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CRITICAL DISCOURSE ANALYSIS ON STUDENT PARTICIPATION IN BILINGUAL MATHEMATICS LEARNING

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Abstract
This research applied Critical Discourse Analysis to investigate how students engage in bilingual mathematics classes at two Islamic boarding schools (pesantrens) in Jember. It aimed to understand how language is used by both students and teachers throughout the learning process and the ways it impacts student involvement. Data were gathered through classroom observations, audio recordings, and field notes. The Initiation-Response-Follow-up (IRF) model was used for analysis. The study revealed that students' ability to participate is closely tied to their confidence in speaking English and the encouragement they receive from teachers. These insights underscored the need for inclusive communication methods and psychological support to boost participation in bilingual classrooms. The research also offered a deeper look at how language functions in educational settings and what that meant for teaching practices in bilingual environments. Ultimately, the findings can help shape more effective teaching strategies within bilingual education, particularly in pesantrens, leading to improved learning experiences and greater student engagement.

Keywords: bilingual, critical discourse analysis, mathematics class

Introduction

The interaction process in the classroom is a two-way communication between teachers and students, with the primary goal of transferring knowledge. Classroom communication is a routine activity that uses language as its primary medium (Musfiqon, 2012; Rubenstein, 2019). Language is used to transfer knowledge from teachers to students and must be straightforward, informative, clear, objective, consistent, concise, and dense. The scientific language used in the classroom plays an important role in facilitating scientific communication and acquiring new ideas from teachers, teaching materials, and peers (Julita, 2020; Silver & Raslinda, 2014).

Although the teacher's language often becomes the dominant component in scientific interactions in the classroom, the role of student language is also important. Crilly (2021), Dewi (2019), Silver and Lwin (2014) show that in fourth-grade mathematics classes using English as the medium of instruction, verbal communication is predominantly led by teachers through exploratory questions and class control. In contrast, students frequently rely on non-verbal cues such as laughter, facial expressions, and hand movements, especially when working independently or in group discussions.

Classroom language and student participation are essential components of the learning process. Communication between teachers and students fosters a shared understanding of the subject matter and serves various purposes, including conveying information, giving instructions, asking questions, and providing answers (Chevalier, 2020; Leona et al., 2021). The language used must be clear, concise, and suitable for the students' level of understanding, while also being sensitive to the diversity of students' linguistic and cultural backgrounds (Fffimore & Snow, 2000).

Active involvement in the learning environment plays a vital role in student development. According to Das et al. (2011) and Maker (2020), meaningful participation often occurs within interactive spaces where students engage with both their peers and more knowledgeable teachers. This collaborative environment is shaped by the use of classroom language, which allows students to engage through presentations, exploration, structured argumentation, and ongoing discussions (Barnes, 1992; Mercer, 2002; Mercer et al., 2010). Such participation helps ensure that every student has the chance to contribute meaningfully and gain from the educational process, ultimately supporting their intellectual and social growth (Goh & Doyle, 2021; Lorusso, 2021; Moje, 2008; Shanahan & Shanahan, 2008). Prior research also indicates a strong link between students' ability to communicate mathematically and their academic success. For instance, Hidayat et al. (2023) found that strong communication skills are closely tied to a student's independence in learning. Similarly, findings by Djamarah and Zain (2002) and Ramadania et al. (2018) show that students with better communication abilities tend to achieve higher outcomes in mathematics.

However, there has been no specific research examining the role of language in measuring the level of student participation in teaching and learning activities in mathematics classes with English as the medium of instruction. This study focuses on the level of student participation measured by language activities used for asking questions, answering, discussing, and communicating student work results in bilingual mathematics learning.

Method

This study employed a qualitative approach with Critical Discourse Analysis (henceforth CDA) to examine the functions of language used by students in bilingual mathematics classes. CDA is an analytical approach that involves critically examining, interpreting, and explaining how discourse is used to create, sustain, and justify social inequalities (Fairclough, 2013; Wodak & Meyer, 2009). This study involved seventh-grade students from both the Excellence and Bilingual programs at two pesantrens (Islamic boarding schools) in Jember, East Java, encompassing all students within those classes. The data gathered included both

verbal elements, such as the words and phrases students used during lessons, and non-verbal cues like images and gestures observed during class participation. Data collection methods consisted of detailed classroom observations focusing on language use by students and teachers, audio recordings of classroom discussions and interactions, field notes capturing key observations, and the collection and analysis of instructional materials utilized during the lessons.

The data collection process was carried out through classroom observations during several learning sessions to obtain a comprehensive picture of language use. Observations were conducted using a non-participant method, where the researchers only observed and recorded the ongoing activities without participating in classroom activities. Data was then analyzed using the Initiation, Response, Follow-up (IRF) model by (Sinclair & Coulthard, 1975) to uncover the complexity of language use in the classroom. The analysis stages included transcribing audio recordings and field notes into written text, coding the data to identify and mark relevant data segments based on the IRF model, and critical analysis to understand how teachers and students collaborate in constructing mathematical meaning through language. Conclusions were drawn from data interpretation to understand the role of language in student participation and its impact on learning.

To ensure the validity and reliability of the data, this study used data triangulation techniques, combining data from various sources (observations, audio recordings, and teaching documents) to obtain a more accurate and comprehensive picture (Creswell, 2010; Crismono, 2023). Ethical aspects of the research were also considered by obtaining permission from the schools and parents of the students and maintaining the confidentiality of students' identities and the data obtained. This methodological approach was expected to provide in-depth insights into the functions of language in student participation in bilingual mathematics classes and its contributions to learning and teaching in Jember Islamic boarding schools.

Findings and Discussion

Data was collected with the help of a data corpus in the form of tables of language patterns of teachers and students in interaction; initiation/I, when a topic is introduced; response/R, indicating engagement and response to initiation; and follow-up/F to extend the conversation by continuing the discussion, asking questions, or continuing the previous phase, recording tools, and small notes. Data was taken from the seventh-grade bilingual and excellence classes with English-language teaching materials. Observations involved 2 classes (Excellence and Bilingual) with 25 students each and 2 meetings, divided into; the first meeting discussing Ordering Integers and Numbers, and the second meeting with the topics Add and Subtract Integers, and Multiplying and Dividing Integers. Each classroom language activity; teacher and student language was classified according to the analysis needs. The total transcription of direct observations consists of 4 tables, but only as an example classification of data sourced from recordings and direct notes of researchers during in-depth observations in one class with the topic Ordering Integers and Numbers.

The transcription of language offers insights into classroom language dynamics during teaching and learning activities while simultaneously observing the real interaction between teachers, students, and teaching materials. The data tables also help understand points where teachers and students use specific language

constructions to maintain smooth and coherent dialogue. In-depth analysis is also based on table data, namely: first, analysis is given to verbal data in the form of language with the participation frequency percentage of each, second, on non-verbal data (gesture) analysis, and third, analysis on interview data as supporting data for the main data. Furthermore, data from Tables 1 and 2 are calculated as a percentage calculation, where the frequency is taken and divided by the total number (I, R, F), then multiplied by 100 to get the percentage value. This serves as a comprehensive depiction of frequency distribution for each category of initiation, response, and follow-up in classroom language data. The detailed data provides a quantitative glimpse of the complex dynamics of language in the classroom and its impact on the level of student oral engagement.

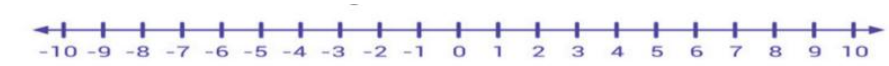
Detailed critical discourse analysis of classroom mathematics language involves analyzing English text discourse in the context of mathematics in Indonesian and Indonesian text discourse in the context of mathematics. This is done to derive the development of meaning from reading mathematical language/problems to writing/responding to answers in mathematical problems in achieving disciplinary literacy and classroom participation as social practice (Moje, 2008; Shanahan & Shanahan, 2008). For instance, the following classroom language data:

- Teacher: "let’s say 1,2,3,4,5,6 (say in English) together ... what do we call??"
- Students: "angka"
- Student 2: "bilangan"
- Students: "nomor"
- Teacher: "... there is the word bigger and higher. What does it mean?"
- Students: "... bigger and higher ..."

This conversation excerpt provides deep meaning in understanding mathematics as part of the thinking culture from a text and classroom communication pattern. The teacher poses a display question (Silver & Raslinda, 2014) aimed at students being able to convey their understood concept ... one, two, three... one, two, three..., in the thinking culture context of most students, meaning it is a number, hence number being the most common response. Also, the answer number is "nomor", which may be in the context of ordinal number. However, the answer "bilangan" as a context of mathematical science is only responded to by an average of one student per class. Other data shows students using Google Translate for the phrase Ordering Integers and Numbers into Mengurutkan Bilangan Bulat dan Bilangan, while the correct mathematical language in Indonesian is Mengurutkan Bilangan Bulat Positif dan Bilangan Bulat Negatif.

Subsequent data analysis involves a deep understanding of topics related to teaching materials. Teachers and students interact with asymmetrical communication (Silver & Lwin, 2014). Language ... the words bigger and higher. What do they mean?... this statement and question function to socialize between the teacher and students and between students in building a relationship and communication system among all involved in the discussion; students, teachers, and teaching materials. This is supported by subsequent interactions using teaching

materials to explain mathematical language concepts of bigger and higher in negative and positive integers. The common thinking culture in Indonesia is that bigger and higher are used generally for comparison, but mathematical language aided by the number line has the meaning; a number will have a higher value when compared to a number on its left side. An example in step 2 (teaching material in Figure 1) where the number 0 has a higher value than all negative numbers, with all negative numbers on the left side of 0, an example notation is 0>-3. For higher in mathematics, it has the same meaning as bigger, referring to the comparison between two numbers or values on the number line. Meanwhile, higher in Indonesian means a rank or position of a number, for example, -2 has a higher rank when compared to -6, but the meaning of higher in mathematics on the number line is a value comparison. This asymmetric classroom language is based on the teaching material in Figure 1, compiled by teachers from various sources and used for personal purposes.



To order integers and numbers:

- **Step 1:** Look at the smallest numbers, which are the negative numbers that are farthest from zero, and arrange them. The bigger the negative number, the smaller the value.
- **Step 2:** Zero is bigger than all negative numbers, so in ordering numbers, it ranks higher than negative.
- **Step 3:** The more numbers move to the right, the bigger they are, so the positive numbers are after zero. The bigger the positive number, the bigger the value.

Figure 1. Source of scientific literacy initiation

The discourse of teaching materials is also interesting to analyze as a learning source where teachers and students are driven to engage in integrated learning activities towards mathematical and scientific literacy (Firdaus et al., 2023; Moje, 2008; Shanahan & Shanahan, 2008). Firstly, it is noteworthy that these teaching materials are sourced from various online and offline learning resources, compiled by a team of teachers, used for teaching purposes within their own environment, and are not for sale. This is done to adapt to the students' English language proficiency, as words like "bigger" and "higher" can be understood in Indonesian translation, but their concepts in mathematical language are not yet comprehended. With the help of a number line (as seen in the teaching materials), complex mathematical language and concepts can be communicated in simple academic language to help students master the subject matter. In this context and situation, the thinking culture and active participation pattern of students play a role in the learning process. This participation process can be calculated by the frequency percentage of student participation observed from verbal and gestural language (solving mathematical problems) (Table 1 and Table 2). The calculation process is based on the recapitulation of participation percentage from verbal expressions; Initiation, Response, or Follow-up from two different classes at the same level with some similarities, namely English-language teaching materials and two languages used by teachers (English, Indonesian). Meanwhile, body expressions (gestures) are directly recorded.

Table 1. Frequency of IRF occurrences in excellence class

No	Stages	Inisiation		Respond		Follow-up	
		Teacher Freq. / %	Students Freq. / %	Teacher Freq. / %	Students Freq. / %	Teacher Freq. / %	Students Freq. / %
1	Warming up	8/89%	1/11%	2/29%	5/71%	0	0
2	Main activities	8/62%	5/38%	4/30%	10/70%	3/100%	0
3	Closing	1/50%	1/50%	2/50%	2/50%	1/50%	1/50%
4	Total	18/72%	7/28%	8/32%	17/68%	4/80%	1/20%

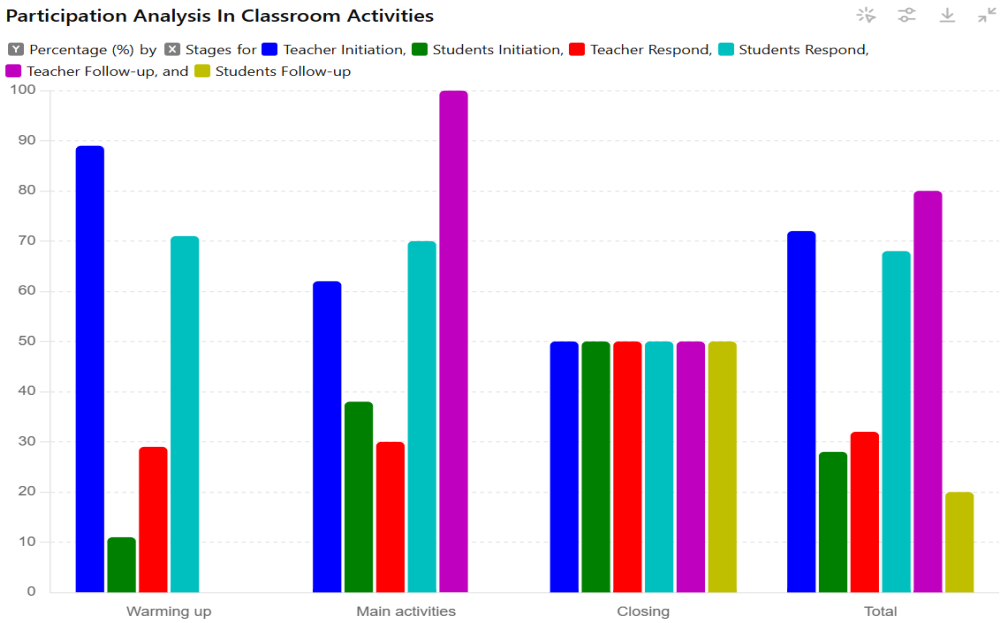


Figure 2. Participation in classroom activities (IRF) in excellence class

Table 2. Frequency of IRF Occurrences in Bilingual Class

No	Stages	Inisiation		Respond		Follow-up	
		Teacher Freq. / %	Students Freq. / %	Teacher Freq. / %	Students Freq / %	Teacher Freq.%	Students Freq. / %
1	Warming up	5/71%	2/29%	2/33%	4/67%	1/50%	1/50%
2	Main activities	9/60%	6/40%	5/31%	11/69%	2/67%	1/33%
3	Closing	1/50%	1/50%	3/60%	2/40%	1/50%	1/50%
4	Total	15/63%	9/37%	10/37%	17/63%	4/57%	3/47%

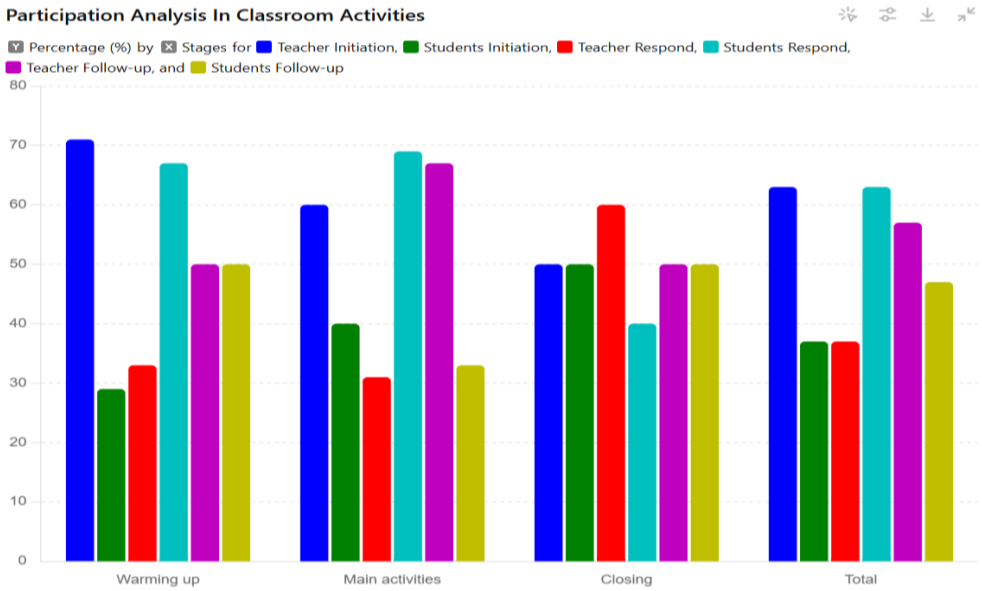


Figure 3. Participation in classroom activities (IRF) in bilingual class

Table 1 shows the cumulative frequency percentage from two Excellence classes, and Table 2 shows the cumulative frequency from two Bilingual classes. Generally, the IRF communication pattern does not show significant differences, as, in general, during the Warming up and Closing activities, teacher language dominates (63% - 87%). However, in the Main activities, student verbal language and gestures dominate (around 70%), especially in the Response (R) phase. The responses typically include hand gestures (solving problems), eye movements, facial expressions, and walking to the board to solve problems. These actions are student responses in mathematical language as a result of exploratory talk and disciplinary literacy (Barnes, 1992; Firdaus et al., 2023; Mercer, 2002; Mercer et al., 2010; Shanahan & Shanahan, 2008). However, in detail, follow-up during the Warming up activities does not occur in Excellence classes but is present in Bilingual classes and performed by both teachers (50%) and students (50%).

Student participation in Warming up activities is more about initiating to warm up the atmosphere and focusing students on the topic, although it is dominated by teachers (around 89% and 71%) and students only respond to teacher questions or statements. On the other hand, student participation is high in providing responses during Main activities, at 71% and 67%, as actions in mathematical language activities to solve problems. Teachers only follow up by motivating behaviors or language activities that deviate, such as students being noisy, not focusing on lessons, daydreaming, not doing anything, or disturbing friends, and correcting or providing corrections to student work.

From the data analysis above, it is evident that the phenomena of disciplinary literacy and social practice as a result of the learning process in class occur after the teacher provides display questions as an initiative for students to be able to convey their prior knowledge about the text and context of the topic being discussed through exploratory talk. Teacher-student interaction is driven by the topic of teaching materials, so student participation in interaction is seen in mathematical language activities provided in verbal and non-verbal responses. Verbal activities

include asking and answering written and oral questions, while non-verbal activities include facial expressions when thinking, eye contact, walking to the board, pointing or writing with hands, etc. Participation is very evident in providing responses during the main activities, i.e., Q&A using Indonesian and English, while answering oral questions or reading answers in English (up to 70%).

However, about 30% of students appear passive. Interviews with teachers and students reveal different meanings. Generally, they can understand the context of mathematical language but feel less confident in expressing it in English. Specifically, the following interview excerpts provide reasons for this condition.

> *... I cannot express myself in English yet*. (Student)
> *... I can solve the problems, but I'm afraid to explain in English; I feel embarrassed to use Indonesian*. (Student)
> *... I try to be brave to read aloud and convey my ideas in English*. (Student)
> *... I'm afraid of being laughed at when reading in English.* (Student)
> *... although the students are quiet and seem indifferent, they are generally actively doing things their own way, because those who are in this class are already considered capable, but English proficiency still varies; some are already brave, and some still have fear.*(Teacher).

This study reveals several important findings related to student participation in bilingual mathematics classes. The data obtained show that active student participation heavily depends on their ability and courage to communicate in English. Generally, students can understand the context of mathematical language, but there are some psychological barriers that hinder their active participation, such as anxiety and fear of making mistakes.

Table 1 and Table 2 show participation frequency based on the IRF (Initiation, Response, Follow-up) model. Generally, the IRF communication pattern does not show significant differences between Excellence and Bilingual classes. In the Warming up and Closing activities, teacher language dominates with a percentage of 63% - 87%. However, in the Main activities, student verbal language and gestures dominate, especially in the Response (R) phase, with a percentage of around 70%. Data analysis shows that active student participation in the main activities is heavily influenced by the phenomena of disciplinary literacy and social practice. After the teacher provides display questions, students can convey their knowledge about the topic being discussed through exploratory talk. Student participation is evident in their verbal and non-verbal activities when interacting with teachers and teaching materials. Interviews with students and teachers indicate that about 30% of students are still passive in class participation. The main reason for student passivity is a lack of confidence in using English. Some students reveal that they are afraid to speak in English for fear of being laughed at or feeling embarrassed if they make mistakes. Teachers also state that although students seem indifferent, they are generally active in completing tasks in their way.

These findings are consistent with previous research showing that mathematical communication skills are closely related to student learning outcomes. Djamarah and Zain (2002) and Hidayat et al. (2023) found that students with good communication skills show better mathematics learning outcomes. Additionally, Ramadania et al., (2018) also support that students with effective communication have higher academic performance in mathematics. This study also

draws on Vygotsky's (1978) theory of the Zone of Proximal Development (ZPD), which highlights the critical role of social interaction in the learning process. Vygotsky suggested that students gain a deeper level of understanding through collaboration with their peers and guidance from more knowledgeable teachers. This concept is reflected in the dynamics of bilingual classrooms, where active student involvement is shaped by both verbal and non-verbal communication with teachers and classmates. Furthermore, the findings align with the ideas of disciplinary literacy and social practice as outlined by Moje (2008) and Shanahan & Shanahan (2008). These scholars argue that scientific literacy in education goes beyond just reading and writing it also involves comprehending and applying scientific language across different subject areas.

These findings highlight the crucial role teachers play in encouraging student engagement. By offering motivation and fostering a supportive learning environment, teachers help students feel more at ease and confident when communicating in English. Moreover, adapting instructional materials to align with students' language proficiency can significantly aid their understanding of mathematical concepts. The study also reveals that integrating Indonesian, English, and the language of mathematics within the classroom setting can boost both scientific literacy and student participation. This multilingual approach not only supports students in grasping mathematical ideas but also encourages their active involvement in classroom discussion, whether spoken or through non-verbal cues. Building proficiency in mathematical communication through dialogue, interaction, and gestures contributes to strengthening students' overall competence and literacy in mathematics.

Conclusion

This study offers fresh insights and makes a meaningful contribution to our understanding of how language influences student engagement in bilingual mathematics classrooms. It demonstrates that using a combination of Indonesian, English, and the language of mathematics can significantly boost students' scientific literacy and encourage more active participation. However, the study has certain limitations. Its focus is restricted to seventh-grade students from two pesantren in Jember, which may limit the broader applicability of the results. Additionally, the reliance on observation and interviews introduces the potential for subjective bias. Despite these constraints, the findings underscore the vital role of teachers in crafting inclusive, supportive communication strategies and fostering a classroom environment where students feel safe and confident using English to engage in learning. The use of teaching materials tailored to students' language abilities and support to overcome psychological barriers, such as anxiety and fear of making mistakes, is highly recommended. Further research is suggested to explore various educational levels and different school contexts to broaden the understanding of language dynamics and student participation in bilingual classrooms.

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