Interaction of Mathematics Learning in Inclusive School

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Abstract
Interaction becomes a very important thing in mathematics learning activities because it can help students gain good conceptual understanding, including in inclusive schools that involve regular students and students with special needs in the same scope. This study aims to describe the interaction in mathematics learning in grade VII at one of the inclusive middle schools in Bandar Lampung, Lampung Province. The subjects in this study were 23 regular students, 2 slow learners, and 1 autistic student. This study used a qualitative approach with a case study method on teacher-student interaction in mathematics learning. The research instruments used were observation sheets, Flanders Interaction Analysis Category System (FIACS) matrix, and unstructured interviews. Furthermore, data analysis was carried out through three stages, namely data reduction, data presentation, and conclusion drawing. The results showed that the dominance of teacher talk proportion was in the aspect of encouraging with an average of 34.31% and the aspect of closed response in student talk to the teacher amounted to 70.65% which appeared during the core learning activities in understanding mathematical concepts and problems, while discussions conducted by students with special needs dominated the aspect of discussion during learning activities involving peer tutors, which was 21.88%. This means that mathematics learning in this study forms student activities in following procedural instructions from the teacher, students and teachers communicating mathematics, and jointly constructing mathematical truths. The interaction that occurs in mathematics learning forms a multi-directional pattern involving reciprocal interactions between teachers, regular students, and students with special needs.
Keywords: mathematics learning interaction, inclusive school, regular students, students with special needs.

Introduction

Education in Indonesia today has developed in line with the country's goal of focusing on the achievement of Sustainable Development Goals, namely ensuring inclusive education that is quality and fair and provides lifelong learning opportunities for everyone. Inclusive education is a program that unites all children and aims to provide the widest possible opportunities to all children, help accelerate the compulsory basic education program, help improve the quality of primary and secondary education by reducing the number of class dropouts and school dropouts, creating an education system that respects diversity, as well as fulfilling the mandate of the 1945 Constitution article 32 paragraphs 1 and 2, Law number 20 of 2003 paragraph 1, and Law number 23 of 2002 article 51. Inclusive education is education that is not discriminatory. The description above can be interpreted as inclusive education is education that aims to provide non-discriminatory services.

In line with UNESCO's opinion, inclusive education is about providing knowledge and forming character and empowering individuals to become valuable parts of society (UNICEF, 2020). Indonesia, through the Minister of National Education Regulation No. 70 of 2009, includes inclusive education programs as one of the national education mandates (Permendiknas, 2009). Inclusive education is then implemented in regular schools, known as inclusive schools. The study results from Nzuza (2023) showed an inclusive learning where students who face learning obstacles better comprehend the curriculum's content through role-play, constructing objects, and drawing so they could transform their contextual affordance into actions, which sheds light on their education journey. Socialization and collaboration are enhanced for students with disabilities through group work, but sometimes working in a group can be a real challenge for students with autistic disorder because they experience more significant sensory processing problems (Page & Davis, 2023). Therefore, inclusive learning should be a concern for each student with disabilities.

Seeing the importance of inclusive education programs, the Lampung Provincial Government responded well through Lampung Province Regional Regulation No.10 of 2013 concerning Services and Fulfillment of the Rights of Persons with Disabilities (PERDA Provinsi Lampung, 2013). This regulation is implemented in real terms by the Lampung Provincial Government by providing inclusive schools that are friendly for students with special needs and regular students to receive education together in the same environment. Likewise, with data distribution on students with special needs in inclusive schools in Indonesia, slow-learners category is the highest in Lampung Province, which are 231 out of 444 slow learner students. The category of slow learners is a special characteristic of students who are slow learners in the academic field (Kemendikbud, 2014). According to the research results of Hadi et al. (2016), slow learners have difficulty embedding mathematical concepts and may lose interest in the assignment or refuse to continue working on the assignment. Student slow learner does not mean they are incapable of learning, but they are slow in understanding abstract concepts and use more memorization than logic or reasoning. Thus, it can be concluded that students with slow learning categories still have difficulty in mathematics.

Slow-learner students have difficulty in providing explanations and formulating problem-solving strategies and lack understanding of mathematical problems (Hasibuan et al., 2022; Metikasari et al., 2019; Putri et al., 2019; Wafiqoh et al., 2022). These issues can

be resolved through collaboration within a team, as peers can offer explanations in accessible language and emphasize the pertinent aspects of the problem, given that they are frequently more attuned than their instructors to the misunderstandings of certain students (Filippatou & Kaldi, 2010). Several studies found the application of mathematics learning for children with special needs used strategies with a realistic mathematics education approach, a constructivist model, and a peer-tutoring method (Aziz et al., 2016; Ginting et al., 2023; Hadi et al., 2016; Lestari, 2020; Listiawati et al., 2023; Putranto et al., 2022; Sutomo et al., 2023). Therefore, students must be given the opportunity to construct their own knowledge, as providing opportunities for students is a strategy to encourage them to interact in study groups.

Through group learning, interactions will certainly emerge. Boaler and Huntley's research found that classes emphasizing student interaction can enhance problem-solving and conceptual understanding of mathematics (Bruce, 2007), thus interaction is an important element to support learning activities. The theory proposed by Piaget (Afifah, 2012) states that students must actively interact with their learning environment to help achieve a higher level of understanding. The results of classroom interaction studies provide valuable feedback for training quality teachers and encouraging students to participate more actively (Goronga, 2013). Hunter & Anthony (2014) found that interaction can help students gain a good conceptual understanding. It can be concluded that interaction plays an important role in the learning process, especially in mathematics.

Based on the observation and interview with the Education Department in Bandarlampung City, there are around 88% of students with special needs have communication and interaction difficulties, including slow-learner and autistic; it is necessary to analyze the interaction of learner students with their learning environment, teachers, and regular students. More technically, the following section will discuss materials and methods related to the ideas above.

Method

This research used a qualitative approach with a case study research method. The research subjects in this study used purposive sampling, which included mathematics teachers, grade VII regular students, and students with special needs in the slow learner and autistic categories at one of the inclusive junior high schools in Bandar Lampung, Lampung Province. Data was collected using non-test techniques: observation and

interview. Then, data was analyzed and validated using triangulation techniques, which are sourced from direct observation, indirect observation, and interviews conducted with research subjects (Cohen et al., 2017; Miles et al., 2014) collected during three meetings as data validation.

1. Observation sheet

There were direct observation notes on-site and indirectly through audio and video recordings. With the observation sheet, the author could record activities during the lesson and include them in the Flanders analysis matrix. There are four stages in using the Flanders Interaction Analysis Category System (FIACS) (Kaur & Tatla, 2015), namely: (1) coding the categorization of interaction talk that appears in teachers and students, (2) placing the appropriate codes in a matrix table consisting of rows and columns and then paired, (3) analyzing the matrix by performing intermediate calculations teacher *talk*, *student talk*, and silence by the FIACS aspect that has been developed by Cai et al. (2021), and (4) additional analysis.

Additional analysis in this research categorizes teacher talk into indirect and direct talk and discussions related to mathematics. Flanders matrix tabulation was written in a 13 x 13 table which means a 13 (row) x 13 (column) table to determine certain aspects of classroom interaction. In addition, it was shown what constitutes a pair of categories. The matrix row represents the first number which is a stimulus and the column represents the second number which is a response to the stimulus given, so that the sequence in the cell is the result of the conversation pair that occurred. There are 13 aspects to pay attention to in the FIACS indicators as follows:

a. Indirect teacher talk, namely:

C1: Accepts feeling. In this category, the teacher accepts students' feelings. Teachers feel that students deserve to express their feelings in negative or positive form.

C2: Praise or encourage. The teacher praises or encourages student actions or behavior. When a student answers a question the teacher asks, the teacher provides positive reinforcement by saying words like 'good', 'very good', 'correct', 'continue', etc.

C3: Accepts or uses students' ideas. Clarifies, builds on, or develops ideas suggested by students.

C4: Ask open questions. Asking questions about content or procedures to get students to answer.

C5: Ask closed questions.

b. Direct teacher talks.

C6: Lecturing. Provide facts or opinions about content or procedures; express the teacher's ideas and explain the material

C7: Gives direction. Give directions or commands that students are expected to obey.

C8: Criticizing or justifying authority. Making statements intended to change a student's behavior from an unacceptable pattern to an acceptable pattern or when the teacher criticizes a student's behavior

c. Student talk, consisting of:

C9: Open response. Students speak in response to the teacher.

C10: Closed response.

C11: Discussion with peer or peer tutoring. The students discuss or work with peers or explain to peers.

C12: Student-initiated talk. If the student's call is to indicate who can speak next, the observer must decide whether the student wants to speak. If so, use this category

d. Silence

C13: Silence or confusion. Brief periods of silence and periods of confusion.

2. Interview guidelines

The interview guide in this study used an unstructured interview guide. This was because the respondents or subjects interviewed are teachers and student representatives who carried out interactive discussions during learning activities. The author could dig up more information from the source with an unstructured interview guide.

To test the validity of the data in this qualitative research, a triangulation test technique was used following Cohen et al. (2017) and Miles et al. (2014). Triangulation technique, namely determining the relevance of data originating from direct observation, indirect observation, and interviews conducted with research subjects, namely teachers and student representatives in research subjects. The data analysis stage in the research included data reduction, data presentation (*data display*), and drawing/verifying conclusions (Miles et.al, 2014).

a. Data Reduction

The data reduction carried out in this research was verbal activities in class related to the mathematics learning process in one of the class VII inclusive junior high schools in Bandar Lampung. The data reduction stages carried out are as follows:

a) Collect data from recorded observations.

b) Transcribe recordings.
c) Determine the code categorization of interaction aspects from the transcription results.
d) Carry out coding analysis of transcription results.

b. Data Presentation

The next step was to present the reduced data. Data presentation was carried out by writing down all the information that has been reduced in the form of conversation transcriptions. The stages of data presentation in this research are:

a) Entering the transcription coding data into the Flanders matrix.
b) Calculates the interaction percentage based on Flanders calculations.

- Percentage of teacher talk $= \frac{C1+C2+C3+C4+C5+C6+C7+C8}{N \times 100}$
- Percentage of direct talk $= \frac{C1+C2+C3+C4+C5}{N \times 100}$
- Percentage of indirect talk $= \frac{C6+C7+C8}{N \times 100}$
- Percentage of student talk $= \frac{C9+C10+C11+C12}{N \times 100}$
- Silence percentage $= \frac{C13}{N \times 100}$

c) Data presented in diagrams and tables resulting from observations and interview results.
d) Describe the results of classroom interaction analysis.

c. Drawing Conclusions

The research conclusion obtained data on interactions between teachers, regular students, and students with special needs, as well as their interaction patterns which were carried out by matching direct and indirect observation or observation data, as well as data verification in the form of unstructured interviews.

Results and Discussion

a. Teacher Talk

The category of teacher talk has two classifications in its discussion, namely direct talk and indirect talk. The number of interactions that occur was calculated using the Flanders system, and the proportions of teacher talk dominate the classification of indirect talk, with an average of 78.25%. In contrast, direct talk is at an average of 21.75% (Table 1).

Table 1. Proportion of Teacher Talk Aspects in Each Meeting.

Classification	Code	Aspect	Proportion Talk (%) per Meeting		
			1st	2nd	3rd
Indirect talk	1	Accept feelings	3,33	1,23	0,00
	2	Praise or encourage	34,00	28,40	40,52
	3	Accept or use ideas of student	3,33	9,47	6,54
	4a	Opened question	6,67	3,70	1,31
	4b	Closed question	31,33	29,63	35,29
Direct talk	5	Lecturing	2,00	14,40	0,65
	6	Give direction	16,00	9,88	10,46
	7	Criticizing or justifying	3,33	3,29	5,23

The interactions carried out by the teachers with regular students were in the form of closed and opened questions which would give rise to answers from regular students and discussions would occur, so that the teacher then provided encouragement or praise. Meanwhile, for autistic students and slow learners, teachers encouraged them when they have solved problems. The interaction process was that the teacher gives opened and closed questions to students and then responds to them by regular students who are then given a response back by the teacher in the form of praise or encouragement. Questions initiated by the teacher were questions related to the concept of distance and displacement or other knowledge related to distance and displacement (reflection, translation, and rotation). The teacher was more dominant as an interactor who gave questions, while students were as interactors who respond.

The teacher's activity in asking questions which the students then respond can create a scheme for the teacher in developing further learning. The teacher provided feedback or respond to students as a form of reciprocity for student responses and creates two-way interaction. The two-way interaction in mathematics learning that took place included mathematical activities in explaining, finding, and justifying mathematical solutions. The teacher's continued action in response to student action is a pedagogical action that will create a new didactic situation that is dynamic, constantly changing, and developing throughout the learning period (Suryadi, 2013). The research results showed that teachers responded in the form of agreement or asking further questions. These follow-up questions were the questions with hints when the answer was not appropriate or had not achieved the goal.

b. Student Talk

Student talk has three aspects of conversation involving regular students and students with special needs consisting of two slow learner students and one autistic student. In this research, slow learner student with the initial Ta is given the code SBK1, the autistic student is given the code SBK2, and the slow learner with the initial Ke is coded SBK3. Student interaction aspects code 8a, 8b, and 10 are given to the teacher, while code 9 occurs with fellow students.

Table 2. Proportion of Student Talk Aspects in Each Meeting.

Code	Aspect	Proportion Talk (%) per Meeting		
		1st	2nd	3rd
8a	Opened response	13,00	5,18	0,74
8b	Closed response	78,00	60,62	73,33
9	Discussion with friends	4,00	19,69	16,30
10	Initiation	5,00	14,51	9,63

Table 2. shows dominance in the aspect of providing closed responses directed at the teacher with an average proportion of 70.65%. Based on the results of observations, regular students could answer teacher questions as reciprocity in mathematics learning interactions. Students answered the teacher's questions regarding the nature of reflection which showed that students could identify the characteristics of the concept of reflection which could be seen in the following excerpt.

Teacher: "*Di sini berapa angkanya?*"

Student: "*Empat*"

Teacher: "*Berarti ke kiri berapa?*"

Student: "*Empat*"

Teacher: "*Karena apa syaratnya?*"

Student: "*Same distance*"

Note: the discussion above presented in Indonesia.

The conversation above shows that there was a two-way interaction between the teacher and regular students. There was no feedback from students with special needs, but they still took notes and paid attention. This first meeting was filled with lots of student talk in answering the teacher's questions as above which were closed responses. This falls into the closed response category because in this context students already know the terms or nature of reflection through previous explanations and the answers can be predicted.

During three meetings, differences were found in the interactions of students with special needs in learning mathematics. Slow learners and autistic students were involved in classroom interactions in mathematics learning under certain conditions. Autistic student preferred to interact with teachers, whereas for fellow students with special needs and regular students occurred outside the context of mathematics learning. Autistic student could follow lessons well, especially when the learning process using media YouTube.

In contrast to the autistic student, slow learner students spent more interaction with regular students. Slow learner students were considered capable of interacting with their environment but need active support from teachers and regular students to help their learning process through peer-tutoring. When peer-tutoring occurred between students, slow learner students would also join and paid attention to their friend's explanation. There were also peer-tutors found on one regular student to slow learner students. Regular students who have already completed the questions would teach other students, especially slow learner students. Regular students helped them by providing explanations and some instructions for solving problems.

Overall, the category student talk went quite well with regular student respond to the teacher after the teacher asked questions. In providing opportunities for students with special needs to be involved actively, the teacher provided directions to join other students in solving problems.

Autistic student did not appear to join in peer-tutoring activities, they tended to solve problems independently and chose to ask questions directly to the teacher. There were times when autistic students don't have time to take notes because the teacher has already continued the next explanation, autistic student takes the initiative to ask regular students for permission to look at their notes. Limited abilities possessed by autistic student and slow learner students caused a tendency to remain silent in students, but it fell into the category of silence when there was no response in a situation that requires a response, such as after asking a question.

c. Silence

The absence of a response to an interaction is classified as a response silence because in its implementation there is no verbal action involved. If we look at the results of observations during the three meetings as a whole, there was not much response silence. The average silence that occurs is 1.99% of all class interactions, but specifically, silence among students with special needs is still higher. Based on the results of research

observations, this condition of silence or silence occurred when the teacher asked students a question, but the students did not provide a reciprocal response or are just silent. The silence that occurs in each category of students (regular and with special needs) is shown in Table 3.

Table 3. Proportion of Silence Aspects in Each Meeting.

Interactor	Proportion Talk (%) per Meeting		
	1st	2nd	3rd
Regular Students	6,25	9,09	9,72
Students with Special Needs	93,75	90,91	90,28

Table 3 clearly shows the dominance of silence to students with special needs. As in the research results, (a) teacher talk and (b) student talk, students with special needs tended to remain silent and participate in learning without actively answering questions verbally given by the teacher related to the material.

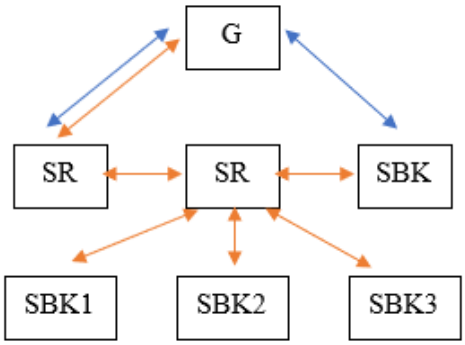
Passive responses given by autistic student and slow learner students are a characteristic form of students with special needs who have difficulties in communicating and interacting in learning (Permendikbud No.157, 2014). However, teachers could use the learning interaction process through peer-tutoring activities or involving regular students and students with special needs to work together. This is in accordance with research by Girli (2013) and Nuryani et al. (2016) which states that the social skills of students with special needs are essential in implementing inclusive education. On the other hand, teachers have also utilized friendly learning media for all students, including autistic student, to develop the student-learning interaction process. This means showing respect for student potential, mediated by teaching in a non-exclusive environment.

Teachers usually direct that students who already understand can help other students, and students who don't understand can join in and ask questions with students who already understand, which is referred to as joint learning. According to Kollosche et al. (2019), joint learning in the application of learning for students with learning difficulties shows high results. This aligns with the opinion of Ibrahim (Aziz et al., 2016) who found that collaborative learning can benefit lower-group students (students with special needs) and upper-group students who work together to complete academic tasks. A systematic review by Garrote et al. (2017) revealed that collaborative activities in an academic context, such as cooperative learning and peer-tutoring, are beneficial for social inclusion. In this regard, this research also found mathematics learning interactions involving activities

between teachers and all students, regular students with regular students, and students with special needs in mathematical action and interpretation.

The research results indicate that the interaction shapes students' activities in following the teacher's procedural instructions, and the mutual communication of mathematics between students and teachers, as well as the construction of mathematical truths together, in line with Cobb's theory regarding the three characteristics of interaction traditions in the mathematics classroom, namely (1) mathematical communication, (2) mathematical activity as procedural instruction, and (3) mathematical truths (Cobb et al., 1992). In this study, mathematical communication occurred when two students work together to complete a task involving finding the result of rotating a triangle. Mathematical activity as procedural occurred when the teacher gives directions in the presence of student misconceptions, in which case the students have actively learned through the teacher's instructional activities, and in this case, all students, including those with special needs, actively interact to respond to the teacher's directions. Mathematical truths in this study were found when students attempt to find a solution to problems of reflection, translation, and rotation.

The interaction relationships that occurred in mathematics learning in inclusive schools then form a pattern or form of interaction that occurs repeatedly. The teacher provides information, directions, and orders which are included in the form of explanations, and also asks questions to students. The students then respond to the interactions carried out by the teacher. The teacher then responds to the student's response in the form of approval or praise, but if there is an error in the answer, the answer does not match the teacher's estimate, or does not achieve the target learning objectives, the teacher will usually ask questions. hint. Instructor behavior and student characteristics can affect student learning (Kyei-Blankson et al., 2016). Thus, interaction between teachers and students takes place in two directions. Likewise, students with special needs can respond to teachers to answer questions or solve problems. Students with special needs also actively interact with regular students so that student interaction occurs in two directions. There are slight differences in interaction patterns for each student with special needs which can be seen in Picture 1.



Picture 1. Interaction Pattern of Mathematics Learning in Inclusive School.

Information:

G : Teacher

SR : Regular students

SBK : Students with special needs

SBK1 : Slow learner 1

SBK2 : Autistic student

SBK3 : Slow learner 2

⟶ : One-way interaction

⟷ : Two-way interaction

Blue line : Initiated by teacher

Orange line : Initiated by SR

Picture 1. shows a rotating pattern between the teacher, students, and among students during mathematical discussion activities, meaning that interaction occurs optimally. Nana Sudjana and Drs. Moh. Uzer Usman in Djamarah (2010) states that interaction has an optimal pattern if there is free, unlimited interaction between teachers and students and students and other students. So, it can be said that the mathematics learning interactions that occurred in this research are good, optimal, and under the application of learning to the goals of inclusive schools.

Conclusion and Suggestion

Based on the eight aspects of teacher talks, the interaction process is dominated by the teacher's activities in providing closed and open questions that test students' mastery of understanding of the material, apart from the four aspects, students are dominated by closed response activities and peer tutor discussion activities. Students also made non-verbal responses with special needs that are included in the silence category. The analysis

of the interaction of students and teachers in mathematics learning in this study consistently shows that mathematics serves as a task that follows procedural instructions during their interaction. Moreover, both teachers and students co-construct and interpret their understanding of mathematical concepts, while student-to-student interaction occurs when they communicate mathematics in solving problems.

This research also found that there were other factors, such as learning media that support the learning process of students with autistic and slow learner students. The teacher utilized all students' sensory tools by providing verbal explanations, body movements, using mirror, and YouTube learning videos.

Future research can use FIACS in group discussion sessions or presentations to identify how interactions work when there are groupings. This research only carried out the same learning models and methods for three meetings, so the dominant interaction that emerged was still in the same pattern. This research has limitations in the use of analysis that only involves verbal activities, so it is hoped that future researchers can develop the use of interaction analysis to be more specific with the classification of non-verbal interaction. Future research could be implemented on the variety of learning media that suit most the needs of students and find out the learning outcomes.

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