Jiang, B. et al. (Eds.) (2025). Proceedings of the 33rd International Conference on Computers in Education.
Asia-Pacific Society for Computers in Education

Dialogic Expertise in Practice: How Expert Teachers Orchestrate Classroom Talk in Distinct Mathematics Lesson Types

Siyu WANG[a], Yaqian ZHENG[a], Mingze SUN[a], Yaping XU[b] & Yanyan LI[a*]
[a]*School of Educational Technology, Beijing Normal University, China*
[b]*School of Educational Technology, Northwest Normal University, China*
*liyy@bnu.edu.cn

Abstract: Dialogic teaching, which emphasizes the strategic use of classroom talk to support student thinking, has been widely recognized for its role in promoting deep learning. While previous research has affirmed the benefits of dialogic interaction, little is known about how expert teachers organize and adapt their discourse across different lesson types. This study addresses this gap by examining the distributional and sequential patterns of discourse moves used by expert mathematics teachers in Chinese middle schools during New lessons and Exercise lessons. Drawing on 40 video-recorded lessons, the study combined statistical analysis and process mining based on first-order Markov modeling to identify discourse structures and interaction flows. Findings reveal consistent discourse routines across lesson types, characterized by structured discourse organization and progressive scaffolding strategies that support coherent dialogue and deep conceptual understanding. However, distinct differences emerged in discourse strategy selection, instructional organization, and interactional structuring, reflecting adaptations to the pedagogical goals of each lesson type. These insights enhance understanding of dialogic expertise and inform the design of teacher development initiatives that promote context-sensitive discourse strategies.

Keywords: Dialogic teaching, expert teachers, discourse moves, lesson types, process mining

1. Introduction

Effective classroom talk is essential for promoting student thinking, engagement, and conceptual understanding (Mercer, 2019). As interest in dialogic teaching continues to grow, increasing attention has been paid to how teachers structure discourse to support learning (Muhonen et al., 2024). While many studies have confirmed the value of dialogic interaction, fewer have examined how specific discourse strategies unfold in real classrooms or how these strategies vary under different instructional conditions.

Among the factors influencing classroom discourse, teacher expertise has been shown to play a decisive role (Derakhshan et al., 2024). Expert teachers are more likely to use questions, prompts, and feedback in ways that build coherence across interactions and sustain student reasoning (Yu & Huang, 2025). Empirical evidence suggests that such teachers engage students more effectively through carefully sequenced talk and responsive adaptation to emerging ideas (Wray & McDonald, 2025). At the same time, discourse patterns are shaped by instructional context, including subject matter, student age, and the structure of teaching tasks. Lesson type, in particular, introduces distinct communicative demands (Amodia-Bidakowska et al., 2023), yet little is known about how expert teachers adjust their talk between lessons designed to introduce new concepts and those focused on practice or review.

This study addresses that gap by examining the discourse of expert mathematics teachers in New and Exercise lessons. Drawing on classroom recordings from Chinese middle schools, we analyze how discourse moves are distributed and how they are sequentially organized across lesson types. Using a combination of statistical analysis and process mining based on first-order Markov modeling, the study aims to uncover how expert teachers orchestrate classroom dialogue in response to differing pedagogical goals. The findings contribute to a deeper understanding of adaptive discourse practices and offer implications for teacher learning and dialogic pedagogy.

2. Literature Review

2.1 Dialogic Teaching and Discourse Moves

Dialogic teaching emphasizes the use of discourse to promote students' critical thinking and problem-solving abilities (Alexander, 2018; Zhang et al., 2025), thereby supporting knowledge construction and the development of higher-order reasoning skills (Mercer, 2019). Grounded in Vygotsky's sociocultural theory, dialogic pedagogy is founded on the premise that meaning is co-constructed through social interaction (Vygotsky et al., 1978), making classroom discourse central to the learning process (Wang et al., 2025). As the primary medium of classroom interaction, discourse externalizes cognitive processes (Webb et al., 2014), enabling students to articulate perspectives, engage in deep reasoning, and formulate critical responses through sustained dialogue (Resnick et al., 2015). Empirical research has shown that teacher-dominated monologic instruction often suppresses students' cognitive engagement, limiting their capacity for reasoning and reflection (Yu & Huang, 2025). In response, scholars advocate for the strategic use of discourse to scaffold students' thinking, promote dialogic exchange, and enhance the pedagogical impact of teacher talk (Muhonen et al., 2024).

To systematically analyze dialogic interaction, discourse moves have been widely adopted as the core unit of analysis (O'Connor & Michaels, 2019). Teacher discourse moves refer to intentional verbal actions used to elicit responses, sustain interaction, and guide classroom dialogue (Tao & Chen, 2024). Analyzing these moves provides insight into how discourse practices influence student learning. Various coding frameworks have been developed to support the quantitative analysis of discourse moves, including the Academically Productive Talk (APT) framework (Michaels & O'Connor, 2015) and the Scheme for Educational Dialogue Analysis (SEDA) (Hennessy et al., 2016). The APT framework classifies discourse moves into three dimensions: responsibility to the learning community, to knowledge, and to reasoning standards, which help teachers prompt students to articulate ideas and justify their thinking. SEDA offers a more fine-grained structure, comprising 33 discourse moves organized into eight categories, and provides a comprehensive tool for analyzing educational dialogue. Building on SEDA, Hennessy et al. (2020) introduced the Cambridge Dialogue Analysis Scheme (CDAS), which streamlines the coding structure to enhance feasibility for large-scale classroom discourse analysis (Amodia-Bidakowska et al., 2023). Designed for broad applicability across subjects and pedagogical contexts, CDAS aligns well with the analytical needs and disciplinary scope of the present study.

2.2 Teachers' Classroom Talk Across Experience Levels and Instructional Contexts

Empirical research has shown that well-structured teacher discourse can enhance students' engagement, metacognitive regulation, and conceptual understanding (Chen, 2020; Smit et al., 2023). Through dialogic interaction, students are supported in articulating their ideas, reasoning through problems, and building shared understanding (Adie et al., 2018). However, much of the existing research has concentrated on the outcomes of dialogic teaching, while offering limited insights into the structural features and adaptive strategies that make teacher discourse effective in diverse classroom settings.

Recent research highlights the role of pedagogical expertise in shaping teachers' discourse strategies. Expert teachers are commonly defined as those with stable instructional experience, strong professional judgment, and flexibility in adapting to student needs (Lachner et al., 2016). Empirical studies have demonstrated that such teachers more effectively orchestrate classroom discourse to support reasoning, engagement, and learning coherence. For example, Omland and Rødnes (2020) found that expert mathematics teachers consistently used open-ended questions and elaborative feedback to promote collaborative inquiry. Derakhshan et al. (2024) further observed that experienced language teachers' discourse was marked by greater simultaneity and immediacy, fostering stronger learner involvement than that of novice teachers. These findings indicate that dialogic expertise is both a marker of pedagogical proficiency and a key mechanism for scaffolding deep learning and sustaining instructional continuity.

Beyond teacher expertise, growing evidence suggests that classroom discourse is closely shaped by instructional context. Discourse practices differ across subject areas, educational stages, and curricular structures, reflecting how teachers align their talk with varying content demands and student needs. For example, Amodia-Bidakowska et al. (2023) found that in upper primary classrooms, reasoned dialogue appeared more frequently in mathematics, while both English and mathematics supported more elaborated contributions than science. Muhonen et al. (2024) found that secondary classrooms had longer dialogic episodes, while early primary grades had more high-quality teacher-led dialogues, with greater subject-specific variation in primary grades. Among contextual dimensions, the contrast between concept-introducing lessons and practice-oriented lessons has received relatively limited attention. Yu and Huang (2025) provided preliminary evidence that teacher discourse occurred more frequently in practice lessons than in new content lessons in Chinese mathematics classrooms. Nevertheless, systematic research on how discourse structures vary with lesson type, particularly in expert teaching contexts, remains scarce.

Despite increasing attention to classroom discourse, little is known about how expert teachers adapt their talk across lesson types or how their discourse is sequentially organized to support learning. To address these gaps, this study aims to investigate the distribution and sequential traits of discourse moves employed by expert mathematics teachers in lessons introducing new content and practice sessions, posing the following research questions:

(1) What are the differences in the distribution of discourse moves used by expert mathematics teachers in New and Exercise lessons?

(2) What are the differences in the sequential patterns of discourse moves used by expert mathematics teachers in New and Exercise lessons?

3. Methods

3.1 Data Sample

This study analyzed 40 video-recorded Grade 8 mathematics lessons sourced from the *Smart Education of China* platform (https://basic.smartedu.cn/), a national open-access repository for high-quality K-12 instructional resources developed by China's Ministry of Education. The sample included 20 New lessons and 20 Exercise lessons, all centered on the same curricular topic and based on a standardized textbook edition. All were delivered by expert teachers with intermediate or senior professional titles and officially recognized as national exemplary classes, each lasting 40-45 minutes to ensure consistency.

3.2 Coding Scheme

This study adapted the Cambridge Discourse Analysis Scheme (CDAS; Hennessy et al., 2020) to code classroom discourse moves. Two pairs of categories were merged for clarity: Simple Coordination and Reasoned Coordination into Coordination (CO), and Reference to Wider Context and Reference Back into Reference Beyond (RB), as shown in Table 1. To differentiate speaker roles, all codes were prefixed with "T." for teachers and "S." for students (e.g., T.COI, S.CO).

Table 1. *The Coding Scheme for Discourse Moves*

Code	Definition	Example
Elaboration invitations (ELI)	Encourages individuals to supplement, elaborate on, evaluate, or clarify their own or others' perspectives.	*Who can further contribute by identifying other types of special quadrilaterals?*
Elaboration (EL)	Builds on, elaborates, evaluates, or clarifies one's own or others' perspectives.	*In other words, a quadrilateral with diagonals that bisect each other is a parallelogram.*
Reasoning invitations (REI)	Invites others to explain or argue a viewpoint, or guide them to make inferences, predictions, or hypotheses.	*Why is segment DF equal to segment BE? Can someone explain the reasoning behind this?*
Reasoning (RE)	Provides an explanation or justification for perspectives, or engages in speculation, prediction, or hypothesis based on reasoning.	*Since AB equals CD and AE equals CF in parallelogram ABCD, it follows that DF equals BE.*
Co-ordination invitations (COI)	Invites the synthesis, summarization, comparison, evaluation, or resolution of multiple perspectives.	*Based on these figures, who can formulate a definition of line-symmetric figures?*
Co-ordination (CO)	Organizes and analyzes multiple perspectives or ideas, synthesizing collective viewpoints, comparing differing opinions, and reasoning based on theory or evidence.	*Through these exercises, we find that a plane figure, when folded along a straight line, exhibits coincident portions on either side of the line. Such a figure is referred to as a line-symmetric figure.*
Agreement (A)	Explicitly express acceptance or endorsement of a particular statement or contribution.	*Excellent, everyone has understood the definition of rational expressions.*
Querying (Q)	Express doubt, disagreement, or challenge a viewpoint.	*Are you sure it's a rhombus? Check its defining characteristics.*
Reference beyond (RB)	Guides connections to prior knowledge, experiences, or views, and to relevant knowledge beyond the lesson topic.	*Can everyone recall the method we learned for finding the least common denominator of fractions?*
Other invitations (OI)	Invites various verbal contributions (e.g., expressions of opinions, ideas), excluding ELI, REI, COI, or RB.	*He said earlier that the diagonals of a parallelogram are opposite. Do you agree with this statement?*
Uncoded (UC)	Discourse not fitting any of the previously defined categories.	*That's the end of our short but joyful learning today.*

3.3 Data Processing

The 40 recorded Grade 8 mathematics lessons were transcribed using the iFlyRec automatic speech recognition tool and manually reviewed for accuracy. The transcripts were segmented into 10,876 teacher discourse utterances based on meaningful instructional units. Prior to formal coding, two trained researchers jointly reviewed the coding scheme and conducted calibration to ensure a shared understanding of category definitions. A random sample of 1,200 utterances was then independently coded, yielding a Cohen's Kappa of 0.80, indicating high inter-rater reliability. Discrepancies were resolved through discussion, and the remaining 9,676 utterances were subsequently coded by the same researchers.

3.4 Data Analysis

This study examined both the distributional and sequential characteristics of expert teachers' discourse in New and Exercise lessons. Descriptive statistics were used to calculate the frequency and distribution of discourse moves, and the Mann-Whitney U test was applied to assess the significance of differences across lesson types. For sequential analysis, process mining was conducted using first-order Markov modeling (FOMM) (Fan et al., 2022), generating transition variance diagrams to visualize and compare discourse flow patterns between the two lesson types.

4. Results

4.1 Distributional Characteristics of Expert Teachers' Discourse Moves in New and Exercise Lessons

Table 2 presents the frequency distribution and significance test results of discourse moves used by expert mathematics teachers across New and Exercise lessons. Overall, OI emerges as the most frequently used move in both lesson types, accounting for 24.73% in New lessons and 25.47% in Exercise lessons. This is followed by ELI (14.38% in New lessons; 18.73% in Exercise lessons), while A ranks third (8.08% and 5.76%, respectively). Notably, the frequencies of RE and Q remain low in both contexts, with RE accounting for only 0.76% in New lessons and 0.48% in Exercise lessons, and Q occurring at 0.54% and 0.69%, respectively.

The results of the Mann-Whitney U test reveal significant differences in the use of discourse moves between New and Exercise lessons. Expert teachers employed REI significantly more frequently in New lessons (U=305.0, z=2.840, p=0.005, $|r|$=0.449), suggesting a stronger emphasis on encouraging student reasoning. The use of COI (U=317.0, z=3.165, p=0.002, $|r|$=0.500) and CO (U=288.0, z=2.380, p=0.017, $|r|$=0.376) was also significantly higher, reflecting more frequent efforts to guide students in synthesizing ideas. In addition, A occurred more often in New lessons (U=303.5, z=2.800, p=0.005, $|r|$=0.443), indicating a greater tendency to affirm and positively reinforce student contributions.

Table 2. *Frequency, Proportional Distribution, and Statistical Comparison of Discourse Moves Used by Expert Mathematics Teachers in New and Exercise Lessons*

Code	New lessons		Exercise lessons		Mann-Whitney U Test		
	F	%	F	%	U	z	Asymp. Sig. (2-tailed)
ELI	1114	14.38%	1375	18.73%	163.0	-1.001	0.323
EL	298	3.85%	357	4.86%	156.0	-1.190	0.239
REI	447	5.77%	253	3.45%	305.0	2.840	**0.005***
RE	59	0.76%	35	0.48%	254.0	1.461	0.140
COI	160	2.07%	78	1.06%	317.0	3.165	**0.002***
CO	119	1.54%	74	1.01%	288.0	2.380	**0.017***
RB	156	2.01%	127	1.73%	270.5	1.907	0.057
A	626	8.08%	423	5.76%	303.5	2.800	**0.005***
Q	42	0.54%	51	0.69%	212.5	0.338	0.739
OI	1916	24.73%	1870	25.47%	227.0	0.730	0.473
UC	552	7.13%	744	10.13%	172.5	-0.744	0.465

Note. U = Mann-Whitney U statistic; z = standardized test statistic; r = effect size. *Asymp. Sig. (2-tailed)* refers to the asymptotic significance level from a two-tailed test. $p < 0.05$ indicates statistical significance.

4.2 Sequential Patterns of Expert Teachers' Discourse Moves in New and Exercise Lessons

To examine how expert teachers adapt their discourse patterns across instructional contexts, this study modeled classroom discourse move sequences in New and Exercise lessons using first-order Markov chains and the process mining toolkit *pMineR* (Fan et al., 2025). The resulting process maps (Figures 1 and 2) visualize the sequential flow of interaction, where each node represents a specific teacher or student move, and each connecting line indicates the transition probability (TP) between moves. To enhance interpretability, only transitions with TP>0.2 were retained, emphasizing core discourse pathways. Transition probabilities in New and Exercise lessons are denoted as TP_n and TP_e, respectively. To capture structural contrasts, a transition difference map was also generated (Figure 3), with a threshold of 0.15 applied to highlight only meaningful differences in usage. In this map, green lines indicate transitions more common in New lessons, red lines those more frequent in Exercise lessons, and black lines reflect comparable usage across both. Together, these visualizations reveal how expert teachers flexibly orchestrate discourse in response to lesson-specific goals and task structures.

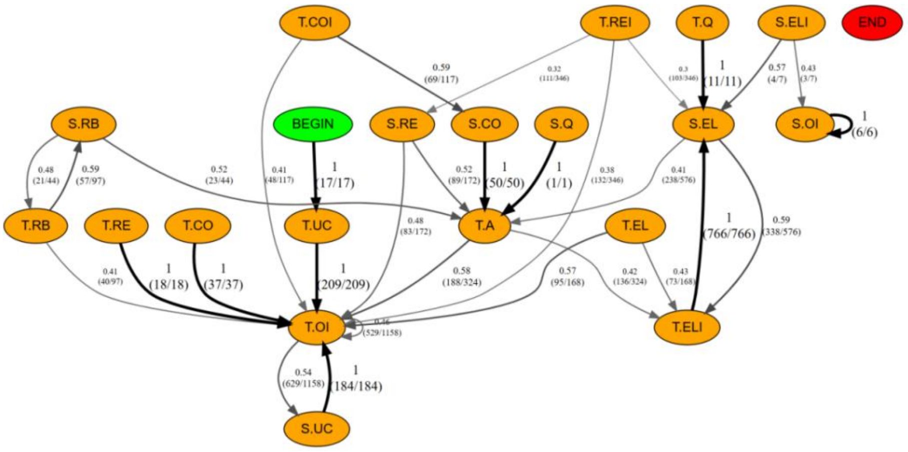

Figure 1. Process Map of Discourse Move Sequences in New Lessons.

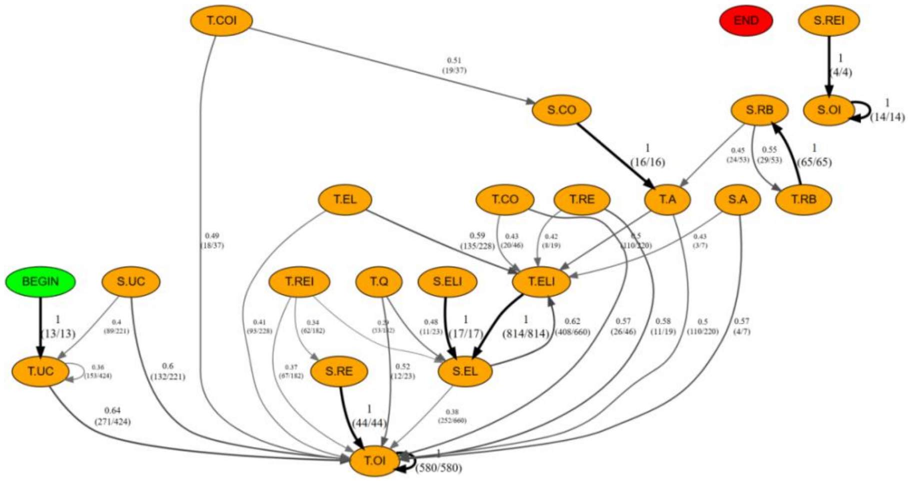

Figure 2. Process Map of Discourse Move Sequences in Exercise Lessons.

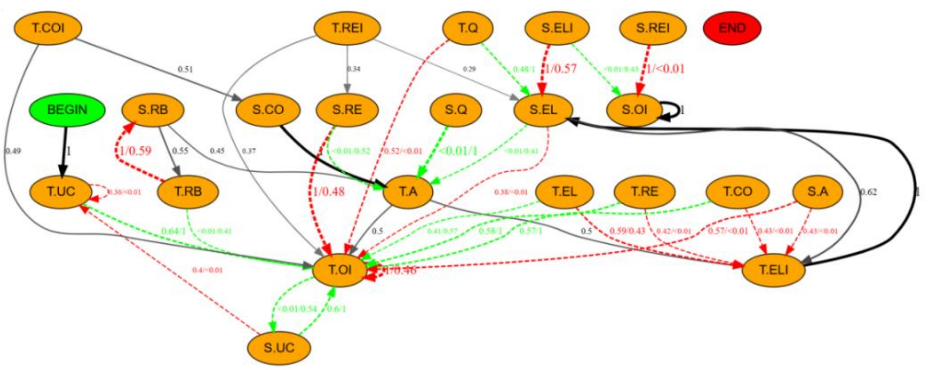

Figure 3. Transition Difference Map of Discourse Moves Between New and Exercise Lessons.

The process maps for both New and Exercise lessons reveal several stable discourse structures reflecting expert teachers' consistent dialogic practices. In both cases, the End node appears as an isolated terminal, indicating flexible, non-formulaic lesson closures. A key feature is the central role of T.OI, acting as the primary interaction hub, receiving transitions from eleven discourse moves in New lessons and thirteen in Exercise lessons. Its self-loop (TP_n=0.46, TP_e=1.00) highlights its function in maintaining interaction flow, particularly in procedurally driven segments. In both lesson types, a recurrent elaboration loop is observed between T.ELI and S.EL, with T.ELI consistently leading to S.EL (TP=1.00), followed by a return to T.ELI (TP_n=0.59, TP_e=0.62), forming a stable pattern of extended elaboration.

While these shared patterns provide a structural foundation for understanding expert discourse practices, clear differences emerge in how teachers adapt their discourse moves to the specific demands of New and Exercise lessons. In New lessons, the instructional opening is highly structured, with teachers consistently transitioning from conventional routines (T.UC) to general invitations (T.OI) with a transition probability of TP_n=1.00. This direct shift often features closed prompts that immediately foreground the lesson's conceptual focus. In contrast, Exercise lessons display more flexible entry patterns. While most begin with T.UC followed by T.OI (TP_e=0.64), a substantial portion (TP_e=0.36) continues with T.UC, during which teachers provide evaluative feedback on homework or learning progress to bridge into task-specific objectives.

The two lesson types also differ in secondary discourse hubs. In New lessons, T.A serves as a secondary node, receiving five transitions and emphasizing frequent affirmative teacher responses. In Exercise lessons, T.ELI takes this role, connecting to six discourse moves and reflecting greater reliance on elaboration invitations to guide interaction.

Foundational interaction patterns further distinguish the two contexts. In New lessons, T.OI frequently leads to brief student responses (S.UC, TP_n=0.54), which are consistently followed by a return to T.OI (TP_n=1.00), forming a recursive loop of confirmation. In contrast, Exercise lessons display a direct self-loop on T.OI (TP_e=1.00), suggesting a procedural use of teacher talk that maintains lesson flow without student response.

Differences are also observed in how teachers follow up on higher-order discourse moves. After T.CO, transitions in New lessons typically lead to T.OI (TP_n=1.00), reflecting efforts to check whole-class understanding. In Exercise lessons, the preferred path is from T.CO to T.ELI (TP_e=0.43), indicating a shift toward individual elaboration. A similar divergence appears after T.RE, which leads to T.OI in New lessons (TP_n=1.00) but to T.ELI in Exercise lessons (TP_e=0.42). Following T.EL, teachers in New lessons more often use T.OI (TP_n=0.57), whereas those in Exercise lessons return to T.ELI (TP_e=0.59). These patterns suggest that New lessons emphasize collective verification, while Exercise lessons tend to foster extended individual responses.

Further contrast is evident in how teachers utilize referential discourse. After T.RB, the transition to student reference (S.RB) occurs more frequently in Exercise lessons (TP_e=1.00) than in New lessons (TP_n=0.59), reflecting a greater emphasis on linking tasks to prior knowledge or strategy transfer in problem-solving contexts.

Teachers' responses to student contributions also differ significantly. In New lessons, teachers often affirm student input through T.A, particularly following S.CO (TP_n=1.00), S.Q (TP_n=1.00), S.RE (TP_n=0.52, TP_e<0.01), and S.EL (TP_n=0.41, TP_e<0.01). In Exercise lessons, however, teachers are more likely to extend the discourse through T.OI, such as in S.RE→T.OI (TP_n=0.48, TP_e=1.00), and S.EL→T.OI appears less frequently (TP_n<0.01, TP_e=0.38). This suggests a stronger emphasis on distributing participation and maintaining lesson rhythm through structured prompts. Lastly, the process maps show more frequent peer-to-peer transitions in Exercise lessons, suggesting a greater degree of student–student interaction in task-oriented contexts.

5. Discussion

Integrating frequency distribution and process-mining analysis, the findings demonstrate that expert teachers maintain consistent discourse practices across lesson types, characterized by shared patterns in structural organization and cognitive scaffolding. Structurally, their discourse reflects a high degree of organization, marked by the use of pre-planned questions and systematic procedural framing to sustain dialogic coherence and align interaction with instructional aims, supporting prior work on the regulatory role of structured discourse in classroom learning (Blatchford & Russell, 2019). Cognitively, expert teachers consistently adopt progressive elaboration strategies, using layered prompts to guide student thinking and build coherent mathematical understanding (Webb et al., 2019).

While expert teachers exhibit consistent discourse practices across lesson types, notable differences emerge in their use of discourse moves, particularly across three dimensions: discourse strategy selection, instructional organization, and interactional structuring.

Expert teachers' discourse strategies diverged notably across lesson types. In New lessons, teachers often responded to student contributions with immediate affirmation, followed by whole-class checks for understanding. This approach helped reduce learners' cognitive uncertainty when encountering new concepts and facilitated the establishment of clear learning expectations through consistent positive feedback and shared validation. From a cognitive load perspective, this pattern reflects a coordinated regulation of intrinsic and extraneous demands, supporting instructional efficiency and conceptual clarity (Zhang et al., 2016). In contrast, Exercise lessons featured a more extended and exploratory discourse pattern. Teachers frequently sustained interaction through elaboration-oriented prompts, encouraging students to extend their own or peers' ideas across multiple turns. These episodes were often interspersed with brief, low-intensity prompts that served as transitional space for cognitive processing. This structure aligns with the pedagogical goals of problem-solving lessons, which emphasize consolidation, application, and transfer. Prior studies have suggested that increasing cognitive demand and extending chains of thought in such contexts can promote deeper understanding and support knowledge transfer (Jou et al., 2016; Moskaliuk et al., 2012).

From the perspective of instructional organization, expert teachers demonstrated context-sensitive strategies that aligned with the goals of each lesson type. In New lessons, discourse was tightly structured and goal-oriented, with teachers frequently using closed questions to focus student attention and establish a coherent conceptual framework. In contrast, Exercise lessons featured more flexible and diagnostic structures. Lesson openings often began with feedback on homework performance, enabling teachers to assess learning needs and link prior knowledge with current tasks. Contextual cues were also used to support knowledge transfer and the internalization of problem-solving strategies. Moreover, teachers placed greater emphasis on expanding dialogic space, encouraging peer interaction and collaborative meaning-making. These practices fostered opportunities for autonomous knowledge reconstruction and dialogic reflection within a framework of consolidation, extension, and transfer (Jen et al., 2016; Zhang, 2018).

In terms of interactional structure, New lessons were characterized by streamlined and rule-governed exchanges, often revolving around confirm–respond–reconfirm sequences. These compact interaction cycles served to regulate classroom pacing and support comprehension monitoring through consistent checks for understanding. In contrast, Exercise lessons relied more heavily on consecutive procedural directives to drive task progression, with fewer contingent responses to individual student contributions. This shift in interactional dynamics reflects a pedagogical focus on efficient content delivery and initial understanding in New lessons, whereas Exercise lessons emphasized sustained task engagement and the practical application of knowledge (Di et al., 2019; Shadiev & Huang, 2020). These differences highlight expert teachers' ability to flexibly structure discourse in response to the functional goals and cognitive demands of each instructional context.

Building on our findings, the study suggests that teacher training should focus on helping novice teachers adapt their discourse strategies to lesson objectives, enhancing teaching flexibility. By examining expert teachers' strategies, this study highlights the contribution of dialogic expertise as an adaptive practice, showing how teachers adjust their strategies to classroom organization and student needs to promote deep learning and engagement. Future research could expand the sample to include teachers with varying experience and subjects, exploring the diversity and adaptability of discourse strategies.

6. Conclusions

This study examined how expert mathematics teachers orchestrate classroom discourse across New and Exercise lessons by integrating frequency-based statistical analysis with process mining based on first-order Markov modeling. The findings reveal both consistent discourse routines, characterized by stable patterns in structural organization and cognitive scaffolding, and context-sensitive adaptations in strategy selection, instructional organization, and interactional structuring. These adaptations reflect expert teachers' ability to align discourse practices with specific pedagogical goals and cognitive demands. These insights deepen theoretical understanding of dialogic expertise and carry practical implications for enhancing teacher learning. Building on the findings of this study, future work could design teacher workshops as a vehicle for professional development, enabling teachers to adapt context-responsive discourse strategies across different lesson types to further enhance dialogic teaching skills. In addition, it would be valuable to explore the development of AI-driven classroom feedback systems that provide teachers with real-time, context-responsive guidance for adjusting discourse strategies during instruction.

Acknowledgements

This work has been supported by the National Science and Technology Major Project of China (Grant No: 2022ZD0115900) and the National Natural Science Foundation of China (Grant No: 62277006).

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