International Society of the Learning Sciences

Exploring the trajectory of learning and using productive peer talk moves

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Abstract: This study reports how pupils learn and use productive peer talk moves in dialogic collaborative problem solving throughout a semester-long talk teaching program. The results revealed a three-stage trajectory: intrusive application, structured application, and autonomous application. It takes time and practice for students to appropriate productive peer talk moves and benefit from their usage. Using productive peer talk moves was not facilitative to the problem-solving process at the beginning, and even was intrusive and disruptive. Students gradually were able to internalize the talk moves and then could integrate the talk moves with their own semantic and expressive intentions. The learning and use of productive peer talk moves also aroused a cascade of long-term effects, including the more respectful language styles, the shift of personal pronouns from "I" to "we", and the enrichment of body gestures.

Introduction

Researchers used productive peer talk moves (e.g., press for reasoning, explain oneself etc.) to scaffold high-quality peer talk (Gillies, 2019). We conceptualized empirically grounded productive peer talk moves (Hu & Chen, 2023) as talk tools to help achieve three goals of effective dialogic collaborative problem solving and taught these talk tools to students throughout one semester (see Table 1). We relied on iTalk–iSee (Hu et al., 2022), a participatory visual learning analytical tool, to facilitate teaching students these talk tools.

Table 1

Talk Tools Taught in the Intervention Program

Talk virtue	Type of talk tools	Talk tool
Equity	We-Talk-Equity	Invite expression; Invite evaluation; Invite building on others; Encourage
Convergence	We-Talk-Convergence	Summarize; Group-reflect; Propose
Open-mindedness	I-Talk	Share information; Express new idea; Build on oneself; Explain oneself; Self-reflect
Open-mindedness	You-Talk	Press for elaboration; Press for explanation; Revoice; Build on others; Evaluate; Compare

There have been theoretical arguments on how people learn a new voice from the perspective of dialogic theory. Bakhtin (1986, pp. 293–294) assumes that "the word in language is half someone else's. It becomes 'one's own' only when the speaker populates it with his intention, with his own accent, when he appropriates the word, adapting it to his own semantic and expressive intention". Wertsch (1991) concludes Bakhtin's dialogic learning as a theory of learning as appropriating the persuasive voices of others. He also specified stages of "ventriloquation" in the process of appropriating foreign voices. That is, people gradually integrate the voices of others through initial speaking without integration to being totally indistinguishable with their own voices. Empirically, there seems no study examining what kind of processes that students may go through from knowing the talk moves to genuinely being able to apply them in their discussion without any external prompts. This is the research gap that the present study aims to fill. Specifically, this short paper aims to answer: how do students internalize and apply talk tools during the program and is there any emergent learning trajectory in the process?

Method

The program recruited 59 fourth-grade primary school students. They were assigned into 20 groups. Group 13 (G13) was chosen as a case to help answer the research questions because its members were very active in learning and using talk tools and thus the intervention was fully put into effect in G13. G13 is also a representative of most groups and did not have atypical issues like difficult members or severe inequality of participation. It consisted of three members: Wu, Fang and Sun (anonymously named). Wu was the most academically advantaged in the group. He reported high-level mathematics self-concept and enjoyment, the lowest degree of social anxiety and the highest level of perspective-taking ability. However, he reported the least family resources. Fang's academic status was in the middle. She also reported high-level mathematics enjoyment and perspective-taking ability. However, her self-concept in mathematics was not high. She also reported the highest level of social anxiety. Fang

was rich in family resources. Sun had the lowest academic status and reported a low-level mathematics self-concept. However, his enjoyment in mathematics was also high. Sun also reported the most family resources.

Students learnt eighteen talk tools in the semester-long intervention program in a form of an independent course *Mathematical Dialogue and Thinking*. We optimized the comparability of the groups in terms of gender, academic competence, and reasoning ability. There are 16 process-open tasks included in the program with one in the pre-test and three in the post-test. They were adapted from international mathematics tests. During the study, students were provided with learning sessions interspersed with practice sessions. In learning sessions, the students learnt talk tools supported by iTalk–iSee. In practice sessions, students reviewed the previous task, received feedback on their group talk and then performed a new task. We presented respective expected talk tools in various practice tasks on the digital white board as hints which, however, were not available for post-test tasks. Students got badges of talk tools that they have satisfied the usage standards in one task. They also spontaneously referred to their badges sheet as prompts in other practice tasks.

Data sources include recorded videos of students' collaborative problem solving of all tasks and students' self-reported characteristics on social anxiety, mathematics learning enjoyment, mathematics self-concept, perspective-taking ability and demographic information. Three trained coders coded the problem-solving transcripts by labeling 18 talk tools. Fuzzy kappa, a modified version of Cohen's kappa that allows each unit of analysis to be assigned multiple codes (Kirilenko & Stepchenkova, 2016), was used to measure the inter-coder agreement on the coding of the talk tools. The indicators for three pairs of coders were all satisfactory (fuzzy kappa values > 0.60). To address the research question, we purposefully selected one case group G13 to illustrate the trajectories of how students learn and apply talk tools.

Results

We observed three emergent stages of learning and using talk tools of G13 throughout the intervention program: intrusive application, structured application, and autonomous application.

After participating in the talk teaching program, G13 first went through the intrusive application stage. They began to learn the talk tools and strengthened the awareness of changing their way of talking. At this stage, they were still not familiar with the different talk tools and reminded each other with any talk tool that they needed to apply or relied on the digital whiteboard in the front of the classroom to check the tools that they forgot to use. Excerpt 1 is a segment when G13 solved a practice task on car routes and tried to apply four We-Talk-Equity tools. Wu looked at the four talk tools shown on the digital white board and reminded the group of the tool "invite evaluation" by voicing the key element of this tool (#96). Sun then gave a positive evaluation to Fang (#97). This tool was initially designed to help students involve marginalized members which was not the case here. In addition, Fang didn't finish her idea yet at turn 95 but presented the full idea at turn 98. Therefore, Sun's evaluation at turn 97 was not an evaluation on Fang, but simply a response to Wu. The usage of talk tool here did not fulfil its design intention but interrupted Fang's idea.

Excerpt 1. "Evaluate, evaluate."

Turn	Start time	End time	Speaker	content	Embodied actions
95	0:08:21	0:08:24	Fang	Only two left. Let's think again. We could first…	 (#95). Fang (middle) is talking while looking at the paper. Sun (right) is looking at the paper. Wu (left) is looking at the digital white board.
96	0:08:26	0:08:26	Wu	Evaluate, evaluate.	
97	0:08:27	0:08:29	Sun	Good, good, good.	
98	0:08:32	0:08:38	Fang	First start from A, then horizontally, then vertically, then this, then this, then this.	

At the structured application stage, G13 became familiar with certain talk tools and applied them for the purpose of discussion rather than for fulfilling teacher's expectation. However, their applications were still very structured. They spontaneously developed some talk routines that structured their discussions (e.g., giving positive compliments to members' ideas, reflect and summarize viewpoints before handing in the paper, take turns to express ideas), appropriated some terms in their discussion (e.g., reflect, add on, evaluate, summarize) and adopted invitational conversation strategies (e.g., invite expression, invite evaluation, invite add-on). These changes made their discussion contrast to their usual conversation style and reflected the impact of the intervention program on these primary school students. For example, they combined the tools of "encourage" and "evaluate others" and developed a usual practice of always giving positive compliments to their members (e.g., "very good", and "you're brilliant") when they had no disagreements with members' new viewpoints.

However, they mostly did not differentiate the quality of the viewpoints when they gave various levels of positive compliments. Such extensive encouraging evaluations seem a routine response to anyone's any new viewpoint which sounded manipulative and did not fulfill the functions of "encourage" and "evaluate others". They also tended to conduct a group reflection and summary in the end of their discussion. As shown in Excerpt 2, they were checking whether there were any identical arrangement solutions of the tiles. They found two duplicated solutions which made them appreciate the usefulness of group reflection in problem solving (#115).

Excerpt 2. "So, our reflection is useful."

Turn	Start time	End time	Speaker	Content	Embodied actions
110	0:13:37	0:13:37	Sun	Do we have this?	 (#115). Wu (left) is talking while pointing at the paper. Fang (middle) and Sun (right) are looking at the paper.
111	0:13:38	0:13:38	Fang	No.	
112	0:13:38	0:13:38	Wu	Like this.	
113	0:13:39	0:13:40	Fang	No. Vertical, vertical and horizontal. No.	
114	0:13:47	0:13:47	Sun	Very good.	
115	0:13:47	0:14:06	Wu	We find that we have had the first two. So, our reflection is useful.	

Along with the familiarity with talk tools, G13 could flexibly adopt certain talk tools in their discussion. One signal of entering the autonomous application stage was that students used a talk tool in various conversational forms rather than directly referring to its name. For example, students were more flexible to use the talk tool "invite add-on". In addition to directly asking others to add on, they used multiple expression forms like "what alternatives do you have?" "What to do next?" "Do you have anything to add?" which made their discussion sound natural but not manipulative. The other signal of entering this stage was that they could sustainably use multiple talk tools in a discussion segment to facilitate collaborative problem solving.

Not all talk tools went through the same stages or at the same pace. For example, we found that even before introducing students the I-Talk and You-Talk tools, they could use most of these tools autonomously. It may indicate that I-Talk and You-Talk tools conform to the usual discussion style of primary school students. They could spontaneously use these talk tools when they actively engage in collaborative problem solving. Therefore, it may not take long for them to get used to and internalize most I-Talk or You-talk tools. Though primary school students could spontaneously adopt these tools to facilitate their discussion, the explicit learning of I-Talk and You-Talk tools could strengthen their awareness of their purposes of talking. Members of G13 sometimes explicitly stated the talk tools that they were going to use. They also referred to members' utterances by recognizing the contained talk tools. These indicated that G13 had a stronger awareness and sensitivity of the various purposes of their talk.

The talk program also brought about some other spontaneous changes in G13. The first change was the overall atmosphere of the group. Members of G13 became more and more respectful and supportive to each other. They began to use the word "please" when they asked their members about questions. This change was possibly affected by the usage of invitational form of talk tools, or their encouraging evaluations to each other. In addition, they became more responsive and patient to each other. If they did not listen carefully and missed some viewpoints, they even apologized to the speaker and asked for restatement. The second change was the sense of group belongings. There was a salient contrast of the usage of personal pronouns in the pre-test and post-tests of G13. The proportion of "we" among all occurrences of personal pronouns largely increased from pre- (15%) to post-tests (48%), while the "I" (from 44% to 20%) and "you" (from 42% to 24%) both decreased. The third change concerned gestures during talking. G13 spontaneously produced more gestures when the members made efforts to purposefully adopt various talk tools in their discussion. For example, all members tended to spread out one hand when they invited others to express new ideas, evaluate, or build on. In addition, they also spontaneously produced gestures when they tried to elaborate or justify their ideas.

Discussion

There was a three-stage trajectory emerged in the process of learning and using productive peer talk moves by one highly involved intervention group: intrusive application, structured application, and autonomous application. Such progressively personalized and flexible usage of these talk tools was consistent with the theoretical account on the process of appropriating others' voices, that is from initial speaking without integration with their own voices to totally with one's own semantic and expressive intention (Bakhtin, 1986; Wertsch, 1991).

Students could access to external prompts of expected talk tools when doing practice tasks. The side effects of such scaffolding during the intrusive application stage were somewhat consistent with previous discussions on the drawbacks of a scripting approach (Dillenbourg, 2002). Talk tools in this intervention program are designed scripts to scaffold peer interaction in dialogic collaborative problem solving. To optimize the effect of external scripts and avoid the overlaying of scripts on students, the design of external scripts should consider students' level of internal script (Fischer et al., 2013). At the intrusive application stage, talk tools provided students with a new way of talking which students might not have corresponding internal scripts. The structured format of these talk tools also affected students' natural conversation. This echoes with the criticism on the "over-scripting" of structured and rigid collaboration scripts (Dillenbourg, 2002; Vogel et al., 2017).

The side effects of external scripts at the intrusive application stage may also be explained by the cognitive load theory. The cognitive load theory assumes that human has limited cognitive capacity. Therefore, when students are not familiar with talk tools, they need to make additional mental efforts in understanding these talk tools and further chose appropriate ones to use. They cannot use the external scripts effortlessly like a familiar tool at least in the beginning of the intervention (Kollar et al., 2007). Instead, the usage of talk tools competes for one's limited cognitive resources (Sweller, 1988) with problem-solving activities and thus may lead to conflicting rather than facilitative relationship between productive peer talk and successful problem-solving. There was an argument on the advantage of the scripting approach that external scripts could help free some cognitive resources for what is more important in an interaction like focusing attention on content rather than procedure (King, 2007). However, even with the accessibility of external scripts, it still consumes students lots of cognitive efforts on which and how to use the external scripts especially at the initial stage of an intervention.

However, the detrimental effects of the external prompts of talk tools soon disappeared when students went to the structured application stage where they were more familiar with the talk tools though they still did not integrate them in natural conversations. They used these tools according to their own intentions but not their own expressive styles. They semantically internalized these tools but were still constrained by the formats of these tools. This echoes previous findings that internalization of the external scripts needs time and practice (Fischer et al., 2013). Students need time to optimally benefit from designed scripts (Popov et al., 2019).

As students really internalized these talk tools, we found them seldom relied on the external prompts but used these talk tools with their own semantic and expressive intentions. The benefits of productive peer talk fulfilled at the autonomous stage where students became more respectful, responsive, and united. The learning and usage of talk tools also aroused a cascade of long-term effects. Students changed their language style by using more "please" and shifted from "I" to "we". The use of personal pronouns indicates students' social position and cognitive state in collaboration (Kacewicz et al., 2014). The usage of inclusive pronouns (e.g., we, us, our) may reduce psychological distance among members and contribute to a sense of group membership and cohesion (Baker, 2010). It indicates that students pay more attention to group rather than individual concerns, receive a higher level of support from the group and are more collaborative rather than competitive compared to the usage of singular first-person pronoun (e.g., I, me, my) (Demmans Epp et al., 2017). The present study showed that students at the autonomous application stage have stronger group belongings and become more supportive to each other in the process of achieving a joint solution.

The study also found that the intervention students spontaneously produced more body gestures at the autonomous application stage. Producing one's own gestures or perceiving others' gestures were both found supportive for learning (Novack & Goldin-Meadow, 2017). Such spontaneous behavioral change further indicated the essential value of explicit learning of productive peer talk.

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Acknowledgments

This work was funded by Hong Kong Research Grants Council, University Grants Committee (Grant 17605221).