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ORIGINAL ARTICLE

In-Service Science Teachers' Understanding and Classroom Implementation of Inquiry-Based Teaching in Turkey: A Multi-Case Qualitative Study

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ABSTRACT

This study examines how in-service middle school science teachers in Turkey conceptualize and implement inquiry-based teaching (IBT) within an examination-driven, centralized system. Employing a qualitative multi-case design, five teachers were purposively selected, and data were triangulated through semi-structured interviews and extended classroom observations. The findings indicate that while teachers value IBT for fostering questioning, evidence-based reasoning, and collaboration, their enactment is constrained by high-stakes examinations, rigid pacing guides, limited laboratory resources, and episodic professional development. Teachers reported adapting by blending inquiry with test-oriented routines, narrowing investigations, and relying on informal peer support to address material and time constraints. Cross-case synthesis reveals an implementation gap between policy rhetoric and everyday practice, sustained by misalignment across curriculum, assessment, and professional learning. The study provides a comprehensive, context-sensitive account of how teachers interpret and negotiate IBT under structural pressures, offering analytic insights that are transferable to similarly centralized systems. Closing this gap requires coherent assessment policies that reward investigative practices, sustained, job-embedded professional learning, and the equitable provision of laboratories, consumables, and manageable class sizes. By foregrounding teachers' voices alongside observed practice, the study advances understanding of the practical conditions under which IBT can transition from aspiration to routine classroom reality across diverse regions and comparable systems worldwide.

KEY WORDS: Inquiry-based teaching, in-service teachers, middle school, multi-case, science

INTRODUCTION

The demand for scientifically literate citizens has become increasingly urgent in the twenty-first century, as societies struggle with challenges such as climate change, public health crises, and the rapid proliferation of technology (National Academies of Sciences, Engineering, and Medicine, 2021; OECD, 2020). Within this global context, the concept of inquiry-based teaching (IBT) has emerged as a keystone of contemporary science education reform. Rooted in socioconstructivist theories of learning, IBT emphasizes that learners develop scientific understanding most effectively when they actively engage in the practices and reasoning processes of scientists themselves (Crawford, 2000).

While the epistemological and pedagogical underpinnings of inquiry have been widely endorsed in policy frameworks and curriculum documents across diverse national contexts (OECD, 2023b; UNESCO, 2024), persistent challenges surround its consistent translation into classroom practice (Blanchard et al., 2010). Scholars such as Furtak et al. (2012) and Minner et al. (2010) have demonstrated that the term "inquiry" remains highly contested, interpreted in ways ranging from hands-on activities and open-ended investigations to more holistic approaches involving scientific argumentation and evidence-based discourse. This conceptual fluidity has contributed to an implementation gap whereby inquiry is frequently reduced to isolated experiments or procedural tasks devoid of deeper cognitive engagement (Capps and Crawford, 2013).

In Turkey, as in many other countries undergoing curriculum reform, the Ministry of National Education (MoNE) has repeatedly revised science education frameworks over the past two decades, explicitly positioning IBT as central to the goal of cultivating scientific literacy (MoNE, 2018). The 2018 science curriculum reform was particularly explicit in its ambition to align national educational outcomes with international benchmarks, emphasizing inquiry as a key pedagogical approach. These policy shifts were motivated by comparative evidence, such as the Programme for International Student Assessment results, which highlighted persistent gaps in Turkish students' higher-order thinking and problem-solving skills compared to peers in OECD countries (OECD, 2023b).

However, despite clear policy directives and a theoretically robust curriculum, empirical studies consistently show that IBT implementation in Turkish classrooms remains fragmented and inconsistent (Kaya and Yılmaz, 2016; Saka and Saka, 2020). Research on both pre-service and in-service teachers suggests that many educators continue to equate

inquiry with teacher-directed demonstrations or prescriptive "cookbook" experiments that leave little room for genuine student autonomy or scientific reasoning (Asay and Orgill, 2010; Zompero et al., 2024). This limited interpretation is not unique to Turkey; studies in diverse contexts, including the United States, Europe, and East Asia, have documented similar tendencies among teachers to adopt superficial forms of inquiry that fit within existing classroom routines without fundamentally transforming epistemic practices (Blanchard et al., 2010; Capps and Crawford, 2013; Lin et al., 2013; OECD, 2023a, 2023b; UNESCO, 2024).

One of the most important structural barriers to authentic IBT identified in the Turkish context is the dominance of centralized, high-stakes national examinations. As Ardıç et al. (2025) argue, the pressure to prepare students for competitive entrance examinations to elite high schools constrains teachers' pedagogical choices, often pushing them toward rote instruction and test preparation at the expense of open-ended inquiry. Similar tensions have been reported in other education systems in which accountability metrics are tightly coupled with standardized assessments (Banilower et al., 2018; Blanchard et al., 2010). Consequently, even when teachers express positive attitudes toward IBT, they often adopt pragmatic strategies that value examination performance over exploratory learning (Köksal and Berberoğlu, 2014).

Another interrelated factor is the adequacy of teachers' professional and pedagogical content knowledge (PCK) for inquiry. Effective IBT requires more than familiarity with activities; it requires a profound understanding of the nature of science, the skillful orchestration of open-ended tasks, and the ability to scaffold student reasoning (Lederman et al., 2014). However, studies show that many teachers receive limited preparation in these domains during initial teacher education and lack access to sustained, high-quality professional development once in service (Gümüş and Bellibaş, 2021). As a result, teachers frequently rely on informal and often *ad hoc* professional development to navigate curriculum reforms and implement inquiry-based practices.

Material and infrastructural constraints compound these issues. Schools in lower-income regions or overcrowded urban centers often lack adequate laboratory facilities, up-to-date equipment, or manageable student-teacher ratios to enable meaningful inquiry-based learning (Nemadziva et al., 2023). Such conditions often force teachers to make pragmatic pedagogical compromises, relying more on demonstrations and textbook exercises than on engaging students in full, hands-on inquiry.

The cumulative effect of these systemic, professional, and material barriers is the emergence of what Blanchard et al. (2010) term "symbolic compliance:" teachers nominally align their lesson plans with policy rhetoric but adapt classroom practice to fit entrenched examination demands and resource realities. This phenomenon raises vital questions about how closely policy-driven reform agendas align with the professional cultures, working conditions, and accountability structures in which teachers operate.

While several quantitative studies have documented Turkish teachers' general attitudes toward inquiry and the obstacles they face (Kizilaslan et al., 2012; Köksal and Berberoğlu, 2014), there remains a considerable scarcity of fine-grained, qualitative work that triangulates teachers' self-reported beliefs with actual classroom practice. Furtak et al. (2012) contend that qualitative case study research is particularly valuable for revealing the complex and sometimes contradictory nature of pedagogical practice, especially the discrepancies between teachers' articulated beliefs and their classroom actions.

Accordingly, this study provides an in-depth, triangulated account of how five in-service middle school science teachers in Turkey conceptualize and enact IBT in everyday classroom practice. Central to the analysis is the notion of an implementation gap, defined here as the continuing discrepancy between the curriculum's formal emphasis on IBT and its constrained, partial, or modified enactment under examination pressures, material limitations, and professional learning conditions. Rather than treating barriers as isolated factors, the study conceptualizes the implementation gap as a systemic pattern produced by misalignment among curriculum goals, assessment regimes, instructional time structures, teacher preparation, and school resources. By combining interviews with extended classroom observations, the study traces how this gap is produced, sustained, and negotiated in practice. It examines not only teachers' stated beliefs about inquiry but also the instructional compromises, adaptations, and workarounds that emerge in real classrooms. Through this analytic lens, the study aims to contribute context-sensitive insights relevant to other centralized education systems where inquiry-oriented reforms coexist with accountability pressures.

Against this backdrop, the study addresses the following research objectives:

- To examine how in-service middle school science teachers in Turkey conceptualize the meaning and purpose of IBT
- To investigate how these conceptions translate into classroom practice
- To identify the perceived systemic, institutional, and material barriers that constrain IBT implementation
- To analyze how teachers navigate and negotiate these tensions in their everyday instructional decision-making.

By addressing these questions, the study aims to contribute empirically grounded recommendations for curriculum designers, teacher educators, and policymakers seeking to foster deeper, more coherent implementation of IBT in centralized education contexts.

METHODOLOGY

Research Design

This study employed a qualitative multi-case study design to generate a rich, context-sensitive understanding of how in-

service middle school science teachers conceptualize and enact IBT within Turkey's centralized, examination-driven education system. A multi-case approach is appropriate for capturing diverse perspectives while allowing detailed within- and cross-case analyses (Yin, 2018). This design aligns with calls for more qualitative, practice-based studies that show how practitioners interpret and translate policy intentions in complex school environments (Furtak et al., 2012; Stake, 2006).

Researcher Role

Recognizing the interpretive nature of qualitative inquiry, the researcher adopted a reflexive stance throughout the study. With a background as a science education scholar and teacher educator in the Turkish public education system, the researcher held a dual role: Serving as both an insider with cultural and linguistic expertise and an outsider observing classroom practice independently. To mitigate potential bias, the researcher maintained a reflexive journal, participated in peer debriefing with two independent colleagues, and triangulated data using multiple sources (Creswell and Poth, 2018).

Research Context

Turkey's education system is highly centralized under the authority of the MoNE, which prescribes detailed national curricula, textbooks, and examination frameworks. The 2018 and 2024 curriculum reforms explicitly positioned IBT as a key strategy for cultivating scientific literacy, aligned with global trends (MoNE, 2018, 2024).

Participants

Purposive sampling was used to select five in-service middle school science teachers who self-identified as incorporating IBT into their teaching. This criterion-based sampling ensured that participants possessed at least some familiarity with the concept of inquiry, maximizing the study's potential to illuminate how IBT is understood and practiced in real settings (Patton, 2015). The sample comprised five teachers, Ezgi, Guney, Serdar, Umay, and Zeynep (pseudonyms), working in different schools within a mid-sized town in western Turkey. All taught grades 5–8 and had a range of teaching experience (from 8 to 16 years) and diverse backgrounds in professional development related to inquiry.

Data Collection

Semi-structured interviews

The primary data source consisted of semi-structured face-to-face interviews with each teacher in a quiet space at their respective schools. The interviews, lasting 30–45 min, were guided by an interview protocol designed to probe participants' conceptual understanding of inquiry, specific classroom strategies, perceived challenges, and reflections on the factors affecting IBT. Key questions included:

> "How would you define IBT in your own words?"
> "Can you give examples of how you implement inquiry in your classroom?"
> "What factors help or hinder your use of inquiry-based methods?"

Probing questions and clarifications were used flexibly to elicit richer narratives and examples. All interviews were conducted in Turkish, audio-recorded with consent, and transcribed verbatim. Participants were invited to review their transcripts for accuracy (member checking); however, none requested any amendments.

Classroom observations

To triangulate the interview data with actual practice, each teacher was observed for at least four consecutive science lessons over a 2-week period. Observations focused on instructional structure, teacher–student interactions, use of questioning, the nature of any experiments or activities, and classroom management during inquiry tasks. Observation notes captured both descriptive accounts (e.g., the sequence of lesson events) and analytical memos (e.g., reflections on the consistency with teachers' stated beliefs).

Ethical Considerations

Ethical clearance was obtained from the researcher's university and the participating schools' administrations. All participants provided written informed consent after being briefed on the study's purpose, data confidentiality, and their right to withdraw at any stage of the study. Pseudonyms are used throughout this manuscript to protect participants' identities. Observation notes excluded any identifiable student information.

Data Analysis

A systematic thematic content analysis was employed to analyze the data (Braun and Clarke, 2021; Mayring, 2014). The analysis proceeded in five key stages:

Familiarization and initial coding

The researcher read and re-read all interview transcripts and observation notes to become deeply familiar with the data. Initial open coding was conducted line-by-line, identifying key phrases, concepts, and patterns related to teachers' conceptions, classroom enactments, and perceived barriers.

Developing a codebook

Codes were grouped into broader categories, and a formal codebook was developed, including definitions and example excerpts to ensure consistency. Categories included, for example, "Conceptions of Inquiry," "Examination Pressure," "Resource Constraints," and "Teacher Adaptations."

Inter-coder reliability

To strengthen trustworthiness, 20% of the transcripts were independently coded by an experienced qualitative researcher with expertise in science education. An inter-coder agreement rate of 85% was achieved, and discrepancies were discussed and resolved, resulting in refinements to the codebook.

Triangulation

Data from interviews and classroom observations were systematically compared to identify consistencies and contradictions between what teachers said and what they did. For example, if a teacher described using student-led

investigations, observations were checked for evidence of student autonomy, questioning, and group work.

Cross-case synthesis

Following within-case analysis, a cross-case thematic synthesis was conducted to identify recurring patterns and divergent elements across the five cases (Stake, 2006; Yin, 2018). This approach facilitated the development of broader, transferable insights relevant to implementing IBT in similar contexts.

Trustworthiness

In addition to triangulation, several strategies were employed to enhance the trustworthiness of the findings.

Credibility

The research process involved prolonged engagement in the field, including repeated observations, member-checking of interview transcripts, and peer debriefing.

Dependability

An audit trail was maintained, documenting coding decisions, codebook revisions, and theme development.

Confirmability

Reflexive memos and peer debriefing helped reduce researcher bias.

Transferability

Thick, rich descriptions of context and cases enable readers to assess relevance to other settings.

Limitations

While the multi-case design and methodological rigor strengthen the study's contribution, certain limitations must be acknowledged. The purposive sample was small and context-specific; thus, findings cannot be generalized. However, as Stake (2006) and Yin (2018) argue, the purpose of qualitative case study research is not statistical generalization but analytic transferability, which offers insights that illuminate similar tensions in comparable contexts.

The combination of semi-structured interviews, extended classroom observations, and systematic triangulation was intended to generate a robust, evidence-based account of how teachers navigate the promises and contradictions of implementing IBT within Turkey's centralized education system.

Findings

This section analyzes how the five teachers' beliefs and classroom practices illuminate different dimensions of the implementation gap between inquiry-oriented curriculum policy and everyday instructional realities. Drawing on interview and observation data, the analysis shows how this gap emerges through (a) varied conceptions of inquiry, (b) the dominance of high-stakes examinations, (c) material and structural constraints, and (d) teachers' adaptive strategies. Individual cases are presented briefly to illustrate these dynamics, followed by a cross-case synthesis that treats the implementation gap as the unifying analytic construct.

Individual case accounts

Case 1: Ezgi – Inquiry eclipsed by examination pressures

Ezgi, a teacher with 10 years of experience, described inquiry as an essential strategy to foster independent thinking: "Rather than explaining things to students, students should draw their own conclusions by investigating and doing inquiry." She highlighted that students enjoyed activities and even contributed materials: "Sometimes they bring materials for the activities, and they like that as well."

Yet Ezgi's practice was shaped profoundly by parental expectations and national examinations: "My students took a test at a for-profit tutoring center… their parents complained that I did not do enough problem-solving… now I conduct fewer activities in order to solve more problems. Unfortunately, I had to do this."

Observation confirmed this conflict. In one lesson, Ezgi began with a well-prepared group activity but shifted mid-class to test drills: "She handed out a test requiring answers in 20 min and then solved questions on the board, abandoning the planned activity," the observation notes stated. Her visible disappointment, expressed in the observation note stating that "she seemed to be disappointed that she was unable to do the activity she had prepared," underscored how systemic examination demands override teachers' pedagogical preferences.

Case 2: Guney – Inquiry as teacher-led questioning

Guney, one of the most senior teachers with 15 years of experience, demonstrated the narrowest understanding of IBT. He equated inquiry solely with posing questions that reinforce examination success: "I ask leading questions regarding the learning objectives; students discover the key concepts through the help of these questions… doing experiments and hands-on activities are too simple for me."

Observation data confirmed this narrow enactment. A lesson on force involved Guney posing questions, students copying answers into notebooks, and no hands-on or student-led investigation: "Next, he wrote a question on the board… picked students to write correct answers… repeated this until the end of class," field notes recorded.

Guney's case shows that teachers can meet formal curriculum demands rhetorically, as illustrated by his statement that "everyone says I am a successful science teacher. The national examinations are the criteria of being successful," without fundamentally shifting to genuine student-led inquiry. His classroom practice, therefore, illustrates symbolic compliance rather than transformative enactment.

Case 3: Serdar – Navigating inquiry amid resource shortages

Serdar, a teacher with 9 years of experience and professional development training in inquiry, consistently described IBT as central to his teaching philosophy: "Inquiry is at the center of life. I always look for evidence and try to explain everything in

terms of science." He expressed deep commitment to fostering curiosity and evidence-based thinking in his students.

However, Serdar candidly acknowledged persistent barriers, including low socio-economic conditions and a lack of laboratory resources: "The laboratory does not have sufficient equipment, but this is not a setback for doing activities… I ask colleagues to borrow material from their schools. Fortunately, they never let me down."

Observation data confirmed Serdar's adaptive strategies. He opened lessons with open-ended questions, refused to supply direct answers, and used improvisation to sustain student engagement. For example, in one lesson about force and motion, he encouraged students to design simple experiments using everyday objects brought from home. When students became distracted, he immediately redirected attention with humor and further questioning: "He said something funny to get their attention back," field notes recorded.

Yet the tension between inquiry and curriculum pacing was evident: "I need to follow the program and complete subjects by a certain time. I wish I could spend more time getting attention from more students," Serdar admitted. His case illustrates an educator who embodies an inquiry stance yet must continually negotiate structural constraints.

Case 4: Umay – A deep inquiry mindset constrained by structure

Umay, an 8-year teacher with training in inquiry, expressed the strongest epistemic commitment to IBT: "Science cannot be learned by memorizing… Science is life… If you do an inquiry, you understand science." She emphasized that real inquiry requires students to observe, question, and experiment.

Despite this, Umay acknowledged structural constraints: "In my 7th grade class, to cover all the subjects, I have to shorten something… the class is crowded… I wish I could do it more often, but the heavy curriculum and class size prevent this."

Limited resources forced pedagogical compromises: "I prepare only one experiment kit and do a demonstration… I know this is not the best way… Students need to investigate by doing, instead of watching."

Observation confirmed her commitment to inquiry within limits. She consistently used "what if" questions, scenarios from science magazines, and encouraged students to discover errors themselves. One group misassembled equipment; rather than correct them directly, Umay asked guiding questions until students identified the mistake: "Rather than correcting it herself, she asked questions to make them understand what they were doing wrong." Her practice showed sophisticated PCK under adverse conditions.

Case 5: Zeynep – Systemic misalignment and peer learning

Zeynep, a 16-year veteran, highlighted the contradiction between policy and practice: "MONE promotes inquiry-based education, but does not provide teachers with enough seminars or in-service training… We learned how to implement it through research and by asking each other questions."

She described how curriculum overload and examinations force teachers to limit inquiry: "In 7th and 8th grades, there are so many concepts to teach… I feel pressure from parents over the national examinations… On the one hand, you need to make students question and think critically… On the other hand, you need to give tests and exercises."

Observation confirmed her pragmatic compromise: While she encouraged inquiry tasks in lower grades, test-solving dominated her upper-grade lessons. Zeynep's reliance on peer networks and external workshops revealed a self-directed professional development model to compensate for institutional gaps.

Cross-Case Analysis: Dimensions of the Implementation Gap

Theme 1: Varied conceptions of inquiry

Teachers endorsed IBT rhetorically but conceptualized it along a spectrum – from inquiry as a mindset (Umay: "Science is life…") to inquiry as a hands-on activity (Ezgi, Zeynep) to inquiry as teacher-directed questioning (Guney). Only Serdar and Umay demonstrated deeper epistemological understandings consistent with international frameworks of authentic inquiry.

Theme 2: The overriding power of examinations

A dominant theme was that high-stakes examinations override policy and curriculum intentions. Ezgi's shift from activities to test practice ("Unfortunately, I had to do this"), Zeynep's parental pressures ("I feel pressure from parents…"), and Guney's justification ("The national examinations are the criteria of being successful") confirm international findings that standardized assessments heavily shape science instruction.

Theme 3: Resource constraints and structural inequities

Insufficient laboratory equipment, crowded classrooms, and rigid curriculum pacing emerged as persistent barriers. Serdar's workaround ("I ask colleagues to borrow material…") and Umay's fallback to demonstrations highlight teachers' improvisation to mitigate systemic shortfalls.

Theme 4: Adaptive strategies and peer networks

Despite these constraints, teachers actively devised adaptive strategies and relied on informal peer networks. As Zeynep explained, "We learned how to implement it through research and by asking each other questions." Serdar similarly described borrowing laboratory materials from colleagues: "Whenever I need something, I ask them. They never let me down." Umay emphasized questioning as an adaptive tool: "I know demonstration is not the best way – but I ask lots of questions so they start thinking for themselves." These examples illustrate how teachers negotiate systemic barriers through collegial support and creative improvisation.

Triangulation: Rhetoric Versus Enactment

Triangulation revealed notable mismatches. Guney's claim of inquiry practice was unsupported by any student-led

investigation. Ezgi's enthusiasm was curtailed by test-focused shifts. In contrast, Serdar's and Umay's practices aligned most closely with their stated beliefs, though both navigated severe material and curricular constraints.

DISCUSSION

This study aimed to explore how in-service middle school science teachers in Turkey understand and enact IBT within a centralized, examination-driven education system that formally promotes inquiry but constrains it in practice. The analysis employed the concept of the implementation gap as a central analytic construct to capture the persistent discrepancy between curriculum-level aspirations for inquiry and the instructional routines observed in classrooms. Rather than attributing this gap to isolated obstacles, the findings indicate that it is produced through interacting forces, including teachers' epistemic understandings of inquiry, assessment regimes, curricular pacing expectations, professional development opportunities, and material conditions. Collectively, these forces shape how inquiry is translated, reshaped, or curtailed in everyday practice.

Viewed through this lens, the findings resonate clearly with international scholarship on reform-oriented science teaching. Teachers such as Serdar and Umay articulated inquiry as a way of knowing grounded in curiosity, evidence, and student sense-making, closely aligned with socio-constructivist perspectives and contemporary frameworks emphasizing scientific practices (Crawford, 2000; Lederman et al., 2014). By contrast, Guney's emphasis on questioning as a route to predetermined answers and Ezgi's tendency to frame inquiry as episodic activities reflect narrower interpretations that have been widely documented in the literature (Capps and Crawford, 2013; Minner et al., 2010). These divergent understandings are not merely personal pedagogical preferences; within the analytic frame adopted here, they constitute an epistemic dimension of the implementation gap. When inquiry is understood primarily as a method or classroom technique rather than as an orientation toward knowledge production, it becomes especially vulnerable to compression under time pressure or to substitution with teacher-directed instruction.

Assessment pressures emerged as the most powerful institutional mechanism sustaining the implementation gap. Despite curriculum documents that foreground inquiry and higher-order reasoning, high-stakes national examinations, together with parental expectations linked to these assessments, implicitly define what counts as successful teaching. Ezgi's decision to abandon a planned investigation in favor of test drills, Zeynep's strategic reduction of inquiry in upper grades, and Guney's explicit equation of good teaching with examination scores illustrate how accountability structures reshape classroom priorities. This pattern mirrors international research demonstrating that standardized testing regimes often narrow instructional practices, even when teachers are committed to inquiry-oriented reform (Ardıç et al., 2025; Banilower et al., 2018; Blanchard et al., 2010). From the perspective of the implementation gap, this represents a form of systemic contradiction: Inquiry is promoted rhetorically in curriculum policy, yet marginalized in practice by assessment systems that privilege coverage, speed, and procedural mastery.

Material and organizational conditions further intensify this contradiction. Crowded classrooms, limited laboratory equipment, shortages of consumable materials, and rigid pacing schedules constrained teachers' capacity to orchestrate sustained, student-driven investigations. Umay's reliance on demonstration when only one experiment kit was available, and Serdar's dependence on borrowing materials from colleagues, provide concrete examples of how infrastructural inequalities translate into pedagogical compromises. Similar dynamics have been documented in other under-resourced contexts, where ambitious instructional reforms struggle to gain traction without parallel investment in facilities and staffing (Nemadziva et al., 2023). Within the analytic framework developed here, these constraints form a structural layer of the implementation gap: even teachers with sophisticated understandings of inquiry must adapt their pedagogy when the physical and organizational conditions of schooling render full enactment impractical.

At the same time, the findings highlight teachers' agency in navigating these systemic tensions. Across cases, participants engaged in ongoing negotiation of the implementation gap through adaptive strategies such as blending inquiry with examination preparation, compressing investigations, improvising materials, and drawing on collegial networks for professional learning. Zeynep's participation in TÜBİTAK workshops and peer collaboration, Serdar's informal borrowing of laboratory equipment, and Umay's deliberate use of questioning to preserve epistemic rigor under limited conditions all illustrate how teachers function as active mediators of reform rather than passive recipients of policy (Dobber et al., 2017; Grossman et al., 2009). However, these adaptations rarely eliminated the gap itself. Instead, they enabled partial or episodic enactments of inquiry that depended heavily on individual initiative rather than systemic support, reinforcing unevenness in students' opportunities to engage in authentic scientific practices.

The persistence of the implementation gap carries significant implications for policy and teacher education. The findings suggest that curriculum reform alone is unlikely to transform classroom practice when assessment regimes, professional development structures, and school-level resources remain unaligned with inquiry-oriented goals. Sustained, job-embedded professional learning that foregrounds epistemic aspects of inquiry, the orchestration of open-ended classroom discourse, and formative assessment practices could help teachers move beyond procedural enactments (Gümüş and Bellibaş, 2021; Lin et al., 2013). Equally important is the redesign of national examinations so that they reward reasoning, argumentation, and the use of evidence, which are

core features of inquiry that are currently marginalized by test-oriented accountability systems. Without such systemic coherence, teachers remain positioned between competing imperatives, and the implementation gap documented in this study is likely to persist.

Finally, although this research is situated in Turkey, the analytical framing and patterns identified are relevant beyond the national context. The coexistence of inquiry-oriented curriculum rhetoric with classroom-level constraints, teacher adaptation without corresponding institutional change, and assessment-driven narrowing of pedagogy mirrors dynamics reported across a range of centralized, accountability-driven systems (OECD, 2020; UNESCO, 2021). Conceptualizing these dynamics through the implementation gap foregrounds reform as a relational process shaped by the interaction of policy instruments, professional cultures, and material conditions. In doing so, the study contributes to broader international conversations about why IBT remains difficult to institutionalize and what forms of systemic alignment might enable it to become a routine feature of science classrooms rather than an occasional pedagogical departure.

CONCLUSION

This study demonstrates that while Turkish middle school science teachers largely endorse the ideals of IBT, the enactment of inquiry in everyday classroom practice remains uneven and constrained by interacting structural forces. Through the lens of the implementation gap, the findings show how misalignment among curriculum policy, high-stakes examinations, professional development opportunities, school leadership structures, and material resources shapes the practice of inquiry. Teachers' classroom decisions reflect neither simple resistance nor full compliance with reform agendas; rather, they represent ongoing negotiation as educators balance inquiry-oriented intentions with accountability pressures, time constraints, and infrastructural limitations.

Importantly, the study also reveals substantial professional commitment and creativity among teachers. Participants drew on peer networks, external workshops, improvised materials, and strategic questioning to preserve elements of inquiry within restrictive environments. These adaptive practices, however, depended heavily on individual initiative and local conditions, resulting in uneven opportunities for students to experience sustained inquiry across schools and grade levels. From a policy perspective, this variation underscores that reliance on teacher resilience alone is insufficient to close the implementation gap.

The findings indicate that narrowing this gap requires coordinated, system-level reform instead of isolated curricular adjustments. Assessment systems should be more closely aligned with inquiry-oriented goals; professional development should extend beyond episodic workshops to sustained, classroom-embedded learning; and schools should be provided with adequate laboratory facilities, manageable class sizes, and protected time for collaboration and reflection. By bringing forward teachers' voices alongside observed classroom practice, this study provides empirically grounded insights for policymakers, teacher educators, and school leaders seeking to establish IBT as a stable and accessible component of science education in Turkey and other centralized education systems facing similar challenges.

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