Empowering Pre-Service Teachers to Adapt Curriculum for Better Climate Change Education Using an Inquiry-Based Activity Template

İklim Değişikliği Eğitimine Yönelik Eğitim Programı Uyarlama Becerilerinin Sorgulama Temelli Öğretimle Desteklenmesi

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Abstract

This study explores how an inquiry-based activity planning template—structured around Inquire, Investigate, and Inspire stages—supports pre-service teachers in designing climate change education activities. The template encouraged participants to generate "I wonder" questions, promote student-led inquiry, and transform complex environmental topics into actionable lessons. Pre-service teachers from various disciplines developed and simulated activity plans using the template. Data sources included written plans and post-implementation interviews. Document analysis focused on inquiry clarity, curricular relevance, feasibility, student engagement, and assessment design. Thematic analysis revealed that using the template iteratively enhanced participants' pedagogical skills, fostering interdisciplinary, inquiry-based approaches, and increasing confidence in lesson design. Participants also reported improved collaboration, real-time lesson refinement, and deeper awareness of student engagement and assessment. Challenges included aligning with rigid curriculum standards and adapting tasks to diverse developmental levels. The study highlights the need for flexible curricular tools and sustained mentorship in teacher education to support inquiry-based learning.

Keywords: Activity template, climate change education, curriculum customization, inquiry-based learning, pre-service teachers.

Öz

Bu araştırma, öğretmen adaylarının iklim değişikliği eğitimi bağlamında sorgulama temelli etkinlikler planlama ve mevcut eğitim programlarını esnek bir şekilde uyarlama becerilerini geliştirmelerine odaklanmaktadır. Çalışmada kullanılan etkinlik şablonu, "Sorgula, Araştır, İlham Ver" adımlarını temel alarak tasarlanmıştır. Bu yapılandırma, öğretmen adaylarının öğrencilerin aktif katılımını teşvik eden ve sorgulama odaklı bir öğrenme ortamı kurgulamasına yardımcı olmayı amaçlamaktadır. Süreç boyunca öğretmen adayları, "Merak ediyorum..." soruları geliştirerek ders planlarının başlangıç noktasını oluşturmuş, bu sayede karmaşık çevresel konuları öğrencilerin anlayabileceği somut öğrenme deneyimlerine dönüştürmeyi öğrenmişlerdir. Çalışmaya farklı bölümlerinden toplam 57 öğretmen adayı katılmıştır. Katılımcılar, sorgulama temelli etkinlik şablonunu kullanarak iklim değişikliği konulu

etkinlik planları geliştirmiştir. Bu planlar kontrollü bir eğitim ortamında uygulanmış ve uygulama sonrasında süreç değerlendirilmiştir. Araştırmanın verileri, katılımcıların hazırladığı yazılı etkinlik planları ve uygulama sonrası gerçekleştirilen yarı yapılandırılmış görüşmelerden elde edilmiştir. Toplanan veriler beş ana başlık altında incelenmiştir: oluşturulan sorgulama sorularının açıklığı ve programa uygunluğu, sorgulama temelli öğrenme stratejilerinin etkinliklere entegrasyonu, planların uygulanabilirlik düzeyi, öğrenci katılımını artırma potansiyeli ve değerlendirme yöntemlerinin niteliği. Görüşme verileri ise öğretmen adaylarının şablonu kullanma deneyimlerini, karşılaştıkları zorlukları ve mesleki gelişim süreçlerini anlamaya yönelik tematik olarak analiz edilmiştir. Elde edilen sonuçlar, etkinlik şablonunun düzenli kullanımı sayesinde öğretmen adaylarının iklim değişikliği gibi disiplinler arası bir konuyu sorgulama temelli ve yerel bağlama uygun bir şekilde ele alma becerilerini geliştirdiğini göstermektedir. Katılımcılar, sadece etkinlik hazırlamakla kalmayıp, öğrencilerin anlamlı öğrenme deneyimleri yaşamalarını hedefleyen planlar geliştirdiklerini ifade etmiştir. Ancak programın esnek olmaması, zaman kısıtları ve farklı yaş gruplarına uygunlaştırma konuları sürecin önündeki başlıca engeller olarak belirtilmiştir. Çalışma, öğretmen eğitiminde sorgulama temelli planlama yaklaşımlarının desteklenmesi gerektiğini vurgulamaktadır.

Anahtar Kelimeler: Eğitim programı uyarlaması, etkinlik şablonu, iklim değişikliği eğitimi, öğretmen adayları, sorgulamaya dayalı öğrenme

1. Introduction

The growing recognition of climate change as a pressing global issue has led to increased attention on the role of education in fostering climate literacy, critical thinking, and proactive citizenship. Since climate change, as a "wicked

problem," encompasses scientific, ethical, and social dimensions, scholars emphasize that traditional didactic approaches are insufficient for addressing the interdisciplinary, complex, and value-laden nature of climate change education (Monroe et al., 2019, 129(3), p. 45). Inquiry-based learning (IBL) allows students to navigate this complexity by fostering curiosity, encouraging critical thinking, and promoting problem-solving—skills that are crucial for comprehending and responding to climate-related issues. (Bybee, 2014, 8(2), p. 32). Previous studies highlight the value of inquiry and socio-scientific issues in promoting deeper understanding of complex topics like climate change (Harrell & Subramaniam, 2015, 7(2), p. 118; Simonneaux & Simonneaux, 2012, 13(1), p. 52). Yet, traditional school curricula often struggle to integrate climate change content and lack the flexibility to support dynamic approaches that are interdisciplinary and inquiry-driven (Monroe et al., 2019, 129(3), p. 48; Reid et al., 2008, 32(1), p. 24). Pre-service teachers, as future educators, must be equipped with tools that enable them to design meaningful climate change education experiences (Ojala, 2015, 23(3), p. 274).

This study explores the application of a customizable, inquiry-based activity template structured around the phases of Inquire, Investigate, and Inspire, initiated by "I wonder…" questions, to integrate climate change education within formal curricular frameworks. By enabling pre-service teachers to adapt the template to different subject areas and classroom settings, the study addresses the broader goal of transforming rigid curricula into responsive learning environments equipped to meet global challenges. The purpose of this study is to explore how this template empowers pre-service teachers to customize curricular activities that address climate change in accessible, engaging, and contextually relevant ways.

Studying this topic is crucial because teachers are key agents in shaping how future generations understand and respond to climate issues (UNESCO, 2023, p. 12). Enabling pre-service teachers to adapt curricula through inquiry-based approaches helps connect theoretical climate science with students' real-life contexts, fostering learning that is both relevant and action-driven (Ojala, 2015, 23(3), p. 275; Bybee, 2014, 8(2), p. 35; Favier et al., 2021, 15(3), p. 211). The purpose of this study is therefore to evaluate how a structured, inquiry-based framework can enhance curricular flexibility, interdisciplinary

integration, and learner engagement within the context of climate change education. The current study also has practical significance for teacher education programs. It offers a replicable model that can be integrated into training courses to prepare future educators for the pedagogical demands of climate literacy. By fostering skills in curricular adaptation and inquiry facilitation, the approach supports broader educational goals related to critical thinking, problem-solving, and environmental stewardship (Elster et al., 2014, 8(2), p. 67). From a constructivist view of learning, which assumes that knowledge is actively constructed by learners through inquiry and social interaction (Bardsley & Bardsley, 2007, p. 113), empowering pre-service teachers to customize curriculum is not merely a technical exercise but a transformative process that prepares educators to meet the evolving demands of a climate-challenged world (UNESCO, 2024, p. 16). The research also adopts a critical perspective on traditional, rigid curriculum structures, advocating for greater flexibility and responsiveness in educational practice to address urgent global issues (OECD, 2024, p. 54). Expanding upon this framework, the current study should be positioned within the wider body of literature on inquiry-based learning, climate change education, and curricular customization.

Despite strong theoretical and empirical support for inquiry-based and customized approaches in climate change education, further research is needed to explore how structured templates can practically empower pre-service teachers to design contextually relevant, inquiry-driven curricula. This study addresses these gaps by investigating how a structured Inquire–Investigate–Inspire template can support pre-service teachers in customizing curriculum to meaningfully integrate climate change topics. It contributes to both theoretical and practical conversation by offering empirical insights into how inquiry-based curricular frameworks can be operationalized in teacher education. The central research questions guiding this study are:

1. How does the inquiry-based activity template support pre-service teachers in adapting existing curricular frameworks to include climate change education?

2. What are the perceived strengths and challenges of using an inquiry-based template for curricular customization in climate change education?

2. Literature Review

2.1 Inquiry-Based Learning in Climate Change Education

Inquiry-Based Learning (IBL) is grounded in constructivist theory, which views knowledge as actively constructed by learners through experience and social interaction. Dewey (1938, p. 25) argued that meaningful education emerges from engagement with real-life situations, emphasizing that "all genuine learning comes through experience." Vygotsky (1978, p. 86) similarly underscored the social dimensions of cognitive development, highlighting the role of collaboration and dialogue in the learning process.

IBL is characterized by processes such as questioning, hypothesizing, investigating, and drawing conclusions. Pedaste et al. (2015, 16(1), p. 47) define it as a pedagogical approach that mirrors authentic scientific inquiry, fostering both conceptual understanding and the development of transferable skills. In the context of climate change education, IBL not only helps students grasp scientific facts but also encourages critical reflection on ethical, social, and political dimensions.

Socio-scientific issues (SSI) frameworks, such as those proposed by Simonneaux and Simonneaux (2012, 13(1), p. 52), reinforce this perspective, arguing that topics like climate change demand interdisciplinary inquiry. Through SSI-oriented IBL, students explore controversial and complex topics, develop argumentation skills, and learn to evaluate evidence in real-world contexts.

Experiential learning further complements IBL by situating learning within students' lived experiences. Kolb's (1984, p. 42) experiential learning cycle emphasizes learning through concrete experience, reflection, conceptualization, and active experimentation. Place-based education and community-focused inquiry allow learners to connect global climate issues with local contexts, fostering a deeper sense of relevance and responsibility. Research shows that this approach enhances environmental literacy and promotes pro-environmental behaviors (Hamilton & Marckini-Polk, 2023, p. 14).

2.2 Barriers to Implementing Inquiry-Based Climate Change Education

While the pedagogical benefits of IBL are well-documented, several barriers hinder its widespread implementation, especially in climate change education. Teachers often feel unprepared to address climate-related topics due to their complexity and perceived scientific uncertainty (Monroe et al., 2019, 129(3), p. 50). In some contexts, the politicization of climate change creates additional challenges, leading educators to avoid or minimize the topic in classroom discussions (Kwauk, 2020, p. 22; Ojala, 2015, 23(3), p. 280).

Structural constraints within education systems also present obstacles. Curricula are frequently rigid, emphasizing standardized testing and content coverage at the expense of inquiry and interdisciplinary exploration (Reid et al., 2008, 32(1), p. 24). Schwab (1973, p. 56) argued for a move away from technocratic curriculum models toward adaptive, teacher-led approaches that respond to local contexts and learner needs. Yet, pre-service teachers often lack the skills and confidence to design such adaptive lessons, particularly on topics that intersect multiple disciplines (Evagorou & Dillon, 2021, p. 11; Boon, 2016, p. 40).

This preparation gap highlights the need for scaffolded curricular tools. Structured planning templates can guide novice educators in developing inquiry-driven lessons while maintaining alignment with formal curriculum expectations. Crawford (2007, p. 118) emphasizes the importance of providing pre-service teachers with clear frameworks that reduce cognitive load and support pedagogical growth.

2.3 The Role of Structured Templates in Curriculum Adaptation

Structured activity templates, such as the Inquire–Investigate–Inspire model, can serve as practical solutions to the challenges outlined above. These templates provide clear, manageable phases that help pre-service teachers navigate the complexities of lesson planning for climate change education (Beatty & Feldman, 2012, p. 23). By breaking down the instructional process into defined steps, templates reduce ambiguity and foster creative, student-centered design while ensuring curricular coherence (Ojala, 2015, 23(3), p. 282).

Templates also promote reflective practice and iterative refinement, allowing teachers to adjust their plans based on student needs and classroom dynamics. When linked to climate education, structured inquiry tools not only build content knowledge but also enhance pedagogical competencies related to inquiry facilitation, assessment, and classroom management (Dupigny-Giroux, 2010, p. 109).

This study seeks to contribute to the growing body of literature advocating curriculum flexibility and teacher agency in education for sustainability. By examining how pre-service teachers utilize an inquiry-based template to design climate change activities, the research offers insights into both the practical application of IBL and the professional development of future educators.

3. Method

3.1. Design of the Study

This qualitative study employed a design-based research (DBR) methodology, characterized by iterative cycles of development, implementation, analysis, and refinement of the inquiry-based activity template (McKenney & Reeves, 2013, p. 7-22). Participants were provided with targeted instruction on the effective use of the activity template and subsequently tasked with designing climate change education activities aligned with curriculum outcomes. These were implemented in simulated classroom environments, specifically through micro-teaching sessions, where participants presented their activities to peers who acted as students. Although such simulations cannot fully replicate the complexities of real classroom dynamics—such as behavioral management, student diversity, and spontaneous interactions—they are widely recognized as effective tools for bridging theory and practice in teacher education (Fernández, 2010; Zeichner, 2012). The structured yet flexible format allowed pre-service teachers to rehearse instructional strategies, receive constructive peer and instructor feedback, and engage in reflective refinement of their pedagogical approaches. This process enabled a contextually grounded evaluation of the template's usability, curricular relevance, and capacity to support novice educators in adapting content for climate change education (Korthagen, 2017).

3.2. Participants

The study engaged a total of 57 pre-service teachers enrolled in a teacher education program in Türkiye, spanning several fields as shown in Table 1. These participants represented a mix of academic levels, including those in their sophomore, junior, and senior years, providing a diverse range of experiences within the teacher preparation journey. To explore in greater depth the experiences and perspectives related to the activity template, a carefully selected subgroup of 15 participants was invited for semi-structured interviews. This interview sample was purposefully chosen to ensure representation across different performance levels—categorized as high, medium, and low achievers—as well as across the various disciplines as displayed in Table 1. Participants were grouped based on their CPA (Cumulative Performance Average) scores into three categories to reflect varying achievement levels:

- High achievers: CPA of 3.50 to 4.00 (n= 18)
- Medium achievers: CPA of 2.50 to 3.49 (n= 25)
- Low achievers: CPA below 2.50 (n= 14)

These ranges provided a clear framework for purposeful sampling, enabling selection of participants with diverse academic performances and perspectives on the activity template.

This stratified approach allowed the study to gather rich, diverse insights reflecting both academic achievement and disciplinary diversity, supporting the iterative improvement and evaluation of the teaching tool.

Table 1: Demographic Distribution of Study Participants by Discipline and Gender

Discipline	n	Female	Male	Interview Participants
Social Studies Education	12	9	3	4
Guidance & Psychological Counseling	12	8	4	3
Elementary Mathematics Education	11	9	2	3
Primary Education	8	7	1	3

Elementary Science Education	7	6	1	1
Turkish Language Education	7	5	2	1
Total	57	43	13	15

3.3. Operationalizing the Inquire–Investigate–Inspire Activity Template in Practice

The Inquire–Investigate–Inspire (3I) activity template functioned as both a pedagogical scaffold and a professional learning framework throughout the course. Originally introduced in the early weeks of the semester, the model was used iteratively by participants to plan, implement, and reflect on climate change education (CCE) activities (see Appendix). Grounded in inquiry-based learning and student agency, the model emphasizes the integration of local knowledge, critical thinking, and action-oriented pedagogy (Anderson, Comay, & Chiarotto, 2017; Orr, 1992).

The template consists of three core stages:

Inquire: This first stage emphasizes the development of curiosity-driven questions, often framed as "I wonder…" statements. Drawing from their observations and lived experiences, students were guided to notice local environmental phenomena, identify issues of personal or communal relevance, and pose meaningful inquiry questions. This phase is designed to foster engagement through place-based and student-centered learning (Anderson et al., 2017, pp. 7–21).

Investigate: The second stage involves systematic exploration through qualitative and/or quantitative methods. Depending on their chosen topic, participants employed a range of strategies including interviews, fieldwork, mapping, and simple experiments. This stage emphasized the cultivation of research skills and critical analysis, with differentiated scaffolding provided to meet varying learner needs (McKenney & Reeves, 2013, pp. 15–18).

Inspire: In the final stage, learners synthesized and communicated their findings and were encouraged to propose or initiate relevant actions. This included student-led initiatives such as com-

munity clean-ups, biodiversity observations, and climate awareness campaigns. Some activities culminated in persuasive letters to community leaders or school administrators, echoing the spirit of democratic engagement and environmental stewardship (Schumacher, 2011). This stage aimed to affirm the value of student voice, emphasizing that knowledge and inquiry are meaningful when connected to real-world application (Orr, 1992, pp. 83–105).

Throughout the semester, pre-service teachers applied the 3I template to design activities that addressed local climate and sustainability challenges. These ranged from schoolyard waste audits and plastic use investigations to climate-themed storytelling and awareness events. Importantly, the model promoted the notion that small-scale, context-specific projects could act as catalysts for broader change. As Schumacher (2011) contends, "*small is beautiful,*" and meaningful action often begins with manageable, community-rooted initiatives.

Activity planning was followed by structured peer and instructor feedback sessions. Each participant submitted a plan based on the 3I template and received formative input on aspects such as inquiry facilitation, curricular alignment, and student engagement. During post-implementation discussions, participants were asked to reflect on the rationale behind their "I wonder" questions, describe learner responses, and evaluate the pedagogical impact of their work. The classroom thus operated as a "living laboratory," where instructional experimentation and collaborative reflection were central to professional growth (McKenney & Reeves, 2013, pp. 7–22).

In addition, safety protocols—both physical and emotional—were foregrounded in activity design. Participants were asked to anticipate potential risks and implement age-appropriate safeguards. For example, in litter-related activities, students were guided to consider what a responsible caregiver would expect in terms of safety and well-being. This ethical framing emphasized educator responsibility and care in real-world educational contexts.

3.4. Data Collection Tools

The data sources for this study comprised (1) customized curriculum activity plans developed by participants (See Appendix) and (2) semi-structured

interviews conducted post-practicum to ensure triangulation and enhance the credibility of findings (Lincoln & Guba, 1985, p.290). The plans included detailed steps for implementation, materials needed, student tasks, and assessment strategies. The interviews focused on what elements were effective or presented difficulties. They explored the influence of the "I wonder" questions on planning and engaging students, as well as how the template shaped their inquiry teaching methods. Participants reflected on how practical it was to carry out the activities, any adjustments made to better suit their classrooms, and their approaches to evaluating student learning and encouraging teamwork. Finally, they considered ways to improve the use of the template and its role in shaping their future instructional practices, particularly in CCE.

3.5. Data Analysis Process

The analysis was designed to examine the effectiveness of the activity template in facilitating the integration of CCE into participants' activity planning and classroom practices. Accordingly, data analysis followed a thematic coding process (Braun & Clarke, 2006), combining both deductive and inductive strategies. The initial coding framework was informed by the five dimensions identified in the literature as critical for inquiry-based curriculum adaptation: (1) clarity and relevance of inquiry questions, (2) integration of inquiry-based learning strategies, (3) feasibility and practicality, (4) student engagement potential, and (5) quality of assessment design. Subsequently, emergent themes were identified from participants' narratives, focusing on their experiences of using the template and their reflections on pedagogical growth.

The researcher used Delve qualitative analysis software to organize and code the data systematically. This tool allowed for effective management and consistent application of codes across the dataset. Its functionalities, including notetaking, organizing codes into categories, and search capabilities, facilitated a thorough and transparent analysis. Employing Delve contributed to maintaining analytical rigor by documenting coding decisions and enabling easy review throughout the iterative process.

3.6. Trustworthiness and Ethical Considerations

To ensure the trustworthiness of the study, multiple strategies were employed in alignment with established qualitative research standards. Partici-

pants were invited to review and validate the accuracy of their interview transcripts and thematic interpretations derived from their responses, contributing to credibility through member checking (Lincoln & Guba, 1985). As the coding process was conducted by a single researcher, additional measures were taken to enhance dependability and confirmability. A detailed audit trail documenting analytical procedures, coding decisions, and theme development was maintained throughout the study. Furthermore, peer debriefing sessions were conducted with colleagues not directly involved in the research to review emerging themes and challenge potential researcher bias, thereby supporting analytical rigor (Shenton, 2004). Ethical approval was obtained from the university's Human Research Ethics Board prior to data collection, and all participants provided informed consent. Anonymity was protected through the use of participant codes, and all data were securely stored in accordance with institutional guidelines.

4. Findings

This study uncovered seven interconnected themes through analysis of activity plans and interview data, reflecting how pre-service teachers interacted with and adapted to a climate change education activity template. The findings highlight how participants navigated curriculum demands, engaged in inquiry-based planning, addressed practical classroom realities, and developed their professional thinking through iterative use of the tool.

4.1. Iterative Adaptation of the Template: Learning Through Practice

One key finding was that the template became more functional and responsive through multiple rounds of use and revision. As participants used the template to design and implement climate change-focused activities, they encountered specific challenges—particularly around curricular fit, disciplinary relevance, inquiry facilitation, and assessment. Their feedback led to successive improvements that helped clarify its purpose and structure.

Initially, pre-service teachers from disciplines outside natural science and social studies, such as Turkish language education, mathematics and counseling, encountered challenges in aligning their activity plans with formal learning objectives. The original version of the template lacked prompts to support this alignment, which led to uncertainty about how to justify climate change

content within subject-specific curricular goals. In response to this feedback, the template was revised to include a dedicated section for clearly articulating learning outcomes. This change proved particularly helpful for participants in translating climate change-related themes into the language of their own disciplines. As an example, a mathematics education candidate shared, *"At first, I couldn't see how to fit this into a math lesson. The revised template helped me clearly define what I was teaching and why it mattered."*

In fields like classroom teaching and counseling, participants responded positively to the inclusion of new interdisciplinary prompts and examples that illustrated how climate issues could intersect with their subject matter. As one pre-service counselor explained, *"Seeing examples tied to emotions and wellbeing made it click for me—I could approach climate change in a way that made sense for my students and my role."* These revisions broadened the perceived relevance of climate change education and encouraged more confident, subject-specific integration across the teaching disciplines.

The revised version also offered more scaffolding for assessment design, which many had found intimidating. With prompts suggesting tools like Kahoot or group evaluations, participants began exploring more engaging and diverse strategies. As an example, an elementary science teacher candidate shared her experience by stating that "Adding *a tool like Kahoot really changed the way I thought about assessment—it became something students could enjoy, and I could learn from."* Participants also welcomed the new section that helped them transform student "I wonder" questions into workable lesson ideas as in stated by a classroom pre-service teacher, *"The guide helped me go from students' curiosity to actual activities we could do. That part made it more practical for me."*

To enhance the practicality of lesson planning, the template was revised to include a section prompting pre-service teachers to reflect real classroom constraints—such as time limits, available resources, and school policies. This addition encouraged participants to critically evaluate and adjust overly ambitious ideas. One social studies education pre-service teacher shared, *"My first plan had this big outdoor experiment. Later, I reworked it into a smaller version that I could actually use in a real school,"* highlighting how the updated template supported more realistic and implementable lesson designs. Overall, these revisions reflect how the template evolved not only as an activity planning tool,

but also as a professional learning scaffold that adapted to users' developmental needs.

4.2. Curriculum Customization and Local Relevance

Participants increasingly adapted their lessons to reflect community-specific environmental concerns and make learning more meaningful for students. Rather than relying solely on generalized facts about climate change, using such place-based prompts, many participants localized climate change by exploring region-specific issues such as increased rainfall, landslide risks, and changing tea cultivation patterns in the area. For instance, a participant from elementary science education department clarified that

"*At first, I thought I just needed to throw in some climate change facts. But the template made me realize I could completely change it up. I could connect it to things happening around here, like heavier rain, landslides, and how tea farming is shifting. That made it feel a lot more real for the students — and honestly, for me too.*"

The template structure—including prompts like "What actions can students take in their own communities?"—encouraged participants to think critically about place-based learning and actionable outcomes. Together, these elements helped participants break down the complexity of climate change and design lessons that were more inquiry-driven, relevant, and pedagogically intentional and supported them in contextualizing content meaningfully.

4.3. Deepening Inquiry Through Experience

Most participants incorporated inquiry-based approaches into their plans by developing open-ended student questions, encouraging exploration, and guiding investigations. The template "I wonder" prompt played a central role in shaping how participants introduced an inquiry.

Over time, participants reported that their questioning strategies evolved from basic, fact-oriented prompts more analytical, locally grounded inquiries that resonated with students' lived experiences. High-performing participants designed investigations around questions such as, "*I wonder how the changing rainfall is affecting farming practices in our region?*" This shift encouraged learners to move beyond textbook knowledge, conduct field observations, collect data, and engage with community members. Likewise, mid-performing par-

ticipants described a similar progression. One reflected, "*My question started off really basic — just about why it rains so much. But later, I made it more about how rainfall affects erosion and farming.*" Through iterative practice and peer feedback, they refined their questions to better connect scientific concepts with regional environmental issues, strengthening both student engagement and relevance. However, lower-performing participants, initially focused on general climate facts, also reported growth. With structured support, they moved toward inquiry-based thinking that was more reflective of students' immediate surroundings, fostering deeper connections between classroom learning and real-world concerns.

4.4. Balancing Ambition with Feasibility

While participants valued the template's flexibility and encouragement of creative activity design, they also encountered practical constraints when translating their ideas into realistic classroom activities. Many grounded their plans in low-cost, accessible materials. One mathematics pre-service teacher explained,

"*I imagined kids going outside to collect natural materials like leaves and simple objects like bottle caps, which we could then use to teach counting, sorting, and basic measurement. It felt realistic because these materials were easy to find, inexpensive, and familiar to the students. Using tangible items helped make abstract math concepts more concrete and engaging for young learners, and I knew I could manage the activity within the limited classroom time and resources.*"

These everyday items were seen as both engaging and manageable within typical classroom settings. Similarly, participants from counseling and psychological guidance highlighted how simple and familiar objects could support emotional reflection alongside environmental learning. As one noted,

"*Having students use familiar objects made it easier for them to open up emotionally and feel more connected — not just to the activity, but to each other and to the topic. For example, when we asked students to bring small personal items or things from nature, like leaves or stones, they started sharing stories about why they chose those objects. This naturally led to conversations about their feelings, memories, and even worries about the environment. It created a safe space where emotional reflection happened without forcing it.*"

However, participants also acknowledged the limits of feasibility. For example, a social studies pre-service teacher shared,

"I had this big idea about visiting a museum, but realistically, there might not be time or approval for that. In the end, I had to think of an alternative that would still give students that sense of real-world connection without leaving the classroom. That's when I started looking into virtual museum tours and local case studies we could explore together in class."

The iterative revisions of the template prompted them to rethink and adapt their plans. One elementary math pre-service teacher explained,

"When we first designed the lesson, we tried to include so many steps — data collection, group discussions, presentations — but after going through the template together with the instructor, I realized it was way too much for a 40-minute class. That process really pushed me to rethink my plan. I ended up focusing on just one core objective and simplifying the activity so it would actually fit the time frame and still be meaningful. It helped me understand that creative ideas need to match real classroom conditions if we want them to work."

Specifically, working closely with the instructor to review the template encouraged pre-service teachers to rethink and adjust their activity plans, helping them transform ambitious ideas into practical activities suited to real classroom conditions.

4.5. Fostering Student Collaboration and Agency

Participants emphasized the importance of fostering collaborative, student-centered learning environments. Many designed lessons incorporating group work, role-play, debates, and student-led investigations to promote active engagement. A social studies candidate noted,

"When students worked in teams, they really took charge of their part and felt like their ideas mattered. Like in a recycling project we designed, everyone pitched in with suggestions, and they got pretty excited seeing what they could do together. It definitely made them more confident and into the lesson."

Similarly, a participant from elementary mathematics noted, *"Using math in real projects, like calculating recycling data, helped students connect with the content in a more hands-on way."* Together, these experiences highlight how collab-

orative, real-world activities can enhance both student engagement and understanding across different subjects.

Counseling students reported similar experiences, explaining how group activities promoted emotional expression and confidence. One participant remarked, "*Group discussions and role-play made students more comfortable and confident to express how they felt about environmental issues.*"

Several participants extended these collaborative approaches into action-oriented projects, supporting students initiating activities like composting systems or school awareness campaigns. These experiences fostered both academic learning and a sense of environmental stewardship.

4.6. Evolving Assessment Practices

Assessment planning emerged as a key area of learning for participants, particularly in balancing traditional methods with technology-based tools. Many initially relied on familiar formats like multiple-choice tests but gradually expanded their strategies to include more interactive and student-centered assessments. As one elementary science pre-service teacher reflected,

"*Multiple-choice tests were my go-to because that's what I used to from my own school experience. But when I tried using Kahoot, I realized assessment could be more than just picking the right answer—it became something interactive. The students were laughing, competing, and actually thinking about the questions in real time. It wasn't just about memorizing facts anymore; it was about staying engaged and reflecting on what they learned while having fun.*"

This shift illustrates how technology-based assessment tools helped participants move beyond rote recall, promoting engagement, real-time feedback, and deeper learning experiences. Others used student presentations and peer feedback to document learning in more dynamic ways. A social studies participant noted, "*Letting students share their findings through presentations made the learning more visible and engaging.*"

Despite ongoing concerns about time constraints, participants increasingly understood the value of diverse assessment approaches that captured not only knowledge acquisition but also collaboration, problem-solving, and action-oriented learning.

Another important finding of this study is that pre-service teachers began to view assessment not only as a way to measure student learning but also as a means to inform and improve their own teaching practices. Several participants reported that interactive assessments, such as student presentations, peer feedback sessions, and digital quizzes, provided real-time insights into how students were processing the material. This feedback loop helped participants identify areas where their instructional strategies could be refined.

As one pre-service teacher from social studies education department explained,

"When students presented their findings, I could see right away which parts they understood well and where they were still confused. It made me think about how I could explain things differently next time or give better examples."

Similarly, an elementary mathematics candidate noted,

"When students asked questions during the Kahoot game or got stuck on certain answers, it was like feedback for me, too. It showed me which concepts I needed to revisit."

Through these experiences, participants began to see assessment as part of their own learning process—supporting professional development by highlighting gaps in instruction, encouraging reflective practice, and prompting instructional adjustments in real time.

4.7. Building Confidence and Professional Identity

Participants consistently reported that using the template supported their growth as future educators, particularly when tackling complex topics like climate change. Several shared that they initially felt uncertain about how to approach this issue in the classroom. One elementary science pre-service teacher described the process by saying,

"At first, teaching climate change felt overwhelming. I wasn't sure how to break it down for young learners. The template helped me figure out where to start—it guided me step by step, from setting goals to choosing activities, so the whole lesson became clearer and easier to plan."

Others noted a shift in how they approached lesson planning altogether. Rather than focusing solely on filling instructional time, they began thinking about how to create purposeful and engaging learning experiences. As one social studies participant reflected,

"Before, I thought planning was just about keeping students busy for a certain amount of time. But this made me think differently—it's about helping students connect what they're learning to real life and giving them reasons to care about the topic."

This process of iterative planning led many participants to feel more capable of designing lessons that were interdisciplinary, inquiry-based, and relevant to their students' communities. Although challenges such as fitting these lessons into curriculum expectations and managing time constraints remained, the template helped participants navigate these complexities. By repeatedly engaging with the tool, they developed greater confidence in their teaching abilities and began to see themselves as educators capable of fostering meaningful learning, not just delivering content.

5. Discussion

This study highlights the potential of the Inquire–Investigate–Inspire (3I) template as a transformative scaffold for pre-service teachers, enabling the design of climate change education (CCE) that is both interdisciplinary and contextually relevant. Grounded in constructivist and inquiry-based learning theories, the template facilitated curiosity-driven instruction, supporting participants in translating complex, abstract environmental concepts into practical, actionable classroom activities (Lazonder - Harmsen, 2016, 86/3, 681–718). By structuring lesson design around students' "I wonder" questions and iterative exploration, the template empowered pre-service teachers to make CCE more engaging and personally meaningful for learners.

These results are consistent with studies that highlight the role of place-based and hands-on learning experiences in promoting environmental responsibility (Hamilton - Marckini-Polk, 2023, 10/1). Participants increasingly localized their activities, connecting global climate narratives to immediate community issues such as rainfall patterns, agricultural changes, or local waste management. This shift represents a critical pedagogical transition:

moving from didactic knowledge transmission to inquiry-driven, real-world engagement that promotes both cognitive and emotional connections with environmental issues.

However, the study also illuminated systemic and pedagogical tensions. Participants reported challenges in integrating inquiry-based CCE into rigid curricular frameworks, often constrained by national standards, time limitations, and discipline-specific content expectations. These barriers are consistent with well-documented obstacles in environmental and sustainability education (Stevenson et al., 2013, 1–6). Some participants struggled to maintain inquiry depth over time due to variability in student readiness and prior knowledge, underscoring the need for differentiated scaffolding and flexible instructional design (Tytler - Prain, 2020, 66/1, 13–21). Such findings suggest that while inquiry templates can catalyze pedagogical innovation, their successful implementation requires structural support within teacher education programs and broader school systems.

Moreover, the study revealed a shift in participants' professional identity and agency. Pre-service teachers reported increased confidence in facilitating interdisciplinary, student-centered learning. Yet this professional growth was accompanied by reflective awareness of the limitations imposed by existing educational policies and assessment systems. These insights resonate with critiques of standardized curricula, which often marginalize socio-scientific inquiry in favor of content mastery (Hulme, 2025, 1–16). Supporting teacher autonomy and professional judgment emerges as a necessary condition for embedding inquiry-based models into everyday classroom practice.

5.1. Conclusions and Implications

This research contributes to a growing body of evidence supporting the integration of structured inquiry templates in pre-service teacher education. The 3I template provided participants with a practical framework to design climate change activities that are both pedagogically rigorous and locally relevant. By scaffolding activity planning around real-world issues and student-led exploration, the template fostered a shift toward action-oriented, interdisciplinary teaching.

However, the findings emphasize that such templates are not standalone solutions. Their effectiveness is contingent upon systemic factors, including ongoing mentorship, institutional encouragement of curricular flexibility, and access to professional development opportunities that extend beyond initial teacher training (Högström - Gericke - Wallin, 2024). Embedding inquiry-based models into teacher education curricula can build long-term capacities for adaptability, critical thinking, and socio-scientific reasoning—competencies essential for addressing global challenges such as climate change, disaster risk, and sustainability.

These findings highlight the need for educational policymakers to reconsider existing curriculum requirements and evaluation practices. Allowing space for localized student-centered inquiry projects could transform classrooms into laboratories of real-world problem solving (UNESCO, 2021). Extending these practices to in-service teacher development would further institutionalize a culture of reflective, participatory learning, promoting environmental literacy across all levels of education (Monroe et al., 2019, 25/6, 791–812).

5.2. Suggestions for Further Research

Although this study offers meaningful contributions, its limitations must also be recognized. The primary implementation of the activity template occurred in simulated teaching environments, raising questions about the generalizability of findings to authentic classroom contexts (Crawford, 2007, 44/4, 613–642). Although the simulations allowed for controlled experimentation, they may not fully capture the complexities of real-world teaching, such as classroom management challenges, student diversity, or administrative constraints.

Additionally, participants entered the study with varying degrees of familiarity with inquiry-based learning and climate education. This heterogeneity could have influenced both their engagement with the template and their perceptions of its utility, introducing potential bias (Cimer, 2007, 4/1, 20–44). Moreover, while participants reported systemic constraints—such as limited instructional time and standardized testing pressures—these factors were not

systematically manipulated or compared, limiting causal interpretations of their impact (Simmie, 2007, 26/2, 163–176).

Future research should pursue longitudinal, field-based studies that investigate the implementation of inquiry-based templates in real classrooms across different educational levels, regions, and sociocultural contexts (Reid et al., 2008). Such research could illuminate how these tools function over time, both in pre-service preparation and in-service teaching practice. Studies should also explore the template's influence on student outcomes, including environmental literacy, critical thinking, and action competence (Drewes - Henderson - Mouza, 2017, 40/1, 67–89).

Furthermore, comparative studies across multiple disciplines would provide insights into the transferability of inquiry frameworks beyond climate change education. For example, applying similar templates to issues like health literacy, disaster risk reduction, or sustainable development could reveal interdisciplinary applications and adaptations (Dupigny-Giroux, 2010, 4/9, 1203–1217). Such research could help refine universal inquiry scaffolds that promote systems thinking and collaborative problem-solving across the curriculum.

Finally, future investigations should incorporate the perspectives of school administrators, curriculum designers, and policy actors, examining the institutional enablers and constraints that affect the scalability of inquiry-based education (Favier et al., 2021, 45/4, 594–620). This broader stakeholder analysis would support the development of sustainable models for integrating flexible, inquiry-driven pedagogy into mainstream educational systems.

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Appendices

Appendix A: Revised Post-Implementation Version Activity Plan Template

Date: _____   Grade Level: _____   Topic: _____

Component	Details
Learning Objectives	• What knowledge or concepts should students understand more deeply? • What inquiry skills (e.g., observation, questioning) should they develop? • What personal or collective values (e.g., responsibility, empathy) should be reflected in their work?
Subjects	*(Identifies the main subject area(s) through which the activity is implemented, ensuring alignment with curricular objectives)* • Which subject(s) does this activity address? • Which key concepts from this subject are central to the inquiry?
Cross-Disciplinary Integration	*(Highlights connections to other disciplines to support interdisciplinary and systems-based understanding of climate and sustainability issues)* • *Which other subjects can be integrated?* • *How do multiple perspectives deepen understanding of the issue?*
Estimated Duration	*(Indicates the approximate time required for inquiry, investigation, and inspiration stages)* • How long will each stage take? • Will the activity span one lesson or multiple sessions?
Materials and Resources	*(List all materials, tools, or resources needed for the activity)*
I Wonder Question	(Write the key "I Wonder" questions that spark curiosity and inquiry for this activity) • What do I notice in my local environment? • What do I wonder about related to this topic? • What issues matter to me? • What do I wonder about climate or sustainability? • What questions will guide my exploration?
Phase	**Activities**
Inquire	*(Students pose questions, activate prior knowledge, and express curiosity)* • What questions do students generate? • How will you encourage questioning?
Investigate	*(Students systematically collect and analyze data to answer their questions)* • What methods will students use to explore? • How will you guide students' research or exploration? • How will data be gathered and interpreted?

	• What resources, tools, or people will help?
Inspire	*(Students develop innovative ideas or solutions and are motivated to take action)* • How will students be encouraged to create or innovate? • What opportunities for motivation and reflection will you provide? • How will you guide to communicate or act on students' findings?
Teaching Tips	*(Suggestions or strategies to support instruction and engagement during the activity)* • How can you scaffold student understanding? • What prompts or examples will you use? • How to manage group work or discussions? • How to encourage place-based and student-centered questioning? • How to support brainstorming and categorization of questions? • How can climate issues intersect with your subject matter?
Assessment of Learning	*(Describe how you will assess student learning and understanding)* • What formative or summative assessments will you use? • How will you identify strengths and areas for improvement? • Will you use self-assessment, peer feedback, or teacher observation?
Safety Considerations	*(Outline any safety considerations to keep students safe during the activity)* • Are there any risks? • What precautions or supervision are required?
Lesson Reflection and Revisions	*(After the lesson, reflect on its effectiveness and note any needed changes)* • What worked well? • What challenges did you encounter? • How will you improve it next time?
References	*(List any sources or materials you used to prepare the activity)*

Appendix B: Sample Activity Plan

Date: _____   **Grade Level:** 4th_____   **Topic:** Plastic Waste

Component	Details
Learning Objectives	• Students identify sources of plastic waste in their immediate environment. • Students develop environmentally responsible behaviors. • Students collaborate to propose and implement local actions to reduce plastic use.
Subjects	Science, Social Studies, Visual Arts, Turkish Language
Cross-Disciplinary Integration	**Science**: Types of materials, pollution causes and effects. **Social Studies**: Environmental responsibility and active citizenship **Visual Arts**: Posters and awareness campaign materials. **Turkish Language**: Opinion writing, oral presentation.
Estimated Duration	2–3 class periods
I Wonder Question	*"Why is there so much plastic on our playground, and what can we do about it?"*
Phase	**Activities**
Inquire	• Observe and photograph plastic waste around the school playground. • Brainstorm reasons for plastic accumulation. • Discuss where plastic comes from and where it goes.
Investigate	• Explore how plastic is made and its impact on ecosystems (videos, reading materials). • Conduct a simple waste audit: categorize, count, and analyze types of plastic collected. • Interview school staff (e.g., janitors or administrators) about school waste policies.
Inspire	• Create posters or infographics to raise awareness about plastic waste. • Propose and implement a "Plastic-Free Week" or start a class recycling system. • Share their actions and ideas with families and school community in a student-led exhibition.
Teaching Tips	• Use local photos or student-taken images to personalize the inquiry. • Incorporate art and storytelling for emotional connection. • Allow flexible group roles (e.g., data collector, artist, presenter). • Use outdoor spaces for real-world exploration.
Assessment of Learning	• Anecdotal records from group work and discussions. • Student journals and reflection drawings. • Rubrics for group presentations or visual campaigns. • Short written reports or multimedia presentations.
Safety Considerations	Provide gloves and enforce handwashing after the audit.

	Avoid collection of sharp or hazardous materials.
	Supervise outdoor activities and ensure awareness of boundaries.
Lesson Reflection & Revisions	The students demonstrated strong interest, particularly during the initial questioning phase and the hands- on waste audit, with many taking initiative in data collection. While most learners achieved the goals of recognizing plastic types and expressing solutions, some required additional guidance in organizing their written work. The lesson faced challenges such as time constraints and weather-related interruptions. Use of visual supports and defined group roles facilitated engagement, though clearer role assignments and scaffolding could further improve involvement. The activity was well aligned with national curriculum standards but would benefit from extended scheduling and integration with language lessons. Future improvements might include tailored research materials, incorporating digital tools, and engaging families or the wider community to strengthen student motivation and learning outcomes.