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Students' Analytical Questions and Interaction Patterns in Group Discussion Facilitated with a Scientific Approach Learning

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Abstract: *Analytical questions are the types of questions that can lead students to gain an understanding of a concept and explore reasoning. This research is a descriptive, qualitative study investigating the emergence of analytical questions and their interaction patterns in group discussions facilitated by a scientific approach to learning. The subjects of this study were 30 students aged 14 years with heterogeneous mathematical abilities; they were distributed into five groups. Data were collected through observation with a video recorder as a tool. Method triangulation was carried out for the data validation process. The data were analyzed through data reduction, data presentation, and conclusion. The results showed that in group discussions: (1) observing is the dominant stage in raising analytical questions, (2) students with low mathematical abilities were dominant in triggering the emergence of analytical questions, and (3) dominant interactions occurred between students with low mathematical ability as the questioner and students with high mathematical ability as the answerer.*

Keywords: *analytical question, scientific approach, interaction pattern*

INTRODUCTION

Asking is an activity that is very common in the learning process. Teachers often ask for various purposes, for example, to measure students' understanding, get information from students, stimulate students' thinking, and control the class (Kucuktepe, 2010; Widodo, 2006). Likewise with students. Students' questions during the learning process also have various purposes, for example, to get an explanation, express curiosity, or even to get attention (Widodo, 2006). No single theory denies the vital role of questions in the learning process (Almeida, 2012; Chin & Osborne, 2008; Graesser & Olde, 2003).

Although it is recognized that questions play an essential role in the learning process, there has not been much research on questions in the learning process. Cahyani et al. (2015) found that the types

of questions used by teachers in learning were query questions, rhetorical, directing, direct information narrow questions, and centralized narrow questions. The types of questions used by students are comprehension and application questions. Faizah et al. (2018) and Yuliani et al. (2014) stated that the dominant types of questions raised by students in learning were questions on the cognitive dimension of understanding. Omari (2018) suggests that teachers can develop students thinking abilities by asking different types of questions to account for the individual differences among students.

For analyzing, questions are generally classified based on specific considerations. In the literature on questions, there are various classifications of questions. One of them is a question related to cognitive processes. In the revised version of Bloom's taxonomy (Anderson et al., 2001), a separation is made between the knowledge and the cognitive process dimension. One of the questions related to cognitive processes is an analytical question (Anderson et al., 2001; Chaffee, 1988). Analytical involves breaking down a problem into problem parts and determining how the parts are interrelated. Three kinds of cognitive processes were included in the analysis: differentiating, organizing, and attributing (Anderson et al., 2001). The analytical question is essential for students to ask to provide an understanding of a concept in detail.

Learning with a scientific approach is learning that is designed in five stages (observing, asking, experimenting, associating, and communicating) to encourage the development of attitudes, knowledge, and skills of students to be better by scientific principles (Hosnan, 2014; In'am & Hajar, 2017; Istungingsih et al., 2018; Prakoso et al., 2018; Tambunan, 2019; Wiyanto, 2017;). (1) *Observing.* It prioritizes the meaningfulness of the learning process. Through observation, students will feel challenged. (2) *Asking*. An effective teacher is a teacher who knows the student's competence and inspires students to grow up. When asking and answering questions, a teacher encourages his students to be good learners. (3) *Experimenting.* Students are required to apply their knowledge to solve problems. (4) *Associating.* Students are required to think systematically and logically to get a conclusion. (5) *Communicating.* Students are asked to present the findings or results obtained during the process. It can be done through group representatives if the learning process is carried out in groups.

The scientific approach also emphasizes the activity of asking questions by students during learning to be able to construct understanding optimally. Analytical questions are essential in this process (Chaffee, 1988; Paul & Elder, 2006). After observing, students are expected to have curiosity and ask analytical questions about the information that has been observed. These analytical questions can be asked of the teacher or other students.

The scientific approach requires students to be actively involved in learning. To demand active students, generally, learning is done through group discussions (Amran et al., 2016; Tesfaye & Berhanu, 2015). Ideally, the formation of groups pays attention to the heterogeneity of student characteristics (Herlina, 2018), for example, mathematical ability. This formation is intended to have a positive dependence between students in the group (Rosita & Leonard, 2015). Students

with high mathematical abilities help students with low mathematical abilities understand a concept (Karsenty, 2020; Salido & Dasari, 2019; Yusupova, 2021). On the other hand, students with high mathematical abilities will increasingly understand the concept. During discussion activities, asking analytical questions helps students to understand a concept (Chaffee, 1988; Paul & Elder, 2006).

The literature review results indicate that no research focusing on the emergence of analytical questions posed by students and their interaction patterns in group discussions facilitated a scientific approach to learning. Therefore, it is crucial to do research that focuses on students' emergence of analytical questions during learning. Thus, this research aims to describe the emergence of analytical questions and their interaction patterns in group discussions facilitated by a scientific approach to learning. The research results become the basis for designing stimuli in learning so that students actively ask analytical questions. Giving the right stimulus will motivate students to understand the concept optimally.

METHOD

This descriptive research with a qualitative approach was conducted by involving 30 students aged 14 years. Data were collected through observation with a video recorder as a tool. Observations were made on learning that applied a scientific approach to the topic of Cartesian Coordinates. The practical learning lasted two hours of learning with a video duration of 1 hour and 1 minute 49 seconds. The researcher only acts as an observer and does not intervene in implementing learning.

Learning with a scientific approach is carried out in groups. As many as 30 students were distributed into five groups so that each group consisted of 6 students. Each group consists of students with high, medium, and low mathematical abilities (Karsenty, 2020), each of which is two students. The teacher arranges the composition of students in a group. Data on students' mathematical abilities were obtained through essay tests. The scores obtained by students are used as the basis for classifying mathematical abilities. Refers to the average test scores of students ($\bar{x}$ = 73.55) with a standard deviation (s = 15.34), the classification of students' mathematical abilities is based on Table 1.

Classification of Test Score (n)		Category of Mathematical Ability
$n > (\bar{x} + {}^1/_2\, s)$	$n > 81.22$	High
$(\bar{x} - {}^1/_2\, s) \leq n \leq (\bar{x} + {}^1/_2\, s)$	$65.88 \leq n \leq 81.22$	Medium
$n < (\bar{x} - {}^1/_2\, s)$	$n < 65.88$	Low

Table 1: The classification of students' mathematical ability

Learning with a scientific approach in a group setting is carried out through the following five stages.

1. Observing

At this stage, students are given a worksheet that contains a phenomenon related to the topic of Cartesian Coordinates. The worksheet illustrates a campground plan in Cartesian Coordinates, as shown in Figure 1.

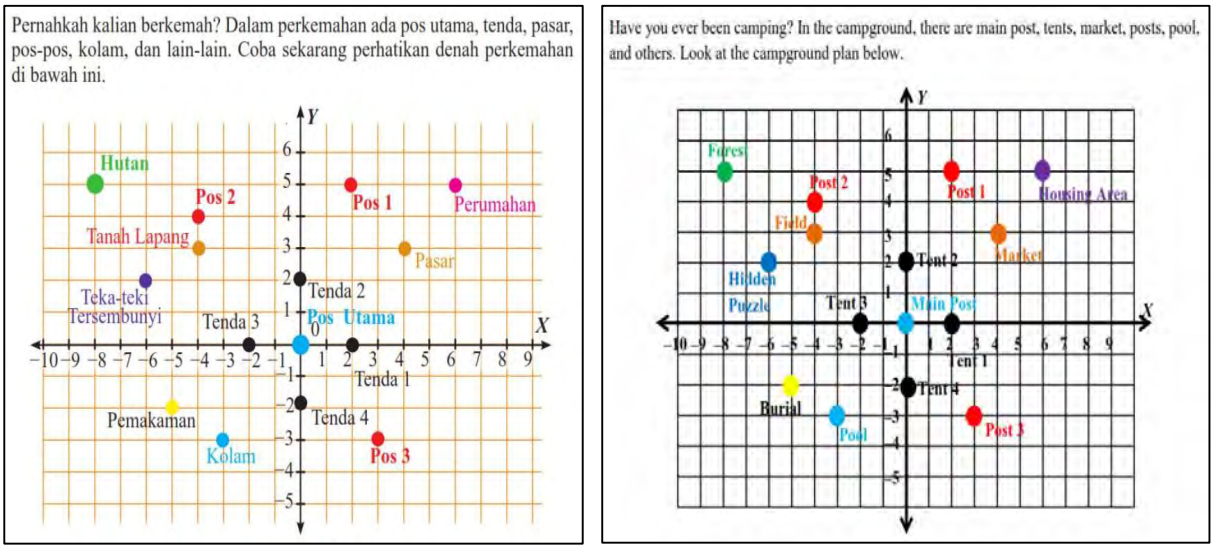


Figure 1: The illustration of a campground plan on a student worksheet

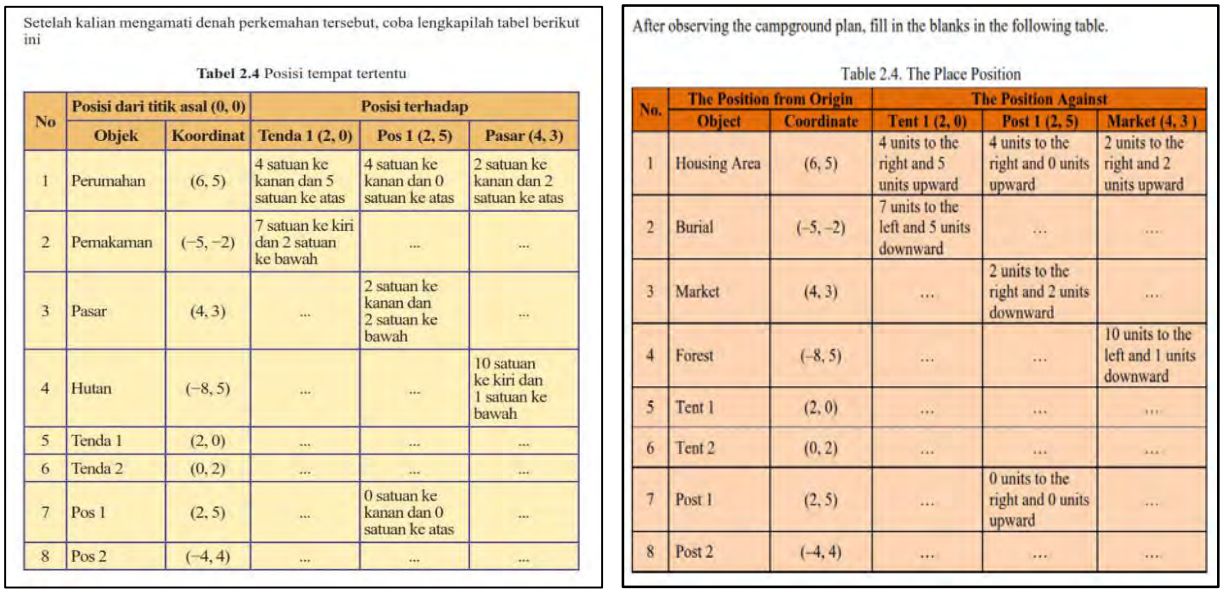
In practice, one group is only given one worksheet. Students are asked to observe the phenomena presented on the worksheet. In the observing activity, it is possible to have conversations between students in their groups.

2. Asking

At this stage, students can ask the teacher if they are confused about understanding the worksheet illustrations. The formulation of this question allows the emergence of conversations between students in groups. This conversation is because another student in the group can answer a student's question. Thus, the questions posed to the teacher were the only questions the students in their group could not answer.

3. Experimenting

At this stage, students are asked to solve the problems presented in the worksheet. This problem-solving process allows the emergence of conversations between students in groups. The result of this interaction will be the result of group work. The problems presented in the worksheet are presented in Figure 2.



Setelah kalian mengamati denah perkemahan tersebut, coba lengkapilah tabel berikut ini

Tabel 2.4 Posisi tempat tertentu

No	Posisi dari titik asal (0, 0)		Posisi terhadap		
	Objek	Koordinat	Tenda 1 (2, 0)	Pos 1 (2, 5)	Pasar (4, 3)
1	Perumahan	(6, 5)	4 satuan ke kanan dan 5 satuan ke atas	4 satuan ke kanan dan 0 satuan ke atas	2 satuan ke kanan dan 2 satuan ke atas
2	Pemakaman	(−5, −2)	7 satuan ke kiri dan 2 satuan ke bawah	...	...
3	Pasar	(4, 3)	...	2 satuan ke kanan dan 2 satuan ke bawah	...
4	Hutan	(−8, 5)	...	...	10 satuan ke kiri dan 1 satuan ke bawah
5	Tenda 1	(2, 0)	...	...	...
6	Tenda 2	(0, 2)	...	...	...
7	Pos 1	(2, 5)	...	0 satuan ke kanan dan 0 satuan ke atas	...
8	Pos 2	(−4, 4)	...	...	...

After observing the campground plan, fill in the blanks in the following table.

Table 2.4. The Place Position

No.	The Position from Origin		The Position Against		
	Object	Coordinate	Tent 1 (2, 0)	Post 1 (2, 5)	Market (4, 3)
1	Housing Area	(6, 5)	4 units to the right and 5 units upward	4 units to the right and 0 units upward	2 units to the right and 2 units upward
2	Burial	(−5, −2)	7 units to the left and 5 units downward	...	....
3	Market	(4, 3)	...	2 units to the right and 2 units downward	...
4	Forest	(−8, 5)	...	...	10 units to the left and 1 units downward
5	Tent 1	(2, 0)	...	...	....
6	Tent 2	(0, 2)	...	...	....
7	Post 1	(2, 5)	...	0 units to the right and 0 units upward	...
8	Post 2	(−4, 4)	...	...	....

Figure 2: The problem in the student worksheet

4. Associating

At this stage, students are asked to formulate conclusions from the problem on the worksheet. Formulating this conclusion allows the emergence of conversations between students in groups.

5. Communicating

At this stage, group representatives are asked to present the results of their discussions in front of the class. The presentation of the results of this discussion allows the emergence of conversations between students in groups.

For data collection, observations were focused on conversations between students in group discussions to identify the emergence of analytical questions orally at each stage of the scientific approach. The analytical question indicators used in this study were modified from Rudsberg et al. (2016), as presented in Table 2.

Analytical Concept	Analytical Question Indicators
Encounter	Questioning an object in an event
Gap	Questioning objects that are not understood or make no sense
	Questioning the situation to be solved
Fast Stand	Questioning information that has been presented in an incident
Relations	Questioning the relationship of previous experiences with new information obtained
Meaning	Questioning things that might happen after a process occurs

Table 2: Concepts and indicators of analytical questions

Data analysis was carried out through three stages: data reduction, data presentation, and concluding (Miles & Huberman, 2014). Before analyzing the data, the researcher transcribed the data from the video recording. After that, the researchers validated the data by triangulating the method. It was done by comparing the data of observations and the transcription of the video recordings. Next, the researcher reduced the data by focusing only on the analytical questions raised by the students. The data resulting from this reduction are then presented to obtain research conclusions.

RESULT AND DISCUSSION

The results of this research indicate that group discussions on learning with a scientific approach raise analytical questions. These analytical questions arise at every stage by students with high, medium, and low mathematical abilities. The number of analytical questions at each stage is presented in Table 3.

Scientific Stage	Math Ability	Number of Analytical Questions	
		Answered	Not answered
Observing	High	0	2
	Medium	2	0
	Low	3	0
Asking	High	0	0
	Medium	2	0
	Low	1	0
Experimenting	High	0	1
	Medium	2	0
	Low	2	0
Associating	High	1	0
	Medium	1	0
	Low	2	0
Communicating	High	0	0
	Medium	0	0
	Low	2	0

Table 3: Number of analytical questions at each stage

Based on the data in Table 3, observing is the most dominant stage in raising analytical questions, which are seven questions. Students with low mathematical abilities at the observing stage raise the dominant analytical questions. In contrast to observing, communicating is the stage that raises the fewest analytical questions in group discussions. Students with low mathematical abilities remain the trigger in raising analytical questions at the communicating stage.

If a thorough analysis is carried out, students with low mathematical abilities can trigger analytical questions. In group discussions, students with low mathematical ability raise ten analytical questions, students with medium mathematical ability raise seven analytical questions, and students with high mathematical abilities only raise four analytical questions. If paying attention to the pattern, the most dominant interaction occurs between students with low mathematical ability as the questioner and students with high mathematical ability as the answerer of questions. On the other hand, there was no interaction between students with high mathematical ability as the questioner and students with low mathematical ability as the answerer of questions. Data related to the interaction patterns of analytical questions in this group discussion are presented in Table 4.

Interaction Pattern	Math Ability	Number of Analytical Questions
Questioner	High	4
	Medium	7
	Low	10
Answerer	High	12
	Medium	4
	Low	2
Questioner – Answerer	High – Medium	1
	High – Low	0
	Medium – High	5
	Medium – Low	2
	Low – High	7
	Low – Medium	3

Table 4: The interaction patterns of analytical questions in group discussion

The research result indicates that observing is the dominant stage in raising analytical questions. At this stage, students are asked to observe a phenomenon related to the topic of Cartesian Coordinates presented on the worksheet. Observing is the initial stage in the scientific approach, which opens students' interest in participating in further learning activities (Azhar, 2015). Raising many analytical questions at this stage indicates that students are inquisitive about the concepts to be studied (Chaffee, 1988; Paul & Elder, 2006). Students with low mathematical abilities have triggered the emergence of analytical questions at this stage. Every question posed by students with low mathematical ability gets responses from other students in their group. It also motivates students to ask questions (Agustini & Sopandi, 2017). The examples of analytical questions that arise at this stage are as follows.

Question 1: What is this illustration about? (Encounter)

Question 2: What are the coordinates of the main post? (Stand Fast)

At the asking stage, not as many analytical questions arise as in the observing stage. It occurs because students are confused, which triggers questions answered at the observing stage. Students with medium mathematical ability have triggered the emergence of analytical questions at this stage. The examples of analytical questions that arise at this stage are as follows.
Question 1: If I want to go to Market from Main Post, should I go to the right or upward first? (Gaps)
Question 2: Will the result differ if I move to the right or upward first? (Meaning)

The emergence of analytical questions again increases at the experimenting stage. Students with low and medium mathematical abilities raise analytical questions with the exact quantities at this stage. The examples of analytical questions that arise at this stage are as follows.
Question 1: The main post is at the center of Cartesian. Is (0, 0) the coordinate? (Relations)
Question 2: The sign is still positive if you move downwards, right? (Gaps)

Students with low mathematical abilities remain a trigger for the emergence of analytical questions at the reasoning stage. The examples of analytical questions that arise at this stage are as follows.
Question 1: At the coordinates (0, –2), there is a Tent 4, right? (Encounter)
Question 2: The Main Post has the same distance to all tents, right? (Gaps)

Communicating is the stage that raises the least number of analytical questions. However, students with low mathematical abilities remain triggers for the emergence of analytical questions. The examples of analytical questions that arise at this stage are as follows.
Question 1: Where is Post 1 located? (Stand Fast)
Question 2: “2 units to the right and three units upward” and “3 units upward and two units to the right” will the result be the same? (Gaps)

In general, students with low mathematical abilities trigger the emergence of analytical questions. Students with high mathematical ability dominantly act as answerers to analytical questions. The low mathematical ability of students confuses understanding concepts (Manik et al. 2017). This confusion stimulates students to raise analytical questions (Sudarti, 2019). In addition, the composition of heterogeneous groups by paying attention to differences in mathematical abilities motivates students to dare to raise questions (Rosita & Leonard, 2015). It is because each question will receive a response from other students in the group. Questions that get responses can bring satisfaction to the questioner (Agustini & Sopandi, 2017). The results showed that only 3 of the 21 questions did not get responses from other students in the group and these three questions came from students with high mathematical abilities.

By paying attention to the pattern, the dominant interaction occurs between students with low mathematical abilities as questioners and students with high mathematical abilities. Students with low mathematical abilities are motivated to raise questions because they always get responses from other students (Agustini & Sopandi, 2017), both with high and medium mathematical abilities.

Adequate mathematical ability becomes the capital to respond to analytical questions in group discussions. In contrast to the dominant interaction, the interaction did not occur between students with high mathematical ability as the questioner and students with low mathematical ability as the answerer. Learning in this discussion group creates a positive dependence between students in understanding a concept (Rosita & Leonard, 2015).

CONCLUSION

In a scientific approach to learning, observing is the dominant stage in raising analytical questions, and communicating is the stage that is less able to raise analytical questions in group discussions. Students with low mathematical ability are dominant in triggering analytical questions, while students with high mathematical abilities are dominant in answering analytical questions. The dominant interaction occurred between students with low mathematical ability as the questioner and students with high mathematical ability as the answerer. Preferably, the interaction does not occur between students with high mathematical ability as the questioner and students with low mathematical ability as the answerer.

Based on the results of this research, teachers should provide stimulus to students in group discussions to raise analytical questions at each stage. However, this research contains weaknesses. It lies in the small number of subjects and the short duration of practical learning. Therefore, this research provides an opportunity to conduct further research by increasing the number of subjects and duration of learning. Besides that, the results of this study provide opportunities for further research related to characterizing analytical questions raised by students in group discussions on learning with a scientific approach. This characteristic is essential so that it is easy to stimulate students to formulate questions in the learning process.

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