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Transcript-Based Lesson Analysis: The Analysis of Classroom Communication in Chemistry Implementing Case-Based and Project-Based Learning

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Abstract

Previous research studies found that Case-Based Method (CBM) and Project-Based Learning (PBL) models increase student motivation, critical thinking, and problem-solving. However, so far, the success of implementing these models has mostly been based on learning outcomes. Not many research studies have been carried out to reveal the effectiveness of these models by analyzing the learning process. This research is a qualitative descriptive study that aims to analyze classroom communication on solving problems in Chemistry lessons implementing the CBM and PBL models using Transcript Based Lesson Analysis (TBLA). TBLA is an analysis method based on communication occurring in the classroom. In this research, TBLA analyzes the classroom communication on solving problems in the Wood Chemistry course at the Department of Chemistry Education, Lambung Mangkurat University, Indonesia. A total of 26 students were involved. The classroom communication was recorded by camcorders and the data were transformed into transcripts. The data was processed using Excel to produce a TBLA graph. The results show that (1) the ratio of lecturer and student communication intensity using the CBM model in the classroom is 1:3, and the PBL model is 1:1. (2) The CBM model provides a good environment for the development of student HOTS through in-depth multi-directional communication patterns in the problem-solving process. (3) PBL builds better collaboration between students compared to the CBM model. This research implies that the quality of classroom communication can be improved by integrating the HOTS questions and independent group work as implemented in the CBM and PBL models.

Keywords: case-based method, classroom communication, problem-solving, project-based learning, transcript-based lesson analysis

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1. Introduction

The Case-Based Method (CBM) and Project Based Learning (PBL) are mandatory learning models in the implementation of the Independent Curriculum (*Kurikulum Merdeka*) in Indonesia. The application of these two learning models in higher education becomes an indicator of collaborative and participatory class implementation (Arung, 2023). The main purpose of CBM and PBL models is to build students' empathy, critical reasoning, and problem-solving abilities through everyday case studies related to the lecture material they are studying (Hidayatno et al, 2013).

Research by Wospakrik et al., (2020), Widiyono et al., (2021), and Bassam (2021) revealed that the implementation of the CBM

and PBL models at various levels of education, from elementary to tertiary institutions, contributes to improving the learning process and outcomes, learning motivation, and collaboration skills of students.

The problem lies in the fact that the justification of the effectiveness of the learning models applied in the classroom, such as the CBM and PBL models, has mostly only been determined through students' cognitive learning outcomes. Evidence of the success of CBM and PBL as reported in several abovementioned studies, still primarily focuses on short-term learning outcomes, such as mastery of material and student graduation rates. A longer period is needed to justify whether the learning design that has been created is effective based on variables such as critical thinking or problem-solving abilities. In other words, it takes time to prove the extent of improvement in critical thinking skills or reasoning abilities when students learn using these two learning models (Linke, 2017).

Apart from looking at learning outcomes, there is a method that can measure the effectiveness of implementing the method in a relatively short time through other variables related to problem-solving, namely communication patterns involving HOTS. This method is called TBLA or Transcript-Based Lesson Analysis, which was first introduced at Nagoya University in Japan. The basic principle of this method is to carry out lesson analysis based on transcript data of lecturer and student conversations during the instructional learning to get an idea of whether the learning activities carried out are under the expected objectives. In carrying out learning studies using TBLA, the facts about how students learn become a highly focused area of attention.

Research by Winarti et al. (2019, 2021) and Janah (2019) showed that by using the TBLA method, several learning success variables that have not been revealed can be demonstrated scientifically. TBLA can reveal a lot of data related to learning, including communication, pedagogical content knowledge (PCK), argumentation skills, and collaboration patterns. Cognitive learning outcomes are no longer the only indicator of learning success with the TBLA method. The application of TBLA can also demonstrate the quality of teaching and the quality of student learning.

This research aims to reveal evidence of the effectiveness of CBM and PBL models by identifying classroom communication patterns in problem-solving by using TBLA. The lesson analysis is going to focus on: (1) the conversation intensity of student and lecturer during a lesson; (2) the appearance of keywords in lecturer and student conversations; (3) dialogue categorization; and (4) continuity of student-centered learning.

Utilizing the TBLA method as a tool to assess the effectiveness of the CBM and PBL learning models will be highly beneficial because these findings make it easier for the lecturers to justify the effectiveness of the learning designs they create, not only based on learning outcomes but also based on the success of the learning process.

2. Method

This research is a qualitative descriptive study that qualitatively describes the classroom communication pattern in the problem-solving process by applying the CBM and PBL learning models. The research was conducted in the Chemistry Education Department, Lambung Mangkurat University, Indonesia, in the Wood Chemistry and Pulp Course, involving 26 students.

The data collected in this research consist of primary and secondary data (Kim, et al, 2017) and Moleong (2013), including; (1) the classroom conversations during the lessons, recorded using a camcorder; (2) learning observation data; and (3) daily journals of classroom learning activities. The data were collected through recording, observation, and documentation assisted by camcorders and voice recorders.

The data in this study were analyzed by applying interaction analysis procedures (Chaudron, 1990) focusing on the following activities: (1) observing classroom interactions, (2) analyzing recordings of lecturer-student interactions, and (3) observing group process activities, considering events of a pedagogical nature and their responses. Subsequently, the data analysis was conducted qualitatively using the steps outlined by Miles and Huberman (1984): (1) data reduction, (b) data presentation, and (c) drawing conclusions.

In the data presentation step, the recording data of classroom conversations were converted into transcripts which were then processed using Excel to produce TBLA graphs. The data were then described qualitatively based on; (1) the use of question words (what, why, how); (2) the students-lecturer interaction in the TBLA graph; (3) the Smallest Dialogue Categorization (SDC) graph (Matsubara & Ikeda, 2015; Rahayu, 2019; Mustika et al, 2020).

3. Result and Discussion

a. The Lesson Analysis of the CBM Implementation

Lesson analysis was carried out on learning that applies the CBM model with students' activities of "identifying problems and planning solutions related to forest issues" raised by the lecturer, namely:

Through the Wood Chemistry course, what efforts can we make to preserve forests?

Transcript data analysis resulted in a graph showing the communication patterns in the class during the problem-solving process using the Case-Based Method (CBM) model, as shown in Figure 1.

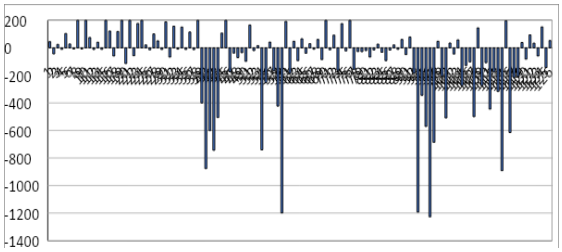

Figure 1. Classroom Communication Patterns Applying CBM: Problem Identification and Solution Planning

In Figure 1, a communication pattern is evident marked by a graph that is sharper downwards than upwards. This indicates that in the classroom implementing CBM, communication is more dominated by students, the lecturer does not talk too much, only occasionally prompting questions and providing guidance. In other words, learning is more personal and student-centered.

The main activity of students is identifying problems and planning solutions to the problems presented by the lecturer regarding efforts to preserve forests by applying the knowledge gained from the Wood Chemistry course. In this learning activity, the lecturer was active at the beginning when helping students understand the problem. This activity is shown by a sharp upward graph at index 1 to 36. Several sharp downward graphs between index 1 to 36 indicate student interaction but it is not too great. Furthermore, from index 39 until the end, the graph is filled with a sharp downward line which shows that throughout the lesson the students' communication activity is very high.

For instance, between minutes 76 to 102, students were actively discussing within groups and between groups. The lecturer did

not intervene except when necessary. The occurrence of this student-centered communication pattern is supported by the level of HOTS questions given by the lecturer, which are more thought-provoking in nature and thus invite many responses from students. An example is the dialogue that occurred in conversation index numbers 76 to 85.

> Lecturer (L): *It was mentioned earlier that by studying wood chemistry we will understand not to use a lot of freon. What other problems can be overcome by applying concepts in wood chemistry? (76)*
>
> Student (S1): *So, should we not use perfume? (Yes) Can you use the perfume then? What perfume was used, and how is it related to wood chemistry? (77)*
>
> S1: *Non-alcoholic perfume. (78)*
> S2: *Alcohol is just a solvent. (79)*
> L: *Does that mean we use non-spray perfume? (80)*
> S3: *Topical perfume. (81)*
> L: *So how do you get the ingredients?* (82)
> S4: *Using materials from trees. (83)*
> S2: *Yes, from trees so you can reforest aromatic plants like cinnamon, what else? (84)*
> S5: *Jasmine flower. (85)*

This is a good example of questions asked by the lecturer in CBM which succeeded in making students actively involved and communicating in solving problems. The high level of questions asked by the lecturer is also proven by the results of the analysis of the variety of "question words" given by the lecturer, as shown in Figure 2.

It can be seen from Figure 2 that during learning the lecturer frequently asked questions. The level of questions varies between questions that ask about "what", and "why" to questions that are confirmatory "how." In learning about forest problems from a wood chemistry perspective, the lecturer often questions the causes of problems and how to overcome them. According to research conducted by Conrad et al., (2023), supported by Lave (1991), questions that are critical and encourage students to take real action in overcoming problems stimulate students to think critically and deeply. This is one of the reasons for the active communication patterns in this class.

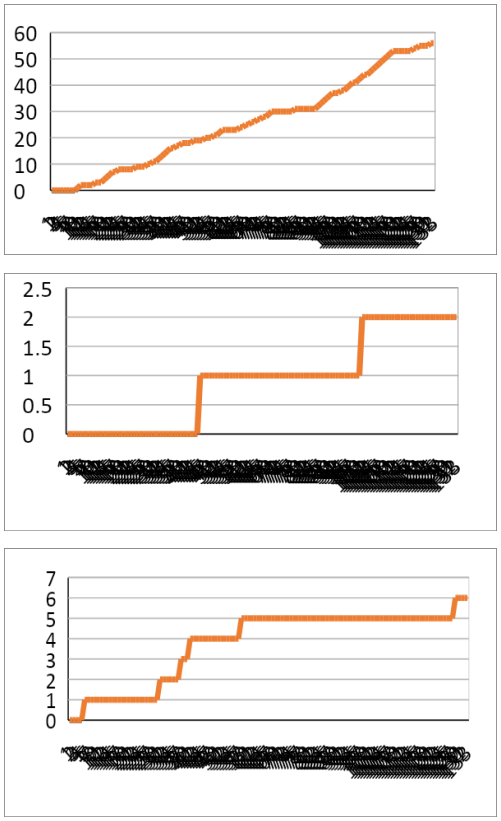

Figure 2. Results of Analysis of Question Use (1) What; (2) Why, (3) How, in Lesson Implementing CBM

Furthermore, in the second lesson which applies CBM with the activity "presenting planning results and solutions" a lesson analysis was carried out with the results as in Figure 3.

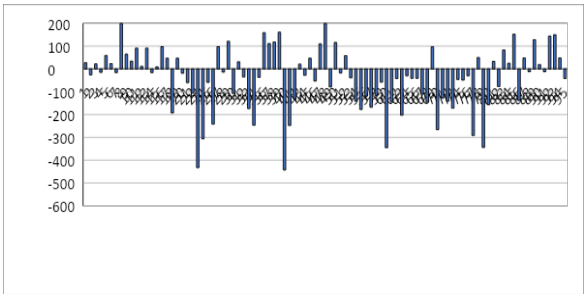

Figure. 3. Classroom Communication Patterns in Lesson Applying CBM: Presenting Solution Planning

In Figure 3, we can see a pattern that is almost the same as the previous learning pattern. The downward lines look more numerous and sharper than the upward lines, indicating higher dialogue activity from students compared to the lecturer. Just like before, these results are also supported by the quality of the questions, as presented in the following analysis of the use of "question words" seen in Figure 4.

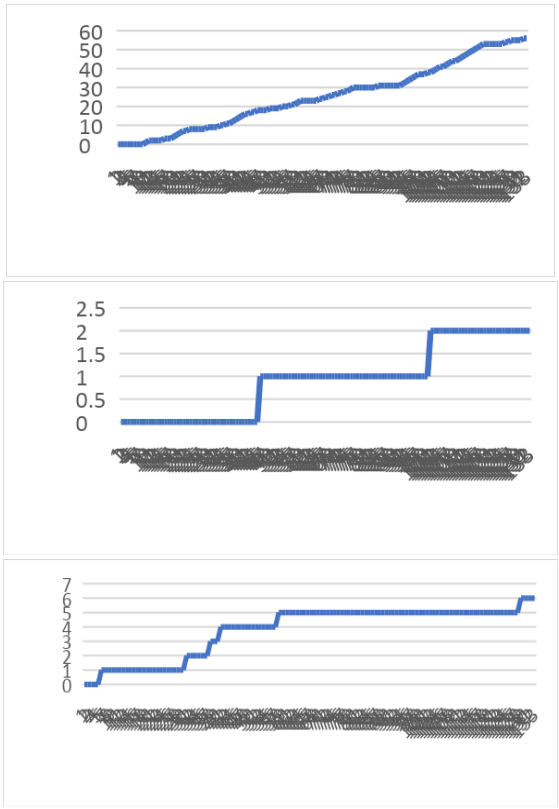

Figure 4. The Use of Questions (1) What; (2) Why, (3) How, in the Lesson Applying CBM

Compared to the previous learning that also applied CBM, there is generally a similar communication pattern. The commonality lies in the high level of student communication activity in the problem-solving process. In learning using the CBM model, student activity is more dominant than the lecturer. The lecturer acts more as a facilitator, guiding and facilitating students in solving the problems presented. From these two studies, it can be concluded that in learning which applies CBM, student participation in the problem-solving process is high, and student communication is more active, supported by questions at the HOTS level by the lecturer.

b. The Lesson Analysis on the PBL Implementation

TBLA analysis of classroom communication patterns in the problem-solving process applying the PBL model produces data as in Figures 5 (1), 5 (2), and 5 (3).

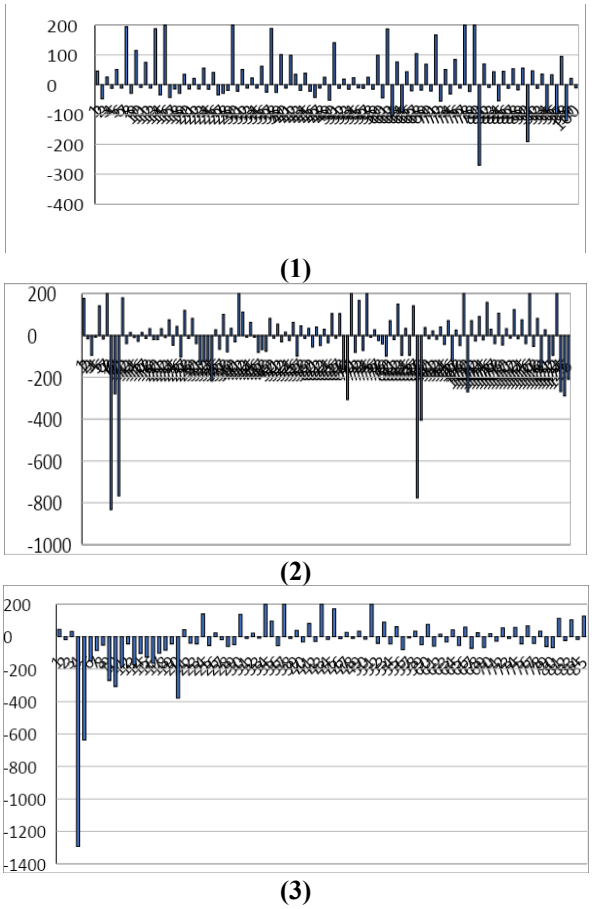

Figure 5. Classroom Communication Patterns in the Problem-Solving Process Applying PBL

Figure 5 (1) shows the first part of the lesson where the lecturer used direct instruction as an introduction, while Figure 5. (2) and Figure 5. (3) show the second and third parts of the lesson where the learning

continued with a presentation of the problem-solving project created by the students.

In Figure 5 (1) the upward graph is the same as the downward graph but the upward graph is sharper. The downward graph tends to be short. At the end of the first part of the lesson, there are several sharp downward graphs. This data shows that throughout the lesson there was a dialogue between the lecturer and students, but the dialogue was brief. At the end of the first learning section, there was quite intense communication between fellow students.

The following are several examples of short communication carried out by the lecturer and students during learning using PBL to complement the explanation in Figure 5 (1) from index 29 to 33.

L: Is wood only used as a building material? What wood is used as raw material? The first is for industry, then for crafts and fuel. As fuel, wood is used as an energy material. What's more, Riduan tries to add it. (29)
S1: Papermaking (30)
L: As a raw material for making paper, is there anything else? (31)
S2: Stems (32)
L: Yes, agree, there is no waste in the stem, what next Rud? (32)
S3:Leaves as waste (33)

Likewise, discussions from conversation index number 67 to 70.

L: If we study the chemical industry, our basis is green chemistry, what is green chemistry? (67)
S1:Green chemistry (68)
L: Yes, that's right, what does green chemistry mean, what is the principle of green? (69)
S2: Environmentally friendly (70)

It appears that in helping students connect the projects with Wood Chemistry concepts, the lecturer still applied LOT (Lower Order Thinking) level questions, such as providing examples and defining, which in Bloom's Taxonomy are categorized as understanding level (C2). The discussion involving the Lower Order Thinking (LOT) level of questions is what causes the communication pattern to be less intensive. However, according to research findings by Ibrahim et al., (2018) and Fatahillah et al., (2022), students who study in classes that train HOTs show better communication and problem-solving abilities than conventional classes.

Nevertheless, entering the second part of the lesson, as seen in Figure 5 (2), there was a change in communication patterns which involved more students when the lecturer asked the group to present the problem-solving project they had created. The lecturer's responses are shorter, followed by increasingly better responses from students.

What is interesting is that, when discussing the project being presented by the students, the lecturer's questions asking about "how" at conversation indexes 31 to 35 were able to provoke long responses from several students.

L: How do you avoid pollution? What else do you use to find charcoal? (31)
S1 (not a group member): Charcoal also creates waste (32)
S2 (group members): What do you mean by waste? We burn it from wood and it turns to ashes and nothing remains (33)
S1: You should take the ashes directly, without adding to environmental problems by burning them and all that. (34)
S3 (group member): Actually, we wanted to use charcoal by taking leftovers from forest burning, but we didn't have any. So we just made it ourselves (35)
S4 (group member): We only took samples as a project, so we made the ashes ourselves first. In this city, quite a lot of people use gas stoves. If the waste is not made of wood anymore. (36)

Based on these findings, it can be concluded that in PBL, communication patterns in problem-solving are still greatly

influenced by the lecturer's ability to ask questions. Open questions given by the lecturer in learning to implement PBL about "how they did it", as in the example above are able to stimulate students to share experiences about what they have done according to their own experiences. The answers given by students can even be an indicator of critical thinking skills that develop as a result of the learning process (Loef Frank, 2007). This is in accordance with the research results of Sarwanto et al., (2021), Fatahillah (2022), Listiaji et al (2022) which stated that open-ended questions given by the lecturer stimulate students to think critically, so they are very appropriate to use to assess students' critical thinking abilities. In PBL because most of the lecturer's questions are open-ended questions that ask about the project work process, the reasons behind each student's activity in doing a project, as well as solutions if they face problems, the student's involvement to contribute to problem-solving according to their experience gets bigger.

Figure 5 (3) shows the third or final part of learning, where at this stage the lecturer engaged students more to reflect on what they have done and the learning they have gained through the projects.

L: What did you get from working on this?
S1: It takes a long time to extract cinnamon, from 2 pm to 8 pm to produce essential oil from 15 cinnamon sticks.
S2: So far, cinnamon has been used as a cooking spice, but I just found out that it can be made into aromatherapy.
L: What else?
S3: So ma'am, we can design the tools too.

Reflection activities carried out by the lecturer, as in this case, are a form of cognitive strategy that guides students to solve problems through the experience they have gained. Schon (1982) refers to it as “reflection in action” which is the basis of cognitive strategy. Through this kind of learning activity, students are also trained to solve problems, by thinking about what they do when working on a project. Not only solving problems, but this kind of cognitive strategy will also train students to make decisions, and think critically and creatively (Preisseisen, 1985). Through communication as this, Jumadi et al., (2021) and Marthaliakirana et al., (2022), found that the PBL significantly influences students' ability to argue scientifically and critically.

Apart from what has been explained above, implementing the PBL model also has other advantages, such as giving students the experience of collaborating and getting to know each other better, as well as helping to develop positive attitudes. This is revealed from students' answers to reflection questions given by the lecturer to the group making the cinnamon-scented candle project, in conversation indexes 174 to 185.

L: …….What experience did you get after doing this project? (174)
S1: Exciting (175)
L: How exciting is it? (176)
S2: Fun, because there is a collaboration (177)
S3: Gained knowledge, and found out that gelam wood can be used as fertilizer. There is a learning process. (178)
L: Yes, there is a learning process, You didn’t know at first then now you know, right? Do you want to add something Nia? (179)
S4: Need patience (180)
L: You need patience because the burning process takes a long time. Earlier, to shorten the burning process with an oven, you can do it in the lab. Husna? (181)
S5:It can be fun, what is more impressive is that you have to patiently wait for the burning time (182)
L: Be patient, okay. Go on, Sifa? (183)
S6: For me, it's the same as other friends, apart from that I get to know Diah's family (184)

Apart from that, students also gained experience in solving problems, as experienced by the group who created a soap-making project from galam wood. This group experiences problems with the inefficiency of the materials used.

L: What are the advantages and disadvantages of maceration with ethanol solvent?
S1: The disadvantage is that it takes quite a long time.

L: The solution?
S: With faster distillation.
L: You can try it later in our laboratory. Are there any other problems?

S2: Too many materials used.
L: What solutions do you provide to make materials efficient?
S2: To make it economical, mix it and only use one type of oil.
L: Can you think about it, what did you get?
S3: Experiment with new things, and find out where to buy lab materials.

Through completing projects and reflecting afterwards, students gain experience solving problems, aligning with the findings of research by Karan et al., (2022) and Purwaningsih et al., (2020).

c. The Comparison of Lecturer-Student Communication Patterns in the Problem-Solving Process Implementing CBM and PBL

Based on the data analysis of communication patterns between the lecturer and students in the problem-solving process implementing CBM and PBL, several findings regarding similarities and differences were obtained as depicted in Figure 6.

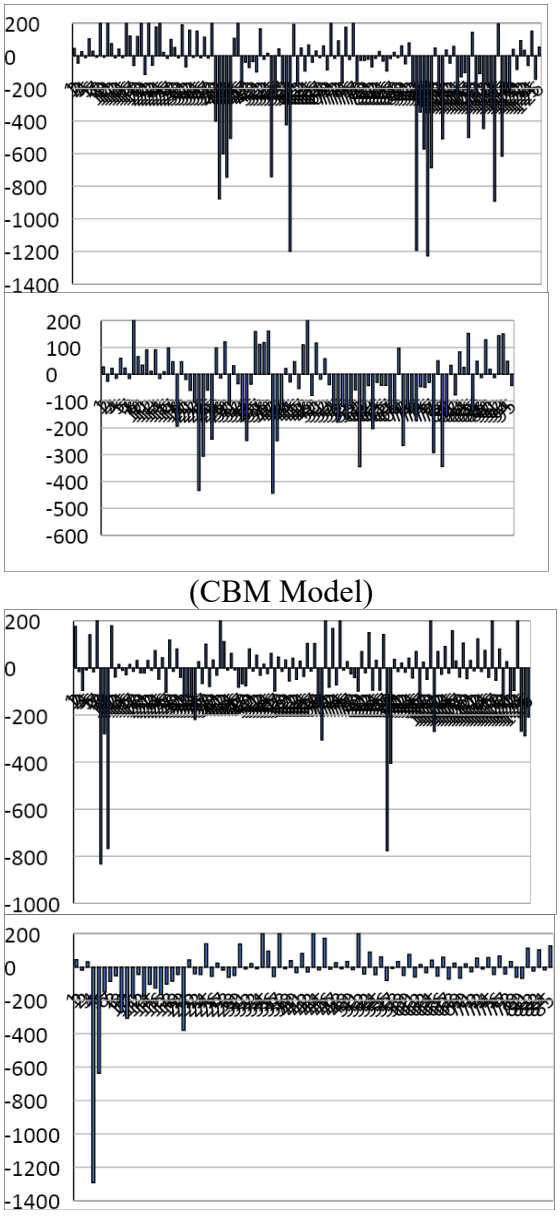

Figure 6. Comparison of Class Communication Patterns in the Problem-Solving Process Applying CBM and PBL

Figure 6 shows a similar pattern where the graph is sharper downwards more than upwards, in other words, both CBM and PBL learning are student-centered. Transcript data also indicates that these two learning models are able to build student involvement in the problem-solving process.

Regarding communication intensity, in classrooms that apply the CBM model, students appear to be more active than in the PBL model. Based on the results of

quantitative calculations of transcript data, the average ratio of conversation intensity between the lecturer and students in learning that applies the CBM model is 1:3, while in the PBL model, it is 1:1. This can be explained from the data where in learning that applies CBM more students are involved in discussions conveying their arguments in response to questions asked by the lecturer.

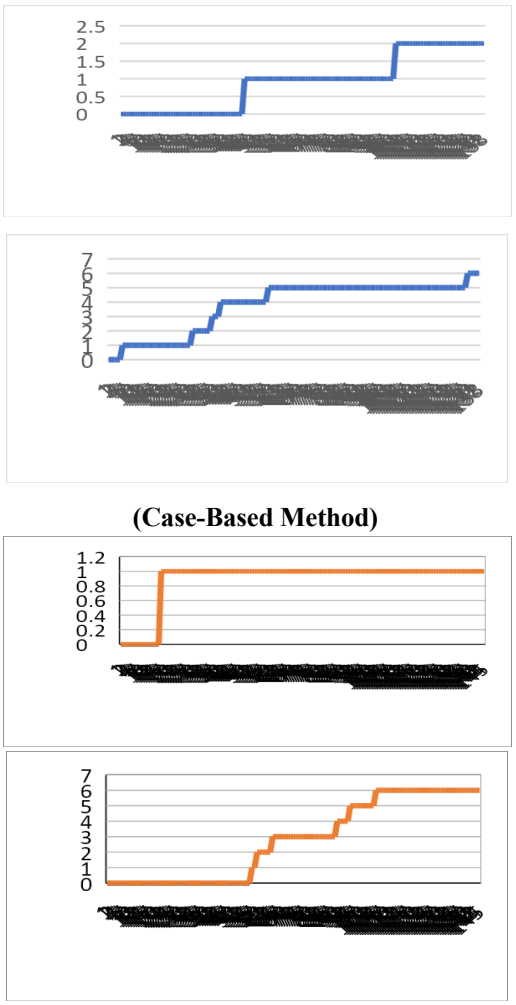

Figure 7. Comparison of the Intensity of "Why" and "How" Questions When Implementing the CBM and PBL Models

From the transcript data, it can be seen that in learning that applies CBM, questions about "why" asked by the lecturer are more intense than in learning that applies PBL. The frequency of "why" questions in CBM learning which requires critical thinking seems to provoke more students to be involved in answering questions, even though not all students' answers are correct.

The difference in the intensity of communication that occurs in the classroom by applying these two models can also be seen from the dialogue patterns that occur between the lecturer and students. The results of the analysis of transcript data show differences in dialogue patterns identified based on the Smallest Dialogue Category (SDC) (Rahayu et al., 2019; Gumartifa et al., 2023) as presented in Figure 8.

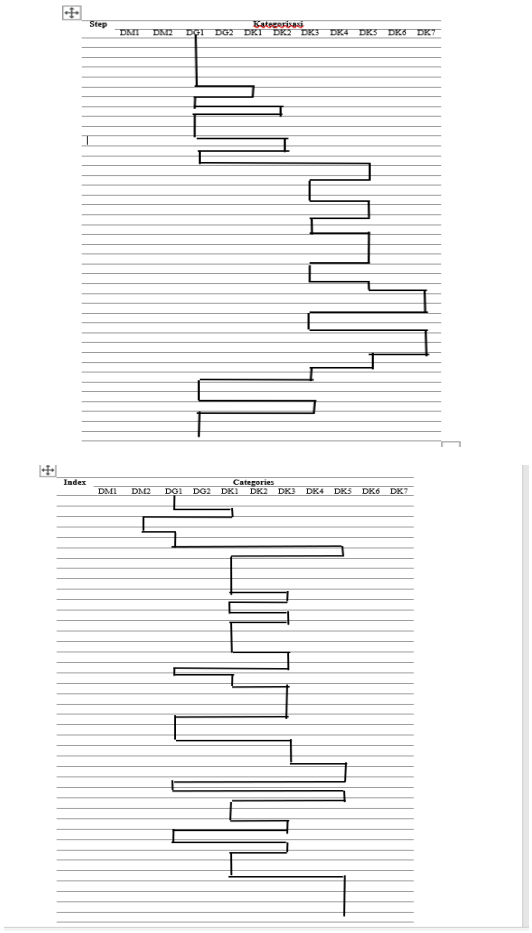

Figure 8. Dialogue Patterns that Occur in Learning that Applies the CBM (Left) and PBL (Right) Models

In the analysis of the SDC, dialogues that occur between the lecturer and students are categorized into 11 (Matsubara & Ikeda, 2015; Rahayu, 2019). The lowest category is

DM 1 (lecturer control level 1, where the lecturer asks questions but students only respond by mumbling). The highest category is DK7 (class control, students discuss with fellow students without lecturer guidance).

In learning that applies the CBM, the dialogue occurring in class between the lecturer and students reaches the DK7 level, while in learning that applies PBL the highest dialogue occurs only up to the DK5 level (students discuss with fellow students with guidance from the lecturer). This data is still limited to in-class activities. Since student activities in creating projects go beyond the classroom, if communication data outside the classroom is also analyzed, the results could be significantly different because outside the classroom, without teacher guidance, students undoubtedly discuss project completion, categorizable as DK7 activities, similar to CBM learning.

Another finding is that the PBL model has advantages in terms of building collaboration between students at the project completion stage. Apart from that, supported by research findings by Cummings et al., (2022), in the PBL model, students also develop their creativity through activities in making learning products that can be concrete solutions to problems they want to solve related to woody plants, such as cinnamon-scented candles, paper from banana humps, eugenol distillation, organic fertilizer from sawwood waste, fertilizer from galam wood ash, and soap from galam leaves. Video recordings and photos of students' activities while they were working on the project became the data that strengthened these findings.

Figure 9. Student activities in PBL

4. Conclusion

The application of the CBM and PBL in training students' problem-solving abilities analyzed using TBLA can reveal the other side of the advantages of these two models. CBM and PBL are able to build student involvement in the problem-solving process. Through HOTS-level questions given by the lecturer while understanding problems, planning solutions, and presenting solution plans, the CBM model excels in building lecturer-student communication patterns and deep thinking in the problem-solving process.

CBM is able to involve more students in expressing opinions as well. On the other hand, through independent project work, the PBL model is superior in terms of building collaboration, developing creativity, and generating positive attitudes as a result of the problem-solving process.

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