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Teaching Socio-Scientific Argumentation in two Chinese Science Classrooms: A Case Study

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Abstract: Engaging students in socio-scientific argumentation is proven effective for resolving everyday issues, yet its integration and implementation in Chinese science classrooms face challenges due to limited curriculum resources and traditional didactic Confucian pedagogy. To investigate these integration efforts, we collaborated with a Chinese science teacher, analyzing four episodes of her SSI argumentation teaching. We found that the teacher consistently framed SSI argumentation activities as addressing everyday problems and tended to engage students in a more authentic version of science practice along with restricted shared epistemic agency. Our fine-grained analysis on teacher's discourse moves that facilitated whole-class argumentation revealed four frequently employed categories: setting norms, revoicing, pressing, and summarizing, all contributing to either sustaining or advancing the whole-class argumentation process. Despite challenges, this study provides insights into effective SSI argumentation integration in Chinese science classrooms.

Introduction

One of the overarching goals in science education is to prepare students to resolve complex science-related everyday issues (e.g., NGSS Lead States, 2013). Engaging students with argumentation practice in the context of socio-scientific issues (SSI) has been proven effective to address this goal (e.g., Sadler & Donnelly, 2006). Socio-scientific issues, such as climate change (e.g., Byrne et al., 2014) and local water quality (Belland et al., 2015), provide ideal contexts for students to make and justify claims or personal decisions with evidence from multiple perspectives or values. Different from scientific argumentation that mostly justifies disciplinary knowledge claims with empirical evidence, SSI argumentation draws on not only students' prior scientific knowledge, but also their life experience, values, and personal identity (Balgopal et al., 2017; Oliveira et al., 2012).

While SSI argumentation has been broadly recognized as a higher order thinking skill by science educational researchers, it remains challenging for teachers due to a lack of curriculum materials (Saunders & Rennie, 2013), instructional time (Chen & Xiao, 2021), appropriate teaching strategies (Pitpiorntapin & Topcu, 2016), and assessment (Tidemand & Nielsen, 2017). SSI argumentation teaching is even rarer in science classrooms in China because of the traditional didactic Confucian pedagogy (Nisbett, 2004). Traditional Chinese instructional approach is widely described as a transmissive process (Wells & Arauz, 2006), with teachers assuming an authoritative role of imparting knowledge and students mostly receiving content knowledge (Biggs, 1998; Huang et al., 2019). However, with several waves of educational reforms, argumentation situated in everyday issues has been increasingly recognized as a key component of scientific thinking in China's recent science standards (Ministry of Education, P. R. China, 2022, p. 38). This recognition puts both opportunities and pressure on science teachers to transform their science teaching.

To explore how Chinese science teachers integrate SSI argumentation teaching into their classrooms, this study took place as a part of a larger project following the design-based research approach. In this larger project, we collaborated with a Chinese science teacher in choosing SSIs, designing instructional materials, and collectively reflecting on teaching videos to understand and improve argumentation teaching practices. Instead of describing the entire process of the teacher's preparing, implementing, and reflecting on SSI argumentation teaching in general, this study specifically focused on capturing features of SSI argumentation implementation in Chinese science classrooms and identifying teaching strategies to better capture science teacher's success, challenges, and roadblocks in implementing SSI argumentation. Thus, we ask the following questions:

1. *What are the main features of a Chinese science teacher's SSI argumentation teaching?*
2. *What strategies did the teacher use to facilitate students in whole-class SSI argumentation?*

Theoretical framework

We used the *Framing-Agency-Version of Practice* (F/A/V) scheme (Sandoval et al., 2021) to roughly characterize SSI argumentation teaching episodes in terms of its framing of SSI topics, locus of authority and accountability, and versions of science practices students engaged. We used the F/A/V scheme for our analysis because it could capture its relation to the teaching practices that are everyday phenomena anchored, student-centered, and scientific practice oriented (Windschitl, Thompson, & Braaten, 2020), and could also characterize changes in teaching in coarse-grained classroom discourse for longitudinal analysis (Sandoval et al., 2021).

The F/A/V scheme consists of three dimensions, namely "*Teacher framing of activity,*" "*Locus of epistemic agency,*" and "*Version of Science Practice.*" For each dimension, each selected episode could be coded as 1 or -1 to capture the dichotomous poles of each dimension or 0 if the locus is in between or unclear.

Teacher Framing of Activity focuses on how teachers frame the purposes of students' academic tasks. This dimension is interested in whether teachers frame students' work in relation to understanding everyday phenomena (1) or memorizing canonical science content (-1). For example, when the science teacher we collaborated with situated the "Classification of Organisms" into an ecological park planning and construction, in which students were envisioned as a manager who needed to choose a best plan for arranging/classifying different organisms, we coded its framing as 1. If framing of "Classification of Organisms" was replaced with learning different types of criteria to classify organisms, we code it as -1. Furthermore, when the academic tasks are not clearly framed in either way above, we code it as 0. With this dimension, we primarily code framing from teachers' transcripts in the introduction of SSI argumentation tasks.

Locus of Epistemic Agency defines "the locus of authority and accountability for what counts as knowledge and acceptable ways of knowledge construction and evaluation in the classroom" (Sandoval et al., 2021, p. 39). In this dimension, we code these interactional transcripts between teachers and students, which include interactions regarding which questions are deemed worthy of exploration, who decides how to complete academic tasks, e.g., laboratory investigation or preparation of argumentation activities, and who has authority to evaluate students' work. Episodes in which students are positioned as the locus of authority and accountability, they are coded as 1. In this sense, students are granted autonomy to decide how to complete tasks and evaluate works. Episodes in which teachers are considered as the sources of primary authority for knowledge construction and evaluation, are coded as -1. When students are given limited agency to conduct a scripted experiment, that is coded as 0. Or locus of epistemic authority is unclear either because it is not raised by teachers or students, or students did not take it when offered by teachers.

Versions of Science Practices examines whether students engage in authentic versions of science practice. In other words, the forms of science practice students involved can be either "highly schooled (-1) or legitimately scientific practices (1)" (Sandoval et al., 2021, p. 40). For example, if students are asked to revise their arguments based on new evidence or concepts that arise, we would code this as a more scientific version of practice. However, these traditional prescribed lab experiments are considered as highly schooled practice (-1) in which students have little freedom for improvision. If students engage in tasks where they have limited/undetermined freedom to conduct a scientific practice, that would be coded as 0. For example, students are tasked with revising an earlier arguments by themselves, but their teachers set the criteria for evaluation.

Among three dimensions, teachers' framing of activity often occurs in the beginning of each SSI argumentation introduction. Agency and version of practice are easily tangled together in the same student-teacher interactional episodes. For those highly authentic science practices, students are more likely to have a higher level of epistemic agency over how to complete tasks. But authentic science practices do not necessarily guarantee a highly shared students' epistemic agency.

Methods

Participants and data sources

This study was conducted in two 6th grade classrooms (Class A and Class B) in a non-profit private middle school in Shanghai China during the 2020-2021 school year. A science teacher, Ms. Li (pseudonym), with one-year science teaching experience, was invited to participate in our project because of her interest in argumentation-oriented instruction and strong desire to explore multiple science teaching pedagogies. Additionally, we had also intended to work with novice teachers, as they are not committed to a traditional lecturing style. A total of 91 (45 in Class A and 46 in Class B) students aging from 11 to 13 also participated in this study.

Throughout the entire semester, we collaborated with Ms. Li and iteratively co-designed two SSI argumentation teaching sessions and embedded them into her existing teaching syllabus, which consisted of four required units, namely, Unit 1 *Introduction to the Science, Unit 2 Biological World, Unit 3 Cell and Reproduction, and Unit 4 Particle Model of Matter*. With Ms. Li, we collectively selected two topics that best fit with her teaching pace and science content involved: (1) *Should endangered wildlife be introduced into ecological parks?* (unit 2); (2) *Do you support the use of cloning technology to solve fertility issues?* (unit 3). To integrate SSI argumentation teaching into Ms. Li's existing syllabus in a smoother way, she suggested that we reduce each SSI argumentation session to 20 minutes at most and schedule them at the end of 45-minute science lessons.

We videotaped two science lessons for both Class A and B, totally four videos (approx. 180 minutes). Two cameras were positioned at the front and rear of the classroom to ensure optimal capture of classroom interactions.With these four lessons, we specifically focused on four episodes of SSI argumentation teaching (approx. 70 mins). Additionally, we observed the classroom setting, and took field notes for capturing more background information.

Data analysis

Our approach to understanding Ms. Li's teaching practices was guided by principles of interaction analysis (Jordan & Henderson, 1995). First, we reviewed the four science lessons and logged the broad segments of activities in terms of academic tasks structure, participation structure, and timestamp. Logging entails recording the start time of a new academic task, and the participation structure with a brief task description (Sandoval et al., 2021). Then, we identified four SSI argumentation teaching episodes in alignment with academic tasks and coded them with F/A/V scheme presented above (Sandoval et al., 2021).

For each episode, we cut it into two parts: (1) Teacher's framing of argumentation purposes in the beginning; (2) Teacher-student interactions around how students prepare written arguments and unfold argumentation activity in whole class. The first part matches with Teacher Framing of Activity in the F/A/V scheme, primarily focusing on Ms. Li's introduction of SSI topic. In our case, we coded the second part in accordance with both Locus of Epistemic Agency and Version of Science Practice, as they closely overlapped with each other in the timeline. For example, in the two SSI argumentation teaching episodes about whether to introduce endangered wildlife animals into an ecological park, Ms. Li gave students free time to formulate their arguments, discussed it with their group's members, and further revised it based on their discussions. But in the whole class discussion, she reinforced her authority in setting acceptable ways for orally presenting arguments, which might weaken students' epistemic agency in fully unfolding arguments. These two episodes were coded as 1 in the dimension of science practice and 0 with respect to the locus of epistemic agency.

Moreover, we further pinpointed four video clips exclusively featuring whole-class SSI argumentation excerpted from the second part of four episodes and transcribed these clips using MAXQDA. Codes focusing on teachers' discourse moves to facilitate whole-class argumentation, encompassing various categories of talk moves with specific goals for argumentation, emerged from constant comparisons. The focus of analysis was on the teacher's utterances, specifically examining her talk turns as the unit of analysis. Hence, wherever Ms. Li's utterance reflected explicit goals for achieving argumentation, we highlighted and coded it. Apart from coding Ms. Li's discourse moves, we also counted the frequency of these codes in each clip. In this way, we could better capture changes in Ms. Li's discourses strategies over time.

Findings

RQ 1: What are the main features of a Chinese science teacher's SSI argumentation teaching?

To capture the main features of our participating teacher's SSI argumentation teaching practices, our findings began with describing her instructional sequences for four episodes and delved into deeper to feature her framing of SSI topics, locus of epistemic agency, and version of science practice using the F/A/V scheme.

Given the fact that Ms. Li co-designed SSI argumentation teaching materials with us and taught them by herself, these episodes shared a similar instructional sequence. All four episodes started with Ms. Li's framing of each SSI and its relevance to both science content students learned and the broader society. Then, Ms. Li invited students to read pertinent materials with both supporting and opposing arguments and write down individual opinions about two SSI topics above. Shortly afterward, students were assigned into groups to discuss, convince each other, and note their own claims and arguments on the worksheets. Finally, a representative in each group shared their claims and arguments with the whole class, taking counterarguments or other adds-on, which were facilitated by Ms. Li.

Teacher's framing purposes of SSI argumentation as addressing everyday problems

In this study, we found that Ms. Li was consistently framing the SSI argumentation as addressing everyday problems across four episodes, as summarized in the Table 1. For example, prior to broaching the idea of introducing endangered animals into an ecological park, Ms. Li initially envisioned her students (in both Class A and B) as the managers tasked with selecting the optimal classification plan for organizing various organisms within the park. As they delved into planning and construction of the ecological park, she revisited the students' role as park manager, presenting them with the additional challenge of deciding whether to introduce endangered animals into the park. This decision remained challenging to make because, while there were an increasing number of animals facing extinction, introducing these endangered animals into ecological parks could potentially limit their freedom, alter their natural behaviors, and disrupt the existing food web. Students were required to make independent decisions supported by arguments, aiming to convince their peers. These subparts of episodes were coded as 1, as Ms. Li articulated the purposes of SSI argumentation in helping decision-making on authentic problems and persuading others to adopt this decision.

<u>Exposing students in authentic version of science practices but with limited shared epistemic agency</u>
Transitioning to these teacher-student interactions around how students prepared written arguments and engaged in whole-class argumentation activities, we observed that Ms. Li tended to engage students in a more authentic version of science practice, along with restricted shared epistemic agency. In the episodes of using cloning to solve fertility issues, Ms. Li gave students free time to formulate their arguments, discussed it with their group's members, and further revised it based on their discussions. But in the whole-class argumentation, she reassumed her authority by setting acceptable ways for orally presenting arguments, which could weaken students' epistemic agency in freely unfolding arguments. For instance, in the following interactional excerpt, student S3 and S4 were able to freely exchange their ideas about maturity of cloning technology initially. However, as discussion delved deeper into the intricacies of cloning technology, Ms. Li redirected the focus by reiterating, "*Please keep in your mind, when you stand up, express your own opinions first, ah, express your own opinions first.*" This restatement reinforced her authority in setting acceptable ways for knowledge construction. These episodes were coded as 1 in the dimension of science practice and 0 with respect to the locus of epistemic agency.

S3: So, what I am saying is that the cloning technology isn't mature yet. Cloning an extinct animal results in a short life. If human cloning fails, wouldn't they die even faster? And the family willing to sacrifice for this would be devastated. Nobody is willing to conduct such an experiment, right?
S4: Cloning animals means the cloned ones dies, not the original being cloned.
S3: Oh, I see. But what if the cloned human dies?
S4: Cloned humans are created from human cells, not from the person directly. They use the person's genes, not the person themselves.
T: Alright, all classmates, **please keep in mind, when you stand up, express your own opinions first, ah, express your own opinions first!** (Class A_2)

There was an episode (Class B_2) that, despite being coded as 1 in the dimension of science practice, we assigned a -1 in terms of the locus of epistemic agency. In this episode, classroom norms were severely violated in whole-class argumentation, such as excessive noise from students. Ms. Li repeatedly requested that students be respectful listeners and, at times, had to interrupt some students' talking by asking for "*Pause for a moment and give them a second to calm down*." In this instance, while students in Class B_2 had experience akin to the construction and revision of arguments before whole-class argumentation as other three episodes, we still assigned -1 in terms of locus of epistemic agency. This was because students had very limited freedom or agency in presenting and communicating their final arguments to the entire classroom, distinguishing it from the dynamics observed in the other three episodes.

Table 1
Summary of F/A/V Coding of Four SSI Argumentation Episodes

Episode	Framing	Agency	VoP
Class A_1	1	0	1
Class A_2	1	0	1
Class B_1	1	0	1
Class B_2	1	-1	1

RQ 2: What strategies did the teacher use to facilitate students' engagement in whole-class SSI argumentation?

To answer the second research question, we pinpointed and coded four video clips exclusively featuring whole-class SSI argumentation excerpted from each episode. The unit of coding was Ms. Li's utterance that was oriented to facilitate whole-class argumentation. Hence, we coded Ms. Li's utterances in terms of its categories of talk move and its further goals for achieving argumentation. For example, Ms. Li remarked "*Okay, he brought out Mr. Darwin again, but with reasons, huh?*" This utterance not only revoiced the preceding student's arguments but also served as a friendly reminder to other students about the importance of supporting arguments along with their claims. It was coded as "revoicing" with additional goal of "prompting arguments." We found that there were four categories of discourse moves that Ms. Li used often to either sustain or advance whole-class argumentation process, which included **setting norms**, **revoicing**, **pressing**, and **summarizing** (the left column in Table 2). Our close examination of Ms. Li's utterances also enabled us to identify a set of goals for facilitating argumentation process (the middle column in Table 2). Additionally, we recorded both occurrence and frequency of codes in the right column of Table 2 as they could reveal the pattern of Ms. Li's use of discourse moves.

Table 2
Codes of Ms. Li's Discourse Moves with Goals for Argumentation and Frequency

Codes of Ms. Li's discourse moves	Goals for argumentation	Codes frequency over four episodes			
		Class A_1	Class B_1	Class A_2	Class B_2
Setting norms	Requesting to be respectful listeners for understanding and comparing claims and arguments.	0	2	1	9
	Presenting claims first followed with arguments.	0	0	2	1
Revoicing	Revoicing for prompting/reconfirming the claims	1	1	0	0
	Revoicing for prompting arguments	1	0	0	0
	Revoicing for rephrasing how arguments were expressed	1	2	0	0
	Revoicing for connecting students' arguments with science concepts	1	0	1	0
Pressing	Requesting students to clarify their arguments	0	0	1	0
Summarizing	Reflecting on argumentation process	1	1	1	1

Setting norms

To facilitate whole-class argumentation, Ms. Li set norms for the legitimate and effective participation of students in SSI argumentation, considering that many Chinese middle school students may not be familiar with how to engage in this type of discourse. In the following excerpt, Ms. Li initially emphasized, "*Being a good listener is the basic respect we should show to our classmates!*" and consistently reinforced it, even at the expense of interrupting student's talk, by requesting a pause to have other students be quiet. As students adhered to the initial norm, introduced guideline for effective participation in argumentation by instructing them to "*organize your own opinions, as well as those of classmates who agree or* disagree *with you*." In repeatedly asking students to listen and jot down new ideas, Ms. Li tried to decentralize her sole role as authority of knowledge construction and prepared students for cross talk, but this reinforced her role as the *guardian of* the classroom norms unexpectedly.

T: Alright, please share your supporting reasons！ Other students, please keep quiet. Being a good listener is the basic respect we should show to our classmates!
S4: First, I think cloning technology, no matter what, must be used, because cloning technology can……, because……
T: Please pause for a moment and give them a second to calm down
Okay, go ahead……
Ss: ……..
T: When listening to other students, you can organize your own opinions, as well as these of classmates who agree or disagree with you, in the table on the second page. (Class B_2).

Revoicing

To streamline the process of argumentation and ensure the smooth flow of students' arguments, Ms. Li frequently employed the discourse move of revoicing during SSI argumentation facilitation. Through revoicing students' statements, she helped either make these arguments explicit to the whole class or link students' everyday language to scientific concepts. In the ensuing excerpt, student S3 contested the decision to introduce endangered animals into the park, presenting a scenario in an ambiguous manner, in which he described a situation where "*wolves mostly preyed on sick animals, and if you place them (endangered animals) in an ecological park, and they (park managers) don't separate herbivores and carnivores, it's possible that if you don't detect if they are sick, and lead to most of these organisms getting infected*." These opposing arguments were detailed and did not explicitly articulate why he objected to the decision. Ms. Li succinctly condensed S3's arguments into crucial scientific concepts of "*natural selection*" and "*food chain*", which intensified S3's opposing arguments through advancing other students' understanding of S3's scenario. This is evident in the response of the subsequent student S4. S4 avoided encountering S3's opposing arguments from *"the perspective of natural selection in the food chain*" but instead shifted focus to S3's other ambiguous arguments concerning human-animal relationships, and counterargued that "*if it becomes accustomed to humans, then it can't survive in the wild anymore."*

T: You don't agree to put them in, right?
S3: Yes, in the past... There was an article about wolves, deer, and humans, do
you all know? In that article, wolves mostly prey on sick animals, right? So, if
you place them in an ecological park, and they don't separate herbivores and
carnivores, it's possible that if you don't detect if they are sick, it might
spread directly in this, in this, in this area, and lead to most of these organisms
getting infected. And, if you place them in a protected area, it could be
surrounded by people. In China, there is no shortage of people; it can be filled
with people.
T: He considered it from the **perspective of natural selection in the food chain**,
right?
S4: Like you, if it becomes accustomed to humans, accustomed to humans, then it
can't survive in the wild anymore. So, it violates the principles of animal
protection, doesn't it?

<u>Pressing</u>
Pressing was the discourse move that Ms. Li only used once to have students clarify his arguments. In the following excerpt, student S1 was asked to further explain what he meant by *"there is nothing else*?" in his arguments concerning the potential involvement of cloning technology in scientific knowledge.

S1: I am against it. Because when we were discussing (unclear) also mentioned
that cloning is replicating the chromosomes, but how can you ensure that apart
from these chromosomes, there is nothing else?
T: **What do you mean by "there is nothing else?"** (Class A_2)

<u>Summarizing</u>
Ms. Li reflected SSI argumentation processes and summarized all student arguments at the end of four episodes, emphasizing the temporary nature of scientific knowledge. As shown in the following excerpt, she concluded that utilization of cloning technology for fertility issues remains unknown because "*this is an ethically significant issue that has not been widely applied so far"* and "it *requires continuous development and argumentation across generations before it can be widely adopted*", revealing the nature that "*science needs constant validation and inquiry*." Throughout all four episodes, she consistently summarized all student arguments and pointed out that there is no clear-cut solution to each SSI topic. She also acknowledged that the issues they argued for could not be resolved by individuals or a small group of people immediately. The process of argumentation was to help them perceive the complexity of application of scientific technology or make informed everyday decisions by considering multiple perspectives.

T: T: So, whether cloning technology is suitable for addressing our fertility It is
issues, uh, including medical purposes? This question remains to be decided.
precisely because this is an ethically significant issue that has not been widely
applied so far. However, regarding certain details, such as saving organs for
critically ill patients, and so on, whether there will be better technologies in
the future to overcome the existing problems, all of this is unknown.
Therefore, the emergence and application of new technologies are not
determined by a few individuals or a group of people saying whether it's
suitable or not. It requires continuous development and argumentation across
generations before it can be widely adopted. Even technologies like genetic
modification, although already in use, remain highly controversial, right? So,
this is why science needs constant validation and inquiry (Class B_2).

Table 2 illustrates all codes for Ms. Li's discourse moves in her four episodes and identifies how these moves are distributed across episodes. From Table 2, three patterns emerge in Ms. Li's discourse move distribution. First, Ms. Li placed more emphasis on setting norms in the last two episodes compared to the first two. Second, revoicing was more frequently used in the first two episodes, with Ms. Li only revoicing students' arguments once and connecting it with scientific concepts in the third episode (Class A_2). Third, summarizing consistently served as an ending signal for argumentation activity in all episodes, emerging as the most prominent discourse pattern observed. These patterns suggest that Ms. Li assumed double roles of facilitator and classroom manager in four episodes, which oscillated between different SSI topics. Ms. Li assumed the role of a facilitator in the first two episodes but transitioned to that of a classroom manager in the latter two.

Discussion and conclusion

This study seeks to explore how Chinese science teachers integrate SSI argumentation teaching into their classrooms and understand the successes, challenges, and roadblocks for one particular teacher in implementing SSI argumentation. Through a coarse-grained analysis of four episodes, we first found that Ms. Li was able to consistently frame the SSI argumentation as addressing everyday problems and tended to engage students in a more authentic version of science practice along with restricted shared epistemic agency, even, at times, with very limited freedom or agency to communicate their ideas with others. Our fine-grained analysis on teacher's discourse moves that facilitated whole-class argumentation, further revealed four frequently employed categories. These included setting norms, revoicing, pressing, and summarizing, all contributing to either sustaining or advancing the whole-class argumentation process. Additionally, the frequency distribution over four categories of discourse move also suggested that our participating teacher assumed double roles of facilitator and classroom manager in four episodes, which oscillated between different SSI topics. Through both coarse- and fine-grained analyzing Ms. Li's teaching practices, we firmly believe that even in the traditional teacher-centered Chinese science classrooms, science teachers could purposefully design and successfully implementing argumentation teaching. But at the same time, as we delved deeper into Ms. Li's teaching practices, specifically, her discourse strategies, we can pinpoint some challenges faced Ms. Li.

First, Ms. Li stepped back from her authoritative position as an informed teacher but still maintained her role as a classroom norm maintainer/manager. As students' participation structure in SSI argumentation became chaotic, Ms. Li's role as a manager became more pronounced. The role of the teacher in classroom argumentation is complex and changeable, ranging from dispenser, facilitator, to participants just in terms of questioning (Chen et al., 2017). In this study, through different discourse strategies like revoicing and pressing, Ms. Li voluntarily relinquished her traditional role of being the knowledge authority by encouraging students to engage in a more scientific version of argumentation, like preparing written arguments by groups for the whole-class argumentation. This fostered an enhanced communication and interaction among students. However, during whole-class argumentation, Ms. Li often assumed the role of classroom manager and used discourse strategies, like setting norms and summarizing, to stabilize the participatory structure and ensure that SSI argumentation unfolded in an organized manner. In this way, students can more effectively acclimate to SSI argumentation activities, ensuring that the classroom pace remains manageable. It is evident that Ms. Li was struggling to maintain a balance between argumentation and traditional science content-oriented teaching. When the functions of multiple roles conflict with each other, Ms. Li prioritized the role of classroom manager.

Second, Ms. Li's understanding of SSI argumentative teaching significantly impacted her instructional practices, which necessitated additional professional support. In our study, Ms. Li's emphasis on the role of classroom manager created significant tension in the relationship between argumentation teaching and maintaining classroom norms. As thus, it remained challenging for her to fulfill both roles (manager and facilitator) within the same episode. To support science teachers' argumentation practices to move beyond this limited understanding, we need to think critically about how to design teacher education experiences for mitigating teachers' misconceptions related to argumentation teaching (McNeill et al., 2017). Furthermore, it is imperative to reform existing science teaching evaluation systems, empower teachers with more flexibility in their practices, and place greater emphasis on students' abilities in applying scientific knowledge in everyday contexts (Simon et al., 2006).

Finally, this study has some limitations. First, this case study exclusively featured one science teacher, potentially restraining the generalizability of findings to the broader China's and international science education research community. Second, in terms of data analysis, we paid more attention to the discursive aspects of teacher-student interactions during the whole-class argumentation, with only a limited exploration of embodied interactions. Employing a multimodal and embodied analysis of classroom interactions might generate more comprehensive understanding of the dynamics between teachers and students. To move this study forward, this could be a potential direction for future exploration.

In conclusion, despite all challenges faced Ms. Li, her attempts to integrate SSI argumentation into classrooms provides a lot of insights for effective argumentation implementation in Chinese science classrooms. As our global landscape becomes increasingly complex, SSI argumentation equips students with the critical thinking skills needed to navigate and address multifaceted socio-scientific issues, such as COVID-19. Engaging students in argumentation within the context of real-world problems not only enhances scientific literacy but also cultivates resilience by fostering adaptability and problem-solving abilities.

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