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Research Article

Critical Thinking Skills of Pre-Service Teachers in Designing Inquiry-Based Lesson Plans in Science

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Abstract

In a socially constructivist classroom, critical thinking is an important skill that teachers need to have to help them deliver lessons effectively. The use of 7E instructional design model is a well-known framework that pre-service teachers use to deliver their lessons. This study examined how pre-service teachers use critical thinking skills in 7E Instructional design lesson plans in science, which is rooted in social constructivism that emphasizes collaborative and learner-centered learning. This study utilized descriptive quantitative method, specifically frequency and weighted means following the 5-point Likert scale, then supplemented with descriptive qualitative data to verify and support the critical thinking skills in designing inquiry-based lesson plans of 162 second-year Bachelor of Elementary Education pre-service teachers. The instrument used in the study was a 35-item research-made questionnaire anchored on the 7E instructional design model that underwent validity and reliability testing, and was divided into seven sub-categories. The findings suggest that pre-service teachers generally use critical thinking skills in designing inquiry-based lesson plans. Pre-service teachers employ critical thinking by designing activities that help learners apply their new knowledge to solve problems, create new outputs, and connect to real-world situations. This study recommends that pre-service teachers' lesson plans must be examined to confirm their use of critical thinking skills, practical opportunities must be provided to them for improvement, and institutional policies must be formulated to guide them in designing lesson plans.

Keywords: *critical thinking skills, Inquiry-Based Lesson Plans, 7E Instructional Design Model, pre-service teachers, teaching science*

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Introduction

Lesson planning is a crucial component in teaching that describes what students will do to attain certain learning outcomes; it states the behavior that the teacher wants to elicit as a result of learning (Farrell, 2002; Savage, 2014; Taşkın, 2017; Contreras et al., 2020). With the global shift towards learner-centered teaching, there is a growing emphasis on designing inquiry-based lesson plans that promote active learning and discovery (Arifin et al., 2025; Gravett & Van Der Merwe, 2023). However, crafting such plans is not a simple procedural task; it demands significant critical thinking skills to move beyond mere format and structure to create genuinely effective learning experiences.

Critical thinking skill involves analyzing

and evaluating information to construct knowledge and make informed decisions (Heard et al., 2020). This skill underpins the implementation of inquiry-based frameworks such as the 7E instructional design model, developed by Eisenkraft (2003) as an extension of the 5E model. The 7E model guides learning through distinct phases: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend. Designing a lesson using this model requires higher order thinking, as the teacher encourages learner questions, open-ended explorations, and idea consolidation, all of which are core components of critical thinking (Ilhami & Laksono, 2022; Porteria & Gaza, 2025).

Despite its importance, studies have indicated that pre-service teachers often focus more on the procedural format of lesson plans rather than on designing plans to meet specific learning outcomes and student needs (Contreras et al., 2020). This suggests an absence of deep, active cognitive processing during the planning stage. Moreover, research in Indonesia found challenges that pre-service teachers face in identifying appropriate media and navigating learning tools (Fakhrunnisa, 2021). Similarly, studies in the Philippines reported that difficulties in formulating objectives and selecting subject matter hinder effective lesson planning (Napanoy et al., 2021; Ferrer, 2021). These challenges point to a potential gap between knowing the structure of a lesson plan and possessing the cognitive skills to design one effectively.

While the literature acknowledges that critical thinking is vital for teaching (Hastuti et al., 2021) and that pre-service teachers' lesson plans often lack cognitive depth and coherence (Maharani et al., 2021), few studies have explicitly examined the direct relationship between pre-service teachers' critical thinking abilities and their capacity to craft effective inquiry-based lesson plans. As Prayogi et al. (2024) suggested, there is a pressing need to re-evaluate how inquiry-based models are used to develop the critical thinking skills of pre-service teachers.

This study describes the critical thinking skills of pre-service teachers in designing inquiry-based lesson plans using the 7E instructional design model. The researchers believe this study contributes meaningfully to advancements in teacher education by fostering critical thinking and improving the skills needed to design inquiry-based lessons, which are foundational for effective facilitation. By examining this relationship, this study provides valuable insights for teacher education programs that aim to equip pre-service teachers with the skills needed to foster meaningful and inquiry-driven learning.

Hence, the primary aim of this study is to determine the level of critical thinking skills demonstrated by pre-service teachers in designing inquiry-based lesson plans. This study addresses the following question: What is the level of critical thinking skills of the pre-service teachers in designing inquiry-based lesson plans in terms of each phase of the model?

Materials and Methods

Research Design

This study utilized a descriptive research design, enriched with qualitative data to examine the level of critical thinking skills of the Bachelor of Elementary Education (BEEd) pre-service teachers in designing inquiry-based lesson plans. This research design was to describe the rate distribution of variables in the study which makes it suitable for the process of this study (Aggarwal & Ranganathan, 2019).

Site and Respondents

In this study, the respondents were 162 second-year BEEd pre-service teachers who were enrolled at the College of Education, Mindanao State University-General Santos City. These pre-service teachers were selected purposefully due to their exposure to the 7Es Instructional Design lesson plan which is necessary to fully capture their experience in crafting 7E Instructional Design lesson plans. Validity concerns were also considered in identifying the research respondents. Hence, this set of criteria made the study effective in describing the critical thinking skills of the pre-service teachers concerning crafting 7E Instructional Design lesson plans.

Instrumentation

The instrument used in the study was a 35-item research-made questionnaire, written in English. In developing the questionnaire, the researchers employed the developmental approach comprising three phases: planning, development, and validation. The questionnaire underwent content validation by a pool of field experts in education. Then it went for pilot testing to test its reliability (□ = 0.96). The indicators of the survey questionnaire were anchored to the 7E learning model of Eisenkraft (2003) which is also based on the theory of constructivism. The indicators per sub -category were formulated based on the description specified by the author of the model. The researchers also contextualized concepts of critical thinking skills in formulating the indicators in designing inquiry-based lesson plans as indicated in the 21st century skills framework of the Partnership for 21st Century Learning (2019).

In his study, Eisenkraft (2003) elaborated

on the significant role of teachers in adjusting, modifying, and planning the lessons for them to facilitate learning better. In the survey, there were seven (7) sections with five (5) questions in every area of the 7E Instructional Design lesson plan, namely, Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend. Moreover, the indicators reflect the active processes related to critical thinking skills while integrating them with the design of the 7Es learning model. For the interview, the given a question to describe their perceptions on crafting 7E Instructional Design lessons plans per-subcategory.

Data Gathering

Before the conduct of the study, the researchers sought permission from the Bachelor of Elementary Education Chairperson to conduct the study. Upon approval, the researchers asked informed consent from the pre-service teachers. Then, the researcher-made questionnaire was validated by pool of experts, then it was pilot tested to check the reliability. After ensuring the reliability and validity of the questionnaire, Google forms were utilized to gather data from the pre-service teachers the end of the Second Semester, Academic Year 2024-2025 in which GED 101 – Teaching Science in Elementary Grades (Biology & Chemistry) was offered with their consent before conducting the study, adhering to establish ethical considerations to human objects. After the quantitative data were generated, twelve (12) pre-service teachers volunteered to undergo a one-on-one interview to verify and support the data based on their experiences in crafting the 7E Instructional Design Lesson Plans in Science in less than an hour. The results of the interview were used to the results from the quantitative data to strengthen the discussion.

Data Analysis

To analyze the data, descriptive statistics, specifically frequency and weighted mean following the 5-point Likert scale of frequency was employed as shown in Table 1. The mean per sub-component was generated for the quantitative data. This data was then examined based on the established interpretation levels.

Table 1.

Likert Scale Range and Interpretation of Pre-Service Teachers' Critical Thinking Skills

Likert Scale	Range	Description	Verbal Interpretation
5	4.21-5.00	Very High	The critical thinking skills of pre-service teachers are always utilized.
4	3.41-4.20	High	The critical thinking skills of pre-service teachers are often utilized.
3	2.61-3.40	Moderate	The critical thinking skills of pre-service teachers are sometimes utilized.
2	1.81-2.60	Low	The critical thinking skills of pre-service teachers are rarely utilized.
1	1.00-1.80	Very Low	The critical thinking skills of pre-service teachers are never utilized.

To strengthen the quantitative results, the researchers interviewed twelve (12) pre-service teachers using a semi-structured interview guide to verify and support the data based on their experiences in crafting the 7E Instructional Design Lesson Plans in Science in less than an hour. The qualitative data was reviewed to support and verify the results.

Results and Discussion

This study examines the level of critical thinking skills of the 162 second-year pre-service teachers in designing inquiry-based lesson plans. The results are chronologically presented by phase of the 7E instructional design model.

Table 1 describes the Elicit phase of the lesson planning indicating a 4.21 mean which manifests a consistent application of their critical thinking skills. The respondents always demonstrate abilities to design activities, encouraging students to activate their prior knowledge, reflect, ask questions, and share insights.

Furthermore, pre-service teachers consistently reflect on the past experiences of their pre-service teachers, ensuring the suitability of the activities for review during lesson planning. The result suggests that pre-service teachers engage in deliberate processes in designing activities to maximize their learning experiences. However, there is a slight decrease in the mean score and

Table 2.

Level of Critical Thinking Skills of BEEd Pre-service Teachers in Elicit Phase

	Mean	SD	Description	Verbal Interpretation
ELICIT				
1. I think of strategies for learners to reflect on their understanding, ask questions, and share insights.	4.15	0.48	Very High	The critical thinking skills of pre-service teachers are always utilized.
2. I design new and exciting review activities that prompt prior knowledge and encourage learners to ask questions.	4.28	0.74	Very High	The critical thinking skills of pre-service teachers are always utilized.
3. I reflect on past experiences with children to evaluate the suitability of selected activities for review during lesson planning.	4.27	0.75	Very High	The critical thinking skills of pre-service teachers are always utilized.
4. I easily think of concepts or ways to connect the prior topic to the new topic.	3.98	0.92	Very High	The critical thinking skills of pre-service teachers are always utilized.
5. I write instructions or process questions to prompt learners to share their ideas on the previous topic.	4.36	0.74	Very High	The critical thinking skills of pre-service teachers are always utilized.
	4.21	**0.73**	**Very High**	**The critical thinking skills of pre-service teachers are always utilized.**

higher variability in their ability to identify concepts or ways to seamlessly relate the prior topic to the new topic. Nonetheless, pre-service teachers still frequently demonstrate critical thinking in deciding which activities and questions to include during this phase.

Reviewing the appropriateness of questions is essential for scaffolding pre-service teachers' prior knowledge, ensuring the questions are not overwhelming for learners (P9). Thought-provoking questions, used in pre-assessment activities, stimulate curiosity and reflection, prompting learners to evaluate their prior knowledge and assumptions (P2). The BEEd pre-service teachers' inclusion of such questions in the elicit phase underscores their awareness of the importance of critical thinking in inquiry-based lesson plans. Research by Rahmatih et al. (2021) found that the quality of questions posed by PGSD students generally fell into the factual cognitive category, requiring low-level cognitive responses, with most questions aimed at the level of analysis. The study also noted that the ability to convert information into questions remained at a basic level, with initial skills in Higher Order Thinking Skills (HOTS). Dimalaluan et al. (2016) revealed that student teachers' performance in questioning was rated as "very satisfactory" by themselves and their cooperating teachers.

These results align with Botes et. al. (2022), who highlighted how pre-service teachers reflected and learned from their peers' teaching experiences, suggesting a collaborative reflection process that allows to formulate powerful ideas for improving the quality of their lesson plans. This solidifies the notion that pre-service teachers can think of ways to help learners reflect on their own thinking by also learning from their own and peers' experiences.

Table 2 presents the Engage part with a mean of 4.15 which suggests that the respondents frequently employ critical thinking skills in planning activities that encourage higher order of thinking and active student engagement. They employ critical thinking skills in designing motivational activities to capture learners' attention and they always select activities that encourage learners to analyze information from various disciplines. Additionally, they often design engaging activities that tap into learners' existing knowledge using their imagination and prepare open-ended questions and prompts that strategically pique learners' interest and curiosity, encouraging them to engage critically with the topic.

BEEd pre-service teachers strive to provide scenarios or activities that will catch students' attention by provoking them to think critically to

stay engaged in the lesson. These include presenting real-life scenarios, followed by strategic questions (P3).

Some activities that are considered in the lesson planning include presenting intriguing scenarios, such as analyzing videos, images, or statements (P1).

Incorporating the activities mentioned above in the lesson plan requires critical thinking among BEEd pre-service teachers. Critical thinking dispositions are perceived as triggers, motivators, and incentives to become skillful and accustomed to critical thinking (Altınkurt, 2015). They must carefully choose activities that will engage students' interest, foster curiosity, and develop higher-order thinking skills. In the context of teacher education, developing a critical thinking curiosity, awareness, dedication, and a strong tendency for pre-service teachers to think and work in a positive way. Gelder (2005) confirmed that pre-service teachers must have the ability to teach critical thinking, regularly exercise their critical thinking skills, and continuously strive to improve them.

In the study of Isaacs et al. (2024), pre-service teachers were able to use their critical thinking skills related to planning, designing, and solving problems to convey an argument. These processes of connecting content to multimedia elements and considering their audience's perspective align with designing attention-grabbing activities.

Table 3, as reflected in 4.18 mean, implies that BEEd pre-service teachers often utilize critical thinking skills when strategizing for the Exploration phase of their lesson plan. They deliberately include experiential and investigative activities in which pre-service teachers construct explanations and predictions anchored on their observations. Furthermore, pre-service teachers think of unconventional strategies for learners to engage in experimentation and investigation. With this, they evaluate the suitability of the activities they intend to incorporate, ensuring they promote problem-solving and investigative skills in learners.

One of the challenges in the ideation process of preparing a lesson plan for pre-service teachers is ensuring the provision of activities that facilitate successful exploration of the topic while providing appropriate guidance during this process (P11). It is crucial to evaluate the benefits and relevance of these activities to the lesson discussion (P9). Therefore, pre-service teachers must exhibit critical and strategic thinking regarding the activities they employ to elicit expected responses and behaviors, which are essential for effectively discussing the topic.

This result corrobate the study of Magaji et al. (2024), that emphasized that problem-based learning is an effective strategy for developing students' problem-solving skills and that pre-service teachers should be actively involved in

Table 3.

Level of Critical Thinking Skills of BEEd Pre-service Teachers in Engage Phase

	Mean	SD	Description	Verbal Interpretation
ENGAGE				
1. I create engaging and thought-provoking activities that are contextualized.	4.04	0.80	High	The critical thinking skills of pre-service teachers are often utilized.
2. I strategically devise prompts that not only pique learners' interest but also foster curiosity, encouraging them to engage critically with the topic at hand.	4.12	0.74	High	The critical thinking skills of pre-service teachers are often utilized.
3. I design fun activities that tap into learners' existing knowledge using my imagination.	4.19	0.77	High	The critical thinking skills of pre-service teachers are often utilized.
4. I use open-ended questions that encourage curiosity and challenge prior knowledge.	4.15	0.78	High	The critical thinking skills of pre-service teachers are often utilized.
5. I select activities that require learners to analyze information from various disciplines.	4.24	0.72	Very High	The critical thinking skills of pre-service teachers are always utilized.
	4.15	**0.76**	**High**	The critical thinking skills of pre-service teachers are often utilized.

Table 4.

Level of Critical Thinking Skills of BEEd Pre-service Teachers in Explore

	Mean	SD	Description	Verbal Interpretation
EXPLORE				
1. I formulate hands on and 7E Instructional Design activities that encourage learners to learn concepts.	4.25	0.69	Very High	The critical thinking skills of pre-service teachers are always utilized.
2. I evaluate activities' appropriateness first and make sure that they foster problem-solving and investigative abilities among learners before writing it.	4.15	0.76	High	The critical thinking skills of pre-service teachers are often utilized.
3. I deliberately select activities that challenge learners to collect data, analyze results, and discern patterns, demonstrating critical thinking in my instructional choices.	4.02	0.76	High	The critical thinking skills of pre-service teachers are often utilized.
4. I foster learners' critical thinking by prompting them to construct explanations and predictions grounded in their observations.	4.28	0.65	Very High	The critical thinking skills of pre-service teachers are always utilized.
5. I think of original ways or opportunities for learners to investigate or experiment.	4.17	0.85	High	The critical thinking skills of pre-service teachers are often utilized.
	4.18	**0.74**	**High**	**The critical thinking skills of pre-service teachers are often utilized.**

designing and experiencing this form of learning to learn how to use it effectively. It shows how pre-service teachers evaluate and incorporate activities that promote problem-solving in learners.

Table 4 shows that the Explain part gained a mean score of 4.20. For planning in the Explain part of an inquiry-based lesson plan, the pre-service teachers often use critical thinking to plan how to discuss the topics. They always use relevant examples and non-examples to illustrate key concepts. They often think of ways or scenarios that will encourage learners to justify their reasoning and use evidence to support their conclusions. BEEd pre-service teachers also use a variety of instructional strategies to accommodate diverse learning styles. They carefully select an explanatory approach that fosters a deeper comprehension of new information about past knowledge, and then effectively communicate concepts and instructions. Moreover, pre-service teachers perceive their role as facilitators during this stage.

The role of pre-service teachers as facilitators and role models is crucial in helping students transform their own reality (Patrick & Ryan, 2005). Instead of just delivering lectures, teachers should act as facilitators during the explanation phase, which means they need to develop strategies to explain topics while encouraging students to actively participate. They should use prompts to get students to contribute during discussions and guide them in analyzing and synthesizing information from different sources to form their own explanations. Therefore, when planning lessons, pre-service teachers carefully consider strategies that make the learning process interactive, requiring critical thinking. For pre-service teachers, becoming an effective educator involves analyzing their own classrooms, the activities they design, and their teaching methods to ensure they are meaningful. As claimed by Peters (2012), pre-service teachers must develop the skills and attitudes necessary to critically reflect on both their own and others' practices.

The study of Laius and Presmann (2024) examined pre-service science teachers' perceptions of using inquiry-based learning and real-life examples during their teacher training. Their study revealed that pre-service teachers who study their science lessons more can provide real-life examples to their classes more. This underscores

Table 5.

Level of Critical Thinking Skills of BEEd Pre-service Teachers in Explain Phase

	Mean	SD	Description	Verbal Interpretation
EXPLAIN				
1. I effectively communicate of concepts and instructions clearly.	4.12	0.78	High	The critical thinking skills of pre-service teachers are often utilized.
2. I use a variety of instructional strategies to accommodate diverse learning styles.	4.19	0.78	High	The critical thinking skills of pre-service teachers are often utilized.
3. I choose a method of explanation that promotes a deeper understanding between new information and prior knowledge.	4.19	0.75	High	The critical thinking skills of pre-service teachers are often utilized.
4. I think of ways or scenarios that will encourage learners to justify their reasoning and use evidence to support their conclusions.	4.20	0.74	High	The critical thinking skills of pre-service teachers are often utilized.
5. I use relevant examples and non-examples to illustrate key concepts.	4.31	0.75	Very High	The critical thinking skills of pre-service teachers are always utilized.
	4.20	**0.76**	**High**	**The critical thinking skills of pre-service teachers are often utilized.**

the importance of equipping pre-service teachers with the content knowledge they need with the subject matter they teach.

Table 5 indicates the gained mean score of 4.28 during the Elaborate phase, presenting a favorable implication that pre-service teachers always think critically when choosing and designing activities for the class. They always tend to present real-world scenarios that allow learners to explore related topics comprehensively. In addition, they always design activities that challenge learners to apply what they have learned in various scenarios, solve problems, and create outputs. The result also implies that pre-service teachers often provide simulation activities and carefully assess the complexity and relevance of elaboration activities.

At the Elaborate, teachers can give independent or group practice to allow the students to explore in applying the concepts (P 12).

Planning for a learning activity in this phase is crucial for the BEEd pre-service teachers since it will let them apply what they have acquired from the previous phases. They carefully consider the activities they intend to employ to achieve the learning competence expected from the students.

In selecting an activity, teachers should consider an activity that requires students to think critically while applying what they have learned. Teachers must provide challenging activities, such as making projects or solving problems, that allow students to think critically and creatively (P8).

This outcome echoes the study of Dagher & Metzger (2024that shed light on how pre-service teachers use digital clinical simulations to practice and reflect on creating an equitable learning environment. These results highlighted the use of simulations in preparing future educators for complex, real-world classroom challenges and intervention designs that support student engagement and learning. This supports the idea that pre-service teachers can design activities that test learners' ability to apply knowledge in real-life situations.

In table 6, the Evaluation phase gained a mean score of 4.38. This indicates that pre-service teachers consistently utilize critical thinking abilities in evaluating the learning outcomes of the learners. These abilities include designing assessments that effectively gauge learning outcomes, aligning assessment types with the expected learning outcomes of the topic, incorporating formative and summative assessments that require learners to evaluate their learning, and varying the difficulty levels of assessment based on students' backgrounds to

Table 6.

Level of Critical Thinking Skills of BEEd Pre-service teachers in Elaborate Phase

	Mean	SD	Description	Verbal Interpretation
ELABORATE				
1. I formulate individual activities that challenge learners to apply their learning in new situations.	4.34	0.72	Very High	The critical thinking skills of pre-service teachers are always utilized.
2. I present scenarios that make connections to real-world situations and explore related topics in greater depth.	4.43	0.63	Very High	The critical thinking skills of pre-service teachers are always utilized.
3. I carefully assess the level of complexity and relevance of elaboration activities.	4.15	0.76	High	The critical thinking skills of pre-service teachers are often utilized.
4. I create new applications and simulation activities that will utilize higher-order thinking skills of the learners.	4.18	0.71	High	The critical thinking skills of pre-service teachers are often utilized.
5. I design activities where learners apply their new knowledge to solve problems or create new outputs.	4.30	0.73	Very High	The critical thinking skills of pre-service teachers are always utilized.
	4.28	0.71	Very High	The critical thinking skills of pre-service teachers are always utilized.

Table 7.

Level of Critical Thinking Skills of BEEd Pre-service teachers in Evaluate Phase

	Mean	SD	Description	Verbal Interpretation
EVALUATE				
1. I design assessments that effectively measure learner learning outcomes.	4.41	0.66	Very High	The critical thinking skills of pre-service teachers are always utilized.
2. I carefully align the types of assessment with the outcomes of the topic.	4.40	0.68	Very High	The critical thinking skills of pre-service teachers are always utilized.
3. I vary the difficulty level of assessment according to grade or age or by gauging their ideal mental capacity of the learners.	4.37	0.72	Very High	The critical thinking skills of pre-service teachers are always utilized.
4. I incorporate formative and summative assessments that require learners to evaluate their learning.	4.39	0.66	Very High	The critical thinking skills of pre-service teachers are always utilized.
5. I vary assessment methods to accommodate different learning styles.	4.32	0.76	Very High	The critical thinking skills of pre-service teachers are always utilized.
	4.38	**0.70**	**Very High**	**The critical thinking skills of pre-service teachers are always utilized.**

accommodate diverse learning styles.

Ensuring that both in-service and pre-service teachers develop strong skills in using assessments for learning is crucial. Their proficiency with assessments directly affects their confidence in applying various assessment strategies, whether created by the teachers themselves or provided by the system (Samad et al., 2008; Ismail et al., 2019; Wilson & Narasuman, 2020). BEEd pre-service teachers carefully plan their assessment activities while preparing lessons, making sure these activities align with the learning objectives. Courses for pre-service teachers can be more effective by focusing on formative assessments, steering clear of traditional methods, and engaging pre-service teachers as active participants in the assessment process (Hill et al., 2017). Additionally, they should design assessment activities that require students to demonstrate their understanding of the concepts they learned.

This result is further supported by the study of Lazarakou (2025), which explored pre-service teachers' beliefs about classroom assessment, finding a strong preference for ormative assessments that support learning and enhance learners' metacognitive development. Its findings underscored the importance of aligning assessments with learning goals corroborating the idea that pre-service teachers are able to design appropriate assessment strategies to enhance learning.

Table 7mirrors Extension phase with a mean score of 4.29. Pre-service teachers responded that they apply critical thinking skills in planning for learning activities in extend phase of the lesson. They identified critical thinking skills they always exhibit, such as developing enrichment activities that link the topic to real-life situations, assessing the significance of assignment activities to enhance learners' comprehension of the subject, devising follow-up activities that promote curiosity and lifelong learning, and formulating innovative assignments to expand learning beyond the classroom. In terms of differentiated enrichment activities, BEEd pre-service teachers often use this strategy to cater to students' learning styles and multiple intelligences.

Ensuring students apply and relate what they have learned to real-life scenarios requires a deliberate process in lesson planning (P11).

Consequently, students are given assignments to enable them to apply their knowledge across several domains (P12).

Designing an inquiry-based lesson plan, especially during the extension phase, is particularly challenging and underscores the importance of critical thinking. Research shows that 7E Instructional Design learning effectively stimulates students' thinking skills (Marshall and Horton, 2011; Yager & Akcay, 2010). BEEd pre-service teachers need to critically analyze the subject matter to determine its relevance and potential

Table 8.

Level of Critical Thinking Skills of BEEd Pre-service Teachers in Extend Phase

	Mean	SD	Description	Verbal Interpretation
E**XTEND**				
1. I formulate creative assignments to extend learning beyond the classroom.	4.25	0.74	Very High	The critical thinking skills of pre-service teachers are always utilized.
2. I evaluate the relevance of assignment activities to deepen learners' understanding of the topic.	4.29	0.70	Very High	The critical thinking skills of pre-service teachers are always utilized.
3. I create follow-up activities that foster a sense of curiosity and lifelong learning.	4.27	0.73	Very High	The critical thinking skills of pre-service teachers are always utilized.
4. I differentiate enrichment activities to cater to the different learning styles and multiple intelligences of the learners.	4.15	0.84	High	The critical thinking skills of pre-service teachers are often utilized.
5. I design enrichment activities that connect the content to real-world scenarios.	4.47	0.65	Very High	The critical thinking skills of pre-service teachers are always utilized.
	4.29	**0.73**	**Very High**	**The critical thinking skills of pre-service teachers are always utilized.**

Table 9

Level of Critical Thinking Skills of BEEd Pre-service Teachers in Designing 7E Inquiry-Based Lesson Plans

	Mean	SD	Description	
Elicit	4.21	0.73	Very High	The critical thinking skills of pre-service teachers are always utilized.
Engage	4.15	0.76	High	The critical thinking skills of pre-service teachers are often utilized.
Explore	4.18	0.74	High	The critical thinking skills of pre-service teachers are often utilized.
Explain	4.20	0.76	High	The critical thinking skills of pre-service teachers are often utilized.
Elaborate	4.28	0.71	Very High	The critical thinking skills of pre-service teachers are always utilized.
Evaluate	4.38	0.70	Very High	The critical thinking skills of pre-service teachers are always utilized.
Extend	4.29	0.73	Very High	The critical thinking skills of pre-service teachers are always utilized.
Over-all mean	**4.24**	**0.73**	**Very High**	**The critical thinking skills of pre-service teachers are always utilized.**

applications in diverse contexts. Definitions of inquiry vary by context, and the lack of a clearly defined philosophy on scientific inquiry, along with limitations in the curriculum, makes it difficult for science teacher educators to teach inquiry effectively (Newman et al., 2004). Therefore, this study adopts five essential features of inquiry as the primary framework for science education, such as: engaging in scientifically oriented questions. Teachers must create learning experiences that allow students to apply their knowledge to real-life scenarios. Consequently, the challenge lies in designing assignments and activities that encourage such application while meeting the learning objectives.

This finding aligns with Abualrob's (2024) study, in which he investigated how pre-service teachers use artificial intelligence to design innovative instructional materials and assignments that link conceptual knowledge to practical application. It highlights the importance of preparing pre-service teachers with tools and strategies that help them design lessons and assessments that are relevant to the real world.

Table 8, shows the overall mean score of 4.24 of each phase, reflecting that most second-year BEEd students perceive themselves as exhibiting critical thinking in crafting 7E Instructional Design lesson plans. The low standard deviation of 0.74 suggests little variability among the responses, indicating a high level of agreement among the respondents regarding their critical thinking skills while making 7E Instructional Design lesson plans. The second-year BEED pre-service teachers perceive themselves as consistently demonstrating critical thinking skills when developing their lesson plans. This result indicates their preparedness to employ effective practices in an 7E Instructional Design teaching approach in elementary education.

This is already expected since critical thinking is a vital competence to be inculcated upon the generations of the 21st century as this will enable them to come out victoriously into the fast-changing world. This is evident in the study by Çarkıt & Kurnaz (2022) which found that pre-service teachers exhibit a high level of critical thinking application. Additionally, Kusaeri and Aditomo's (2019) research involving 223 pre-service mathematics teachers revealed that 21.4% of respondents considered developing one or more skills in critical thinking as one of their top three learning objectives. This demonstrates that pre-service teachers recognize the importance of cultivating s critical thinking skills, both in lesson planning and teaching practices.

Overall, pre-service teachers actively employed critical thinking skills in designing inquiry-based lesson plans. BEEd pre-service teachers engaged in a deliberate process and a thoughtful approach in designing learning activities and assessments that promote active learning, problem-solving, and real-world application of knowledge. They demonstrate their ability to analyze, evaluate, and synthesize information, ensuring their lesson plans effectively promote

positive learning experiences, which are good indicators for their future effectiveness as educators.

In today's modern era, the primary goal of the education system is to produce individuals who are literate, creative, innovative, and critical thinkers (Aybek, 2006). Educators, including pre-service teachers, and other stakeholders must exhibit dedication to crafting programs that help learners develop critical thinking skills (King et al., 1990). Moreover, pre-service teachers often use critical thinking skills to design inquiry-based lesson plans. Various interventions can enhance these critical thinking skills and competence in inquiry-based lesson planning (Mugaloglu & Sarıbas, 2010).

Eliciting and building upon prior knowledge is a crucial aspect of contemporary learning (Greeno, 1996). The pre-service teachers demonstrated thorough reflection on strategies, concepts, experiences, and instructions aimed at encouraging learners to activate their prior knowledge. One of the probable reasons why pre-service teachers exhibited high critical thinking skills in developing strategies to activate prior knowledge includes their exposure to comprehensive training in reflective practices, practical classroom experience, and a strong emphasis on student-centered learning which is highly embedded in the course syllabus. These factors collectively enhanced their ability to design effective and relevant instructional strategies. This approach was supported by a study conducted by Otero (2004), which involved 23 pre-service teachers. The study revealed that all participants included strategies for eliciting prior knowledge in their lesson plans. These strategies were typically highlighted in their pre-assessments and were also integrated into their learning objectives.

Student engagement is the cornerstone of effective instruction. Rothstein and Mathis (2013) emphasize the importance of educators in developing the K-12 students' intellectual capacities through cognitively engaging tasks. The results above indicate that pre-service teachers strategically create, devise, select, and design appealing and thought-provoking activities, such as prompts, open-ended questions, and information analysis, to foster curiosity and imagination, thereby engaging learners in the lesson. A possible rationale for the result is their rigorous training in innovative teaching methods and active learning strategies. In addition, their practical classroom experiences such as teaching demonstrations likely reinforced the importance of stimulating student curiosity and imagination. This is supported by Beasley (2014) who explored the evolving understanding of student engagement among pre-service teachers. Involving two pre-service teachers, the study found that their later reflections suggested a more fully developed understanding of student engagement. This understanding indicated a level of confidence that should be invaluable in their first classrooms. Additionally, Shernoff et.al. (2003) advocated for a focus on student engagement, as it results in increased student autonomy and presents appropriate challenges within the classroom.

People construct their understanding of the world through experiencing things and reflecting on those experiences (Bereiter, 1994). As demonstrated by the results, pre-service teachers formulate, evaluate, and select appropriate activities such as hands-on, 7E Instructional Design predictions from observations and experiments to foster problem-solving and investigative abilities during the exploration stage of the lesson plan. The result can be attributed to their comprehensive training in 7E Instructional Design learning, such as designing hands-on experiments to predict outcomes and analyze data. To cite a specific example, their education programs include workshops that aim to develop hands-on activities and strategies for their effective classroom implementation. Additionally, practical teaching experiences that refine these 7E Instructional Design methods further enhance their ability to foster students' problem-solving and investigative abilities during the Exploration stage of lesson plans. This phase aims to provide students with a common experience, enabling them to engage directly with the topic and explore the concept independently. This approach helps students build their own understanding and identify any unsatisfactory explanations they may have (Rahman, 2022).

Education programs increasingly bear the responsibility of preparing new teachers who can effectively enhance learning for all students. Drawing from the outcome, in order to explain the lessons, the pre-service teachers think, choose, and use a variety of instructional strategies, methods of explanation, and relevant examples to effectively communicate clearly and accommodate diverse learning styles. One explanation for their high critical thinking level in the Explanation phase might be their training in techniques which include Universal Design for Learning (UDL) and cultural and contextualized responsive teaching. For instance, they were taught to use multiple means of representation, like combining visual aids and storytelling to explain scientific concepts, or to incorporate students' cultural backgrounds into lessons to make them more relatable and engaging. Furthermore, practical experiences in diverse classroom settings enabled them to apply these strategies effectively, ensuring clear

communication and accommodating various learning styles. This was also manifested in a study by Sandholtz (2011), involving 290 pre-service teachers, which reported that 77% of the participants described effective instructional experiences as those incorporating student participation. These pre-service teachers reported using various strategies to engage students, including manipulatives, visual representations, realia, games, and hands-on activities, to accommodate all types of learners and maximize their learning experience.

Moreover, pre-service teachers utilized critical thinking comprehensively in formulating, presenting, assessing, and designing activities that encourage learners to challenge themselves. One justification for the result could be their comprehensive training in Bloom's Taxonomy and 7E Instructional Design learning. In line with that, their education courses often include peer review and reflective practice, allowing them to refine their ability to present and assess activities that push the pre-service teachers to challenge their own understanding and skills. These activities help students connect and apply their new knowledge to solve problems, create new outputs, and relate to real-world situations. This approach is also evident in the study of Garrison (1991), which explored how pre-service teachers were engaged in organizing information, corresponding to the problem identification phase. They then clarified and justified concepts and ideas, aligning with the problem definition phase. An Exploratory phase followed, during which students participated in information inquiry. Additionally, the student teachers suggested initial ideas for solving the case study, which can be perceived as the phase of developing alternatives.

In line with this, pre-service teachers enhanced lessons by designing activities using new applications and simulations that foster higher order thinking and appropriate assessments. One probable reason is their extensive exposure to educational technology and digital tools. Their programs often include coursework on creating digital assessments, such as Google Forms and Kahoot!, which align with these simulations and effectively assess higher order thinking skills. Moreover, practical experience with these tools in classroom settings allows them to refine their approaches and understand the most effective ways to integrate technology into their lesson plans. A study by Ruys et al. (2012), involving 100 primary school student teachers and 323 lesson plans, identified three key strengths: (a) 74.3% included well-designed learning tasks aligned with objectives and pupil development, (b) 90.1% featured adequately chosen or developed materials and resources, and (c) 65.9% paid explicit attention to formal and informal evaluations. These findings indicate that second-year pre-service teachers are well-equipped to create effective lesson plans, having been trained in developing learning tasks, materials, and evaluations during their first year of teacher education.

Similarly, pre-service teachers incorporate evaluations in their lesson plans by designing both formative and summative assessments that align with learning outcomes and are appropriate for the grade level and age of the students. A likely reason for this is their targeted training in educational assessment methods, such as creating rubrics and performance tasks that align with specific learning outcomes. Their educational courses also often include practical experience in diverse classroom settings such as classroom immersions, allowing them to tailor these assessments to be age- and grade-appropriate, ensuring they effectively measure student progress. It is crucial that pre-service teachers are given more opportunities to engage with all Assessment for Learning strategies during their initial teacher education (Macken et al., 2020). A detailed examination of assessment programs in initial teacher education reveals various approaches, including offering a dedicated course on assessment (Craven et al., 2014; Izci & Caliskan, 2017; Levy-Vered & Alhija, 2018) and integrating assessment concepts into the broader curriculum or general education courses (Brevik, et al., 2017; Greenberg & Walsh, 2012).

Lastly, pre-service teachers develop, assess, and create innovative and enriched assignments to enhance learners' understanding, foster creativity, accommodate different learning styles, and connect concepts to real-world scenarios using multiple intelligences theory. Pre-service teachers likely demonstrate high critical thinking skills in developing enrichment assignments due to extensive training in differentiated instruction and multiple intelligences theory –both of which are integrated into majority of course syllabi. This training enables them to , create tasks like multimedia presentations that cater to various learning styles. Their programs emphasize real-world connections and provide practical teaching experiences, enabling them to design and refine projects such as community-based research, enhancing understanding and fostering creativity among diverse learners. Tanak (2020), in a study of 15 undergraduate pre-service teachers, found that they advanced their inquiry levels by incorporating all five features of inquiry, including evidence and explanation. Additionally, pre-service teachers demonstrate the ability to design activities that are both creative and reasoning-enriched.

Conclusion and Recommendations

This study examined the critical thinking skills demonstrated by pre-service teachers when designing 7E instructional plans for science lessons. Findings reveal that these pre-service teachers effectively apply critical thinking skills to create 7E lesson plans that promote knowledge application, problem-solving, and real-world connections. Their training in educational technology equips them to develop aligned digital assessments and simulations, while practical classroom experiences enable effective tool integration. Research confirms their ability to design well-aligned tasks, select appropriate materials, and implement through evaluations (Ruys et al,, 2012).

Future researchers may use these results to strengthen the critical thinking integration in 7E Instructional Design. Training in differentiated instruction and multiple intelligences theory further enables innovative assignments that foster creativity and real-world connections.

The researchers recommend that educators using 7E Instructional Design should review pre-service teachers' actual lesson plans to verify these critical thinking competencies. Additional opportunities to develop critical thinking skills should be provided across all lesson plan designs. Finally, workshops and modules on embedding critical thinking in science lesson planning should be developed to guide pre-service teachers.

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