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More than Just Adding Subjects: Unpacking Secondary Mathematics Teachers' Challenges in Implementing Interdisciplinary Thematic Learning under China's 2022 Curriculum Reform

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Abstract

China's 2022 compulsory education curriculum reform mandates that no less than 10% of class hours be allocated to interdisciplinary thematic learning, marking a shift from subject-centered to competency-oriented education. However, empirical research on how secondary mathematics teachers perceive and struggle with this policy remains scarce, particularly under China's examination-oriented system. Adopting a qualitative semi-structured interview approach, this study investigates the practical dilemmas of three junior secondary mathematics teachers in Zhejiang Province with 3, 8, and 15 years of experience. Grounded in an integrated theoretical framework (Beane, 1997; Guskey, 2002; Fullan, 2007), the research identifies five core themes. First, teachers face conceptual ambiguity between genuine interdisciplinary integration and superficial subject patching. Second, they express widespread pedagogical anxiety, especially regarding assessment of interdisciplinary outcomes. Third, they are restricted by structural constraints including time scarcity, fragmented schedules, resource shortages, and high-stakes examination pressure. Fourth, they suffer from collaborative isolation and inadequate leadership support. Fifth, they adopt pragmatic coping strategies that represent compromised compliance rather than authentic implementation. The results reveal that without systemic reform of the high-stakes examination system, even teachers with clear conceptual awareness cannot promote high-quality interdisciplinary instruction. This study enriches empirical literature on the policy-practice gap in China's mathematics curriculum reform, provides implications for teacher professional development and assessment reform, and offers references for policymakers and international researchers engaged in curriculum integration.

Keywords: Interdisciplinary Thematic Learning, Mathematics Teaching, Curriculum Reform, Teacher Challenges, Qualitative Study, China

Introduction

In the context of rapid globalization, digital transformation, and increasingly complex social challenges, education worldwide is undergoing a profound paradigm shift—moving away from the traditional subject-centered, knowledge-transmission model toward interdisciplinary, competency-oriented education that aligns with real-world problem-solving

(Bairy & Inamdar, 2026). Modern society demands individuals who can integrate knowledge, methods, and perspectives from multiple disciplines to address practical issues such as environmental sustainability, technological innovation, and social governance, rather than relying on isolated, discipline-specific expertise. As a foundational discipline with strong abstractness, logic, and systematicity, mathematics has long been taught as an independent knowledge system, emphasizing theoretical rigor, procedural mastery, and exam-oriented training while neglecting its practical application and cross-disciplinary connection. However, the unique value of mathematics as a universal language for data analysis, real-world modeling, and logical reasoning has been increasingly recognized, making it a core subject in global interdisciplinary education reform (Maass et al., 2019). The Organisation for Economic Co-operation and Development (OECD) Education 2030 framework highlights cross-disciplinary competencies such as critical thinking, collaboration, and innovative problem-solving as core goals of modern education, driving curriculum reforms in Asia, Europe, North America, and other regions to prioritize interdisciplinary integration.

Against this global trend, China launched the 2022 compulsory education curriculum reform, a landmark policy that redefines the orientation and structure of basic education. The Ministry of Education (2022) issued the Compulsory Education Curriculum Plan (2022 Edition) and revised curriculum standards for all subjects, stipulating that no less than 10% of total teaching hours must be devoted to interdisciplinary thematic learning. This mandate is not a superficial adjustment of curriculum structure, but a fundamental reorientation of educational goals: to break disciplinary barriers, reconstruct curriculum content around real-life themes, and focus on cultivating students' key competencies rather than mere knowledge memorization and skill training (Zhu & Gao, 2025). For mathematics education, this reform represents a subversion of the decades-long "two basics" (basic knowledge and basic skills) tradition that has dominated Chinese mathematics classrooms (Zhang et al., 2004). Traditional mathematics teaching overemphasizes formula recitation, repetitive problem-solving, and discrete knowledge points, with little attention to connecting mathematics to real life or other disciplines. The 2022 reform aims to reverse this trend, positioning mathematics as a bridge between disciplines and a tool for solving practical problems.

Nevertheless, international research consistently shows that the implementation of interdisciplinary mathematics teaching faces multiple universal challenges, even in countries with long-standing educational innovation traditions. Teachers often struggle with conceptual confusion, failing to distinguish genuine interdisciplinary integration from superficial subject combination (Stentoft, 2017). Many lack the pedagogical skills and confidence to design authentic interdisciplinary tasks, leading to professional insecurity (Ellebæk et al., 2026). Structural barriers such as insufficient time, inadequate resources, and rigid schedules further hinder implementation, forcing teachers to prioritize disciplinary content over integrated learning (Berry et al., 2025). Most critically, high-stakes assessment systems that focus on single-discipline knowledge create a persistent constraint: teachers are compelled to prioritize exam-tested content rather than innovative interdisciplinary practices (Bramley et al., 2025). Worse still, mathematics is frequently marginalized in interdisciplinary activities, reduced to a mere computational tool rather than a core discipline with unique thinking value and analytical methods (Just & Siller, 2022; Spreitzer et al., 2025), which severely undermines the educational value of interdisciplinary mathematics learning.

Despite these universal challenges, a prominent research gap exists in the Chinese context: few empirical studies have explored the authentic experiences and practical dilemmas of secondary mathematics teachers implementing interdisciplinary thematic learning under the 2022 reform. Existing domestic research mostly stays at the level of policy interpretation, theoretical discussion, and idealized pedagogical design (Zhu & Gao, 2025; Zhang et al., 2025), focusing on what interdisciplinary learning "should be" rather than what it "is" in real classrooms. These studies often propose ideal implementation models without considering the complex constraints faced by frontline teachers. Meanwhile, international research is mostly rooted in Western educational contexts with distinct curriculum systems, teacher training mechanisms, and cultural environments—contexts that differ significantly from China's centralized policy-making, high-stakes examination, and academic achievement-oriented education system (Zhang et al., 2004). This gap makes it difficult to accurately grasp the actual difficulties of mathematics teachers and formulate targeted support strategies compatible with China's educational reality. Without centering teachers' lived experiences, curriculum reforms risk remaining theoretical ideals rather than practical realities.

To fill this gap, this study aims to investigate the perceived challenges, manifestation patterns, and support needs of junior secondary mathematics teachers in implementing interdisciplinary thematic learning under China's 2022 curriculum reform. The scope of this study is limited to three mathematics teachers from two public schools in Zhejiang Province, focusing on their conceptual understanding, pedagogical practices, structural constraints, collaborative experiences, and coping strategies. This research does not seek to evaluate the overall effectiveness of the reform but rather to provide an in-depth, qualitative account of frontline implementation realities.

1. What challenges do secondary mathematics teachers perceive in implementing interdisciplinary thematic learning?
2. How do these challenges manifest across conceptual, pedagogical, structural and collaborative dimensions?
3. What supportive conditions do teachers expect to address these challenges?

Literature Review

Interdisciplinary Thematic Learning: Connotations and Theoretical Basis

The distinction between multidisciplinary, interdisciplinary, and transdisciplinary learning serves as the logical starting point for understanding interdisciplinary thematic learning (Bramley et al., 2025). Although these terms are frequently used interchangeably in educational discourse, they reflect distinctly different levels of curriculum integration. Multidisciplinary learning means examining multiple disciplines independently around a shared theme, with weak or no explicit connection across subject areas. Interdisciplinary learning refers to synthesizing knowledge, methods, and perspectives from two or more disciplines to address a common problem or explore a theme, where each discipline contributes substantively to the learning process. Transdisciplinary learning means moving beyond conventional disciplinary boundaries to generate new knowledge and approaches that cannot be attained through single-discipline inquiry. The 2022 curriculum reform emphasizes genuine interdisciplinary integration rather than superficial multidisciplinary patching, which is the core criterion for evaluating the quality of implementation.

Beane (1997), a representative scholar of curriculum integration theory, argues that genuine curriculum integration should center on real-life situations and student interests, integrating individual experiences, social contexts, disciplinary knowledge, and curriculum design into a cohesive whole. He emphasizes that the goal of integration is not merely to combine different subjects, but to help learners deepen their understanding of themselves and the world, and develop the ability to apply knowledge to real-world problems. This theory provides a normative standard for distinguishing substantive integration (interconnected disciplines enhancing learning) from superficial combination (mechanical addition of disciplinary content without meaningful connection).

Venville et al. (2012) point out a fundamental "curriculum tension" in integrated education, which is particularly prominent in mathematics teaching. On the one hand, disciplinary teaching ensures the systematicness and rigor of specialized knowledge, which is essential for mastering mathematics with its hierarchical structure and logical rigor. On the other hand, integrated teaching conforms to the authenticity of students' daily experiences, enhancing the practicality and meaningfulness of learning. Resolving this tension—balancing disciplinary rigor and interdisciplinary integration—is a core challenge for mathematics teachers implementing the reform.

Global Challenges in Implementing Interdisciplinary Mathematics Teaching

Existing international literature classifies obstacles to interdisciplinary mathematics teaching into three interrelated levels: teacher-level, school-level, and policy-level (Corrigan, 2020, as cited in Berry et al., 2025). At the teacher level, the core dilemmas are professional competence anxiety and pedagogical adaptation difficulties. Teachers often lack knowledge of disciplines other than their own, making it difficult to design high-quality interdisciplinary tasks (Ellebæk et al., 2026). Trained in traditional teacher-centered, exam-oriented modes, teachers struggle to adapt to student-centered interdisciplinary teaching, which requires them to act as facilitators rather than lecturers, weakening their professional identity and confidence.

Recent empirical studies have further highlighted the persistence of these challenges even in well-resourced educational systems. For instance, Berry et al. (2025) found that Australian secondary teachers, despite positive attitudes toward STEM integration, continued to face significant obstacles in collaborative planning and resource allocation. Similarly, Bramley et al. (2025) documented how UK teachers' agency in implementing interdisciplinary curricula was constrained by accountability pressures and fragmented leadership support. These findings align with the struggles reported by Chinese teachers in the present study, yet also raise critical questions about how context-specific factors—such as China's centralized examination system—may intensify or reshape these challenges. While Western studies often emphasize teacher autonomy and school-level innovation, the Chinese context introduces a top-down mandate (the 10% interdisciplinary instruction time) that paradoxically encourages superficial compliance rather than deep pedagogical change. Thus, this study not only confirms the universality of certain implementation barriers but also challenges the assumption that policy mandates alone can drive meaningful reform without systemic assessment alignment.

At the school level, prominent problems include rigid curriculum arrangements, lack of collaborative planning time, and insufficient teaching resources. Many schools lack a clear vision for interdisciplinary integration, providing only policy dissemination rather than concrete guidance (Berry et al., 2025). Time constraints are particularly acute because teachers have no extra time to collaborate across disciplines or develop interdisciplinary materials, as confirmed by the LabSTEM project survey in Danish schools (Ellebæk et al., 2026).

At the policy level, the misalignment between curriculum reform goals and high-stakes assessment systems is the most critical constraint. British teachers reported that interdisciplinary teaching could not be sustained under existing assessment systems, as external exams forced them to prioritize tested disciplinary knowledge (Bramley et al., 2025). Mathematics is often reduced to a "calculation tool" in interdisciplinary practices, with its core thinking such as reasoning, modeling, and demonstration rarely highlighted (Just & Siller, 2022; Spreitzer et al., 2025), which further marginalizes the discipline.

China's 2022 Curriculum Reform: Policy Background and Research Gap

The 2022 compulsory education curriculum reform is a landmark policy in China's basic education, mandating no less than 10% of class hours for interdisciplinary thematic learning to cultivate students' key competencies (Ministry of Education, 2022; Zhu & Gao, 2025). The reform emphasizes "big ideas" and "big unit teaching" as core paths to promote interdisciplinary integration, encouraging teachers to design curriculum units around central themes or real problems.

Zhu and Gao (2025) summarized the educational value of interdisciplinary thematic learning into three aspects. The first is improving students' interdisciplinary literacy, the second is reconstructing curriculum content to break disciplinary boundaries, and the third is transforming classroom teaching to student-centered inquiry. Zhang et al. (2025) classified big ideas into life-oriented, transdisciplinary, and disciplinary types, proposing big unit teaching as an effective way to connect theory and practice.

However, existing domestic research has obvious limitations. Most studies are theoretical discussions or design proposals, lacking empirical investigations based on frontline teachers' real experiences. There is a shortage of in-depth qualitative research focusing on teachers' perceptions, struggles, and coping strategies. Many studies ignore the structural and institutional constraints in China's education system, assuming that teachers can implement reforms as long as they receive training or resources. This study precisely fills this gap by taking teachers' practical experiences as the core.

Theoretical Framework

This study constructs an integrated theoretical framework based on three classic theories to guide analysis and interpretation. The first is curriculum integration theory proposed by Beane in 1997, which provides a normative framework for distinguishing genuine integration from superficial patching and guides the analysis of teachers' conceptual challenges. The second is teacher change theory proposed by Guskey in 2002, which holds that teacher belief change follows the sequence of professional development, classroom practice change, student learning outcome change, and belief change, and this theory helps explain teachers'

resistance to interdisciplinary practices without positive learning outcomes. The third is curriculum implementation theory proposed by Fullan in 2007, which emphasizes systemic coherence including curriculum, assessment, professional development, and leadership as the key to successful reform and guides the analysis of structural and collaborative challenges. Based on this framework, the study analyzes teachers' challenges from four dimensions including conceptual, pedagogical, structural, and collaborative, so as to ensure a comprehensive understanding of the complexity of implementation dilemmas.

Methodology

Research Design

This study adopts a qualitative semi-structured interview design, which is suitable for exploring individuals' subjective experiences, cognitive perceptions, and practical dilemmas in specific contexts (Merriam & Tisdale, 2016). Qualitative research focuses on depth rather than breadth, capturing rich, context-dependent information that cannot be obtained through quantitative surveys. Semi-structured interviews balance structure and flexibility by following a pre-determined outline to cover key topics while allowing follow-up questions to explore in-depth insights. This design aligns with the research goal of centering teachers' authentic voices.

Participants

Purposive sampling was used to select three junior secondary mathematics teachers from two public schools in Zhejiang Province (Jiaxing and Haining), a pioneer region in implementing the 2022 reform with high educational standards. The sample includes teachers with 3, 8, and 15 years of teaching experience to ensure diversity across career stages including novice, mid-career, and senior, enabling cross-case comparison of challenge manifestations. All participants use People's Education Press mathematics textbooks that are aligned with 2022 standards and have received reform-related training. Detailed information is shown in Table 1.

Table 1
Participant Basic Information

Pseudonym	Teaching Experience	Professional Title	Teaching Grade	School Location	Interdisciplinary Training Experience
Teacher A	8 years	First-level teacher	Grade 8	Jiaxing	Occasional district-level workshops
Teacher B	15 years	Senior teacher	Grade 9 (Grade Leader)	Haining	Municipal-level training
Teacher C	3 years	Second-level teacher	Grade 7	Haining	University-related coursework only

Data Collection

Data were collected through one-on-one semi-structured interviews in April 2026, when teachers had at least one year of reform implementation experience. Each interview lasted about 30 minutes and was conducted via online video for two teachers or face-to-face for one teacher according to participants' preferences. The interview outline includes five modules covering basic understanding of interdisciplinary thematic learning, perceived challenges in multiple dimensions, coping strategies, support needs, and overall reflection. All interviews were audio-recorded with informed consent and transcribed verbatim to ensure the integrity of original data.

Data Analysis

Data analysis followed Braun and Clarke's (2006) six-step thematic analysis method. The first step is familiarizing with transcripts through repeated reading to grasp the overall information. The second step is conducting line-by-line open coding to generate initial codes that reflect key meanings. The third step is summarizing and categorizing codes to form preliminary themes with similar attributes. The fourth step is cross-checking and revising themes to ensure logical rationality and data support. The fifth step is defining and naming core themes clearly to highlight the core content. The sixth step is organizing materials and writing research results with sufficient evidence. Transcripts were imported into NVivo 14 for coding management, generating 32 initial codes that were further condensed into five core themes. To ensure the credibility of the research, the study adopted member checking, peer debriefing, reflexive journaling, and rich description as proposed by Lincoln and Guba in 1985.

Researcher Positionality

The researcher is a postgraduate student in mathematics education with frontline secondary mathematics teaching experience in China, which helps establish a good rapport with participants and gain a deep understanding of their professional contexts. During the research process, efforts were made to bracket pre-conceived assumptions, maintain a reflective attitude, and avoid subjective bias through peer feedback and reflexive journaling, so as to ensure the objectivity and authenticity of the research results.

Findings

Thematic analysis of interview data identifies five interrelated core themes that comprehensively reflect the practical challenges faced by secondary mathematics teachers in implementing interdisciplinary thematic learning under the 2022 curriculum reform. These themes are interwoven and mutually reinforced, forming a complex barrier system that restricts the effective implementation of the reform. Drawing on the integrated theoretical framework—Beane's (1997) curriculum integration theory, Guskey's (2002) teacher change theory, and Fullan's (2007) curriculum implementation theory—we organize the findings to highlight how conceptual, pedagogical, structural, and collaborative dimensions of challenges manifest in teachers' daily practice.

Conceptual Confusion: Genuine Integration vs. Superficial Patching

Consistent with Beane's (1997) distinction between substantive curriculum integration and mere multidisciplinary combination, all three participating teachers reported varying degrees of conceptual ambiguity regarding interdisciplinary thematic learning. Although they can accurately state the policy requirements of the 2022 curriculum reform such as the 10% class

hour allocation, they lack a clear and operable definition to distinguish genuine interdisciplinary integration from simple mechanical combination of subjects. In actual teaching design, most of their attempts stay at the level of superficial patching rather than realizing deep integration—a phenomenon that Beane warned against when he argued that authentic integration must center on real-life situations and student interests, not on the mechanical addition of disciplinary content.

Teacher A with 8 years of teaching experience mentioned that he clearly knows that interdisciplinary learning is not simply adding content of other subjects to mathematics, but in practical lesson design, he still unconsciously adopts a mechanical combination method. For example, when teaching statistics, he will add environmental pollution data as an introduction, but the environmental content is only an independent appendage and cannot form an organic connection with mathematical knowledge, and he does not know how to build a real integrated relationship between the two. Teacher C as a novice teacher with 3 years of experience expressed greater confusion, stating that there is no clear standard to judge what kind of lesson design meets the requirements of real integration. The school training only puts forward the requirement of integrating other disciplines but does not give specific cases and operational guidelines, making him worry that his design is only superficial and can only cope with school inspections.

Among the three teachers, only Teacher B with 15 years of teaching experience and a senior professional title has a relatively clear understanding of genuine integration. She believes that real integration means that the content of other disciplines is indispensable, and the mathematical problem cannot be deeply solved or understood without these contents. If the content of other disciplines can be removed at will, it is a false integration. She takes the integration of geometry and art as an example, where students use geometric principles to carry out architectural design, and art is not an add-on but a necessary carrier for applying geometric knowledge. However, Teacher B also admitted that even with clear conceptual awareness, it is extremely difficult to translate this understanding into conventional teaching design due to constraints such as time and energy. This gap between conceptual clarity and practical enactment reflects what Fullan (2007) describes as the lack of systemic coherence: teachers may understand the reform's intention, but without aligned structural supports, their understanding cannot translate into changed practice.

The shared experience across the three teachers confirms that the lack of clear operational standards leads to widespread conceptual confusion, making it difficult for teachers to move beyond superficial integration.

Pedagogical Insecurity: Focus on Assessment Dilemmas

Guskey's (2002) teacher change theory posits that teachers' beliefs change only after they see positive changes in student learning outcomes. This theoretical lens helps explain why widespread pedagogical insecurity exists among all participating teachers: the assessment of interdisciplinary learning outcomes—the most prominent and difficult problem—directly undermines the feedback loop that Guskey identifies as essential for teacher change. All three teachers said that they lack clear assessment criteria and operable tools to evaluate students' interdisciplinary learning outcomes, which directly affects the stability and sustainability of their interdisciplinary teaching practice.

Interdisciplinary learning focuses on cultivating students' key competencies such as interdisciplinary thinking, comprehensive application ability, and cooperative literacy, which are difficult to measure through traditional test methods. Teacher A complained that students' mastery of mathematical knowledge can be evaluated through tests and homework, but there is no mature standard to assess interdisciplinary competencies. The school does not provide assessment rubrics nor relevant training, so he can only grade students based on classroom participation or the completeness of project reports, which is highly subjective and unfair. Teacher C also said that he cannot find a scientific assessment basis, and the grading of works and reports is too subjective, so he can only give all students a passing score to avoid unfairness. In Guskey's terms, without credible evidence that interdisciplinary learning improves valued outcomes (e.g., examination scores or demonstrable competencies), teachers have no incentive to persist with the new pedagogy.

In addition to assessment dilemmas, teachers also face difficulties in adapting to teaching methods. Traditional mathematics teaching adopts a teacher-centered model with clear steps and fixed procedures, while interdisciplinary learning requires creating real situations, organizing group cooperation, and guiding students to explore independently. Teachers who are accustomed to traditional teaching find it difficult to transform their roles into facilitators, and they often worry about loose classroom management and incomplete coverage of knowledge points. Even Teacher B with rich teaching experience admitted that she is used to controlling the classroom progress and guiding students to solve problems step by step, while interdisciplinary learning requires letting go of control and allowing students to explore independently. This makes her worry that students will neglect the learning of mathematical key knowledge. Once in an interdisciplinary lesson integrating mathematics and environmental science, students spent a lot of time discussing environmental issues but ignored mathematical calculations, and she had to intervene forcibly, which deviated from the original intention of interdisciplinary learning. This kind of pedagogical insecurity directly weakens teachers' confidence in implementing high-quality interdisciplinary teaching, reinforcing the vicious cycle that Guskey described: without observable student success, teachers retreat to familiar practices.

Structural Constraints: Time, Resources, and High-Stakes Examinations

Structural constraints are regarded as the most fundamental and insurmountable obstacles by all teachers, which are mainly reflected in three interrelated aspects: time shortage, resource scarcity, and high-stakes examination pressure. From the perspective of Fullan's (2007) curriculum implementation theory, these factors represent failures of systemic coherence—the alignment of curriculum, assessment, professional development, and leadership—which Fullan identifies as the key determinant of successful reform. Without addressing these structural barriers, even the most well-designed policy mandate cannot produce meaningful change.

First, the shortage of time is a common dilemma. The traditional 40-minute single class hour is highly fragmented and cannot support the complete process of interdisciplinary inquiry activities that require exploration, cooperation, and reflection. At the same time, teachers are burdened with heavy daily teaching work including preparing lessons, correcting homework, and attending meetings, and there is no extra time to collect materials, design interdisciplinary lessons or carry out cross-disciplinary cooperation. Teacher A said that the

class schedule is full of 40-minute classes without flexible time for long-term interdisciplinary projects, and he has no time to design complex interdisciplinary activities even if he wants to. Teacher C added that as a new teacher, he already spends a lot of time on basic lesson preparation, and it is impossible to carry out detailed interdisciplinary design without working overtime for a long time.

Second, the shortage of teaching resources further aggravates the difficulty. There is a serious lack of supporting cases, lesson plans, and learning materials for interdisciplinary mathematics teaching. Unlike traditional mathematics teaching with rich resources, interdisciplinary lessons require teachers to develop materials from scratch, which is time-consuming and laborious with unstable quality. Teacher B said that there are very few high-quality interdisciplinary mathematics lesson plans available, and the school does not provide resource support, so teachers can only search online or make their own, which greatly increases the workload.

Third, the pressure of the high school entrance examination is the core constraint that dominates all teaching decisions. The high school entrance examination only tests pure mathematical knowledge without involving interdisciplinary content, and teachers' teaching behaviors are completely guided by examination-oriented goals. Teacher B emphasized bluntly that if the high school entrance examination does not change, all reform efforts will be in vain. Interdisciplinary learning can only be carried out as a formalistic project for open classes or school inspections, but cannot be integrated into conventional teaching. Spending too much time on interdisciplinary activities will lead to a decline in students' examination scores, which is unacceptable for both teachers and students. The three teachers unanimously stated that the 10% interdisciplinary class hour requirement only exists in policy documents, and in actual teaching, it is completely compressed by examination-oriented teaching, becoming a mere formality. This finding starkly illustrates Fullan's core argument: when assessment systems remain misaligned with curriculum reform goals, implementation inevitably fails.

Collaborative Isolation: Weak Peer Cooperation and Inadequate Leadership Support

All participating teachers are in a state of fighting alone in the process of implementing interdisciplinary thematic learning, and cross-disciplinary collaboration is extremely limited. Fullan's (2007) framework emphasizes that successful curriculum implementation requires not only individual teacher change but also collective capacity building and supportive leadership. The collaborative isolation observed in this study directly violates this condition.

Interdisciplinary teaching inherently requires the joint participation of teachers of multiple disciplines, but the reality of cooperation is very unsatisfactory. The main reasons for collaborative isolation include inconsistent teaching schedules of different subject teachers, conflicting teaching objectives, and lack of fixed communication platforms. Teacher A said that he wants to cooperate with science or art teachers to design interdisciplinary lessons, but the class schedules and preparation time of different subjects are completely misaligned, and there is no chance to conduct in-depth discussions. He can only design independently, making it impossible to realize real integration of multi-disciplinary knowledge. Teacher C added that when he takes the initiative to communicate with teachers of other subjects, most colleagues are busy with their own examination-oriented teaching and have no time or

willingness to participate in interdisciplinary cooperation, and even think that this is a waste of teaching time.

In addition to the lack of peer cooperation, school leadership support is mostly superficial and symbolic. Schools only convey policy documents and put forward implementation requirements, but do not take practical measures to solve problems such as time adjustment, resource allocation, and targeted training. Teacher B as a grade leader pointed out that school leaders only emphasize the importance of interdisciplinary learning in meetings but do not solve practical difficulties for teachers. She once applied to the school for arranging common preparation time for mathematics and science teachers, but was rejected on the grounds of disrupting the original schedule. The lack of a collaborative atmosphere and institutional support makes it impossible for teachers to form a joint force, and they can only explore independently, which seriously restricts the quality and effect of interdisciplinary teaching. Teacher C said that he feels very frustrated when trying to promote new teaching models without support from the school and cooperation from colleagues, and even has the idea of giving up. This pattern of isolation and inadequate leadership exemplifies what Fullan calls the absence of "coherence making"—the active role that school leaders must play to align schedules, resources, and professional learning opportunities around reform goals.

Coping Strategies: Pragmatic Compromises Rather Than Authentic Implementation

In order to cope with the dual pressure of policy inspection and practical constraints, all three teachers have formed a set of pragmatic coping strategies, which are essentially compromised adaptations rather than the authentic implementation of the reform's original intention. These strategies can be understood through Guskey's (2002) teacher change sequence: because teachers have not observed positive student learning outcomes (especially examination results) from interdisciplinary teaching, they have not internalized the reform's beliefs. Consequently, they adopt superficial compliance to satisfy external policy demands while protecting their core examination-oriented practice.

The first common strategy is micro-integration, that is, embedding a small amount of superficial interdisciplinary elements in conventional mathematics classrooms, such as adding simple life scenes or brief cross-disciplinary connections, so as to meet the superficial requirements of the policy without affecting the normal progress of examination-oriented teaching. Teacher A said that he has no time to design complete interdisciplinary lessons, so he only adds a small interdisciplinary link in regular teaching, such as integrating shopping discount scenarios when teaching percentages, which can cope with policy checks without delaying exam review.

The second strategy is assessment simplification, that is, replacing the assessment of interdisciplinary competencies with traditional homework or test scores, avoiding the complexity of comprehensive competency evaluation. Teacher C said that he does not know how to assess interdisciplinary competencies scientifically, so he still uses traditional mathematical tests to evaluate students after interdisciplinary activities, which is simple and consistent with examination requirements.

The third strategy is task decentralization, that is, assigning simple interdisciplinary tasks as after-class homework to reduce the pressure on classroom teaching time. Teacher B said that

she assigns some simple data collection and calculation tasks as homework, such as counting family water consumption and calculating averages, so that students can complete interdisciplinary learning outside class without occupying normal teaching time.

All teachers clearly realize that these strategies cannot realize the educational value of interdisciplinary learning and deviate from the reform's goal of cultivating students' key competencies, but they said that under the constraints of the examination system and time resources, this is the only feasible way. From a theoretical perspective, these pragmatic compromises represent what Fullan (2007) would call "failed implementation with symbolic compliance"—the policy mandate is formally satisfied, but its substantive intentions are not realized. Guskey's (2002) model further suggests that without changing the assessment system to provide teachers with evidence that interdisciplinary learning yields desirable student outcomes, such superficial coping will persist and may even become institutionalized.

Discussion

Core Findings Summary

The findings reveal three core contradictions underlying teachers' implementation difficulties. First, conceptual clarity about genuine interdisciplinary integration does not translate into practice without systemic structural supports. Second, the high-stakes examination system overrides reform goals, rendering even well-intentioned teachers unable to prioritize interdisciplinary teaching. Third, teachers' pragmatic coping strategies—micro-integration, assessment simplification, and task decentralization—represent rational compromises under existing constraints rather than resistance to change. These conclusions are elaborated below through comparison with international literature and theoretical implications.

Comparison with International Literature

The challenges faced by Chinese mathematics teachers in implementing interdisciplinary learning are highly consistent with those in Western countries in terms of basic dimensions, reflecting the universality of interdisciplinary teaching dilemmas. Similar to Danish teachers in Ellebæk et al.'s study, Chinese teachers also face problems such as lack of cross-disciplinary knowledge, difficulty in adapting to student-centered teaching methods, and extreme shortage of time. Consistent with Australian teachers in Berry et al.'s research, Chinese teachers also encounter school-level barriers including rigid curriculum arrangements, lack of cooperative planning time, and insufficient peer support. Like British teachers in Bramley et al.'s study, Chinese teachers also believe that interdisciplinary teaching cannot be effectively promoted without the support of the assessment system and school system. However, this study also finds three distinctive characteristics rooted in the Chinese educational context. First, more decisive and absolute in its impact. In Western contexts, assessment is only one of the influencing factors, while in China, the high school entrance examination dominates all teaching behaviors and becomes the root cause of all implementation dilemmas. Second, the reform presents a strong top-down mandatory attribute. The 10% class hour requirement is a mandatory policy, which makes teachers focus on formal coping rather than autonomous practice, which is different from the voluntary promotion model in most Western countries. Third, the marginalization of mathematics in interdisciplinary practices is more serious. Under the pressure of examinations, mathematics is completely reduced to a computational tool, and its core values such as logical reasoning, modeling, and demonstration are completely

ignored, which is more prominent than the marginalization phenomenon in Western STEM education.

Theoretical Implications

The findings of this study have important supplementary and refining significance for the three theoretical frameworks applied in the research, especially providing empirical evidence for the application of these theories in non-Western high-stakes examination contexts. For Beane's curriculum integration theory, this study confirms the rationality of the distinction between substantive integration and superficial patching, and at the same time points out that the theory needs to fully consider the influence of systemic constraints such as assessment and time in practical application. Even if teachers have a correct conceptual understanding, they cannot implement genuine integration without external support, which expands the application scope of the theory. For Guskey's teacher change theory, this study verifies the rationality of the view that belief change comes after practice and outcome changes. Teachers in this study have received policy training and recognized the theoretical value of interdisciplinary learning, but they are still unwilling to carry out real practice because they have not seen the improvement of students' examination scores and other key outcomes. This indicates that in the Chinese educational context, promoting teacher change must start with improving the outcomes that teachers and the system pay attention to. For Fullan's curriculum implementation theory, this study strongly confirms the core view that systemic coherence determines the success or failure of reform. The misalignment between curriculum reform goals and assessment systems, as well as the lack of organizational support such as time, resources, and cooperation, directly leads to the disconnection between policy and practice, which provides strong empirical support for the theory.

Practical Implications

Based on the research findings, this study proposes four targeted practical suggestions to promote the effective implementation of interdisciplinary thematic learning in junior high school mathematics. First, it is necessary to clarify conceptual guidance and formulate operable implementation standards. Education authorities and schools should develop clear guidelines for interdisciplinary mathematics teaching, provide a large number of high-quality cases that can be referenced and replicated, help teachers accurately distinguish between genuine integration and superficial patching, and solve the problem of conceptual confusion. Second, it is urgent to build an interdisciplinary assessment system compatible with competency orientation. Research and develop clear assessment criteria and operable tools such as rubrics, adopt formative assessment methods such as performance evaluation and portfolio, and gradually incorporate interdisciplinary content into the high school entrance examination to reverse the situation that teachers only focus on examination-oriented teaching. Third, systemic adjustment should be carried out to solve structural constraints. Schools should optimize the class schedule to set up flexible interdisciplinary time blocks, develop and promote public interdisciplinary teaching resources to reduce the burden on teachers, and steadily promote the reform of the high-stakes examination system to align assessment with reform goals. Fourth, it is essential to build a collaborative support system and a supportive school culture. Establish fixed cross-disciplinary teaching teams and cooperative planning mechanisms, adjust teachers' schedules to ensure common preparation time, strengthen school leaders' practical support rather than verbal emphasis, create an

atmosphere of collaborative innovation, and help teachers get rid of the state of fighting alone.

Limitations and Future Research

This study has certain limitations that need to be improved in future research. First, the sample size is small, only including three junior high school mathematics teachers from two cities in Zhejiang Province. Although the purposive sampling of different teaching ages ensures the diversity of data, the findings are difficult to be directly generalized to the whole country. Future research can expand the sample scope to cover different regions, urban and rural areas, and different types of schools to enhance the universality of the conclusions. Second, this study only adopts the interview method to collect teachers' subjective perception data, without classroom observation and student outcome verification. Future research can use a mixed research method combining interviews, observations, and student assessments to present a more comprehensive implementation picture. Third, this study only focuses on mathematics teachers, while interdisciplinary learning involves multiple disciplines. Future research can adopt a multi-disciplinary perspective to explore the collaborative dilemmas and solutions of teachers of different subjects. In addition, future research can also carry out longitudinal tracking studies to observe the changes in teachers' implementation behaviors and perceptions with the promotion of the reform, and evaluate the effectiveness of different support strategies to provide more practical guidance for policy optimization.

Conclusion

The 2022 compulsory education curriculum reform marks a profound transformation of Chinese basic education toward interdisciplinary, competency-oriented learning. The mandate that no less than 10% of total class hours be devoted to interdisciplinary thematic learning has presented unprecedented challenges for frontline mathematics teachers. Drawing on an integrated theoretical framework (Beane, 1997; Guskey, 2002; Fullan, 2007) and in-depth qualitative interviews with three junior secondary mathematics teachers in Zhejiang Province, this study reveals that the gap between policy ideals and classroom practice is not merely a matter of teacher resistance or lack of training, but a systematic outcome of multiple, interlocking barriers.

The findings identify five interconnected challenges—conceptual confusion regarding genuine integration versus superficial patching, pedagogical insecurity centered on assessment dilemmas, structural constraints of time, resources, and high-stakes examinations, collaborative isolation with weak peer and leadership support, and pragmatic coping strategies that substitute authentic implementation with symbolic compliance. Among these, the misalignment between the reform’s competency-oriented goals and the existing high-stakes examination system emerges as the most fundamental constraint. Even conceptually clear and pedagogically experienced teachers cannot sustain high-quality interdisciplinary instruction when examination results dominate all educational decisions.

Theoretically, this study extends the applicability of curriculum integration theory, teacher change theory, and curriculum implementation theory to non-Western, high-stakes assessment contexts. It demonstrates that Beane’s distinction between substantive integration and superficial combination, while analytically powerful, requires systemic

supports to be operationalized; that Guskey's belief-change sequence is blocked when assessment systems do not reward new pedagogies; and that Fullan's emphasis on systemic coherence is not merely desirable but absolutely necessary for reform success.

Practically, the findings underscore that promoting interdisciplinary thematic learning is not a matter of teacher training alone, but a systemic project requiring simultaneous adjustments in curriculum design, assessment reform, school scheduling, resource allocation, and leadership support. Without changing the high school entrance examination system to include interdisciplinary competencies, teachers will continue to adopt superficial coping strategies that satisfy policy inspection while preserving examination-oriented instruction.
This study has limitations, including a small sample from one province and reliance on self-reported interview data. Future research should expand to diverse regions, incorporate classroom observations and student outcome measures, and employ longitudinal designs to track how teachers' practices evolve as the reform matures. Nevertheless, by centering frontline teachers' authentic voices, this research provides a realistic perspective on the policy-practice gap in China's mathematics curriculum reform and offers a Chinese case reference for international scholarship on curriculum integration under high-stakes accountability systems.

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