching practice.

4.2 Findings on Depth, Clarity and Focus in AI-Assisted Reflections
A comparison between the original reflections and those rewritten with ChatGPT revealed notable shifts across the dimensions of depth, clarity and focus.

4.2.1 Depth
In the early reflections, participants gave surface-level accountings of classroom events without connecting them to pedagogical or philosophical theory. After ChatGPT utilization, reflections demonstrated greater analytic depth, such as connecting classroom experiences to teaching beliefs or interpreting particular incidents as transformative.
For instance, one participant wrote,

> "*I noticed that students were not engaging with the lesson.*" *(P5)*

After AI-assisted revision, the same participant reflected:

> "*I noticed a lack of engagement, which made me reflect on how lecture-based instruction may not motivate learners. This led me to reconsider my belief in the student's role as an active knowledge constructor.*" *(P5)*

Another participant expressed:

> "*I was teaching in a traditional way, but I realized that the students weren't engaging. I started to think the problem might lie in my instructional approach rather than in the students. This prompted me to explore more participatory strategies.*" *(P7)*

These quotes, based on written reflections of the participants', indicate a strong shift from surface observation to deeper, identity-oriented analysis. This change demonstrates movement from the description of behaviors to interpretation of underlying causes and implications—reflecting more in-depth reflective involvement.

4.2.2 Clarity

The early reflections at times were unclear or did not have sufficient structural coherence. Following the use of ChatGPT, the participants' reflections had clearer expression and more logical organization of ideas—typically moving from awareness of the issues, through analysis, to insights.

One participant explained:

> "*I realized the use of videos in a sound lesson failed due to an internet outage, and this made me appreciate the importance of having a backup plan. I now believe in the necessity of preparing Plan B for every session.*" *(P11)*

This quote illustrates a shift from fragmented narration to structured argumentation, marking an improvement in reflective coherence.

4.2.3 Focus

The participants shifted from narrating vaguely related events to selecting a single incident and analyzing it in depth.

One participant reflected:

> "*At first, I used to write everything that happened in the lesson. But after using ChatGPT, I began to focus on one incident and reflect deeply on it.*" *(P3)*

Another participant noted:

> "*Instead of reviewing all lesson details, I focused on a moment when students didn't understand a scientific experiment. I reflected on why the concept wasn't clear and realized I had rushed the conclusion without allowing enough time for observation.*" *(P10)*

These reflections show a shift from fragmented reports to more focused analysis, demonstrating greater reflective accuracy. Reflections were coded for depth (surface to identity-linked analysis), clarity (unclear to precise), and focus (unfocused to highly focused). These parameters followed standard qualitative criteria. This development is well illustrated in Table 2, which presents a comparative summary of traditional reflections and ChatGPT-facilitated reflections with regard to depth, clarity and focus.

Table 2: Comparison of Reflection Depth, Clarity and Focus: Traditional vs. ChatGPT-Assisted (Qualitative Coding)

Dimension	Traditional (No. of Reflections)	ChatGPT-Assisted
Surface-level Depth	13	3
Moderate Depth	6	9
High Analytical Depth	1	8
Unclear	9	2
Very Clear	4	12
Unfocused	12	3
Highly Focused	2	13

4.3 Findings on Pedagogical Insights, Instructional Decision-Making and Identity Transformation

The results for Research Question 3 reveal a multilayered transformation in how preservice teachers engage with pedagogical reflection when supported by ChatGPT. When comparing traditional reflections with those supported by AI, three key areas of growth became clear: better understanding of teaching practices, more thoughtful instructional choices and a stronger sense of professional identity. These findings, supported by both structural (Korthagen's Onion Model) and theoretical frameworks (Mezirow's TLT and Kolb's Experiential Learning Cycle), demonstrate how AI-assisted reflection deepens professional understanding.

Whereas traditional reflections tended to remain descriptive and focused on external aspects such as environment or behavior, ChatGPT-assisted reflections enabled participants to articulate pedagogical rationale, reconsider their teaching values and reimagine their professional identity. It turns out that AI integration can support reflective growth from surface-level observations to more intentional, critically engaged and mission-oriented perspectives.

To further contextualize these developments, the findings were interpreted through the dual lenses of Mezirow's TLT and Kolb's Experiential Learning Cycle. According to Mezirow (1991), TL entails a reassessment of meaning structures prompted by disorienting dilemmas. Several AI-assisted reflections exhibited precisely such moments of epistemic disruption and reorientation. For example, one participant noted:

> *"I started putting myself in my students' shoes… I had never asked myself this question before using ChatGPT ''* (P18).

This kind of metacognitive repositioning reflects the dislodging of prior assumptions and the emergence of new interpretive frames.

In parallel, Kolb's (1984) model, which emphasizes the iterative cycle of concrete experience, reflective observation, abstract conceptualization and active experimentation, was evident in the way participants began to revise their practice in response to reflection. One teacher commented:

> *"I stopped seeing myself as someone who executes a plan. I started realizing I can adapt and shape it when needed" (P5),*

while another noted:

> *"Professional identity isn't formed only in lectures, but in facing real classroom situations and analyzing them consciously" (P7),*

which speaks to an evolving pedagogical reflexivity grounded in experiential engagement and strategic adaptation.

Finally, participants demonstrated enhanced interpretive and diagnostic capacities, as they were capable of extending behaviors beyond the classroom context. As one noted:

> *"Now I read students' behavior more deeply and connect it to their emotional or cognitive background" (P6).*

In terms of pedagogical insight, traditional reflections frequently emphasized classroom actions without establishing a clear link to learning objectives or underlying pedagogical theories. Conversely, ChatGPT-supported reflections exhibited a marked shift toward more analytically grounded considerations, emphasizing active learning, student agency and dialogic teaching as central to effective practice. One participant encapsulated this transition by noting,

> *"I've come to see that explaining a concept isn't enough. I need to allow students to discover it on their own" (P3).*

Such statements signal an emergent understanding of pedagogy as an interactive, inquiry-driven process, rather than a transmission of content.

This deeper insight was closely aligned with changes in instructional decision-making. Participants utilizing AI support demonstrated a more nuanced capacity to justify pedagogical choices in relation to learner diversity and contextual specificity. While traditional justifications often rested on generic rationale—e.g.,

> *"I used an experiment because students don't understand without examples" (P12)*

The AI-assisted responses reflected more deliberate pedagogical intentionality:

> *"I chose the experiment because it engages students with sensory intelligence, especially those who struggle with abstract thinking" (P8).*

If anything, such reflections prove that ChatGPT facilitated a shift from procedural teaching to a more diagnostic, student-responsive mode of instructional planning. Quantitative data presented in Table 3 corroborate this shift, with substantial increases across all three dimensions: pedagogical insight (from 6 to 17), instructionally grounded decisions (from 4 to 15), and evidence of identity transformation (from 3 to 14).

Table 3: Comparison of Pedagogical Insights, Instructional Decisions, and Identity Transformation: Traditional vs. ChatGPT-Assisted (Thematic Coding)

Dimension	Traditional	ChatGPT-Assisted
Clear Pedagogical Insights	6	17
Instructionally Justified Decisions	4	15
Evidence of Identity Transformation	3	14

Most importantly, these shifts culminated in a reconfiguration of teacher identity. Traditional reflections often equated professional identity with task performance and curricular delivery. In contrast, AI-supported reflections revealed a more introspective and ethically grounded conceptualization of the teacher-self. As one participant reflected,

> *"After this experience, I felt that my role is not just delivering content but nurturing critical and empathetic human beings" (P10).*

Bottom line: the emergence of a more expansive professional consciousness rooted in relationality, care and purpose.

These qualitative developments were further analyzed using Korthagen's (2001) Onion Model, which conceptualizes teacher identity across six nested levels: environment, behavior, competencies, beliefs, identity and mission. Traditional reflections largely occupied the outer layers—environment and behavior—often recounting classroom conditions without critical interrogation. For instance, while some noted a lack of participation, few connected this to environmental factors. In contrast, AI-assisted reflections demonstrated enhanced contextual awareness, as evidenced by one participant's observation:

> *"I linked that [lack of participation] to the seating arrangement, which limits interaction" (P5).*

If anything, this is but a shift from observation to interpretation, situating behavior within broader environmental constraints.

With respect to competencies, AI-facilitated reflections demonstrated pedagogically informed reasoning, particularly concerning student motivation and instructional scaffolding. One teacher wrote:

> *"I began the lesson with a mysterious image to prompt questions and then had students generate hypotheses. This approach captured their attention more than direct explanation" (P13),*

reflecting an evolution from technique deployment to purposeful strategy selection. The most significant transformations, however, occurred at the level of beliefs, where participants re-evaluated foundational assumptions about teaching and learning. As one remarked,

> *"I used to think that good explanations were enough, but I now believe that students constructing knowledge themselves is far more effective" (P2).*

AI-assisted reflections also enabled participants to articulate emerging professional identities, with teachers framing themselves not merely as conveyors

of knowledge but as facilitators of intellectual and emotional development. One participant stated:

> *"I now see myself as a teacher who empowers learners, not one who simply provides answers" (P3).*

A select group progressed even further, formulating reflective positions aligned with a deeper sense of mission. These individuals began to articulate existential aims for their practice, as in the case of one teacher who observed:

> *"I feel my goal in teaching is no longer just academic success but also nurturing human potential and curiosity" (P9).*

As noted in the methodology, the six levels of Korthagen's Onion Model are presented here in their original form, though they were operationalized into five analytical categories for coding purposes. Table 4 illustrates these vertical shifts, illustrating how ChatGPT-assisted reflections moved beyond surface-level engagement to negotiate professional identity.

Table 4: Distribution of Reflections across Onion Model Levels: Traditional vs. ChatGPT-Assisted (Qualitative Frequencies)

Onion Model Level	Traditional	ChatGPT-Assisted
Environment & Behavior	17	20
Competencies	11	18
Beliefs	6	17
Identity	3	14
Mission (Deeper Purpose)	1	7

5. Discussion

The study demonstrates that reflective writing using ChatGPT significantly deepened preservice elementary teachers' reflection, enhanced their pedagogical thinking and enabled their professional identity construction. These findings are aligned with Mezirow's (1991) TLT and Kolb's (1984) Experiential Learning Cycle, demonstrating how technology can scaffold meaningful, reflective learning.

To add to this, a key observation here is the way that surface, descriptive reflection gives way to deeper, identity-level insight in ChatGPT-supported entries. Such a transition, in line with Korthagen's (2001) Onion Model, is one toward more intentional and values-oriented reflection—pointing to AI's role in supporting professional self-awareness and development (García-Lázaro & Reyes-de-Cózar, 2024).

In this context, and in accordance with Mezirow's idea of a "disorienting dilemma," the use of ChatGPT prompted learners to re-analyze their teaching experiences and question their early assumptions. It acted not only as a language instrument but also as a metacognitive scaffold that promoted logical discourse and upper-level cognitive engagement. These findings are consistent with recent studies positioning generative AI as an agent of reflective collaboration (Abualrob, 2025; Choi, 2025), emphasizing its potential for augmenting the cognitive and emotional activities involved in TL.

Furthermore, the more reflective and clear thoughts of the participants manifested a move toward pedagogically theory-informed instructional decision-making instead of trial-and-error practices. In accordance with Kolb's (1984) model, they bridged classroom practice and learning theories, with more cognitive engagement. Further, most of the participants highlighted student agency, multimodality and inclusiveness—manifesting a step toward a constructivist pedagogy (Bonney et al., 2024; Kılıç, 2022).

Therefore, the change in participants from curriculum implementers to designers of meaningful learning experiences is a definite change in professional identity as outlined in Mezirow's (1991) model. Their movement toward the deeper levels of Korthagen's Onion Model suggests a growing self-concept motivated by internal values and purpose. It is consistent with D'Amato and Krasny's (2011) assertion that TL results in profound personal and ethical development.

Notably, this study addresses a crucial gap in teacher education literature by comparing traditional and AI-assisted reflective modes. Conventional reflections showed limited coherence, depth, and theoretical links, while AI-supported reflections were more analytical and structured, aligning with Rodgers' (2002) and Zeichner's (1987) multidimensional model. Interestingly, the participants did not perceive AI as replacing their judgment but rather as enhancing the articulation and expression of their professional thinking—a finding echoed by Chiu (2025), who emphasizes the irreplaceability of human emotional and moral thought in education.

While ChatGPT supported deeper reflection, certain risks must be acknowledged, including over-reliance on AI prompts, reduced authenticity of reflections and concerns about authorship and ethical use. Without critical engagement and guided facilitation, AI-generated input may overshadow rather than enrich personal meaning-making. These risks underline the importance of embedding ethical guidelines and reflective scaffolds to ensure AI serves as a support, not a substitute, for human judgment.

In conclusion, although the findings of the research are promising, they also call into question the potential overuse of AI and the necessity for systematic facilitation. The effectiveness of the findings was also contingent to some degree on the capacity of participants to critically interact with ChatGPT questions, indicating that AI utilization needs to be supplemented with reflective frameworks and instructional support. Future studies could explore the long-term effect of AI-facilitated reflection on teaching performance and professional identity formation and contrast the relative efficacy of a variety of AI tools for scaffolding TL experiences.

6. Conclusions

The present study examined the use of reflective writing with ChatGPT to support TL and professional identity formation in preservice elementary teachers with a focus on science teaching. Grounded in Mezirow's TLT, Kolb's Experiential Learning Cycle, and the Onion Model of Reflection, results indicated that AI

journaling can be used as a stimulus for deeper reflection, instructional insight and identity reconstruction.

Traditional reflections also merely demonstrated participants' early recognition of teaching approaches but tended to remain superficial. By comparison, reflections transformed through ChatGPT responses had more depth, clarity and focus, progressing toward higher-level pedagogical thinking and value-driven decision-making. Incorporating AI into reflective practice also facilitated preservice teachers' challenging of assumptions, reframing professional roles and articulation of a deeper sense of professional identity, ultimately being congruent with integral components of TL.

Notably, the research does not imply that AI substitutes for human reflection or teaching. Instead, it points to the potential for generative AI tools such as ChatGPT to facilitate reflective thinking and make possible the education of teachers—as long as they are engaged in a critical and thoughtful manner. The results add to an accumulating body of research that views AI not as a menace to human-centered education, but as a tool that, if used judiciously, can strengthen the professional learning of aspiring teachers.

In sum, the integration of AI-supported reflection in teacher preparation holds great potential for enhancing the learning experience of preservice teachers. It encourages greater reflection on pedagogical practice and assists in framing a meaningful and sustainable professional identity—a quality we desire in the current dynamic context of 21st-century teaching.

7. Implications and Study Limitations

The theoretical implications of the current research suggest that teacher education programs should integrate re-reflective practices enabled by AI into practicum courses, enriching aspects related to TL and the construction of professional identity. Practical implications extend to policy reform. Education authorities, curriculum planners, and teacher education institutions may adopt AI-assisted reflection models to improve elementary science teaching. These models can also equip educators with competencies to meet future needs. It is also critical that policymakers, along with education administrators, make policies ensuring the ethical, critical and pedagogically responsible implementation of AI technologies in teacher education programs.

This study has multiple limitations that need close consideration. The participant sample only included 20 female preservice teachers from one educational institution (AAUP Faculty of Education), thus limiting the generalizability of the findings to diverse contexts. Additionally, the short practicum period of one semester could provide only a fleeting view of reflective practices, without exhaustive knowledge of a long teaching career. Lastly, while ChatGPT was used to develop well-structured prompts, the output generated did not necessarily meet pedagogical expectations and required critical interaction and supervision. This study calls for future research with larger, more diverse samples, longitudinal designs to track long-term effects, and comparisons of different AI

tools to better understand their role in fostering reflection and transformative learning.

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