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Managing A Discursive Journey for Classroom Inquiry: Examination of a Teacher's Discursive Moves

Yilmaz Soysal[1]*

[1]Department of Elementary Education, Faculty of Education, Istanbul Aydin University, Istanbul, Turkey

*Corresponding author: yilmazsoysal8706@gmail.com

ABSTRACT This study presents an analysis of teacher discursive moves (TDMs) that aid students in altering their thinking and talking systems. The participants were a science who handled the immersion inquiry activities. The primary data source was the video recorded in the classroom. This video-based data was analyzed through systematic observation in two phases comprising coding and counting to reveal the mechanics of the discursive journey. Three assertions were made for the dynamics of the discursive journey. First, the teacher enacted a wide range of TDMs incorporating dialogically/monologically oriented, simplified (observe-compare-predict), and rather sophisticated moves (challenging). The challenging moves were the most featured among all analytical TDMs. Second, once higher-order categories were composed by collapsing subcategories of the displayed TDMs, the communicating-framing moves were the most prominent performed moves. Lastly, the teacher created an argumentative atmosphere in which the students had the right to evaluate and judge their classmates and teacher's utterances that modified the epistemic and social authority of the discursive journey. Finally, educational recommendations are offered in the context of teachers noticing the mechanics and dynamics of the discourse journey.

Keywords Teacher Discursive Moves, Classroom Discourse, Social Languages, Science Learning, Vygostkian Perspective

1. INTRODUCTION

In his seminal work, Acts of Meaning, Jerome Bruner (1990) signaled the newly emerged discursive psychology signs. This new psychology advocates the fundamental assumptions of the learning and teaching of Vygotskian tenets (Vygotsky, 1981; Vygotsky, 1978; Eun, 2019). In a Vygotskian sense, learning signifies acquiring an alternative language incorporating specific thinking and talking styles (Bakhtin, 1986; Kim & Roth, 2018). However, before elaborating on this view of learning, certain concepts must be elaborated to demonstrate the need for the current study.

In the Vygotskian sense, the meaning-making of a phenomenon can be attained in two planes (Vygotsky, 1978): interpsychological (social plane) and intrapsychological (cognitive plane). On the interpsychological plane, a teacher and students can rehearse and perform various social languages (Bakhtin, 1986) under diverse semiotic mechanisms (symbols, diagrams, graphics, gestures, intonations, and mimicking) as in the forms of speech genres (Wertsch 1991). On the intrapsychological plane, following the internalization of the reproduced phenomena among the group members, individual thinking as the appropriation of the previously negotiated concepts for individualized schemes is performed (Vygotsky, 1978).

For the interpsychological plane, Vygotsky (1987) clarified two terms: spontaneous and scientific concepts. The former "is developed through everyday experience and communication and are formed aside from any process aimed specifically at mastering them" (Scott, 1997; p. 16). On the other hand, Vygotsky (1987) believed that scientific concepts could be formed through formal instruction as "the birth of the scientific concept begins not with an immediate encounter with things but with a mediated relationship to the object" (p. 219).

This differentiation between the spontaneous and scientific concepts implies that there can be different thinking and talking approaches to a phenomenon for different groups. While learners consider and apply spontaneous concepts in explicating a phenomenon, scientists tend to operate a more formal array of terminologies or jargon. In this sense, Bakhtin (1986) defined social languages as "a discourse peculiar to a

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specific stratum of society (professional, age group, etc.) within a given system at a given time" (Holquist & Emerson, 1981; p. 430). A stratum of society refers to the communities of children, scientists, teachers, or any other specific groups of learners or thinkers and talkers.

A social language implies that the same phenomenon can be conceived differently by different groups of learners. For instance, a solid-state physicist would consider a glass using the existence of the intermolecular forces and interactions among these forces in terms of resting in the solid state. On the other hand, a glassblower deals with the artistic aspects of the produced glass. For the solid-state physicist and glassblower, the realities of glass within social, cultural, historical, and contextual worlds influence the ways of thinking and talking. The former discerns the glass through scientific experimenting accompanied by particular discourses (e.g., states of matter, intermolecular forces, and atoms). The latter would discuss how glass blowing should be undertaken to design state-of-art creations. It is needed since s/he has artistic design concerns about shaping the glasses aesthetically by applying specific glass-blowing techniques. This example directly reveals the intimate relationship between thought (ways of thinking) and language (ways of talking).

Leach and Scott (2002) and Scott (1998) explained the social languages phenomenon for the school science by defining three social languages for science teaching. These are everyday social languages of the learners, social languages of scientists, and the social languages of school science. First, the everyday social languages of learners refer to spontaneous concepts. Second, the social languages of scientists mean the specific and formal ways of meaning-making of the same world which the students inhabit. Thirdly, the social languages of school science are delimited.

Students can use expressions such as "flowers feed on the earth." or "I have consumed my energy today." Both of which are far from being scientifically appropriate. However, students using this everyday social language can express the occurrences in their environment and do not feel uncomfortable about this. This is because the learner has observed plants in soil and when s/he adds some nutrients such as water to the soil, and then the plant draws up the nutrients through its roots and grows. Moreover, when a child becomes tired after playing tag, s/he can think that the activity was energy-consuming. For the first instance, an expert in plant physiology would account for the feeding of plants by photosynthesis through chemical equations using specific jargon. For the second example, an expert in biological energy systems can explain a human becoming tired by considering the energy transformations.

1.1 The main tension of science teaching and significance of the current study

When this is the case, there are two alternative languages: everyday social languages learners and social languages of scientists. When this dichotomy is infused into the instruction, there will be an inevitable discursive tension for the teachers in general and science teachers in particular.

Science teachers' pedagogical decisions and accompanied actions as Teacher Discursive Moves (TDMs) are essential to managing the discursive exchanges. In addition, science teachers should consider the social languages that learners bring to the class. For the curricular reality, a teacher has to convey specific content to students, and the curricular contents are inherently closer to the social languages of scientists. At this point, there are numerous questions to be raised:

Which social languages of the different groups of learners should be prioritized by teachers during classroom discourse?

Is there an order of importance between social languages of learner groups regarding the meaningful learning of science concepts?

Suppose a teacher starts by considering the everyday social languages of learners. What are the ways for her to maintain and finalize classroom discourse (discursive journey, a sequence of discourse) to recognize and appropriate an alternative thinking and talking system in the form of scientists' social languages or social languages of school science?

Only a few scholars have responded to the questions given above. One example is the work of Mortimer and Scott (2003). They presented insights into each part of the framework through episode analysis by ignoring any quantitative cumulative analysis of TDMs during a discursive journey. They paid less attention to teacher interventions that were revealed by a few categories within their framework.

There have been numerous contributing studies exploring TDMs in-depth, taking different research purposes into account (e.g., Carpenter et al., 2020; Kawalkar & Vijapurkar, 2013; McMahon, 2012; McNeill & Pimentel, 2010; Ng et al., 2021; Pimentel & McNeill, 2013; Oh, 2010; Oh & Campbell, 2013; van Booven, 2015). However, this was not implemented within a continuum of classroom discourse as a discursive journey. Therefore, two scholarly purposes are awaiting further research:

1) To make a fine-grained analysis of TDMs displayed during a student-led in-class science inquiry,

2) To demonstrate how a teacher handles and manages a discursive journey or sequence by performing particular TDMs.

Some assumptions regarding the fundamentals of the classroom discourse within a Vygotskian sense were initially hypothesized in the current study. Firstly, the existence of presumable clashes between the two social languages was accepted. The confrontation of the two social languages can create a genuine discursive tension for teachers. If a teacher allows for the two differentiated speaking styles, s/he should manage the classroom discourse through specific TDMs. This kind of classroom discourse flow (from the everyday social languages of learners to the social languages of school science) depicts a compelling discursive journey. As expected, handling and managing this thorny discursive flow is possible through the aid of particular TDMs that should be performed in the appropriate contexts and relevant moments during the negotiations. Given the assumptions mentioned above, the research questions of the current study were:

Which TDMs were enacted by an experienced science teacher of sixth-graders during a discursive journey through a student-centered teaching activity?

How was the teacher able to manage the discursive journey by initially considering and negotiating the everyday social languages of learners and completed by prompting the students to recognize and appropriate the social languages of school science?

This study attaches importance in terms of several aspects. First, the TDMs were not considered isolated from the flow of the classroom discourse in the current study. This implies that the present study was not aimed to produce a sole description of the what-aspects of the TDMs. In addition, the current study tries to exemplify how a science teacher enacts different versions and combinations of the TDMs to persuade students that there may be novel ways of seeing and speaking about natural phenomena. The current study accepts science teaching as convincing a group of learners to think and talk in novel ways to capture different or more explicative conceptual profiles developed and used by experts or scientists. However, it has not been exemplified how a science teacher uses his/her talk moves to press students to get a discursive journey from a narrower conceptual profile to a broader one. In addition, the current study was conceptualized around the teacher noticing term that has been centralized for teacher education research in terms of planning and implementing high-quality, pedagogically-oriented professional development programs. In the context of the current study, the teacher noticing refers that science teachers may not have an explicit understanding and pedagogic cognition about the TDMs that are used effectively in convincing students to think and talk in new ways. Thus, the current study can be thought of as a prototype in depicturing teacher-led talk initiations purposed to maintain science teaching as persuasion that can be thought of as an alternative teaching philosophy established within the sociocultural paradigm for the conventional conceptual change theory. In other words, the outcomes of the present study can be considered by science teacher educators in designing and implementing talk-based professional development programs where discourses of discursive psychology are featured and handled.

2. LITERATURE REVIEW

To manage a discursive journey, a teacher can perform miscellaneous TDMs. These TDMs can consist of discursive purposes to lead the students to a single or multiple aspects of the phenomenon or reality under discussion. Moreover, while some TDMs can permit social and verbal interactions, others can inhibit the interactive discursive exchanges (Mortimer & Scott, 2003).

A teacher can provide information to students in a discursive journey by direct lecturing, logical expositions, or verbal cloze (Chin, 2007; Mau & Harkness, 2020; McMahon, 2012). A teacher can make solid evaluations of student responses based on the canonical knowledge of science using comprehension checks or affirmation-cum-direct instruction (Oliveira, 2010; van Booven, 2015). If a teacher employs only knowledge providers and evaluator moves, then the classroom discourse can be considered subject-centered, incorporating only school science social language (Bansal, 2018; Grinath & Southerland, 2019; Tabach, Hershkowitz, Azmon, & Dreyfus, 2020).

In order to expand the scope of the negotiation, a teacher can elicit student-led utterances (Kawalkar & Vijapurkar, 2013; Wei, Murphy, & Firetto, 2018). A teacher can also direct student attention to a focal aspect of the discussion through, for instance, introducing a scientific story by selecting students to rehearse it (Leach & Scott, 2002; Soysal, 2020a). After collecting several ideas from the students, a teacher can select, summarise, and consolidate these ideas that would be prominent in determining the other streaming of classroom discourse (Oh & Campbell, 2013, van Booven, 2015; Soysal, 2020a). A teacher can demonstrate to students how scientists have studied a phenomenon using the modeling and rehearsing aspects of the processes of science (Grey & Rogan-Klyve, 2018; McMahon, 2012; Oh, 2010). A teacher can also clarify the background thinking, reasoning, or intention of a student-led utterance by explicitly asking for clarification or further elucidation of the proposed utterances (Pimentel & McNeill, 2013; Soysal, 2021).

In order to invoke reflective thinking, a teacher can operate reflective toss or toss-back by throwing the responsibility of learning back to the students (Magnusson, 2021; van Zee & Minstrell, 1997b). Furthermore, in associating the student-led utterances with each other, a teacher can prompt for and link students' ideas to build on the shared topics (Brown & Kennedy, 2011; Soysal, 2021). Another way of associating the student-led ideas with each other is to engage students in legitimizing the evaluation of the other student's conceptual and procedural discourse (van Zee & Minstrell, 1997a; Soysal, 2021).

A teacher can act as a challenger, discussant, or negotiator by posing constructive challenges or debating and applying ideas (McMahon, 2012; Simon, Erduran, & Osborne, 2006). For an argumentative discourse, a teacher can encourage justified and evidence-based reasoning by checking the student-led evidence or directly prompting students for justified or warranted reasoning (Simon et al., 2006). In particular, for in-depth negotiations of meaning, a teacher can encourage students to monitor discursive events in the classroom discourse to keep them cognitively alive for the internally consistent streaming of classroom discourse or asking about a mind-change that led students to monitor their previous and current thinking (van Zee & Minstrell, 1997a; Soysal, 2020b).

The discursive exchanges given above can be more visible within an intellectually comfortable classroom atmosphere. A teacher may maintain neutrality and foster a respectful environment to present changes in previously held thinking and talking (van Booven, 2015; van Zee & Minstrell, 1997a). To summarise, the current studies reveal several aspects of the displayed TDMs. There is a need for further research into the ways and extent to which a teacher plays out a particular combination of TDMs in convincing students to appropriate novels ways of seeing and speaking about natural phenomena.

3. METHOD

3.1 Research Design

The present study was designed and conducted as a naturalistic inquiry (Creswell & Poth, 2016) where there was no intervention to the teacher's in-class implementations. In other words, the TDMs enacted by the teacher was solely observed and analyzed within its naturalistic setting, where the teacher and students socially and verbally interacted without any external intervention. As a qualitative research methodology (Creswell & Poth, 2016), by a case study, it was purposed to explore a phenomenon within some particular context in the current study. The phenomenon explored in the current study was the discursive journey where the teacher performed specific TDMs to convince the students to think and speak in different ways while considering science concepts. The TDMs were explored within a specific context in which the teacher behaved as a discussant, challenger, and negotiator to show the students that their existing mental models as the core component of their alternative conceptions may be less explanatory when it comes to identifying a natural phenomenon that was subjected to science lessons. Through a case study (Creswell & Poth, 2016), in the present study, it was undertaken to explore a variety of lenses to extract multiple facets of the phenomenon under examination. Diversifying and qualitatively distinctive categories of the enacted TDMs were deeply explored as the multifaceted aspects of the discursive journey.

3.2 Participants

The participants were an experienced science teacher and 26 sixth-grade students (Females = 12, Males = 14) aged 11-12 years. They attended a private school that had several instructional and leisure time facilities. The teacher (male) was 33-year-old, and he was a Ph.D. student in science education. He had four years of in-class teaching experience with middle schoolers in a state school located in a big city in Turkey. He worked for an international project that aimed to disseminate student-centered teaching in the Turkish context. He was on a journey to become a science teacher educator. He had joined a professional group that was designing, planning, and implementing higher quality professional development programs for elementary and secondary science teachers. The participant teacher was engaged in designing and implementing professional development activities to enhance novice science teachers' knowledge and skills regarding the student-centered approach of Argument-based Inquiry (ABI; Hand & Keys, 1999). After managing university-led workshops for prompting the novice teachers to recognize a new teaching approach, the participant teacher provided on-site professional support for the development of teachers in their schools. Thus, the teacher had on-site and on-site in-depth experiences to manage the well-structured ABI implementation detailed below.

3.3 ABI Implementation and the Science Content

The teacher had implemented several ABI activities in the project schools, one of which was selected for this study. The content of the implementation was the theory of matter in general and the properties of matter in particular, which was embedded in the available elementary science curriculum content. This topic was selected because it contained an outstanding negotiation of meaning (Mortimer, 1998). The discursive purpose of the teacher was to create a discursive atmosphere in which the students would present their theoretical models (Buty & Mortimer, 2008; Ziman, 2001) in response to their conceptual, epistemological, and ontological contradictions revealed by the teacher during the initial phases of the implementation. Thus, there were three interwoven phases of the implementation.

Phase 1: Initial Social Negotiations of Meanings

In this phase, the teacher produced many challenging discursive moments based on the utterances of the students. He initiated the negotiation with an array of questioning-based discursive exchanges that were mind-stretching and thought-provoking for the students. The teacher-led questioning served to show the students that they could hold conceptual, epistemological, and ontological conflicts regarding the properties of matter. Therefore, the students had to ponder these contradictions to clarify them by establishing and negotiating their theoretical models. The teacher's aim in this stage was to listen actively to the students' utterances, present their thinking fallacies about atoms and matter to the class, and pose scaffolding questions to guide the students towards an alternative way of thinking about matter and the building blocks. At the end of this phase, the students were asked to design their theoretical models regarding positions of the atoms and molecules in specific matter or within a solution of two items of matter (salt-water), the existence of the intermolecular forces, particular states of the matters, matter combinations as solutions (salt-water, sugar-water, water-oil), and the solid-liquid-gas states of solutions as the mixtures of different matter (e.g., the solid-state imagining of a salt-water solution).

Phase 2: Students' Modelling

The students constructed their models and engaged in reasoning about the models to generate evidence in the form of arguments in this phase. The discursive quality of the next phase (whole group negotiations) was firmly based upon the diversity of the models that the students produced. In this phase, the teacher supported the students in rethinking, redefining, and regenerating their initial models by pointing out the non-functional parts of the models they had created (Buty, Tiberghien, & Le Maréchal, 2004; Mortimer 1998). Some of the student groups were working on the same modeling procedures. The teacher, therefore, prompted the students to alternative model aspects of the phenomenon to create a variation of generated models to augment the scope of negotiation after modeling.

Phase 3: Whole Group Negotiations

During the whole group negotiations, each group engaged in discussions about their theoretical models and presented them to the other groups. The teacher drew up a specific order of presentation of the groups. One of the fundamental purposes of the third phase was to increase the breadth of the student-student negotiations by comparing and contrasting models students produced (Cavagnetto, 2010; Cavagnetto & Hand, 2012). Thus, different aspects of the same phenomenon (e.g., representations of the intermolecular forces within a water-salt solution) could be modeled by two different student groups. They might generate distinctive models even though they engaged in mental reflections on the same phenomenon. These examples were the most productive discursive moments for the classroom discourse. The teacher deliberately invited other student groups to criticize, evaluate and judge their classmates' thinking. The groups criticized each other in terms of the relevancy and actuality of the model and the derived arguments regarding matter and properties from the generated model. This resulted in more verbal exchanges between the teacher and students and between the students. Every group tried to convince the other groups that their models revealed reality in the best way.

3.4 Data Collection

The ABI implementation lasted about 190 minutes, and the discursive exchanges were video recorded in the laboratory. The teacher was aided by an assistant who located the cameras in the best points in the laboratory to capture the discursive exchanges. The assistant also walked around the classroom using the camera to record the one-to-one negotiations. The video recording quality was sufficient for the simultaneous verbal initiations of the students to be differentiated. The class participants had been informed about the video recording purposes when they had completed consent forms agreeing to participate in the study.

3.5 Data Analysis

Coding and Quantifying by Systematic Observation

Before the analysis, the video-taped data was verbatim transcribed. Verbal and non-verbal interactions were incorporated into the transcript. Analysing non-verbal interactions (gestures, intonation, and body language) helped capture the nuances among the presented TDMs. The data was analyzed by systematic observation, a branch of discourse analysis (Mercer, 2010; Sandoval, Kawasaki, & Clark, 2021). In the context of the current study, the displayed TDMs were allocated to a set of collapsed categories. The primary aim of the categorization was to obtain quantitative proportions regarding the relative occurrences of the TDMs. The researcher determined the relative frequencies of talk turns, which he abstracted from the types of utterances given by the teacher. A set of categories was generated into which the whole teacher-led talks could be discerned and classified. Discerning the given TDMs was very important in avoiding divergent TDMs labeled with the same codes (Mercer, 2010; Sandoval et al., 2021).

The researcher had trained himself to allocate any piece of teacher-led talk to a category that had been generated for the TDMs. The researcher established the following two control mechanisms. First, the TDMs labeled in the same way were continuously compared with themselves to achieve internal consistency. Second, a labeled TDM was also continuously compared and contrasted with other possible labels to accomplish an external consistency. The internal consistency showed the homogeneity of the TDMs coded with the same code from the catalog. The external consistency displayed the heterogeneity of the presented TDMs labeled by exclusively mutual codes from the catalog described below.

The Developed Coding Catalogue

For a systematic observation, researchers can develop their categorizing system or adopt an "off the shelf" system (Mercer, 2010, p. 4; Sandoval et al., 2021). For the current study, both theory-based and data-driven codes were operated together for coding and counting. The coding catalog (see Table 1) incorporated six higher-order categories, 17 subcategories, and more than 150 analytical codes gathered around the subcategories.

The labels within the catalog (Table 1) were contextually influenced and were applied in this sense. This implies that throughout the negotiations, the context of the discussion was inherently dynamic and changeable. In particular episodes of the negotiations, the students asserted claims.

Table 1 Detected higher-order categories and characterizing subcategories for the TDMs

Higher-order categories (Label)	Subcategories as TDMs	Label	Descriptions
Knowledge Providing & Evaluating (KPE)	Direct affirmation	DA	The teacher accepts the correctness of the student-led response.
	Soft rejection	SR	The teacher acknowledges and welcomes the student-led response.
	Presents logical expositions	PLE	The teacher tries to present an internally consistent idea or argument
Observe-Compare-Predict (OCP)	Asks for making observations	MO	The teacher prompts the students to make an on-moment observation regarding an event during classroom discourse.
	Asks for simple comparisons	SC	Teacher requests from the students to make a comparison between two cases, objects, ideas, etc.
	Asks for making predictions	MP	The teacher guides the students to make guesses and projections
Communicating & Framing (COF)	Embodies	EMB	The teacher provides concrete analogies, examples, cases, or ideas to increase students' comprehension.
	Probes	PRO	The teacher asks the student to expand on his/her response, either asking for further explanation or clarification of the student's response.
	Requests for clarification	RFC	The teacher asks for further clarification and explanation of student-led ideas.
	Monitors	MON	The teacher encourages students to monitor their understanding of a classmate's thinking.
Evaluating-Judging-Critiquing (EJC)	Prompt students for evaluating classmates' ideas	ECI	The teacher asks students to judge and critiquing ideas, arguments, opinions already mentioned in the discourse.
	Prompt students for evaluating teacher-led ideas	ETI	The teacher prompts the students to evaluate and judging a teacher-led argument, example, or idea.
Challenging (CHA)	Challenges (plays devil's advocate role)	CHA	The teacher points out counter-arguments, contradictions, and flaws in the argument of the students.
	Asks for alternative points of views	APV	The teacher seeks alternative student-led responses by collecting ideas through low interanimation
Managing the Discourse's Flow (MDF)*	Consults for determining further negotiation flow	CNF	The teacher invites the student to determine which negotiation topic should be featured.
	Determining further negotiation flow	DNF	The teacher selects a specific point of view to negotiate and eliminate others.
	Asks for permission to engage in the negotiation	PEN	The teacher tries to get permission to be involved in the negotiations among the students.

Thus, the content or orientation of the proposed claim determined the context or streaming of the negotiation (Furtak, Hardy, Beinbrech, Shavelson, & Shemwell, 2010). For the created and continuously changed contexts of the negotiations, the labels for the TDMs were also subject to change even though the teacher presented the same discursive move. For instance, in one episode, the teacher asked the students to undertake a simple observation and make an accompanying prediction. Within the same episode context, after a few talk turns, the teacher used the student's simple observation and related prediction to challenge the previously proposed student-led idea. In this situation, even though the teacher asked for the students to make a simple observation and an associated prediction, the label for the displayed move was determined as challenging. Because the teacher was pointing out contradictions or detecting the flaws in the claims of the student. Several TDMs were labeled by different codes even though the teacher presented them within the same verbal utterance to change the context of the negotiation. This discernment increased the accuracy of the calibration of the analysis process and the validity of the internal and external consistency of the catalog (Mercer, 2010; Sandoval et al., 2021).

4. RESULT AND DISCUSSION

The findings are presented according to the assertions and discussed in this section.

#Assertion-I: *The teacher presented a wide range of TDMs incorporating both dialogically and monologically oriented ones. Moreover, the teacher displayed simplified TDMs such as observe-compare-predict and more sophisticated moves, for instance, challenging.*

As seen in Table 1, the teacher presented a broad genre of TDMs to manage the discursive journey. The 17 subcategories of the displayed TDMs were gathered around six higher-order categories. The percentages of the presented TDMs are shown in Figure 1. By varying proportions, the teacher was able to diversify the range of his discursive moves. The TDMs incorporated both monologic (e.g., knowledge providing and evaluating moves) and dialogic orientations (e.g., evaluating-judging-

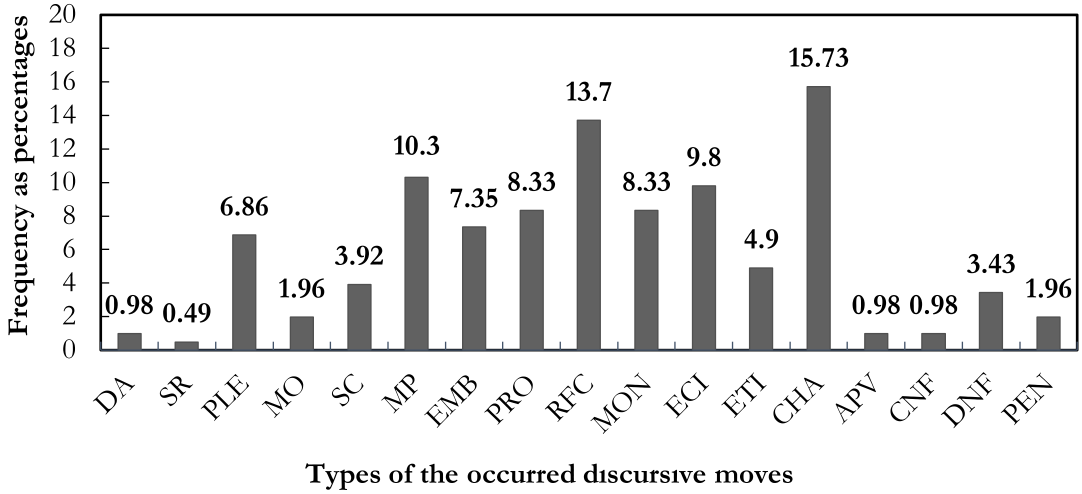

Figure 1 Comparison of the occurrences of the TDMs (%)

critiquing moves). In addition, the teacher presented both simplified (e.g., observe-compare-predict) and more sophisticated TDMs (e.g., challenging).

During the implementation, the teacher confirmed the student-led responses. She also asked for simple observations, comparisons, and projections. The teacher also performed communicating-TDMs to capture the underlying meanings, assumptions, and reasoning behind the student-led utterances. Moreover, the teacher allowed for student-led evaluations and judgments when the students were negotiating their models. In addition, he acted as a challenger to show the students their conceptual, epistemological, and ontological conflicts to carry the negotiation one step further. Finally, the teacher also presented particular TDMs to manage the flow of the discursive exchanges.

During the discursive journey, it appeared that the teacher tried to draw the distinctive social languages together. By performing more dialogically oriented TDMs, the teacher seemed to present the everyday social languages of the learners. By displaying more monologically oriented TDMs, the teacher intended to invite the students to recognize an alternative thinking-talking system invented and used by scientists. The discursive journey seemed to be characterized by the co-existence and co-operation of the dialogical and monological interactions with the aid of the diversified TDMs. This is because the discursive journey was designed to be open-ended to welcome the students' responses and slightly structured to convince them that there can be alternative and more robust social languages in addition to their less explanatory everyday social languages (Cavagnetto & Hand, 2012).

During the discursive journey, there was also a gradual sophistication in the revealed TDMs. The more monologic TDMs are only associated with the teacher's voice, and the student-led contributions were taken as listening and comprehending what the teacher was saying. On the other hand, the dialogic interactions in this journey can be considered the students' open-ended contributions, which could be independent of the presented TDMs.

However, this was not the reality of the described discursive journey since there should be interdependence between more-less sophisticated or more-less dialogic-monologic TDMs. In the first phase of the implementation, the teacher allowed for more open-ended exchanges through more dialogically oriented TDMs. At this stage, the teacher made more space for the students' vocabularies rather than the vocabularies of school science. Creating a wide range of TDMs might provide a gradual decontextualization implying that the students isolated the descriptions of scientific concepts from their contexts (Mortimer & Scott, 2003; Martin, Xu, & Seah, 2021).

In this discursive journey, the teacher had to display a variety of TDMs to guide the students to a transformation in which the learned phenomena from the here-and-now of everyday views were relocated to the generalizable statements of science (Scott, 1998; Tang, Tan, & Mortimer, 2021). In this implementation stage, the students considered the newly introduced social language as belonging to others (Bakhtin, 1934; Barreto et al., 2021). Thus, the teacher had to perform more dialogically oriented discursive moves to comprehend the ways of the student-led talking-thinking styles. For this purpose, the teacher presented moves such as prompting the students to clarify their ideas (Ng et al., 2021; van Zee & Minstrell, 1997a), make simple observations, comparisons, or predictions (Ng et al., 2021; Oh, 2010; Oh & Campbell, 2013), evaluating, judging and critiquing others (Crawford, 2000; Ng et al., 2021; van Zee & Minstrell, 1997b).

Other arguments can explicate the fruitfulness of the TDMs. The teacher had inherent accountability in re-contextualizing the de-contextualized students' ideas produced around their theoretical models. The teacher frequently acted as a challenger and negotiator. Herein the

Table 2 Example excerpt displaying types of the revealed TDMs and patterns of interactions

Tur	Spea	Utterance	PI*	TDM**
30	**T**	Anyway, let us return to the beginning. Now, a friend of yours previously mentioned that atoms are gluey. So let us discuss this idea, what do you think about this?	I	Monitors // Consults for determining further negotiation topics
31	**S4**	It was my idea! In matter, the atoms compose the building blocks of a substance by adhering to each other. That is my idea.	R	-
32	**T**	Then atoms are within matter? Should I understand this from your idea?	FQ	Requests for clarification
33	**S4**	Yes, Sir, the atoms are within matter.	R	-
34	**T**	All right, how many atoms? Only one atom?	FQ	Probes
35	**S1**	Sir, considerably plentiful, millions and millions.	R	-
36	**T**	[Showing the pen in his hand…] Students, are there atoms within that pen?	FQ	Embodies
37	**S1**	There are, of course.	R	-
38	**S2**	Sir, the pen you are holding is solid; the atoms within it are so closely positioned… I mean, they are very close to each other.	R	-
39	**T**	Do you mean that there are atoms within that pen?	FQ	Requests for clarification
40	**S2**	Yes! No?	R	-
41	**S4**	But in the form of particles.	R	-
42	**T**	If that is true, I am now touching the atoms of that pen. Is that so?	FQ	Requests for clarification
43	**S4**	In my opinion, there are no atoms on the surface of the pen. Otherwise, how could anyone touch the atoms!	R	-
44	**T**	Are there no atoms on the surface? Or are they positioned within matter or on the surfaces of matter?	FQ	Probes
45	**S4**	Inside!	R	-
46	**S1**	No! On the surface!	R	-
47	**S3**	Inside… No… On the surface!	R	-
48	**T**	Is it important whether the atoms are inside or on the surface of matter? As you had mentioned, all matter is composed of atoms. However, then, I am touching that pen's atoms! I could alter the places of the atoms by turning the pen's cover from one side to another. So, are the atoms within matter or dispersed on the surface of the matter, or are the atoms dispersed to all parts of matter?	FQ	Challenges (plays devil's advocate role)
49	**S4**	All points of matter are filled with atoms. Neither inside nor on the surface of a matter. Everywhere!	R	-
50	**T**	If that is so, then am I able to touch the atoms? Is this what you imply?	FQ	Requests for clarification

* PI: Patterns of interaction; **TDM: Teacher discursive move

instructional purpose was to convince the students that their everyday speaking did not work well to deal with the recognized conflicts made explicit.

In the discursive journey, the teacher innately transmitted particular scientific facts about atoms, molecules, intermolecular forces, and solutions through specific TDMs such as direct lecturing (Aukerman, Johnson, & Chambers Schuldt, 2017; Edwards & Mercer, 1987), presenting logical expositions (Aukerman et al., 2017; Lemke, 1990), providing authoritative narratives (Scott, 1998) or presenting verbal cloze (Chin, 2007). These particular TDMs were gathered around the first higher category (Table 1). Indeed, the domination of these more dialogically oriented TDMs is not in keeping with the discursive journey depicted in the current study (Cavagnetto & Hand, 2012).

In this discursive journey, the students had already negotiated the content regarding the properties of matter. During the whole group negotiations, there were plenty of opportunities for the students to move on to the worlds of scientific thinking and talking as an alternative. This recontextualization was more attainable by presenting more monologic TDMs but applied after the ample dialogical interactions (Mortimer & Scott, 2003; van der Veen, Dobber, & van Oers, 2018). In this context, there were no drawbacks to the dominance of the teacher-centered reviewing or wrapping-up discursive moves since, for the students, the newly recognized and accepted speaking system had gradually appeared to belong to them (Bakhtin, 1934).

#Assertion-II: *Analytically, challenging TDMs were the most featured moves among all presented TDMs. When higher-order categories were composed by collapsing subcategories of the presented TDMs, communicating and framing TDMs were the most prominent performed moves by the teacher.*

The teacher presented 204 analytically coded TDMs that had been collapsed to compose higher-order categories. Particular TDMs were prominent (Figure 1), and certain discursive moves that aimed to challenge the students' ideas (e.g., playing the role of devil's advocate)

Table 2 Example excerpt displaying types of the revealed TDMs and patterns of interactions (*continued*)

Tur	Speaker	Utterance	PI*	TDM**
51	**S4**	[Using a nervous voice tone…] They inside matter!	R	-
52	**S2**	Within matter, Sir.	R	-
53	**S3**	Namely, they are inside. The atoms are the raw materials of the substances.	R	-
54	**T**	I have no idea… Let us discuss this. What do you think [The teacher uttered by turning to face all the class]	FQ	Consults for determining further negotiation topics
55	**S4**	Sir, all I know is that the inside of the pen is composed of atoms, and the outside is filled with particles.	R	-
56	**S3**	Sir, in my opinion, the atoms are inside.	R	-
57	**S7**	Sir, for me, atoms are everywhere. Everywhere within matter. Since these (atoms) are the building blocks, everything has atoms!	R	-
58	**S9**	Indeed, an atom is a substance that is composed of merged structures. I mean, atoms multiply by merging.	R	-
59	**S7**	Sir, atoms are the tiniest building blocks of all matter.	R	-
60	**S9**	As I agreed, the thing called an atom is very tiny. So, we cannot see it. Nevertheless, they adhere together when forming matter.	R	-
61	**T**	How smart are these atoms? They have been neatly arranged. I mean, is there something that keeps the atoms together? Do they come side by side through their consciousness? In your opinion, how would it happen? So symmetrical and smooth… As you see, there are handsome students in the classroom. How did the atoms of their faces come to be side by side? [The teacher poured out some water on a front desk and made an explanation: "It is not spreading out so much. As you know, it will spread out a little more; then, it stops. Then, how is it possible for the water to rest in an orderly manner?"]	FQ	Challenges (plays devil's advocate role) // Embodies
62	**S9**	Sir, once you poured the water on this place… That puddle has a mass and volume. However, Sir, the bonds among the atoms of water are decisive in gathering. It will stay gathered unless we vaporize the puddle.	R	-
63	**T**	I am looking so closely, but I do not see any bounds you mentioned. [The teacher leans towards the desktop and takes a closer look at the puddle]	FQ	Challenges (plays devil's advocate role)
64	**S9**	Sir! Because the atoms are already invisible. Thus, the bounds are smaller than the atoms, and then they are invisible.	R	-
65	**S7**	Sir, solids are more jointed, but gases are separated, and liquids are relatively separated compared to solids.	R	-
66	**S9**	Yes, Sir. The bounds are more pressed for the solids, lesser for the liquids… Moreover, the gases are independent.	R	-
67	**T**	All right! I am going to reduce the spaces you mentioned! Let us bring the water molecules closer… Is that OK now? Can I reduce the spaces within the atoms you talked about? [The teacher tried to bring the puddle together with his hand]	FQ	Challenges (plays devil's advocate role)
68	**S7**	No! Sir, there is no such thing! The bounds I mentioned are inside the atoms!	R	-
69	**T**	However, you previously mentioned that everywhere on the matter is covered by atoms. That is where I touch the atoms. So then, am I wrong?	FQ	Challenges (plays devil's advocate role)
70	**S7**	Sir! As we mentioned, "…The particles are more compressed for the solids, lesser for the liquids… Furthermore, the gases hold independent particles."	R	-
71	**T**	Then, I understand that matter is composed of particles rather than atoms. However, what do you mean by particles?	FQ	Reformulates // Probes

* PI: Patterns of interaction; **TDM: Teacher discursive move

constituted about 16% of the teacher's presented moves and were most frequently displayed. The other prominent moves were requesting clarification move (13.7%), asking the students to make simple predictions (10.3%), and guiding the students to make judgments, legitimization, evaluations, and criticisms for their classmates' thinking (9.8%). Table 2 presents an example in which about eight-minute discursive interactions can be traced, showing how the teacher performed the TDMs.

Several columns display the different aspects of a sequence of the classroom activity that incorporated several talk turns (Table 2; T: Teacher; S1: Student-1 who provided an answer initially) from Turn-30 to Turn-71. The utterances of the contributors are classified as "I" for Initiate, "R" for Response, "F" for follow-up questioning as a triadic dialogue; IRF and that triadic dialogue pattern characterizes any discursive talk (Mehan, 1979; Mercer & Barnes, 2020; Sinclair & Coulthard, 1975).

This sequence (from Turn-30 to Turn-71) was the second episode in which the teacher pooled the student-led ideas but did not interrogate them. This is redefined as low interanimation of ideas (Mortimer & Scott, 2003). This implies that teachers gather student ideas without examining them. In other words, teachers only want to be informed about the range of the ideas to eliminate irrelevant ones. Beyond, teachers select some other ideas that are important in fitting the streamlining the classroom discourse to a teaching agenda that was more associated with the social languages of school science.

In this sense, within Turn-30, the teacher recalled a proposed idea of a student (Student-4) and reformulated it. This was a discursive monitoring move to encourage the students to monitor their understanding of a classmate's thinking (Phillips-Galloway & McClain, 2020; van Zee & Minstrell, 1997a). The teacher then asked the students to determine the flow or further aspects of the topic under negotiation (Turn-30). In a latent sense, the teacher selected Student-4's idea since; she proposed that atoms adhere to each other within matter (Turn-31). Thus, the teacher wished to discuss intermolecular forces (social languages of school science) or something (everyday social languages of the learners) that holds atoms together. As expected, the proposal of Student-4 was closer to the social languages of school science as indirectly presented within the available curriculum.

After the response from Student-4, the teacher requested clarification from the student concerning whether the atoms are in the substances (Turn-32). Student-4 claimed that the atoms are within the substances (Turn-33). To probe the proposed response, the teacher asked how many atoms there were within a substance if they were embedded in the atoms (Turn-34). Student-1 immediately responded that there were countless atoms within the materials (Turn-33). Within Turn-36, the teacher tried to prepare the background for the further deeper negotiation initiated in Turn-48. Within Turn-36, the teacher proposed an idea of whether there were atoms in the pen she was holding to make this abstract phenomenon concrete for the sake of the students' reasoning.

Within Turn-37 and Turn-38, Student-1 and Student-2 consecutively provided utterances in response to the teacher-led question. Even though the teacher requested clarification using Turn-39, she proposed a thought-provoking idea by asking, "Do you think there are atoms within the pen I am holding?" The theoretical aspect of the teacher-led questioning was revealed when Student-2 (Turn-40) and Student-4 (Turn-41) responded cautiously with, "Isn't it?". Then, using the student-led information, the teacher presented reasoning concerned with atoms based on the students' responses and asked for clarification in terms of whether she was touching the atoms of the pen (Turn-41).

Within Turn-43, Student-4 withdrew his answer and stated that since it is not possible to touch the atoms, the surfaces of the matters could not consist of any atoms. In order to probe this response, the teacher rehearsed her first question to obtain a more in-depth explanation by trying to increase the possible or alternative responses (Turn-44). However, within the next three turns, the student-led responses appeared confused as they provided discordant utterances regarding the positioning of the atoms within the substances (Turn-45, Turn-46, and Turn-47).

When the teacher noticed that there were competing responses, he presented the first challenge. The teacher first mentioned the previous arguments of the students concerning atoms and matter. The teacher then proposed a challenging example that pointed to the idea that when he replaces a part of a pen, he moves the atoms of the pen from one side to another (Turn-48). He completed his utterance by rehearsing whether there are atoms within all parts of a substance. After the quick response of Student-4 (Turn-49), the teacher repeated the possibility of whether he could touch the atoms of any matter to understand the background reasoning of the student-led response (Turn-50). The students provided simplistic responses within consecutive talk turns (51-52-53); however, there was a consensus in the student-led responses implying there are atoms within substances. Finally, in Turn-54, the teacher invited all class members to contribute again to the classroom discourse by stating the importance of the discussion point concerning the positioning of the atoms within matter.

There was an array of student-led responses from Turn-55 to Turn-60 based on the invitation from the teacher. From the evaluation of these six student-led responses, it appears that the consensus was around the idea that atoms are dispersed to all parts of a substance. In order to augment the scope of the negotiation for supporting the further theoretical modeling procedures of the students, the teacher presented the second challenge (Turn-61). Based on the student-led responses, the teacher explicated his understanding by referring to the idea of whether atoms are conscious entities since they gathered together to create perfectly symmetrical substances. Next, the teacher presented an individual think-aloud interrogation. This included the idea of whether atoms gathered together to create smooth figures in nature or just in front of the students in the class. Then, the teacher poured some water on a desk placed at the front of the lab, asked how the waterhole stayed static and did not spread, and waited for the students' reactions to this more profound challenge.

In Turn-62, Student-9 gave a sophisticated response referring to the intermolecular forces and the relations between these forces and states of matter. By playing the devil's advocate role, the teacher leaned towards the pool of water and exclaimed that he could not see anything that bound the molecules together (Turn-63). Within the next three talk turns (64-65-66), two students argued that the naked eye could not observe the bonds among the atoms as atoms are not subjected to their basic observation (Student-9). Student-7 supported the proposal of Student-9 by adding the idea that the bonds among the atoms of a substance can be moved apart or come closer based on the states of matter (solid, liquid, and gas formations). Finally, within these three student-led talk turns, Student-9 reinforced the proposal of Student-7 (Turn-66).

The teacher listened carefully to the students and reacted to their responses with the challenging move (Turn-67). Student-7 rigorously objected to the last challenge of the teacher and countered it by defending the idea that the bounds of the atoms are embedded in the water (Turn-68). Immediately, adopting a background discursive move, the teacher reminded the students that they had claimed that atoms were dispersed to all parts of the substances (Turn-69). This move was coded as a challenging move rather than a monitoring move, as shown in the catalog through which the teacher enacted a counter-argument. Student-7 responded by comparing the distances between the particles of an atom in terms of the three states of matter (Turn-70). The teacher then presented the term particle to lead and probe the topic under negotiation, reformulated the student-led response, and initiated the next episode. The students were to discuss the particular states of matter (Turn-71).

To explicate, in constructing a discursive journey from the everyday social languages of the students to the social languages of school science, the teacher presented challenging TDMs for particular purposes. The students were expected to convince the teacher who had adopted a primarily neutral position regarding the student-led claims; however, this did not mean that the teacher could be persuaded with simplified premises. As explained above, the teacher behaved as a class member seeking justified arguments that were rational, convincing, acknowledgeable, and believable. In other words, the teacher offered concrete meta-communicative signals that if the students wanted to be accepted by the teacher and the other members of the class. Therefore, S/he had to propose well-structured arguments that might at the least be warranted. These findings should be elaborated, first concerning the nature and necessity of the argumentative discourse for a theoretical modeling process.

During the implementation, the students were involved in theoretical modeling to create an argument concerning the nature and structure of matter and its properties. When the students were rigorously challenged, they felt that they had to generate stronger arguments to defend their claims and persuade others regarding the validity of their utterances (Manz & Suárez, 2018; McMahon, 2012; Simon et al., 2006). Through the challenging TDMs, all the proposed arguments consisted of resolving the problems or issues emanating from the contradictions. According to Bachelard (1968), "two people must first contradict each other if they wish to understand each other. Truth is the child of argument, not of fond affinity." (p. 114). In the presence of concrete challenging TDMs, the end goal of creating a valid theoretical model was essential to the resolution of the differences in the arguments of the students (Erduran, Simon, & Osborne, 2004; Firetto et al., 2019; Osborne, Erduran, & Simon, 2004; Simon et al., 2006). Challenging TDMs were considerably instrumental in aiding the students to select one explanation over another. In addition, this group of moves was enacted to eliminate a student-led explanation regarding the topic under negotiation during the discursive journey.

Another explanation comes from van Eemeren and Grootendorst (2004), who defined argument construction as a "verbal, social and rational activity aimed at convincing a reasonable critic of the acceptability of a standpoint by putting forward a constellation of propositions justifying or refuting the proposition expressed in the standpoint." (p. 1). There should be justification and refutation procedures in the student-led argument construction as substantially observed during this discursive journey. They mainly were made possible with challenging TDMs (Firetto et al., 2019; McMahon, 2012; Simon et al., 2006). Thus, the teacher made available and public the conceptual, ontological, and epistemological conflicts of the students (Mortimer & Scott, 2003) mainly through challenging TDMs.

In support of this idea, the students proposed explanations in response to the teacher-led questioning. The students inherently used their everyday social languages in meaning-making of the phenomenon presented by the teacher. However, the teacher was able to show the conflicts within the students' everyday thinking and talking when discussing matter and properties. In the presence of the concrete challenges, the students were mainly convinced that their reasoning did not incorporate explanatory and exploratory power in analyzing the unidentified facets of the phenomenon. When this was the case, during the discursive journey, the students tried to appropriate other thinking-talking systems as an alternative to their social languages and including more powerful aspects in accounting for the dynamics of matter and properties (Bakhtin, 1934, Mortimer & Scott, 2003; Soysal, 2021). Thus, detecting the fallacious aspects within the everyday social languages of the students and prompting the students to embrace a more intellectually stronger social language was more feasible under the guidance of the teacher (Engle & Conant, 2002; Lemke, 1990; Mortimer & Scott, 2003; Soysal, 2021).

Another aspect of Assertion-II is that when the higher-order categories were composed, in a broader sense, the communicating-framing TDMs had the highest occurrence proportion (38%) among the other moves (see Figure 2). The communicating-framing moves included four different sub-moves in which the teacher; embodied (7.35%), probed (8.33%), requested for clarification (13.7%), and monitored (8.33%).

The teacher presented the two-fold communicating-framing TDMs to identify, elaborate, reformulate, probing, and frame the student-led utterances. The teacher conducted the communicating-TDMs to clarify and discern the background meaning embedded in the student-

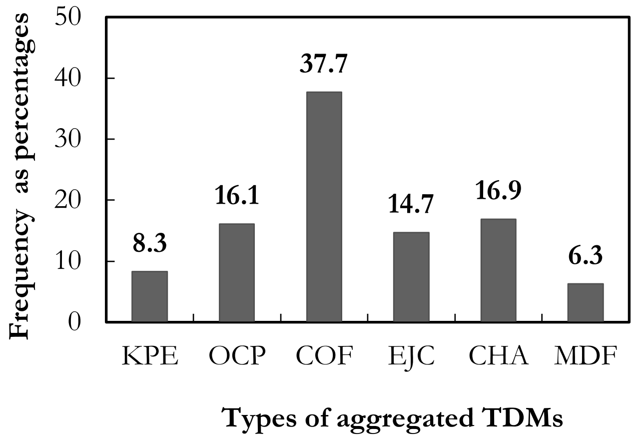

Figure 2 Collapsed categories of the TDMs (%)

led utterances (Edwards and Mercer 1987; Lemke 1990; Kawalkar and Vijapurkar 2013; van Booven 2015). After the teacher clarified and probed the student-led utterances, the students could externalize their understanding of the topic under negotiation. The externalization of the background meanings of the student-led responses appeared to be considered influential in extending the scope of the negotiations. The teacher first had to capture the meaning underlying the student-led utterances to determine that they possessed conceptual, epistemological, and ontological cognitive contributions.

The primary purpose of presenting the communicating-TDMs was to make the student-led utterances available for whole-class members in the process of revoicing (Chapin, O'Connor, & Anderson, 2003; O'Connor & Michaels, 2019). This was a procedure of the familiarisation of the proposed ideas during the negotiations. When the teacher performed the communicating moves, the underlying meanings of the student-led utterances become apparent to all the students. Some studies found that these TDMs offered the students opportunities to support, argue or refute their classmates' utterances since the contributors had comprehended each other's utterances (Martin & Hand, 2009; McNeill & Pimentel, 2010; Simon et al., 2006). As revealed in this study, first, the teacher and students needed to understand the implicit or explicit lexical orientations of each other's utterances. Then, it was possible to detect the fallacious utterances embedded in the student-led utterances' semantic structures. Thus, if class members wanted to contradict each other, they first had to find whether the ideas of the others were authentic or whether they had an underlying meaning.

The teacher's framing/monitoring discursive move encouraged the students to follow their understanding of a classmate's utterances. The teacher stimulated his students to be cognisant of others' proposed ideas (Soysal, 2021; van Zee & Minstrell, 1997a; 1997b; van Zee, 2000). The monitoring move of the teacher provided the students with a metacognitive framing tool (Berland & Hammer, 2012; Ha & Kim, 2017) in tracing the occurrences of the classroom discourse (e.g., "*If you notice… She is drawing the atoms as she had seen them before, did you notice this?*" Turn-75). The teacher frequently reminded his students to eliminate particular ideas or attach importance to other ideas during the discursive journey. By way of monitoring discursive moves, the students were led to be conscious of the stream of the featured points during the negotiations (e.g., "*For your attention, I am now mixing up these two solid substances and these two solid substances are now mixed, aren't they?*" Turn-200). In this discursive journey, the teacher repeatedly reminded his students to determine where the context of the negotiation was and what would be the context of the negotiation in further phases of the negotiations (e.g., "*We are going to discuss whether making models with play dough reflects reality, whether we are close the actuality and not. But a little later, OK?*" Turn-275). There were teacher-led foreground and background reminders, allowing the students to monitor which aspects of the everyday social languages were not helpful and to which aspects of the social languages of the school science should they pay attention in illustrating the various features of the matters and properties when designing theoretical models (e.g., "*A major question has been raised just now concerning how many salt molecules are inserted into the water molecules*" Turn-308).

The monitoring move provided a frame for the students, allowing them to comprehend the initial conceptual, epistemological, and ontological points they had discussed. In this sense, framing through monitoring characterized the student-led discursive expectations, on-moment conceptual or procedural schemas, and negotiation patterns for what was taking place in the classroom discourse at that moment (Ha & Kim, 2017). Therefore, the students comprehended that the negotiation groups and teacher drove forward certain concepts, explanations, illustrations, drawings, or reasoning while excluding or ignoring others. Namely, the monitoring move helped the students in individual sense-making or an on-moment cognitive patterning regarding "what is it that's going on here?"

To summarise, during the discursive journey, both challenging and communicating-framing discursive moves were of significant importance. The teacher brought the student-led cognitive contradictions to the fore through the challenging discursive moves, permitting them to shift from their everyday social languages. However, as shown in this study, these appropriating processes of the students were more viable in the frequent and intentional uses of the communicating-framing moves.

#Assertion-III: *The teacher created an argumentative and evaluative context in which the students had the right to legitimate, criticize, evaluate and judge their classmates and teacher's utterances that modified the epistemic and social authority discursive journey.*

For the depicted discursive journey, the teacher needed to present particular discursive moves to prompt the students to evaluate their classmates or teacher's utterances. This group of TDMs is labeled as Evaluating-Judging-Critiquing (EJC; Table 1). The EJC moves occupied an important place within the moves presented by the teacher (14.7%, Figure 2). The teacher prompted the students to evaluate and judge their utterances and of their classmates through the EJC moves (e.g., "*Is there anyone who wants to pose a question to a classmate? Would it happen the way she explained?*" Turn-88). EJC moves were also used in the case studies carried out by van Zee and Minstrell (1997a, 1997b) and van Zee (2000) in the same manner as in the current study.

The teacher placed the route of the discursive journey under the control and guidance of the student-led evaluations, legitimization, criticisms, and judgments. This was more feasible through EJC moves performed by the teacher as a persuasion process. To explicate, the teacher continuously directed the students to judge and evaluate the teacher-led or student-led utterances ("*According to what she says, is there a hole in that wall? What do you want to say to her?*" Turn-98). In an evaluative discursive context, the teacher tried to persuade the students that they already held cognitive contradictions regarding the topic under negotiation ("*Did you see the modeling of your friends? Is there anyone who wants to critique it? Or do you have questions for this modeling?*" Turn-208). The teacher allowed the students to contrast the utterances of others that substantially differed. However, some had to be selected while eliminating others to reach a consensus (e.g., "*Then, OK. All right, for your consideration, is this a true model that explicates the reality? Or does it demonstrate the actuality? So, what are your evaluations, ideas? Please talk about them.*" Turn-220). Thus, this was not a conventional classroom discourse; instead, the teacher adapted reflective discourse through the EJC moves.

In the setting of this discursive journey, the teacher implemented reflective discourse (Chin, 2006; 2007; Kelly & Licona, 2018) instead of a binary Socratic discourse while he executed the EJC moves. Socratic discourse is conducted "in a humiliating manner, in front of company, with plenty of irony and sarcasm"; (Santas, 1979, p. 5). However, the EJC moves favored another type of discursive intentionality. The teacher acknowledged the student-led responses as valuable contributions by considering the students as co-legitimators or co-evaluators (van Booven, 2015). The teacher tried to convince the students that the thinking-talking style of the school science social languages might be more relevant in theorizing. The teacher was not alone in coping with countless counter or alternative student-led ideas in the classroom. The teacher was supported by members of the class in the process of the discursive journey. Based on the teacher-led demands, the students made detailed evaluations and judgments when the utterances of their peers were not plausible or incorporated less explanatory power.

Moreover, when the teacher presented the EJC moves, responsiveness was obtained (Studhalter et al., 2021). This shows that the teacher was able to use the student-led information to manage the discursive journey. During the discursive journey, the teacher performed the EJC moves by deliberately associating the various student-led ideas with each other, which led to the students pondering on what we know and why we believe the utterances of others (Berland & Hammer, 2012; Colley & Windschitl, 2021; Hutchison & Hammer, 2010; Scherr & Hammer, 2009). Thus, in the negotiations, the teacher did not act as the sole person who decided what was correct and why this was so (Cazden, 1988; Colley & Windschitl, 2021; Lemke, 1990); instead, the student body was the co-evaluators and co-judgers.

The presence of the co-evaluators and co-judgers of the discursive journey signified that there were co-authorities of the journey. The teacher's EJC moves had the potential to modify the power relations. This implies a novel reconfiguration of the power allocations in shifting the speaking styles of the students. For this discursive journey, there are two authorities: epistemic and social authority (Berland & Hammer, 2012; Maeng, 2021). A teacher can prioritize what counts and what does not count as an intellectual contribution, which implies the epistemic authority of classroom discourse (Lefstein, 2008; Lin, 2007; Maeng, 2021). This provides a discursive control mechanism and places the teacher as an undisputable primary knower. Suppose a teacher monopolizes this epistemic authority (Berland & Hammer, 2012). In that case, s/he also creates the social authority, and therefore determines, for example, the students' talk turns or permits students to say something about the topic under negotiation.

In this discursive journey, the teacher allocated his epistemic and social authority through the EJC moves. Once the teacher allocated his authority, there was more than one authority to manage the classroom discourse. First, the students had the epistemic authority in that they were guided in legitimizing what (student-led utterances) counted as plausible in the theoretical modeling. In other words, they had opportunities to determine whether a student-led utterance would be acknowledged when the teacher said, "*So, what do you want to say, class? Do you agree with her comment? I mean, is it possible that it occurs as your classmate mentioned?*" (Turn-224).

For this discursive journey, the social aspect of authority was monitored by taking the allocations of patterns of interactions (talk turns) into account (Jin, Wei, Duan, Guo, & Wang, 2016) and the basic frame in which to fragment the teacher-student interactions was a triadic dialogue (Mercer & Dawes, 2014). The dominative triadic dialogues mainly occurred as IRF questioning with the teacher initiating the verbal exchanges through, for instance, a question (I); then, the students responded (R),

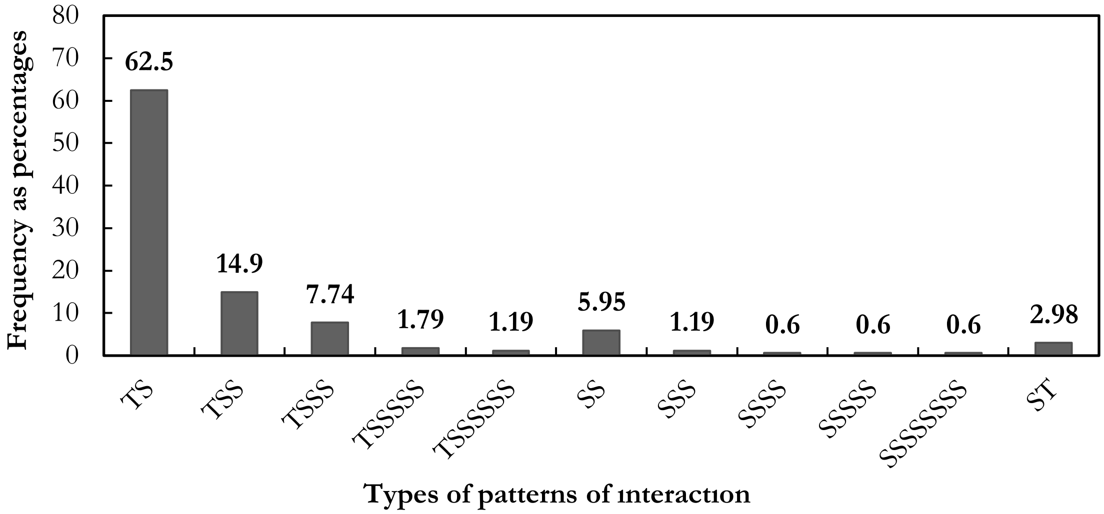

Figure 3 Percentages of patterns of interaction

and lastly, the teacher posed another contingent question (F) based on the students' previous responses (Lemke, 1990).

During this discursive journey, the interactions between the teacher and students occurred as open-ended chains: IRFRFRF. Beyond the teacher executing the EJC moves, the streaming of the patterns of interactions was anticipated to be sequenced as TSSS…SSS (T: Teacher; S: Student). Thus, the social negotiations of meanings were mainly carried out among the students as they were expected to hold the social authority by legitimatizing the thinking of their classmates (Maeng, 2021; McNeill & Pimentel, 2009). This discursive patterning confirmed the need for a modification in the social authority of the discursive journey in addition to the epistemic authority. A closer look at the patterns of interactions that emerged showed another reality in the current study.

Teacher-student and student-student exchanges were counted to determine the patterns of interactions, as shown in Figure 3. The [T-S] patterning signifies a sole teacher-student interaction continuing as T-S-T-S-…-T-S with a [T-S-S] pattern revealing a triadic exchange of teacher-student-student. [T-S-S-S] displays another discursive pattern which is a quadruple of teacher-student-student-student. The [S-S] pattern represents a student-led initiation of the dialogue through a question and another student responding to the posed question. In addition, [S-S-S] demonstrates a triadic exchange incorporating three different student-led voices. Finally, the pattern [S-T] confirms a student-posed question to the teacher, who was required to respond.

Most verbal exchanges were between the teacher who engaged in follow-up questioning and a student who responded ([T-S]: 62.5%; Figure 3). About 15% of all the patterning was detected as [T-S-S], with other types of patterns of interactions being detected at lower frequencies.

At first appearance, it seems that the proportions of the patterning of interaction stated above might have a damaging influence on social authority sharing. To explain, when the teacher drew away from the negotiations, the discursive streaming could have been blocked for that type of discursive journey. However, when the teacher noticed that the streaming of the classroom discourse was disrupted, he began to initiate another streaming that was more instrumental in advancing the classroom discourse. In addition, the teacher needed to behave as a moderator and strictly manage purposeful negotiation streaming approximating to the school science social languages.

Indeed, the teacher wanted to arrive at a position with his students at the end of the negotiations. This seemed more attainable under the purposeful guidance of the teacher who was monitoring and modifying the streaming of the negotiation through a *meta-discursive lens*. The students provided diversified responses pooled, selected, eliminated, and featured for the discursive journey. The teacher was not the sole person who selected or eliminated the proposed ideas. Instead, the teacher recognized and assigned the students as selectors and eliminators mainly through the EJC moves. Thus, in the current study, this sharing of the social-epistemic authority authorized the students to evaluate and judge their classmates' ideas, but under the scaffolding guidance of the teacher. This process might be directly reflected in the patterns of the interactions. Three seminal works are given below support this finding in the current study concerning the relationship between the EJC moves and epistemic-social authority sharing.

Firstly, Hogan, Nastasi, and Pressley (1999) undertook a fine-grained analysis of discourse patterns by comparing peer-guided and teacher-guided discussions. In their study, even though more talk took place in small student groups, the students' arguments were under-articulated and piecemeal. The students could not recognize what they needed to clarify and present to the group members without guiding TDMs. In this sense, the teachers crystallized the need and essence of discussion streaming more precisely for purposeful meaning-making (Hogan et al., 1999). Thus, TS-dominated discursive patterning cannot confirm a damaging influence on social authority sharing, as seen in the current study. Once the teacher prompted the students to evaluate and judge their classmates' reasoning, he had to abide by the end purpose of the implementation-defined as transiting the students from a social language to another.

Secondly, the teacher performed particular TDMs that were intrinsic to the current study. The teacher enacted certain TDMs in modifying the streaming of the negotiations. The teacher performed managing moves. He consulted the students to determine further negotiation streaming or asked for their permission to engage in the negotiations (Table 1). Even though the relative percentages of managing moves remained at the lower boundary (6.3%; Figure 3), it can be considered that these moves were worthwhile in restructuring and sharing social authority in addition to the EJC moves. This contributed to the ethos of mutual respect in which neither the teacher nor the students were the primary motivators of the initiation of their new topics (Christoph & Nystrand, 2001; Hartl, 2021). Instead, during the negotiations, the students were engaged in listening and responding to the utterances of others through the managing (MDF moves, Table 1) and EJC moves. In conclusion, the TS-dominated patterning of interactions did not have a damaging influence; instead, it promoted scaffolding and aided in continuing to travel during the discursive journey (Christoph & Nystrand, 2001; Hartl, 2021).

Thirdly, Engle and Conant (2002) defined productive disciplinary engagement (PDE) as incorporating four principles: problematizing, authority, accountability, and resources. During a discursive journey, the students need to be prompted to undertake intellectual problems, as was the case in the current study in making the student-led cognitive contradictions public (problematizing). After this, the students need to be given authority in addressing the conceptual, epistemological, and ontological contradictions (authority). However, there must be a contract for accountability that implies that "students' intellectual work is made accountable to others and disciplinary norms" (Engle & Conant, 2002; p. 401). During the discursive journey, the students had to provide plausible arguments to convince their classmates and the teacher. They favored the social languages of the school science in handling the discursive journey. Finally, the students must be provided with sufficient resources to understand the first three principles. In the current study, during the modeling processes, the students were provided with adequate materials to establish their theoretical modeling.

In terms of sharing the authority through the EJC moves, the second and third guiding principles of PDE, in particular, are explanatory in terms of the findings of this study. First, the teacher delivered authority to the students by allowing them to evaluate, judge, criticize and legitimatize the thinking and talking of their classmates. In this way, the teacher assigned the students to be the co-judgers and co-evaluators of the proposed ideas. This (epistemic-social) authority sharing through the EJC moves was undertaken to make the students accountable to others and the disciplinary norms (school science social languages). The teacher had to guide the students to make evaluations and judgments of the proposed ideas. Thus, intentionally, as the discussant chair, he directed the students to discuss with each other, creating a discursive environment in which authority sharing and accountability fluctuated during the journey from one social language to another. While the students were held responsible for the evaluations and judgments of the other's thinking and made themselves accountable to the others' thinking and the social languages of school science, the teacher positioned himself as a moderator frequently involved in the negotiations. The teacher, therefore, maintains an internally consistent discursive streaming through the TS-dominated exchanges.

5. CONCLUSION AND RECOMMENDATION

This study shows several dynamics of a discursive journey managed through particular TDMs. A teacher can benefit from diverse TDMs, which can be dialogical/monologically oriented and simplistic/sophisticated in the presence of alternative thinking-talking styles. Furthermore, shifting an everyday social language into a dissimilar one can be better accomplished in making the student-led conceptual, epistemological, or ontological conflictions public, convincing the students that their social languages tend to be less illustrative in shedding light on phenomena. However, this persuasion process can be more easily attained when the arguers comprehend each other's thinking and talking background intentions and meanings. Moreover, a teacher can find proponents (students as co-evaluators) that bring to light that the everyday social languages of students cannot be sufficiently instrumental in explicating a phenomenon compared to alternative social languages when s/he presents the EJC moves. Finally, in the discursive journey investigated in-depth in this study, the primary issue is that in order to achieve an intellectual consensus, it is necessary to share the epistemic-social authority and configure an ethos of mutual respect rather than creating an environment in which the students only contradict or try to outdo each other. One of the most paramount educational recommendations of the present study is teacher noticing about the dynamics of the discourse journey. This study infers that science teaching is a multifaceted enterprise in the presence of mutually exclusive thinking and talking systems. Therefore, science teachers should be engaged in professional development programs to capture their talk moves' discourse functions within an in-class discourse journey by acting as reflective practitioners.

6. LIMITATION OF THE STUDY AND FUTURE DIRECTION

Even though the current study presents an in-depth and fine-grained qualitative analysis of the TDMs in the science teaching context, some limitations should be acknowledged and further detailed for future directions. First and foremost, there was only one teacher whose talks moves were investigated in-depth. It would be more illuminating to examine more than a science teacher's TDMs. As mentioned, the participatory science teacher was an experienced one. It would be a limitation of the current study not to compare and contrast the diversity of the TDMs that might be enacted differently by more experienced and beginner science teachers. In addition, limited verbal data corpus was deeply systematically analyzed in the present study. A more longitudinal data collection, analysis, and interpretation may permit the detecting of additional typologies of the TDMs extracted in the present study. A chemistry-based content was used in the implementation to trigger and maintain the verbal interactions. To detect additional aspects of the TDMs, biology-related, physics-related, astrophysics-related, or the topics in the earth sciences should be used to see saturated typologies of the TDMs based on the concepts under consideration.

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