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Teaching Strategy in Effective Science Learning Based on Classroom Discourse and Empirical Research

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ABSTRACT

The purpose of this article is to explain the results of a study of effective teaching strategies in learning science in the classroom based on classroom discourse and relevant research. The method used is the literature review by collecting and reviewing the results of scientific studies about learning science in class. The results of this study reveal that there is four general patterns in teaching science in class, namely 1) the way the teacher explains science material in front of the class is by get rid the use common IRE (initiation, response, evaluation), use 'turn taking' and 'wait time' strategy, use the pronoun of 'we'/ use 'hedges', use metadiscourse; 2) the way the teacher organizes student group discussions is by giving attention to the leadership style of the group leader and build culture meaning; 3) the way the teacher asks questions and responds to students' answers is by remain open minded about any student's answer from a science question, be patient and give students the opportunity to explore their knowledge, and stimulating student's productive thinking with the concept of IRFRF (initiation-response-feedback-response-feedback); and 4) the way the teacher accustoms science attitudes to students is by build a student's scientific attitude early, familiarize students with the concept of POE (prediction - observation - explain), familiarize students with being skeptical (suspicious of something), and to recognize the importance of interpretation in science and to be able to share their findings. This article will explain in detail several ways of teaching science in class that can be used as a reference for science teachers.

Keywords: *teaching strategy, science learning, classroom discourse*

1. INTRODUCTION

Being an ideal science teacher and being able to master pedagogy in setting up effective science classes is not easy. As if concocting both abilities in oneself, of course, it needs its skills and experience. But even so, there have been many studies in the field of classroom discourse that can be a picture lesson for teachers about how to teach science to students and how teachers should speak, behave and act on students in science classes. This article will briefly review the results of research in the field of classroom discourse. One way to test how knowledge is formed socially in classrooms and other social settings is to use the discourse analysis approach. Discourse analysis can contribute to new insights into the dynamic and complex relationship between discourse, social practice, and learning [1]. In discourse analysis research on science learning also known as the term SSK (sociology of scientific knowledge) which can broaden our understanding of the science process through observing actual practices in the classroom [2]. Some data and facts from the results of empirical classroom discourse studies will be presented and grouped into four major sections, namely: 1) the way the teacher speaks and explains the science concepts in front of the class, 2) the way the teacher manages the student workgroup/ discussion group questions

and respond to students' answers, 3) the way the teacher gives questions and responds to student answers and 4) the way the teacher familiarizes students with scientific attitudes.

1.1. Research Purposes and Questions

The purpose of this article is to explain effective teaching strategies in learning science in the classroom based on classroom discourse and relevant research. The question in this article is 'How is an effective science teaching strategy in the classroom based on classroom discourse and relevant research?'

2. METHOD

The literature review is used as a method for analyzing and synthesizing science teaching strategies in the classroom based on classroom discourse and relevant research. The author collects relevant studies on classroom discourse in teaching science then analyzes and synthesizes it into several sub-sections of the discussion. The number of relevant articles that have been analyzed is 11 articles from international scientific journals.

3. RESULT AND DISCUSSION

Through gathering 11 research resources related to classroom discourse on teaching science in the classroom, it can be abstracted into four sub-sections. The four subsections are the way the teacher explains and talks about science concepts in front of the class, how to manage student discussion groups, how the teacher throws questions and answers students' questions, and how the teacher accustoms science attitudes to students. The following is a detailed explanation of the four abstractions:

3.1. The Way of teachers Speak and Explain the Concept of Science in Front of the Class

The first discussion is the basic skill for a teacher when teaching, namely the ability to explain a science concept and interact in class together with students. In explaining and interacting in the classroom, the teacher should get rid of the use of common turn-taking IRE theory from Mehan [3], namely starting an explanation with 'Initiation', waiting for 'Response' from students, and giving 'Evaluation' to the students' responses. An example that students can do is to open a lesson with 'Initiation' by throwing a question first to the student, for example: "Now all students, think of something you can eat, what is that?" Then wait a while for the child to answer our question. If the student has answered; "Snake ...!", Then the teacher gave 'Evaluation' to the students: "wait a minute, wait a minute, raise your hand then answer one by one". This step will limit the student's response or thinking. In vice versa, the teacher can use the new one concept, IRF concept (Initiation-Response-Feedback), replacing evaluation into feedback that serves to give feedback and reinforcement to any student response [4]. The involvement of students in the context of natural interactions and dialogical processes will make learning more connected between the speaker (teacher) and listener (students). Teachers need to interpret the teaching situation because students build their knowledge depending on how they are involved [1].

The second skill that must be possessed by the teacher in explaining science concepts is 'turn-taking' and 'wait time'. The purpose of this turn-taking is to give the right or opportunity a few moments to the teacher and to anyone students to think and answer or give their opinion. On this turn taking an opportunity, students and teachers can fill in the blanks of the silent opportunities given to talk to each other in any tone and make the topic of class lessons become an ordinary informal conversation in daily life. Turn taking can be conducted by throwing a question, then allowing students to think (wait time) and to answer, then take over again with evaluation/ feedback on student responses [5]. Based on research from Rowe in Cazden [5] said that the addition of 'wait time' for teachers when asking questions with students has many benefits. Some of the benefits of the addition of the 'wait time' are the teacher's response to be more flexible, the teacher becomes a little questioning but the meaning becomes more complex and profound, the teacher becomes more proficient in utilizing student responses, the academic performance of some students increases and students become inhuman hurry to answer the teacher's question but think more deeply. The following is an example of 'turn taking' in the classroom which is the original conversation between the teacher and students from the results of a study using discourse analysis in the class [5]:

[Lisa is telling us the story of "Tico and the Golden Wings" by Leo Lionni. The children and I do not agree about Tico, I applaud him as a nonconformist while they see hm as a threat to the community .....]

Teacher : I dont think it's fair that Tico has to give up his golden wings.
Lisa : It is fair. See, he was nicer when he didn't have any wings. They didn't like him when he had gold.
Wally : He thinks he's better if he has golden wings.
Eddie : He is better
Jill : But he's not supposed to be better. The wishing bird was wrong to give him those wings.
Deanna : She has to give him his wish. He's the one who shouldn't have asked for golden wings.
Wally : He could put black wings on top of the golden wings and try to trick them.
Deanna : They'd sneak up and see the gold. He should just give every bird one golden feather and keep one for himself.
Teacher : Why can't he decide for himself what kind of wings he wants?
Wally : He has to decide to have black wings.

The third skill that teachers must possess in explaining science processes is the use of pronoun ('we'). There are many benefits when in teaching using the inclusive pronoun

"we" (meaning 'I' and 'you'), namely that it can eliminate the impression of absolute teacher authority and place the position of teacher and student in the same social group, as partners and colleagues the process of scientific inquiry, invites students to identify science with closer relationships, build class solidarity - both students as individual members and as a community, and able to create an atmosphere of cooperative and warm learning interactions. Encouraging inclusive learning and building a learning atmosphere with a more symmetrical or egalitarian relationship between teachers and students are the main points in the use of the pronoun 'we' [6]. This conversation is the differences in using the pronoun 'we', 'I' and 'You'

Teacher 1: Ok, we are going to use all of these materials to learn about worms.
Teacher 2: Now, I want you to use all the materials on your desks to conduct an investigation about worms.
Teacher 3: Today, you are required to conduct an investigation about earthworms.

The fourth skill is the using 'Hedges'. This skill reminds teacher to do not judge students' responses directly, but by using 'hedges'. How to justify if the student's answer is wrong is by: 1) not judging students' answers directly if the answer is wrong, 2) invite students to respond to whether the student's answer is wrong or correct, 3) remain polite and praise students for their courage to answer and then explain right, 4) switch to classmates to correct politely, 5) use hedges for example "that potentially lead to loss of face ..." [6].

The fifth skill of the teacher in explaining science concepts is to use the concept of 'metadiscourse' or by using connective sentences when want to start to explain some new topic to students. Tang further explained that in the use of the concept of metadiscourse, teachers can use 'text connective' (earlier conversations, futures, sequencers, topicalizer), 'knowledge connective' (prior knowledge, applied knowledge), 'activity connective' (on going activity, external activity) and evaluative connective (importance, challenge, affect, sensory experiences, logic, scientist, personal beliefs) [7].

Table 1. The Examples of the Using of Metadiscourse Concept

Connective Category	Function	Examples
Earlier conversation	Relate to an earlier conversation	"Let's say I have the drumstick. If I go back to the experiment just now, which one is my heat source?"
Fiture conversation	Signpost to an anticipated conversation in the near future	"Okay, we will learn more about the metal displacement reaction in the next few chapters. Likewise for electrolysis . . ."
Prior knowledge	Relate to students' prior knowledge	"From your knowledge from sec 1 and sec 2, when you were learning fractional distillation, alright, can you try to predict with a reason, which of these gas will be distilled out first? I'm trying to link back to what you've learnt before"
External activity	Relate to activities outside class	"Remember I told you about the marathon? For example, I ask Yi Kai, a primary 4 student to go and run against a primary 6 student. Who do you think will win?"
Challenge	Signal the difficulty encountered by most students regarding specific content	"If not, then we are going to the difficult part, which is crafting explanation using kinetic model of matter".
Sensory experiences	Evidential status based on observation	"We observed that the amount of water vapor in cup A was more. Did you all see that? So this statement, is one very important solid evidence . . . And this is an evidence

		that we want to use".

The final skill is that teachers also need to focus on PCK (pedagogical content knowledge) through three stages, namely adaptation, tailoring, and translation of specific content knowledge [8]. PCK concept consists of 3 things, namely 1) flexibility (the nature of the teacher when explaining, not rigid / not strictly), 2) richness (make connection among ideas and reality), 3) learner centered.

3.2. The Way of Teacher Manages Student Discussion Groups

In science teaching, it is very necessary to multiply practical activities or project group-based investigations or discussions. The teacher's skills in managing student groups can also be a determinant of the success of science learning. At least two teacher skills must be fulfilled in guiding the student discussion group, first is the attention to the leadership style of the group leader, and second is the teacher's skill in building culture meaning in the group.

The first skill of class management became a small group discussion, namely, the teacher should pay attention to the leadership style of each group of students. According to Richmond & Striley [9] there are several types of leadership styles in student groups, namely inclusive, persuasive, alienating (superiority). The best is to direct the group leader to be inclusive, namely to accept the opinions of all members of the group without exception. Furthermore, the second teacher skill is the need to build a collaborative culture in solving science problems by involving students to actively participate in their research groups [10]. Teachers need to get used to students to collaborate in solving science problems.

3.3. The Way of Teacher Gives Questions and Responds to Student Answers

The interaction between teachers and students in science learning is needed as a dialogical process between subjects of science. The dialogical process can be achieved through question and answer activities between teachers and students so that science learning can be in two directions. The following are some of the skills teachers need to have in science learning. The first skill is that the teacher needs to remain open-minded about any student's answer from a science question because there is a 'Scaffolding'/ 'Enculturation' process to bridge the gap between 'commonsense' and 'scientific views' held by students. Piaget (Driver et al., 1994) further explained that in learning science, students take the process of 'children scientific reasoning' with three phases, namely scheme, accommodation, and assimilation. The second skill is that the teacher needs to be patient and allow students to explore their knowledge, the teacher needs to be neutral to gather a lot of opinions from students and guide students to build their knowledge.

The third skill of the teacher in questioning with students is the teacher's skill in stimulating student's productive thinking with the concept of IRFRF (initiation-response-feedback-response-feedback), also can use several types of questions as follows: 1) Socrates question, 2) reflective toss-ask much time for further question based on student's answer (only 1 student), 3) pumping questioning shift to other students [4].

3.4. The Way of the Teacher Familiarizes the Attitude of Science to Students

In science learning, it is not enough to just explain natural phenomena and scientific processes, but also need to learn and change the attitude of science to students as a young scientist. Teachers need to build a student's scientific attitude early on. There are several skills that teachers must have in science learning. The first skill is that in science learning teachers need to familiarize students with the concept of POE (prediction - observation - explain), familiarize students with being skeptical (suspicious of something), and to recognize the importance of interpretation in science and to be able to share their findings [2].

The second skill is that teachers need to understand the concept of SSK (sociology of scientific knowledge). SSK means that scientific knowledge is built together through social interaction in a learning community (teachers and students). The knowledge is not just what is seen, but it can also be something that is behind it[11]. Students in science learning are not like blank papers, but they have brought prior knowledge both experiences, beliefs, and habits that sometimes match science but sometimes also contrary to science, the teacher's job is to try to build the right scientific knowledge and help students to release priors their current knowledge is against science. For example, prior knowledge about the center of the universe is the earth, then science emerges against that theory and belief. Prior knowledge sometimes contradicts the nature of science (something that can be measured or investigated empirically and clearly). That the nature of science can change with the presence of discoveries because it is tentative.

The second skill is that the teacher should be able to understand the scheme of building knowledge in students and then can direct science learning in the classroom according to the level of development of the student's knowledge. Piaget said that knowledge was built by recognizing subjects, such as scientific reasoning (scheme = dog black - white dog still dog - accommodation = cat / different kind) through the disequilibrium phase (imbalance between hairy but dog barking -cat that doesn't bark). Teachers need to understand that learning is a social construction of knowledge. Furthermore, Piaget [11] also said about commonsense knowledge/reasoning from children, for example, plants need to be given water to

drink. Children need to leave the commonsense that has been wrong.

The third skill is that teachers need to get used to '5E' steps in science learning. Step 5E explained by Kelly & Crawford include the Engage, Explore, Explain, Extend, and Evaluate stages [2]. The Engage stage is how the teacher can generate student interest at the beginning of learning about a science concept. The Explore Phase is how teachers can invite students to explore science knowledge through trial/investigation activities. The explain stage is how the teacher asks students to be able to explain the results of their investigation. The Extend stage is on how teachers can develop students 'knowledge based on the empirical experience of their research and provide information that enriches students' knowledge. And the evaluation stage on how teachers and students can reflect the results of their thinking and learning.

4. CONCLUSION

The conclusion of this paper is that to teach science, teachers need to pay attention to some aspects and skills in teaching science that must be mastered. Some of these aspects are the way the teacher speaks and explains the concepts in front of the class, the way the teacher manages students in work groups/discussion groups, the teacher gives questions and responds to students' answers, and the way the teacher familiarizes students with scientific attitudes.

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