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METACOGNITIVE–DISCURSIVE ACTIVITIES IN JUNIOR HIGH SCHOOL MATHEMATICS LEARNING: A COMPARATIVE STUDY IN SOUTHWEST SUMBA, INDONESIA

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Abstract

This study compares metacognitive–discursive activities in Grade-7 mathematics learning in two private Catholic junior high schools in Southwest Sumba, Indonesia: SMPK St. Paulus Karuni (n=14) and SMPK St. Aloysius Weetebula (n=13). A convergent parallel mixed-methods design was used, combining pre–post test results with classroom discourse analysis. Students completed an initial test consisting of 12 mathematics items and 6 logic items, and the same test was administered again after one semester. Classroom lessons were video-recorded and transcribed; focal segments were analyzed using a metacognitive–discursive activity category system (Karuni: 08:20–15:35; Weetebula: 44:10–51:23). Baseline results indicated similar initial achievement (combined averages 21% at Karuni and 19% at Weetebula), with both cohorts struggling on fraction items, particularly those involving unlike denominators. Discourse coding showed that Karuni displayed a more sustained metacognitive–discursive teaching culture, including more frequent student participation in explaining, justifying, and checking solutions, alongside active peer discussion and limited impact of negative discursive events. In Weetebula, metacognitive moves appeared more teacher-mediated and negative discursive events (e.g., low audibility, fragmented explanations, interruptions) occurred more frequently, reducing clarity of meaning-making. Post-test results aligned with these patterns. Karuni improved to 27% (mathematics) and 66% (logic), yielding a combined average of 34%, whereas Weetebula reached 16% (mathematics) and 36% (logic), with a combined average of 20%. Overall, the findings suggest that sustained student engagement in metacognitive–discursive interaction is associated with stronger learning development over one semester.

Keywords

category system, comparative analysis, mathematics learning, metacognitive–discursive

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METACOGNITIVE–DISCURSIVE ACTIVITIES IN JUNIOR HIGH SCHOOL MATHEMATICS LEARNING: A COMPARATIVE STUDY IN SOUTHWEST SUMBA, INDONESIA

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Abstract

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Keywords: category system, comparative analysis, mathematics learning, metacognitive–discursive

Introduction

The Program for International Student Assessment (PISA) is an international assessment of 15-year-old students coordinated by the Organisation for Economic

Co-operation and Development (OECD). Since 2000, PISA has evaluated students' literacy in reading, mathematics, and science to provide cross-national indicators of educational quality (Putri & Vebrian, 2019). Indonesia has participated in PISA since its inception, yet its mathematics performance remains consistently below the OECD mean, and many students experience difficulty even with lower-level items that require basic mathematical reasoning (Fadillah & Ni'mah, 2019; Hawa & Putra, 2018). These outcomes point to persistent challenges in students' foundational understanding and in classroom practices that support reasoning, justification, and problem solving. Strengthening classroom learning processes—particularly teacher–student and student–student interaction—therefore becomes a practical pathway for improving learning quality and supporting longer-term achievement (Nurcahyani, 2022).

One promising perspective for improving classroom learning is the integration of metacognitive activity with a discursive teaching culture. Metacognitive activity involves planning solution steps, monitoring the correctness and coherence of statements and procedures, and reflecting on the adequacy of strategies and results (Cohors-Fresenborg & Kaune, 2007). However, metacognitive processes become visible and learnable in classrooms only when they are supported by discursive norms—i.e., norms that require participants to make their contributions understandable to others, to invite clarification, to justify claims, and to negotiate meaning in interaction. Prior work has shown that the development of metacognitive and discursive activities can serve as indicators of teaching quality and can be cultivated through specific interaction patterns in classroom discussion (Cohors-Fresenborg & Nowińska, 2021; Kaune et al., 2012).

To study such interaction patterns, Cohors-Fresenborg and Kaune (2007) developed a metacognitive–discursive activity category system that enables researchers to mark metacognitive activities in classroom interaction between teachers and students as well as among students. Recent Indonesian studies have adopted this system to analyze how classroom culture emerges through talk and how students adapt to new discussion norms. For example, Moza (2021) analyzed Grade-7 learning on integer computation and documented metacognitive (planning, monitoring, reflection), discursive, and negative discursive activities through coded utterances. Rato (2021) reported the presence of metacognitive and discursive culture in Grade-7 mathematics learning at SMPK St. Aloysius Weetebula, while also noting negative discursive activities that can hinder understanding. While these studies provide important insights within single settings, comparative evidence across contrasting classroom contexts remains limited, especially in relation to how discourse patterns align with learning development.

This study addresses that gap by comparing Grade-7 mathematics learning in two private Catholic junior high schools in Southwest Sumba, Indonesia: SMPK St. Paulus Karuni (rural) and SMPK St. Aloysius Weetebula (town). Karuni is known for its mathematics project classes involving teachers and lecturers affiliated with the Cognitive Mathematics Institute and emphasizes interactive, metacognitive learning, with many students coming from low-to-middle economic backgrounds. Weetebula adopts an inclusive learning approach with students from more varied socioeconomic backgrounds. Against this contextual contrast, the present research aims to evaluate and compare metacognitive–discursive activities in classroom interaction in both schools using the category system, and to relate observed interaction patterns to students' learning development over one semester. By documenting how metacognitive and discursive activities are enacted (and where negative discursive events disrupt understanding), the study is expected to contribute a clearer account of interaction-based factors that shape the effectiveness of mathematics learning in comparable Grade-7 settings.

Literature Review

Metacognitive-discursive activity category system

Cohors-Fresenborg and Kaune (2007) conducted research at the Institute for Cognitive Mathematics at the University of Osnabrueck from 2001 to 2003 to analyze the state of teaching in practicing reflection and metacognition in junior high school mathematics teaching. One of the findings of this research is the development of a category system that allows marking metacognitive activities in interactions that occur in the classroom between students and teachers, as well as interactions between students. Therefore, the metacognitive-discursive activity category system is used as a tool to analyze learning, especially when discussions occur in class. This category system consists of 3 parts, namely discursive activity, discursive-negative and metacognitive. Metacognitive activities are classified into 3 parts, namely planning, reflection and monitoring.

Perencanaan		Pemantauan		Refleksi		Diskursif	
P1	Keterangan **fokus perhatian**, keterangan **alat kerja / metode** yang dapat digunakan atau **hasil** (**sementara**) atau **penjelasan** yang akan dicapai	M1	Pengawasan kegiatan bidang khusus	R1	Analisis struktur dari suatu penjelasan bidang khusus	D1	Tindakan untuk **perbaikan** debat / **menetapkan** kontribusi debat
P1a	Aktivitas perencanaan satu langkah			R1a	Tanpa mempertimbangkan pengubahan bentuk atau restrukturisasi tambahan	D1a	Menyebutkan titik tinjauan atau orang yang ditinjau; menanyakan titik tinjauan atau orang yang ditinjau (khususnya untuk menjamin dasar dari diskusi); menemukan penetapan yang kurang atau salah
P1b	Aktivitas perencanaan multi langkah atau keterangan pendekatan perencanaan alternatif			R1b	Dengan mempertimbangkan pengubahan bentuk atau restrukturisasi tambahan	D1b	Pembatalan kontribusi diri sendiri dari orang lain atau persetujuan terhadap kontribusi orang lain
						D1c	Pengulangan apa yang telah dikatakan sebagai dasar untuk argumentasi lebih lanjut atau untuk memastikan tentang apa yang telah dikatakan atau ditulis atau dimaksudkan
						D1d	Tindakan (contohnya: penataan) untuk memudahkan debat

Figure 1. Sample category system table from Cohors-Fresenborg and Nowińska (2021)

In the metacognitive-discursive activity category system, planning, reflection, monitoring, discursive, and negative discursive activities are categorized with different colors to aid classification visualization. Categories and sub-categories are identified by abbreviations and numbers, and may include sub-aspects with italicized prefixes. The prefixes used are:

f : for required metacognitive activities.
b : for complex or reasoned metacognitive activities.
fb : for necessary and reasonable metacognitive activities.
bf : for reasonable and necessary metacognitive activity.

These codes facilitate the identification and classification of metacognitive activities in research.

Video transcript software-10.08

In this research, Video Transcript-10.08 is a software used to produce transcripts from learning videos as well as emission lines based on existing transcripts. The tool also provides a metacognitive and discursive category system menu that allows writing appropriate categories for each utterance in the transcript. A transcript was created to facilitate analysis of the video. The following is an overview of the Video Transcript-10.8 tool and a sample category system table from Cohors- Fresenborg and Nowińska (2021).

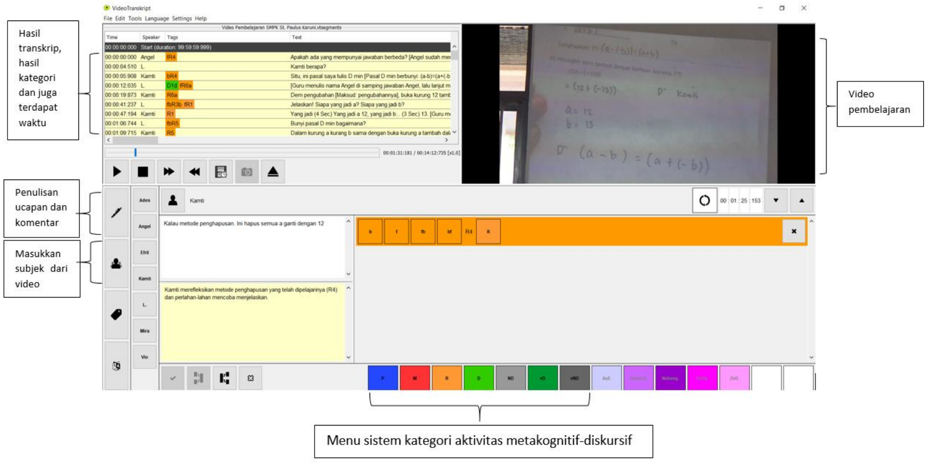

Figure 3. Overview of the video transcript-10.8 device

Method

This research utilized convergent parallel mixed methods design, combining quantitative and qualitative approaches. Researchers collected both types of data simultaneously and integrated them for a comprehensive analysis. This design allows for simultaneous data collection and merging of quantitative and qualitative findings to interpret the research problem comprehensively.

This research involved mathematics teachers and Class VII students from SMPK St. Paulus Karuni and SMPK St. Aloysius Weetebula. The study compared the learning processes using metacognitive-discursive activity categories over two semesters in the 2023/2024 academic year. Data collection included initial and final tests and learning video documentation. The initial test consisted of 12 mathematics questions and 6 logic questions, covering basic calculations, error spotting, problem-solving, and understanding instructions. The logic test evaluated students' comprehension and ability to solve questions based on given information.

Learning videos were recorded and transcribed using Video Transcript-10.8 for further analysis. The final test, identical to the initial test, measured improvement in understanding after one semester. Data analysis involved both quantitative and qualitative methods. Quantitative analysis used descriptive statistics to assess changes in student performance from pre-test to post-test. Qualitative analysis included transcribing videos, identifying metacognitive-discursive activities, coding and classifying these activities, and examining the relationship between teaching processes and the metacognitive-discursive teaching culture. The Video Transcript-10.8 software facilitated categorizing and analyzing utterances to provide insights into the effectiveness of the teaching methods.

The overall analysis of the selected scenes deals with the following questions:

P1. How does metacognitive teaching culture appear in this scene? Are metacognitive activities found almost only in teachers, or are they also found in students? Do students practice such activities without request from the teacher? In this analysis, consideration should be given to those activities that are documented in more detail.
P2. Does the metacognitive activity contain detailed reasons or explanations? Are these statements only made at the teacher's request, or do students also provide detailed reasons or explanations without a direct request from the teacher?
P3. Is there discursive activity with special qualities, such as D1c and D1d for example?
P4. Are there negative discursive activities that make it difficult to understand mathematical content?
P5. Do teachers try to educate students in a better culture of discursive conversation, and does such education have an effect?
P6. To what extent do students practice discussion among themselves, or does the teacher comment on students' individual statements before they speak again?

Ethical considerations were addressed throughout the study. Participation was voluntary, and all participants (teachers and students) were informed about the study objectives and procedures prior to data collection. Written consent was obtained from the schools and the participants' guardians where applicable. Participants were informed that they could withdraw from the study at any time without penalty. To protect confidentiality, all respondents were anonymized in the transcripts and reporting; no real names were used, and identifying information was removed.

Findings and Discussion

Initial test

The initial test was administered to establish students' baseline competence in mathematics and logic. At SMPK St. Paulus Karuni (n=14), mathematics scores ranged from 7 to 15 with an average of 18%, while logic scores ranged from 1 to 9 with an average of 33%; the combined average across both components was 21%. At SMPK St. Aloysius Weetebula (n=13), mathematics scores ranged from 6 to 16 with an average of 17%, while logic scores ranged from 1 to 9 with an average of 27%; the combined average was 19%. These results indicate broadly similar initial abilities across the two schools, with Karuni slightly higher in logic.

Item-level patterns showed that both cohorts performed relatively well on whole-number calculations (80% at Karuni and 90% at Weetebula) but struggled with fraction problems, particularly those involving unlike denominators. No students in either school answered fraction items 2c and 2d correctly at baseline.

Analysis of learning videos with a metacognitive-discursive activity category system

SMPK St. Paulus Karuni

The learning video was documented at the fourth meeting, where the material on integers and the concept of bookkeeping in an account book were discussed. At this meeting, new students are introduced to the metacognitive-discursive teaching culture for three days so that students are not yet accustomed to that culture and the teacher will continue to guide students to practice the rules during the learning process. At the beginning of the lesson, the teacher tells the students that exercise 1.4 from the student handbook will be discussed.

★ **Latihan 1.4** Terdapat kesalahan pembukuan dalam kartu rekening berikut. Garisbawahilah dan perbaikilah kesalahan tersebut!

No.	Tanggal	Saldo Awal	Pembukuan		Saldo Akhir
			Penarikan	Penyetoran	
6.	13-09-09	130.000	25.000		105.000
7.	14-09-09	105.000		31.000	136.000
8.	18-09-09	136.000	17.000		120.000
9.	21-09-09	120.000	25.000		85.000
10.	25-09-09	85.000		30.000	55.000

Figure 4 . Exercise 1.4 from the student handbook

Students were asked to find and correct errors in a bookkeeping account card, guided by the teacher to analyze each line and explain its meaning. The learning video, 1 hour and 4 minutes long, was analyzed from the 8th minute and 20th second to the 15th minute and 35th second. This segment, lasting 7 minutes and 45 seconds, showcases students presenting answers, following discussion rules, and providing peer feedback. The results of the transcript and analysis of the learning video can be seen in the table below:

Table 1. Excerpt of transcript analysis of SMPK St. Paulus Karuni using category system

Name	Representative excerpt (Text)	Code(s)	Comment (short)
L (Teacher)	"Come on KR… present your answer."	P2	Initiates public sharing under document camera to support class discourse.
L → KR	"Explain!"	fR1a	Prompts student to verbalize reasoning/representation.
KR	Explains line 6; shows figures and result.	R1a; D1a	Student explanation tied to the written record.
L	"Is there an error in that part?"	fM3	Requests checking/verification of work and interpretation.
KR	"No… Is there something wrong?"	M3; fM3	Self-check then seeks peer/teacher confirmation.
L	"Ask your friends: right or wrong?"	D2	Models/normalizes agreed discussion norms.
KR → class	"Friends, is my answer right or wrong?"	fM3	Peer-check request aligned to norms.
Peer (HAEA)	"Correct."	M3	Peer verification.
KR → class	"Anyone want to comment / different answer?"	fR3b	Invites alternatives/feedback beyond correctness.

Name	Representative excerpt (Text)	Code(s)	Comment (short)
KR	Explains line 7; requests check again.	R1a; fM3	Cycles: explain → check.
KR	"In number 8… there is one error…"	bM5	Detects inconsistency; indicates reflective repair.
HAEA	Offers alternative withdrawal; explains.	D1b; bR3b; fM5	Provides alternative and asks for validation.
UPWN	Notes misreading (e.g., missing "thousand").	M3	Checks correspondence between spoken and written quantities.
L	Orchestrates comparison (vote/contrast) and asks "Why?"	R6a; fM5; fbR5	Structures contrasting solutions and elicits justification.
KR	Revises (e.g., corrects 120 → 120,000); requests check.	bM3; fM3	Visible correction and re-verification.

From the transcript results and analysis results using Video Trankript-10.8 software, emission lines are obtained as shown in the image below:

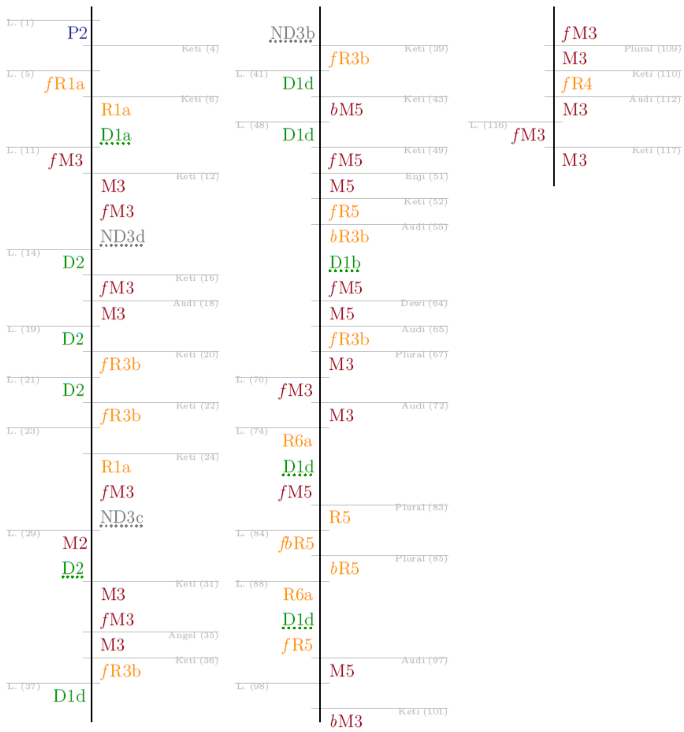

Figure 5. Radiation line for class VIIA SMPK St. Paulus Karuni

SMPK St. Aloysius Weetebula

The learning video was documented at the fifth meeting, where the material on integers, especially multiplication, was discussed. At the beginning of the lesson, the teacher conveys the concept of calculating multiplication of integers, then gives examples related to everyday life. Next, the teacher introduces the properties of multiplication such as commutative, associative and distributive. The teacher invites students to practice solving questions related to these characteristics. One of the questions discussed is as shown in the following picture:

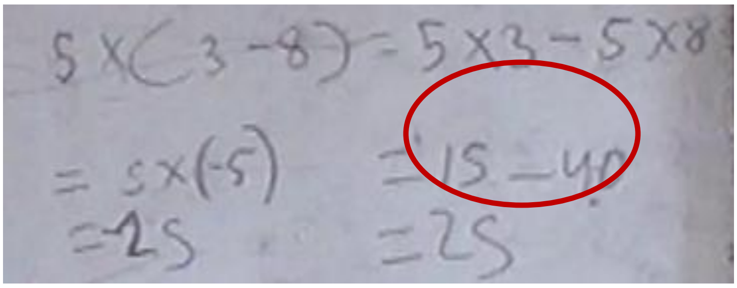

Figure 6. Practice questions discussed

In teaching the distributive property, the teacher used numbers 5, 3, and 8 to demonstrate its application to subtraction. A student's initial answer of 25 was corrected by another student to negative 25. The teacher then asked for explanations, giving students opportunities to understand and articulate their reasoning. With the teacher's guidance, students used concepts of money and debt to explain their answers. The learning video, lasting 51 minutes and 25 seconds, was analyzed from the 44th minute and 10th second to the 51st minute and 23rd second, focusing on 7 minutes and 4 seconds of content related to integer calculations and the distributive property. The results of the transcript and analysis of the learning video can be seen in the table below:

Table 2. Excerpt of transcript analysis of SMPK St. Aloysius Weetebula using category system

Name	Representative excerpt (Text)	Code(s)	Comment (short)
L (Teacher)	Calls HW to board; gives marker; "Write here."	D1a; P2	Organizes public work display to start discussion.
L → HW	"Use what?" / "How do you do it?"	fR4; fbR4	Requests method/strategy explanation.
HW	"Don't use claws… (no scratch)."	R4	States approach, not yet elaborated.
HW	Explains in very low volume (inaudible).	ND3b	Communication breakdown limits shared understanding.
L	"Turn up the volume… facing here."	D2	Teacher repairs discourse norm (audibility/clarity).
HW	Partial explanation; points to terms; still unclear.	bR4; vD1a; ND3b	Attempted explanation, but incomplete.
L	Re-asks for clearer language; writes; asks HW to check.	fM2; fM3; R7	Teacher mediates meaning-making, seeks confirmation.
HW	Re-explains differently (switches structure).	M2; ND3d	Inconsistent explanation creates further confusion.
L → GDF	Invites peer to articulate HW's thinking.	fR7	Delegates clarification to peer.
GDF	Tries to interpret (-(40–15)) but ambiguous.	R7; ND3b	Peer interpretation helps but remains unclear.

Name	Representative excerpt (Text)	Code(s)	Comment (short)
L	Misinterprets as “-40 - 15 = -55”.	R3c; ND1a	Teacher reveals misunderstanding but also introduces confusion.
L	Introduces everyday-life analogy (debt/money).	fR2a; P1a	Reframing strategy to stabilize meaning.
HW	“I used debt… debt of 40, paid 15, remaining 25.”	bR3b	Clearer justification through contextual model.
L	Summarizes “two versions… compare money and debt.”	R6a; ND3b	Attempts closure; phrasing still somewhat fragmented.

From the transcript results and analysis results using Video Trankript-10.8 software, emission lines are obtained as shown in the image below:

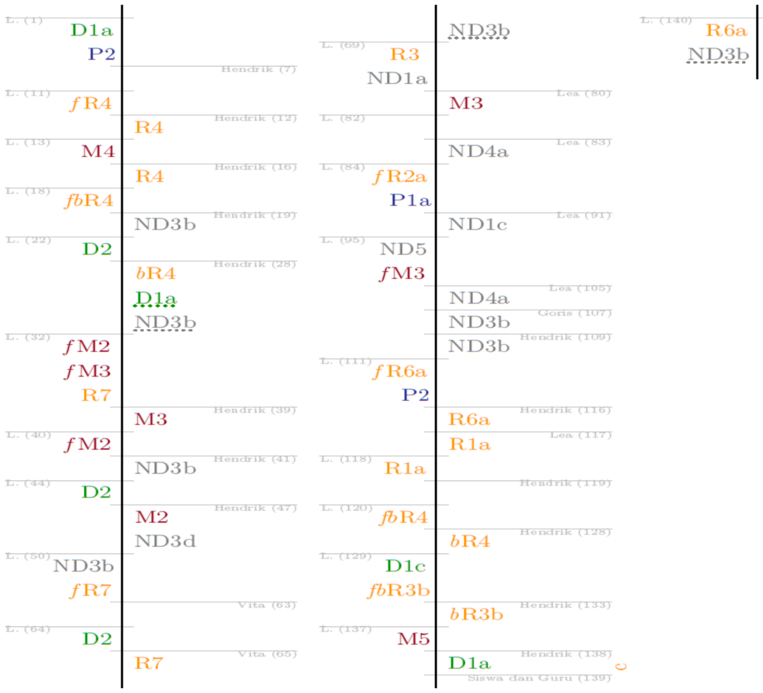

Figure 1. Radiation line class VIIA SMPK St. Aloysius Weetebula

Analysis all over scene teaching Which chosen related with questions following:

Table 3. Analysis of questions

Question	SMPK St. Paulus Karuni	SMPK St. Aloysius Weetebula
RQ1 (Metacognitive teaching culture)	The metacognitive teaching culture is clearly visible in teacher–student and student–student interaction. The teacher structures the discussion and reinforces question–answer norms; students increasingly engage in reflective and	The metacognitive teaching culture appears mainly through teacher scaffolding (detailed instructions and requests to explain thinking). Students do explain methods and peers occasionally contribute, but it is more frequently teacher-initiated.

Question	SMPK St. Paulus Karuni	SMPK St. Aloysius Weetebula
	argumentative talk, although consistency is still developing.	
RQ2 (Reasons and detailed explanations)	Students frequently provide reasons and step-by-step justifications on their own initiative; discussion encourages verification and elaboration of answers.	Detailed explanations occur mainly when requested by the teacher, with occasional student initiative; students describe computational steps/strategies, but these are not always understood by the class.
RQ3 (Specific discursive quality: D1c/D1d)	D1c (repetition/clarification) is not observed. D1d is observed in teacher talk to move the discussion forward when peer responses are limited.	D1c is observed in teacher talk (revoicing student explanations as a basis for discussion). D1d is not observed in either teacher or student talk.
RQ4 (Negative discursive activities)	No negative discursive (ND) activity is observed that directly hinders mathematical understanding. Some unclear utterances or incomplete sentences could disrupt the flow, but the impact appears limited.	ND activity occurs relatively frequently (both teacher and students): low volume, fragmented/incomplete explanations, less relevant questions, and interruptions. These conditions create confusion and hinder understanding of the mathematical content.
RQ5 (Teacher efforts to foster discussion culture)	The teacher consistently trains discussion norms (how to ask, invite comments, and elicit alternatives), strengthening mathematical communication and student independence.	The teacher fosters discussion culture by demanding audible, clear communication and more precise language; these efforts support a collaborative learning environment.
RQ6 (Peer discussion vs. teacher intervention)	Peer discussion is relatively active: students check, comment, and respond without constant teacher interruption—an indication that discursive norms are becoming internalized.	Peer interaction is more strongly mediated by the teacher; students tend to respond to teacher prompts/questions, so autonomous peer discussion remains limited.

Table 4. Relationship between learning process analysis and discursive metacognitive teaching culture analysis

SMPK St. Paulus Karuni	SMPK St. Aloysius Weetebula
The analysis shows that the teacher uses a metacognitive-discursive approach, focusing on developing students' problem-solving and discussion skills. By encouraging explanations, checking understanding, and fostering peer discussions, this method helps students grasp their thought processes and learn from interactions. The positive classroom culture supports active student engagement.	In analyzing the learning process, teacher interactions guide students in understanding math concepts through direction, questioning, and feedback. The metacognitive-discursive teaching culture fosters clear communication and thoughtful expression. These analyses highlight how a supportive teaching culture enhances students' understanding and development of metacognitive and discursive skills.

Final Test

After one semester, a final test was given to students from class VIIA SMPK St. Paulus Karuni and SMPK St. Aloysius Weetebula to assess the development of their abilities. At SMPK St. Paulus Karuni, mathematics test scores ranged from 3 to 28, with an average percentage of 27%. On the logic test, two students scored the maximum 11 out of 11, with an average percentage of 66%. Combined final test scores showed an overall average of 34%. At SMPK St. Aloysius Weetebula, mathematics test scores range from 1 to 16, with an average percentage of 16%. On the logic test, one student got a maximum score of 11, with an average percentage of 36%. Combined final test scores indicate an overall average of 20%. Significant differences can be seen in the average percentage of the final test: SMPK St. Paulus Karuni has an average percentage in mathematics of 27% and logic of 66%, while SMPK St. Aloysius Weetebula has an average percentage in mathematics of 16% and logic of 36%.

Discussion

The results suggest that differences in learning development across the two classrooms are consistent with differences in how metacognitive–discursive activity was enacted during instruction. Although baseline achievement was broadly comparable (combined averages 21% vs 19%), the discourse analysis indicates that Karuni more consistently distributed metacognitive work beyond the teacher: students participated in explanation, justification, and checking routines, and peer discussion was relatively active. In contrast, Weetebula showed metacognitive activity that remained largely teacher-mediated, with student contributions more dependent on teacher elicitation and with more frequent discourse breakdowns (e.g., fragmented explanations and interruptions).

This contrast offers a plausible instructional interpretation for why Karuni showed stronger gains, especially in logic (33%→66%) and in overall performance (21%→34%). When students routinely explain and justify their procedures and respond to requests for checking, they practice monitoring and reflection as part of the classroom norm, not only as an individual skill. Such interaction can strengthen reasoning-oriented competencies that are closely aligned with the logic component of the test. Additionally, the emergence of correct solutions on fraction items 2c/2d by several Karuni students—items no students could solve at baseline—suggests that at least some students developed conceptual resources for non-routine fraction reasoning, which typically benefits from explanation-and-verification cycles.

In Weetebula, the smaller overall improvement (19%→20%) can be interpreted in relation to two observed interaction constraints. First, when metacognitive prompts are concentrated in teacher talk, students may have fewer opportunities to internalize monitoring and verification as their own routine moves. Second, more frequent negative discursive events likely reduce the classroom's shared access to mathematical meaning, making it harder for students to benefit from each other's contributions. Importantly, the slight decline in mathematics (17%→16%) should not be over-interpreted as "worsening ability" without considering measurement conditions (e.g., test difficulty balance, attendance, time-on-task). However, it is consistent with the observation that mathematical explanations in Weetebula were less consistently understood at the whole-class level.

Several limitations should be noted. The discourse analysis was based on selected segments rather than continuous coverage of the full instructional sequence, which constrains claims about overall classroom culture across the semester. In addition, the study compares only two classes, so contextual factors (teacher experience, pacing, curriculum implementation, student attendance) may also contribute to the observed outcomes. Future research could strengthen inference by (a) coding a larger set of lessons per teacher, (b) reporting inter-rater reliability for coding, and (c) linking specific discourse episodes (e.g., peer-checking sequences, repair after confusion) to item-level gains on fraction and reasoning tasks.

Conclusion

This study compared metacognitive–discursive activities in Grade-7 mathematics learning in two private Catholic junior high schools in Southwest Sumba, Indonesia: SMPK St. Paulus Karuni and SMPK St. Aloysius Weetebula. Baseline test results indicated broadly comparable initial achievement profiles, including relatively high performance on whole-number computation and substantial difficulty with fraction items involving unlike denominators. Classroom discourse analysis using the metacognitive–discursive activity category system revealed a clearer and more sustained metacognitive–discursive teaching culture in Karuni, characterized by more active student participation in explaining, justifying, and checking solutions, alongside relatively active peer discussion. In Weetebula, metacognitive activity was observed but tended to remain more teacher-mediated, and negative discursive events occurred more frequently in ways that reduced clarity of mathematical meaning-making.

Learning-development results after one semester aligned with these interaction patterns. Karuni showed larger overall improvement, particularly in logic performance, and several students were able to solve fraction items that no students could answer at baseline. Weetebula showed modest improvement in logic but minimal overall change and a slight decline in mathematics. Taken together, the findings support the interpretation that a classroom culture that repeatedly engages students in explanation, monitoring, and peer verification is associated with stronger development, especially on reasoning-oriented tasks.

At the same time, conclusions should be interpreted within the study's constraints. The discourse analysis was based on selected teaching scenes and the comparison involved only two classrooms; therefore, contextual factors such as teacher experience, lesson pacing, and classroom composition may also contribute to observed differences. Future research should expand lesson coverage, apply inter-rater reliability procedures for coding, and examine how particular discourse episodes relate to item-level learning, especially for fraction concepts and mathematical reasoning.

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