Man In India, 97 (13) : 159-170

TEACHER'S TALK IN PHYSICS CLASSROOM

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This paper discussed communicative approach in teacher's talks from dialogic perspective. This study analyzes a physics lesson carried out by a physics teacher during a 70-minute lesson. This study used an analytical procedure by Scott (2008) to identify and analyze the discourse: interactive/dialogic, non-interactive/dialogic, interactive/authoritative, and non-interactive/authoritative. Finding showed that IA-NA has the highest frequency if compared to other types of turn taking. From the empirical analysis, this study discussed several issues encountered during analysis that leads to the initial finding.

Keywords: Science Practice, Science Discourse, Dialogic Teaching.

1. INTRODUCTION

This study looked into the communicative approach adopted by a teacher according to four characteristic outlined by Scott (2008). A sociocultural framework developed by Vygotsky (1978) is underpinning the analysis to account for learning, language and cognition. According to Vygotsky (1978), meaning making is constructed socially to allow the development of knowledge. This assumption is in line with dialogic approach in teaching as proposed by Alexander (2006). According to Alexander (2006), teaching and learning is viewed to be meaningful when teacher and students are engaged in dialogic talk when communicating science. Dialogic is defined as an effort to collaboratively build meaning (Bakhtin, 1986) instead of transmitting knowledge. Hence, Bakhtin (1986) viewed discourse as monologic against dialogic approach. A preliminary study carried out by Shahari and Phang (2016) revealed that monologic talk is prevailed among their samples. Teachers are observed to conduct lesson with non-interactive/authoritative and interactive/authoritative during knowledge distribution.

From this finding, we are seeking more explanation on how each role of communicative talk is positioned during talk.

2. LITERATURE REVIEW

A concern about science discourse in Malaysia has invited studies regarding language and cognition. The attention was rasied during the implementation of the 'Teaching and Learning Science and Mathematics in English' (ETeMS and in Malay acronym, PPSMI, which stands for *Pengajaran dan Pembelajaran Sains dan Matematik dalam Bahasa Inggeris*). The policy was introduced in 2003 as an

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effort to change language mode from Bahasa Malaysia to English.In the following years, the policy was abolished and replaced with the 'to Uphold Bahasa Malaysia and to Strengthen the *English* language' (MBMMBI) policy from 2012 (Selamat *et al.*, 2010). The reverse incident occurred to lessen society's anxiety to learn science using second language. Selamat *et al.*, (2010) indicated that most science teachers possessed a medium standard of command in English that might hamper the science learning process. Another evidence drawn from Cheong (2010) when investigating the implementation of ETeMS amongst Chinese mainstream schools in Malaysia. For the Chinese community, Chinese language is used during explanatory stage instead of English. Therefore, it can be assumed that language is choose to enable teachers to engage students with the learning process.A struggle with proficiency in English, has become a barrier for students in learning science. This is why, Selamat *et al.*, (2010) proposed that teaching science in Bahasa Malaysia creates a more meaningful learning experience. With this approach, students would have more freedom to express their ideas and thoughts comfortably.

This debate shows that focus about language is very limited to explore how language is evolving at personal level. A cultural turn is necessary to further understand on what hinders students from engaging with scientific knowledge. This claim is made according to a finding from Rahman and Phang (2016) which showed that teachers faced a challenge to teach physics beyond content knowledge. To start, we begin to focus on how teachers work with students and develop understanding about scientific ideas. The initiation is taken according to socio constructivism perspective as suggested by Vygostky (1978). This brief vignette has raised some interesting questions in relation to scientific practices that take part during meaning making process.

In order to develop ideas about scientific knowledge, everyday talk and scientific ways of talking literally portray different roles during social interaction. In classroom setting, both discourse interplay and teacher must approach the transition process with scientific practice. Dialogic is regarded as one of the influential discourse pedagogy for science education to be genuine (Matusov, 2009). To become epistemologically sophisticated, students require a shift from their everyday talk to the scientific ways of talking. For instance, when talking about a falling object, students must learn to shift their understanding and terminologies from "heaviness" to "the concept of gravitational force" during their explanation. The discourse that accompanied during the transition must be done at social level to be valuable for students.

Previous studies about linguistic patterning of teacher-student interaction had developed different characteristics of discourse. The most general characteristics had been monologic and dialogic. Monologic is often associated with the role of teachers as authoritative due to the emphasis to transmit knowledge. On the other

hand, dialogic is considered as the sophisticated ways of communicating and is more challenging to conduct. Scott (2008) defined dialogic as the communicative approach that involves teacher and students' mutual dependency during knowledge development.

Sinclair and Coulthard (1975) suggested a microscopic analysis to understand features embedded in classroom interaction. The analysis consisted of a basic sequence coding known as initiation, responses, and evaluation (IRF). The sequences are limited to understand the social endeavour committed by teacher and students. Scott (2008) suggested a communicative approach analysis to explore how teachers promote students interaction. The discourse analysis involved four characteristics, which are interactive/dialogic, non-interactive/dialogic, interactive/ authoritative, and non-interactive/authoritative. The interactive approach involved more than one speaker at one time, which are teacher and students. Meanwhile, the non-interactive approach only involves the teacher as the main speaker and the source of knowledge. Adding to these features, Scott (2008) added dialogic and authoritative to elaborate the quality of interactions. Dialogic teachers are willing to explore students' ideas, unlike authoritative. Approach made by Scott's (2008) when characterizing the discourse help to deal with issues concerning the impact of these given accesses for students to participate when they are paired with authoritative dialogic roles. The link between teacher and students' roles in this analysis has been made clear by Scott (2008), which might support the recognition of the interaction pattern. Therefore, this study adhered to Scott's (2008) in searching for discourse patterns in physics lessons to determine the values associated to the meaning making process.

3. OBJECTIVE

This study looked into the following research questions:

1. What is the sequence of science discourse in physics classrooms?
2. How does the sequence of science discourse function in physics classrooms?

4. METHOD

The data used in this study had been part of a huge data collection for a Doctor of Philosophy (PhD) project. This study is a single case analysis as it only involved one lesson from 44 lessons. The duration of a Physics lesson is 70-minute and conducted by Miss B at secondary school in Johor, Malaysia. Miss B has nearly four years experience in teaching Physics. The lesson was audio-video recorded and transcribed by using Transana software. Prior to data collection, consent from the teacher was obtained to audio-video record the lesson.

4.1 The Coding Scheme

There are four categories in the coding scheme, derived from the dialogic teaching observational framework developed by Scott and Asoko (2006): interactive/dialogic (ID), non-interactive/dialogic (ND), interactive/authoritative (IA), and non-interactive-authoritative (NA). The description for each coding analysis, according to Scott (2008), is given below.

1. *Interactive/Dialogic (ID):* the teacher and students explore ideas, generating new meanings, posing genuine questions, as well as offering, listening to, and working on different points of view
2. *Interactive/Authoritative (IA):* the teacher leads students through a sequence of questions and answers with the aim of reaching one specific point of view
3. *Non-interactive/Dialogic (ND):* the teacher considers various points of view, setting out, exploring, and working on the different perspectives
4. *Non-interactive-Authoritative (NA):* the teacher presents one specific point of view

4.2 Application of the Coding Scheme

Line by line utterance made by Miss B is analyzed using the coding scheme of the communicative approach. Each coding represented a narrative episode of the communicative approach. Subsequently, each episode was indexed with time code by using the Transana software to identify the shifting between communicative approaches. At the end of analysis, the pattern of sequence is identified and the process that took place in the communicative approach is determined.

5. RESULT

After the analysis, there are twelve type of interaction labeled as ID-ND, ID-NA, ID-IA, IA-ID, IA-NA, IA-ND, NA-ID, NA-IA, NA-ND, ND-ID, ND-IA and ND-NA emerged from teacher-students discourse. Table 1 shows the summary of turn taking between each mode of interaction between Miss B and her students. Table 1 depicts that the turn taking from IA to NA displayed the highest frequency, which is 5. This is followed by the turn taking of interaction from NA-ID ($f = 4$), and from NA-IA ($f = 4$). The other turn taking episodes appeared twice ($f = 2$) during the interaction: from ID-ND, ID-NA, ID-IA, IA-ID, and ND-IA. Nonetheless, the turn taking that occurred between ND and ID happened only once ($f = 1$) throughout the interaction. However, three types of turn taking did not exist during the interaction, which are IA-ND, NA-ND, and ND-NA.

TABLE 1: FREQUENCY OF SHIFT BETWEEN SCIENCE DISCOURSE PRACTICES

Coding	*ID – ND*	*ID – NA*	*ID – IA*	*IA – ID*	*IA – NA*	*IA – ND*	*NA – ID*	*NA – IA*	*NA – ND*	*ND – ID*	*ND – IA*	*ND – NA*
Frequency	2	2	2	2	5	0	4	3	0	1	2	0

Figure 1 below illustrated a mapping process done using time code in Transana to identify turn taking process. The discursive pattern revealed shifting from one mode of communicative approach to another.

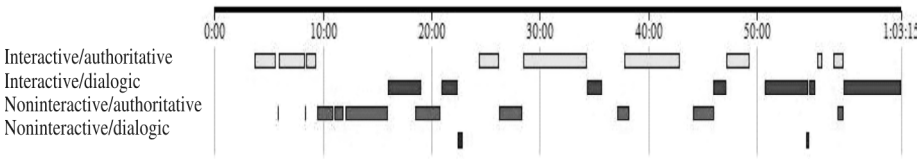

Figure 1: Science Discourse Coding of Teacher-Students Conversation during Physics Lesson

The analysis presented above reveals that the communicative approach of analysis by Scott (2008) can be used to characterize the interaction between the teacher and the students in physics classrooms. It can be seen here, the shifting process is temporal between communicative approaches as the utterance moves on. Thereby, it is cannot be simply concluded that NA-ID prevail because it is the objective choice made by Miss B. From the analysis, we discovered that the organization of the interaction exhibited has a tendency to be brief rather than sustained. The temporal pattern of shifting in the communicative approach is similar to that previously discovered by Scott (2008).

The sequence pattern above help to give an overview on how IA-NA occurred much often if compared to other turn taking. This in turn helps this study to discuss further about the value of science discourse carried during teaching.

6.0 DISCUSSION

In science discourse, the communicative approach plays a significant role in allowing progression of knowledge development. With the analysis above, this study discovered a further distinctive feature of the teaching sequence. These arguments are worth commenting to explain the value of communicating physics in the classroom, as well as the limitations of this analysis.

Case 1: Why IA-NA Occurred?

The shift from IA to NA occurred more frequently if compared to other turn taking activities. The shift from IA to NA interactions is discovered when Miss B tagged a correct concept, although without making her point of view explicit. In different episodes, NA presents when Miss B draw a conclusion from the students' answers

to assert the correct physics concepts. Sometimes, an assertion of ideas is interpreted when students failed to give any answer. This is seen when the classroom community is quietly waiting for the teacher's answer. We described Miss B as a person who likes to maximize students' participation and at the same time acquire control within the process.

Extract below is an episode of IA-NA during the lesson that contains teacher (T) and student (S/Ss) participation. Miss B prompted students to identify a formula for a refractive index. The students, apparently in line 2 and 4, had been able to mention one of the formula to calculate refractive index, which is by using Snell's Law, $n = \sin i/\sin r$.

1 *T*: Ok, 7(d)... Ok, 7(d). Given velocity in air and inside water are. Ok, calculate the refraction index. Ok, from... (pause) this tittle, calculate the refraction index. Which formula you want to use? Aaa…(pause), hurry up (urge for responses).
2 *S*: $n = \sin i/\sin r$.
3 *T*: what is '*i*'?
4 S: *i* is angle of incident.
5 *T*: what? (with a loud voice)
6 *S*: {seek for confirmation from nearby friends-discussing}
7 *T*: what is '*i*'?
8 *S*: angle of incident.
9 *T*: what? (loud voice)
10 *S*: real depth.
11 *T*: Real depth? (with deep voice, showed agreement with the answer). Who taught you that? (disappointed at student's answer-angle of incident). Ok real depth, ok, correct.

When Miss B made a prompt, it had been noted that she urged for quick responses from the students (quick/ "*cepat"*). One male student (male 1) answered the question with a formula for reflective index (line 2). Following this, Miss B evaluated male 1's answer by seeking for further details about the formula. The episode is regard as dialogic when Miss B acknowledged students for their ideas. Male 1 replied that the symbol *i* represented an angle of incident (line 4). But, Miss B confronted the answer with doubt in line 5 to assign her disagreement. Moving from this, the student began to feel insecure with his answer and reaching for confirmation from his friends (line 6). Miss B communicative approach in line 5 has a root for authoritative because she refused to accept wrong answer. This interpretation is supported when Miss B immediately accepted male 2's answer and ended the discussion.

This is why the authoritative nature had been very common throughout the lesson. According to Scott (2008), such action appears when the teacher has an intention to reshape or to ignore students' answer because the answer fails to contribution to the science story. This approach requires the students to determine the kind of knowledge that Miss B had demanded from him. The gap above

reappeared again in line 9, when the students failed to provide explanation for his answer in line 8. In summary, the shift from interactive to non-interactive occurred when Miss B leans to become authoritative. Despite her authoritative role that demands for specific answer, Miss B did acknowledge students as a contributor during discussion.

From Scott (2008), non-interactive is defined as teaching that only involves a teacher. However in our case, students' are allowed to participate in the meaning making process. The downfall of turn taking is seen not due to participation but mainly because of the epistemic status carried by the discourse. Hence, the learning process is hampered when students had insufficient guideline on how the discourse must proceed. Thus, the student began guessing the possible answer for the question, which was the reflective angle (line 8). Lidar *et al.*, (2006) described such move as epistemological move blocks because the teacher failed to direct the conversation so that the students could create a meaning for reflective index. The struggle to initiate dialogic interaction is evident in the excerpt above.

Case 2: The Fine Line between Four Characteristic

According to Scott (2008), a talk is dialogic when meaning making process considered a range of ideas during the process. On contrary, authoritative is viewed when teacher is selective to students' responses. The empirical evidence in Figure 1 showed that authoritative and dialogic is often shifting during the interaction. In the example below, the learning process began in line 2 when the classroom community mentioned copper as a suitable material for cooking ware. In this case, the students had successfully identified the phenomenon under investigation because their answers are derived from their life experience.

1 *T*: State what are the characteristics for a pot that can heat up quickly. You're your reason for the characteristics. Ok, this is a problem statement. Firstly, which material is suitable for the pot? Clay or copper?
2 *Ss*: Copper.
3 *T*: Why copper?
4 *S*: Because of its high in heat capacity.
5 *S*: The heat capacity is low.
6 *T*: Because the heat capacity is low. Please make a correction. Ok, why the heat capacity is low?
7 *S*: easy to cook.
8 *T*: Wrong. Of course it is easier to cook.... what else?
9 *S*: [female 2] it can absorb heat quickly.
10 *T*: Ok. Number two, material for the handle. What?
11 *Ss*: Polymer.
12 *T*: Yes. Why polymer?
13 *S*: [Female] It is a weak conductor.
14 *T*: Yes, a weak conductor. Other than that? It has...
15 *S*: High specific heat capacity.
16 *T*: Ok, that is the exact answer if compared to weak heat insulator.

Now, Miss B made a move to link the phenomenon with the physics concepts. Students' responses are described as mixed (lines 4 and 5). This showed that students has their own ideas regardless and are not afraid to share their ideas. Miss B decided to make a selective move by accepting a correct answer in line 4. Her attempt has ignored other responses and indirectly send a signal that other responses are wrong (line 5). This move further emphasizes her authoritative role. This gesture offered a signal to the students that what is considered right or wrong is decided by the expert, where the expert is their teacher. Miss B unconsciously becomes arbiter to her students.

In line 6, Miss B prompted for justification on why copper has low heat capacity. Female 1 mentioned that the cooking process is easier if the appliance is made from cooper. Miss B instantly replied that the answer is wrong. Although she agreed that copper requires less time to cook, this was not the answer that Miss B had hoped for. So, Miss B began to initiate another response (line 8) by reformulating female 1's idea. Another student made an attempt in line 9 that coopers has a characteristic to quickly absorb a heat from stove. In line 10, Miss B replied with "Ok" to imply her agreement with the answer. The dialogic conversation does not play a significant role in reasoning between these two statements. In fact, this is the vague line between authoritative and dialogic interactions. Miss B's rejection and initiation for further explanation (line 8) consisted of both authoritative and dialogic moves at the same time. However, the temporal shifting was very brief because Miss B accepted the explanation without arguing why female 1's idea is inaccurate. Another example is when Miss B asked about the best material to build a handle for cooking ware. To further evaluate students' responses, Miss B asked why they had chosen polymer as the material. A similar incident of favoring certain ideas is found when high specific heat capacity (line 15) is accepted as the correct answer. The epistemic status carried by each idea influence communicative approach made by Miss B. These episodes are evidences that dialogic surface in the interaction, but we navigated in authoritative way. Highlighting that certain explanation is accepted, while others are rejected, cannot be distinguished as a matter of interactive and non-interactive only.

Interactive and non interactive approaches differ according to students' participation. Scott (2006) described non interactive approach as lecturing. We discovered that generally, the lesson is interactive because Miss B encouraged students' participation in discussion. The interactive approach, however, is often shadowed by the non-interactive approach. This could be clearly observed in the episode below. The episode below shows that Miss B had become very expressive about her point of view.

1 *T*: Ok, If 'apparent', we have two of them. An image or object?
2 *S*: (mixed responses)
3 *T*: apparent (teacher repeating the word "apparent", several times, seeking for confirmation of agreement)
4 *S*: Image.
5 *T*: Apparent is image. Real is for object. So, D is real depth, and d is apparent depth.

This episode is worth commenting because at this point, although the students were involved in the interactive process, their responses were implicitly controlled by the teacher. In line 3, the teacher emphasized the word "apparent" with the intention for the student to reach one conclusion; whether apparent depth represented the image's position or the object's position. We described Miss B as making a rhetorical move because she wanted he students to change the answer and aware with her disagreement.

By using Scott (2006) characteristic of communicative approach, we find that it is difficult to truly explain the context constitute between interactive versus non interactive and authoritative versus dialogic. It is because we find that teacher's talk can be authoritative even when the discourse is dialogic. Students in this episode play a significant role in meaning making but the dialogic discourse is in a great control by Miss B. According to Scott and Ametller (2007), authoritative role play a significant part to create a meaningful learning experience. Thereby, teacher must know the right timing to become authoritative. Scott and Ametller (2007) added that this position is suitable at the early phase of discussion and when making a conclusion.

Hence, when we find that, the analysis of communicative approach is overlapping in our context. This explains that Miss B has a consensus regarding dialogic and authoritative approach. Scott et al (2006) previously mentioned about a fundamental tension between dialogic and authoritative. They described the tension as a causal relationship where each communicative approach might give rise to another. This has lead to conclusion that the pattern of talk can be determined using Scott (2006) communicative approach.

Case 3: When Interactive is Entangled with IRF Pattern

The turn taking analysis revealed that Miss B is authoritative because she had always focused on the correct answer. We discovered that interactive communication with IRE pattern authoritative in nature as shown in the following episode.

Initiation
T: Ok, first point is?. Explain the fluid flow at the bottom part. Hah, so what?
2 *S*: The flowing fluid below the wing is slower.

Response

3 *T*: Ok, according to your friend, Her first point, she talked about the flowing fluid, and her second point talked about pressure. So, your first point is about the flowing fluid, so you must mention what happened with the flowing fluid at the top and bottom part of the wing. Ok, hurry up (pointing the microphone towards a female student).

4 *S*: Pressure at the top is higher if compared to the one at the bottom.

Evaluation

5 *T*: Ok, correct. Secondly?, If the flowing fluid is higher, the pressure?. According to Bernoulli's principle, when the flowing fluid is higher or if the velocity of the air is higher, so what happened to the pressure? (pause)

6 *Ss*: Lower

During Bernoulli's explanation, Miss B has emphasized certain ideas to funnel her explanation. From the explanation, it can be said that Miss B has done a great job in constructing her explanation but it was delivered in a poor manner. To explain a Bernoulli's phenomenon, Miss B attempt to form a causal explanation with two variables known as velocity and pressure. This turn taking discourse reflected Miss B's effort to form a causal reasoning. The interpretation is supported by Russ *et al.*, (2007) that mention about causal reasoning as an approach to promote scientific inquiry. But, as described above, the interactive context is impaired with IRF pattern which position Miss B as authoritative. There are two types of IRF pattern. According to Sharpe (2008), spiral IRF pattern has a potential for dialogic discourse instead of sequential IRF. Spiral IRF differs than sequential IRF because the teacher makes no attempt for evaluation rather returning the turn back to students for further thinking. From the analysis above, Miss B has misunderstood the primary function of IRF which lead her to become authoritative. She used IRF pattern for reaching students' ideas but was unable to develop further the thinking process.

7. CONCLUSION

During analysis, we discovered that teachers exhibit awareness about the important to engage student in dialogic form of discussion. From the analysis, we encountered three cases that interplay with our interpretation. In case 1, we discussed about the process that leads to the occurrence of IA-NA. Following this analytical procedure, we also discussed issues related to analytical framework suggested by Scott (2008). In case 3, we reason why most of the interaction in Miss B is considered as authoritative. The discussion give a supporting interpretation when the empirical analysis showed IA-NA scored the highest frequency.

This study illustrated that through the analysis of the communicative approach, as suggested by Scott (2008), between teacher and students, the value of science discourse in physics classrooms could be both identified and described. This norm of communicative approach is neither regular nor unique to the Malaysian culture

of science education. However, this finding is different from Shahari and Phang (2016). From their analysis, interactive/dialogic and non-interactive/dialogic approaches are dominant features among samples. On contrary, we find that IA and NA are more dominant during the interaction. The distinction between dialogic and authoritative hence requires a further investigation to fully represent the social setting in classroom. We had raised our concern about the difficulties to use one label for a single episode of utterance in previous section. For further study, we recommend other researchers to use a microanalysis that helps to understand the epistemic meaning carried by each utterance. The analysis will help to justify toward the extent the episode can be considered as dialogic or authoritative.

Acknowledgement

Special thanks to Universiti Teknologi Malaysia under Fundamental Research Grant Scheme numbered R.J130000.7831.4F754.

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