



Promoting academically productive student dialogue during collaborative learning

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ABSTRACT

Interest in the key role talk plays in the construction of knowledge, understanding and learning has gathered momentum in recent years as research has demonstrated how students learn from each other and how teachers, in turn, can utilise this information to structure classroom experiences to promote student engagement and productive academic dialogue. This paper discusses research that highlights the importance of structuring collaborative learning experiences that challenge students' thinking and scaffold their learning to promote critical and creative problem-solving and enhanced cognitive understandings. Future directions include investigating changes to students' cognitions as a consequence of specific types of dialogic interactions and the role of interpersonal synchrony in promoting prosocial behaviours and dialogic interactions.

1. Introduction

Interest in academic talk and its capacity to promote cognitive development and educational attainment has gathered momentum over the last three decades as studies have emerged that have demonstrated the key role social interaction plays in the joint construction of knowledge, understanding, and learning and how such interaction has the capacity to benefit students' socialization and academic achievements (Mercer, 2000, 2008; Resnick, 1991; Wells, 2007). Rojas-Drummond and Mercer (2003) and Rojas-Drummond, Perez, Velez, Gomez, and Mendoza (2003) in reporting on studies conducted in British and Mexican schools found that when students worked in classrooms where there was a careful integration of teacher-led discourse and peer group interaction, students learned how to coordinate their thinking around the task at hand; promoting individual reasoning and learning. Wegerif, Mercer, and Dawes (1999) found that students' individual reasoning ability, as measured on a standardized test of reasoning, was enhanced when they were taught how to engage in exploratory talk where they learned to articulate their reasons for specific decisions as they cooperated with others on small group tasks. The findings led the authors to note that the use of exploratory talk can improve group reasoning and that it can be taught to students and transfer to other educational contexts, leading to enhanced individual cognitive performances on a standardized non-verbal reasoning test.

Others who have investigated the powerful effect of talk on students' thinking and learning include Resnick (1991, 2010), Resnick, Michaels, and O'Connor (2010) and Michaels, O'Connor, and Resnick (2008). Evidence has emerged from these studies that teacher-led discussion where students learn how to engage in reasoned arguments and debates supports the growth of disciplinary knowledge and a deeper understanding of complex concepts. The results of engaging in discourse-intensive instruction helped students to build on the ideas of others, seek clarification when needed, and draw reasonable conclusions, based upon the evidence presented. In so doing, they learnt to engage in dialogic discourse that is relevant to their discipline (e.g., math, science, literacy), enabling them to acquire the relevant discourse-based reasoning skills needed to promulgate an argument. Moreover, Resnick et al. argues that this type of discourse is more likely to emerge when students understand that they are accountable for the reasoning they

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demonstrate and the conclusions they draw. This includes being accountable to their group or class (i.e., community), accountable to expected standards of reasoning (i.e., talk that draws logical and reasonable connections), and accountable to knowledge (i.e., publicly available facts, texts and other available information).

In science, Kuhn (2009, 2016) argues that repeated dialogic interactions on a topic enhances students' quality of reasoning of that topic provided they, in turn, have regular opportunities to evaluate evidence and make causal judgments and predictions. Moreover, these higher-order thinking skills where students learn how to reason and problem-solve and engage in argumentation need to be actively promoted and consolidated through curricula interventions where students have opportunities to investigate topics together, address ambiguities and seek clarifications, propose potential explanations, and make connections to current understandings and knowledge.

In a corpus of studies that investigated students' explanatory behaviours under different conditions, Webb (2009) and Webb and colleagues (Webb & Mastergeorge, 2003; Webb et al., 2008; Webb et al., 2014) emphasise the importance of teachers pressing students to explain their thinking to each other during their interventions with small groups and whole class discussions. While Webb et al. have found that teachers used different teaching strategies to encourage dialogic interactions, it is only when they probed students' explanations to clarify their thinking and problem-solving strategies that students learned to engage with others' ideas at a higher level. Moreover, it is this willingness to ask for specific explanations, persistence in seeking assistance, and the modification of help-seeking strategies that are associated with being able to solve group-work problems without additional assistance.

In summary, studies by Mercer (2000, 2008), Rojas-Drummond and Mercer (2003), Resnick et al. (2010), Michaels et al., 2008, Kuhn (2009, 2016), Webb (2009), Webb and Mastergeorge (2003), Webb et al. (2008), Webb et al. (2014) highlight the importance of discourse-intensive interaction where teachers play an active role in pressing students to engage in reasoned argumentation, and where students, in turn, learn to evaluate the evidence, explain their reasoning, and make causal judgments and predictions. Moreover, it is apparent that these higher-order thinking skills are promoted and consolidated when students have opportunities to interact with others, share ideas, challenge different perspectives, and draw links between current understandings and knowledge.

2. Structuring student interaction

Although students benefit academically and socially from well-structured learning experiences where they have opportunities to interact with others around tasks, Meloth and Deering (1999) found that students rarely engage in high-level discourse or explanatory behaviour unless they are explicitly taught to do so. Similarly, King (1999) observed that generally students do not elaborate on information, do not ask thought-provoking questions, and do not spontaneously activate and use their relevant prior knowledge without some external guidance. Chinn, O'Donnell, and Jinks (2000) found that students do not engage in high-level discourse unless they are explicitly required to provide reasons for their conclusions. This is a concern because King (2002) found that the cognitive and metacognitive levels of group discussions are positively correlated with students' cognitive and metacognitive outcomes. In effect, task-related talk about information, concepts, strategies and thinking is very important to student learning yet it will not emerge unless students are explicitly taught how to exchange ideas, provide explanations and justifications, engage in speculation, make inferences, develop hypotheses, and draw conclusions: characteristics of high-level discourse known to promote thinking and learning (King, 2008).

Teaching students to engage critically and constructively with each other's ideas, challenge perspectives, and discuss alternative propositions are important discourse moves students need to learn if they are to talk and reason effectively together (Rojas-Drummond & Mercer, 2003). Rojas-Drummond and Zapata (2004), in a study of 86 Grade 5 students who were taught to use Exploratory Talk (Mercer, 2000) as a way of engaging critically yet constructively with others ideas, reported that the students who had been trained to do so produced significantly more and better arguments, expressed their positions in a more cogent and explicit way, and provided more links and support to sustain their opinions than their untrained peers, and this had a highly significant effect on their capacity to solve problems. Likewise, Veenman, Denessen, van den Akker, and Rijt (2005) found when students were taught how to engage in helping behaviours during cooperative group learning, they demonstrated significantly more high-level elaborative behaviours than their untrained peers. Students thought aloud, verbalised their thoughts, and provided each other with extended elaborations and these results had positive effects on their thinking, reasoning and achievement outcomes.

Others who have investigated the importance of teaching students how to engage in dialogic interactions with their peers include Anderson et al. (2001) and Clark et al. (2003) who used collaborative reasoning where students are taught how to use different reasoning stratagems to advance an argument during group discussion. Collaborative reasoning essentially provides teachers with a framework for facilitating discussion among small groups of students. This includes encouraging students to listen carefully to the issues presented, explain their position, expand on their ideas and provide reasons and justifications with evidence to support their stance. As part of the dialogic interaction that occurs, students are taught to engage in reasoned argumentation where they learn to challenge others' ideas and ways of reasoning, clarify different positions and make suggestions on how to improve future discussions, and, in so doing, they learn develop argument stratagems. Anderson et al. argues that once an argument stratagem has been internalized or appropriated and is used in a discussion, it will snowball and be used with increasing frequency by others involved in the discussion. In essence, children learn new ways of talking and thinking from interacting with others in collaborative discussions.

2.1. The teacher's role in fostering student interaction

Teachers need to be strong advocates for inducting students into different ways of thinking and learning by making explicit how to express ideas, seek help, contest alternative propositions, and reason cogently (Gillies, 2004a). Gillies and Khan (2008) found that

when teachers were taught specific communication skills designed to challenge students' cognitive and metacognitive thinking during cooperative learning, they used more challenging and scaffolding language to mediate students' learning than teachers who were not explicitly taught to use these communication skills. Furthermore, the students in these teachers' classes provided significantly more elaborate and help-giving behaviours to group members than peers in the untrained teachers' classes and they obtained higher scores on the follow-up reasoning and problem-solving tasks.

In reporting on the organizational principles that support student learning in elementary science classrooms, [Howe et al. \(2007\)](#) highlighted the importance of the teacher's role in ensuring that not only their students understood how to listen, question, help, explain, and reach consensus during their small group activities but that they also modelled these behaviours in their interactions with their students. When this occurred, the groups worked effectively together with the students recording significantly more new ideas and explaining their reasoning to each other. Moreover, it was these verbal behaviours that were related to achievement gains on post-test science scores. [Howe \(2014\)](#) in a review of her own research on the development of students' conceptual understandings in science noted that in all instances, it was the expression of contrasting ideas as students worked collaboratively with their peers that contributed to gains in conceptual understandings.

Similar results were reported by [Webb, Franke, Ing, Turrou, and Johnson \(2015\)](#) who found that teacher practices played an important role in fostering productive student participation. While teachers' invitations to students to explain their thinking and actively listen to others' ideas did encourage some productive student participation, how teachers followed up on these invitations played a more important role. This included helping students to engage with others' ideas when students did not know how to respond, helping students engage in depth with another student's idea rather than engaging at a superficial level, and helping students focus on key ideas embedded in another student's work rather than focusing on less important issues. Engagement occurred when teachers probed or pressed students to continue engaging with others' ideas, provided scaffolding to help students consider additional ideas or options to support their understandings, and validated students' capacities to engage with others' ideas.

Others who have highlighted the importance of the teachers' role in promoting student interaction include [Reznitskaya, Anderson, and Kuo \(2007\)](#) and [Reznitskaya et al. \(2009\)](#) who argue that student interaction is facilitated when teachers create environments where students feel empowered to become independent thinkers and active participants in classroom discussions. In such environments, teachers actively provide support for the development of argumentative skills by prompting students to provide reasons that support their positions, modelling the use of evidence, or challenging students to explain their anomalous reasoning. In turn, students learn to engage in more dialogic interactions focused on making reasoned judgements, and it is these interactions that have been demonstrated to have a positive effect on students' capacities to internalize argumentative skills and to transfer them to new contexts, tasks, and modes of communication.

3. Collaborative learning experiences

Collaborative learning (commonly referred to as cooperative learning) is well established as a pedagogical practice that is used in classrooms to promote student engagement, socialization and learning ([Blatchford, Kutnick, Baines, & Galton, 2003](#); [Johnson & Johnson, 2003](#); [Sharan, 1980](#); [Slavin, 1996](#)). When students cooperate, they learn to listen to what others say, seek clarification on misconceptions, provide help and assistance to others, and engage in knowledge-building practices that promote learning ([Johnson & Johnson, 2003](#)). In so doing, students learn to talk and reason among themselves and build relationships that promote group cohesion, confidence and trust; critically important if students are to learn successfully with others ([Roseth, Johnson, & Johnson, 2008](#)).

Creating small group experiences, though, where students are able to discuss tasks in a meaningful way can be quite challenging unless students understand how they are expected to work together and what they are expected to achieve. [Sharan \(1980\)](#) argued this could be achieved by emphasising the importance of *guided group inquiry* where students were involved in: (a) selecting a topic within a general problem area identified by the teacher; (b) planning together to ensure that specific learning tasks, goals, and procedures to be implemented are consistent with the topic to be investigated; (c) implementing their plans using a variety of activities, sources of information, and skills; (d) analysing and evaluating the information they have obtained; and organising to present it to the wider class where students and teacher together evaluate the group's contribution to the work of the class.

While [Sharan \(1980\)](#) emphasised the importance of a guided inquiry approach to harnessing the potential of the group, [Johnson and Johnson \(1990\)](#) demonstrated that it was only under certain conditions that group efforts could be expected to be productive and these conditions included: (a) establishing clear perceptions of positive interdependence; (b) ensuring group members were able to engage in face-to-face interaction; (c) emphasizing individual accountability for the contributions members made; (d) promoting appropriate use of interpersonal and small group skills; and, (e) encouraging regular reflection by group members on the progress they were making to achieve the group's goal.

Building on the research from [Johnson and Johnson \(1990\)](#) and [Sharan \(1980\)](#), it is clear that groups need to, not only be well structured so students understand what they are expected to do and how they are expected to behave, but they, also, need to know that it is important to provide enough detail in their responses to each other to enable their peers to benefit from any interaction that occurs. [Cohen \(1994\)](#) and [Cohen, Lotan, Abram, Scarloss, and Schultz \(2002\)](#) found that this was more likely to occur when students had opportunities to work on tasks that were ill-structured and open-ended and discovery-based where there were no right answers or procedures to follow. With this type of task, group members had to share available resources (i.e., knowledge, information, problem-solving strategies) that no individual alone possessed to complete the task. In this sense, group members were reciprocally interdependent and productivity depended on interaction with their peers. Moreover, it is the frequency of the task-related interactions that occurs with this type of task that have been consistently demonstrated to be related to follow-up academic gains. Certainly,

Gillies (2003a), in reporting on five studies she had undertaken on students working cooperatively together, found that it was the help giving behaviours (i.e., explanations, directions, directions with physical prompts – “Watch how I do it [student uses hands to demonstrate]) that were more closely associated with students’ learning to complete group problem-solving tasks together.

In a series of follow-up studies that examined the effects of small group learning on students’ behaviours, interactions, and learning, Gillies (2003b, 2004b, 2006, 2008) has consistently found that the students in the structured groups (i.e., where interdependence among group members was clearly established and group members understood they were to work together to complete the task) demonstrated more cooperative behaviour, used more sophisticated language strategies and discussed more relevant task-content as they shared, debated, and clarified information with each other. In so doing, they developed clearer understandings of the task at hand and recorded significantly more task-related interactions than their peers in unstructured groups. Moreover, Gillies argued that while it was not possible to say whether it was the group interactions or the ill-structured group tasks that led the students to think more deeply about the problems they were working on, it was the students in the structured groups who provided more help and assistance to each other, engaged in more content-related talk, and demonstrated more complex thinking and problem-solving skills and these outcomes were consistent across all studies. Given that it is the frequency of task-related interactions that are important for group productivity and academic achievement (Cohen, 1994), then it could be expected that the students in the structured cooperative groups would also derive greater learning benefits from their group experiences than their peers in the unstructured groups (Gillies, 2006).

Others who emphasize the importance of structuring cooperative learning experiences to promote student engagement in productive academic discourses include Johnson and Johnson (2016) and Slavin (2014) who noted that students are more likely to be motivated to interact with others, engage in the task and help each other to succeed when they feel a sense of group cohesion. Furthermore, the quality of the group interactions that emanate is thought to be largely determined by the cohesiveness of the group. In a best evidence synthesis of elementary science programs that focused on enhancing teachers’ classroom instruction with the potential to improve science learning, Slavin, Lake, Hanley, and Thurston (2014) found, were those that included cooperative learning where students worked together in small groups on inquiry-based group tasks.

In a meta-analysis of 65 studies on the effects of face-to-face cooperative learning in primary, secondary and tertiary education settings, Kyndt et al. (2013) found that cooperative learning had a positive effect on students’ achievement and attitude. Similarly, Warfa (2015), in a meta-analytic review of the effects of cooperative learning on students’ achievements in chemistry in high school and college, found positive associations between achievement in chemistry and cooperative learning. The review involved 25 chemical education studies and 3985 participants and had an effect size of 0.68 suggesting that median student performance in a cooperative learning group would be at the 75th percentile when compared to that of a student in a traditional group performing at the 50th percentile. In both meta-analytic studies, Kyndt et al. and Warfa emphasized the importance of students working in structured small groups that included the five essential elements (i.e., positive interdependence, individual accountability, face-to-face promotive interactions; interpersonal and small-group skills, & group processing) previously identified by Johnson and Johnson (1990).

4. Theoretical background for productive academic talk

There is a large volume of research that has demonstrated the benefits students derive from collaborating with others to complete a task, solve a problem or achieve a group’s goal (Blatchford, Baines, Rubie-Davies, Bassett, & Chowne, 2006; Johnson & Johnson, 2016; Slavin, 2014). When students have opportunities to interact with others, they learn to listen to what others say, share ideas, give and receive help, clarify misunderstandings, and resolve problems, and, in so doing, construct new understandings or ways of thinking (Mercer & Littleton, 2007). Social interaction aids cognitive development when partners are actively engaged in shared thinking processes in which they challenge others’ understanding of a task, share their own insights, and attempt to reconcile contradictory positions (Rogoff & Toma, 1997). The process of constructing shared understandings or meaning from social interaction can be explained from both personal and social constructivism. In the former, Damon (1984) proposed that social interaction is critically important for challenging children’s views by forcing them to re-examine their own points of view and often re-structure them as they search for logical coherence. The cognitive conflict experienced acts as a catalyst for change, often motivating children to reconcile their own conceptions of a situation with the feedback they are receiving from others. Interaction with others is a trigger for social and cognitive change, although the change itself is achieved by the individual.

Social constructivism, on the other hand, emphasizes the interpersonal dimensions of learning where more capable peers or adults mediate the learning that occurs by focusing attention on relevant information and providing the culturally available tools of thought (e.g., language, artefacts) for problem-solving and reasoning needed for the development of higher cognitive functions in children (Hogan & Tudge, 1999). As children are introduced to new patterns of thought and forms of expression when they engage in dialogues with adults or more competent peers, they gradually internalize these exchanges until, eventually, they become part of their mental repertoires. Once internalization has occurred, children retain the ability to reproduce these jointly produced cognitive performances independently of others (Damon & Phelps, 1989). In this sense, both personal and social constructivism emphasize the importance of social interaction as a stimulus for cognitive growth and development (Wells, 2007).

4.1. Promoting productive academic talk

Promoting students’ productive academic talk can be challenging in many classrooms where teachers often have a propensity to transmit knowledge while students sit passively and listen with few opportunities to be actively engaged in making meaning from

what they are being taught. Unfortunately, this has been the trend for many years with classrooms tending to be teacher-centered and discourse revolving around teachers asking questions that require students to respond with pre-determined answers (Howe & Abedin, 2013). The widespread use of this type of discourse where talk is essentially unidirectional rather than multidirectional (involving teachers & students) tends to be cognitively unchallenging, leading to children not learning as effectively as they could because their capacities to engage in explanatory discourse where they critique and justify different propositions may be inhibited or not fully developed (R. Alexander, 2008).

Interactions between teachers and students are critically important if teachers, in turn, are to be successful at engaging students in the learning process. Such interactions, R. Alexander (2008) proposes include having a range of pedagogical repertoires for ‘organising interaction’ within the class, ‘teaching talk’ from direct instruction to discussion and dialogue, and ‘learning talk’ where students have opportunities to experience interacting with others. Such experiences include learning how to ask questions, explain, analyse information and solve problems, and argue, reason and adopt positions on the problem at hand. Concurrently, students learn to develop the dispositions of listening, being receptive to alternative propositions, thinking about what they hear, and giving others time to think before responding. While all three pedagogical repertoires have a place in teaching, Alexander proposes that it is the ‘learning talk’ repertoire where teaching is dialogic rather than monologic that enables students to develop different talk repertoires on which different types of thinking and understanding are based.

When teachers engage in more discussion and dialogue in their classrooms where they encourage the exchange of ideas with the purpose of sharing information and solving problems and achieving common understandings by building on each other’s ideas that guide and prompt students thinking, then students, in turn, are more likely to engage in ‘learning talk’ (A. Alexander, 2008, p. 112). Such classrooms, Alexander found are characterized by teachers asking more genuinely open questions, allowing students more time to think before responding, engaging in extended and substantive exchanges with students in order to arrive at logical and valid conclusions, and spending more time on prompting and facilitating discussion. In turn, students are more responsive and confident in their discussions, there is more student interaction with other students, students’ responses tend to be more explanatory, and more students exercise initiative in their discussions with both the teacher and other students.

Fostering dialogic talk in classrooms, Boyd and Markarian (2011) observed (drawing on Freire, 2005), requires teachers to: (a) adopt a tone of voice that is conversational rather than didactic; (b) attend to what is being said; (c) encourage students to elaborate on their ideas; (d) engage other students in the topic being discussed; (e) seek other students’ opinions before expressing an opinion; (f) review previously discussed topics with the intention of adding additional insights; (g) indicate to students that their comments are important; and, (h) always use humour to encourage continuing participation with the task at hand. Importantly, “good teachers listen to, follow, and support students’ ideas, purposes, lines of reasoning” (p. 519). Moreover, if teachers listen to their students and acknowledge the experiences they bring to the classroom discussion, they can help students to engage in more meaningful, insightful, and educational discussions.

4.2. Types of talk repertoires

Others who have investigated different types of talk repertoires that teachers demonstrate include Scott and Mortimer (2005) and Scott, Mortimer, and Aguiar (2006) who argue that, in science education, in particular, talk is characterised by both authoritative and dialogic discourses which they further argue can be either interactive or noninteractive. For example, teachers often introduce new ideas or the canonical scientific view with an authoritative introduction which is both interactive and noninteractive. In interactive-authoritative talk, the teacher focuses on one specific topic and leads the students through a question and answer routine, very similar to an initiation-response-feedback (IRF) sequence, in order to consolidate a point of view whereas in noninteractive-authoritative talk, the teacher presents a specific point of view with little follow-up discussion. In contrast, in interactive-dialogic talk, both the teacher and students consider a range of ideas and ask questions as they explore and work on different perspectives whereas in noninteractive-dialogic talk, the teacher may summarize different views, explicitly considering and drawing attention to these different points of view.

The type of talk teachers implement is often dependent on the stage of the lesson and the type of scaffolding teachers need to exercise to ensure students are able to follow the development of the scientific narrative being presented (Scott & Mortimer, 2005). In fact, Scott et al. (2006) argue that these different types of talk repertoires are needed as teachers use different types of talk for different purposes when teaching science. Moreover, these different ways of talking are an inevitable part of teaching as teachers move between authoritative and dialogic approaches to support meaningful learning in students. However, they also emphasize that both types of talk repertoires are needed because the authoritative approach is often used to introduce new ideas while the dialogic enables the application and exploration of these ideas. In this sense, Scott et al. (2006) note that the authoritative often acts as a seed for dialogicity and vice versa.

Certainly, teachers need to be mindful of the way they interact with students and how their discourses can promote student interest in a topic and the learning that occurs. Seymour and Lehrer (2006) report on how one very experienced teacher’s pedagogical content knowledge (PCK) changed as a result of way her Grade 6 students talked and acted about the mathematics they were learning. Initially, the teacher responded to variations in student talk and activity by asking students to repeat what they had said so others could hear it or by asking a question to elicit further information. However, because of the limited progress students made in developing their mathematical thinking, the teacher began to orchestrate classroom conversations that focused more on aspects of students’ mathematical talk and activity; ways of talking that “wrapped around engaging students in conversations about translating among representations” (p. 567). In so doing, she learned to probe students to explicate their thinking to help them develop their understandings of different concepts. Webb (2009) found that when teachers are active in probing students’ explanations to help

them to make their problem-solving and thinking strategies more explicit, students provide more information on how they solved different problems (Webb et al., 2009). Moreover, Webb et al. (2014) also found that teachers need to follow-up on students' initial explanations as this determines whether other students will engage at a deeper level with the explanations presented and learn (Webb et al., 2014).

Erdogan and Campbell (2008) investigated the effect of teacher questions, question types, and interaction patterns that were evident in high and low levels of constructivist teaching. Fourteen teachers who had participated in a one-year professional development project on implementing constructivist teaching practices in their science programs volunteered to participate by providing videotapes of three of the best lessons that they taught. Using a coding scheme developed by expert science teachers, the two lowest and the two highest levels of constructivist teaching practices demonstrated on the videotapes were selected to identify the role teachers play in facilitating student learning. The results showed that the teachers who implemented constructivist teaching practices with high levels of integrity (HLCTP) asked significantly more questions, generally, and significantly more open questions than other types of questions (including closed & task-oriented questions) in comparison to the teachers who implemented constructive teaching practices with low levels of integrity (LLCTP). Moreover, the HLCPT teachers asked significantly more closed questions designed to focus students' attention on what is or is not important in an investigation while many of their open questions were categorized as enabling questions designed to promote students to take action on what they were learning. In fact, HLCPT classrooms were more focused on knowledge construction where teachers were found to be actively listening to students' comments and responding to them so the students, in turn, provided more reasons for the responses they generated.

In contrast to the questions teachers pose and the interaction patterns that they generate, Aguiar, Mortimer, and Scott (2010) investigated how the responses students generated to wonderment questions (i.e., conceptually difficult questions) affected a teacher's explanatory style and modified the forms of ongoing classroom discourse that resulted. Three classroom episodes of a very experienced science teacher who taught grades 7 and 9 were analysed according to whether they were: (a) continuation questions where students sought further clarification of ideas; (b) extrapolation questions where students went beyond the teacher's explanations and often presented alternative ideas than those presented; or, (c) contestation questions where students expressed alternative views to a problem and, in so doing, challenged the teacher's explanation.

The results demonstrated that the continuation questions were interactive-authoritative with both the teacher and students providing additional information on the topic in a question-answer sequence. Extrapolation questions were characterised by the students raising alternative points of view which they discussed with the teacher. This type of discourse was interactive-dialogic where students were free to debate and construct new ideas, free of evaluative comments by the teacher. In so doing, Aguiar et al. (2010) noted that they changed the way the teacher communicated with the teacher providing more prompts for students to consider as they built upon other students' ideas to develop new understandings. Contestation questions challenged the logic of different points of view as students needed to provide evidence to not only support their argument but also rebut the alternative thesis. The discourse that emanated was interactive-dialogic as students engaged in a process of hypothesizing, predicting, and explaining their perspectives, contributing to a surge of new ideas and knowledge. In short, the authors found that all three types of questions emerged during science lessons as a result of interactions between the teacher and students and they affected the teacher's explanatory style and the discourse that resulted with continuation questions tending to provide additional information on a topic while the explanatory and contestation questions were more open and dialogic, enabling the teacher and students to discuss alternative viewpoints in the light of the available evidence. It is these latter types of questions that are posed within a dialogic discourse that are widely recognised as leading to enhanced cognitive understandings and the development of higher-order thinking skills in students learning science (Kuhn & Crowell, 2011; Kuhn, 2016).

Given the importance of dialogical interactions in classrooms for promoting students reasoning, problem-solving, and learning and the key role teachers play in fostering these interactions, Gillies (2016) reported on a study that involved three, Year 7 teachers and 17 groups of students (3–5 students per group) from their classes that examined how teachers engage in dialogical teaching and how the students, in turn, demonstrate different dialogic interactions. The study focused, specifically on the types of prompting and mediating behaviours that teachers used to promote thinking, problem-solving, and reasoning in their students. It also sought to provide examples of the different dialogical interactions students used as they worked cooperatively together on specific problem-solving tasks in science. Prior to the commencement of the study, all teachers had participated in three days of professional learning workshops where they were introduced to the cooperative inquiry-science units they had agreed to teach and a dialogic approach to teaching designed to challenge students' thinking and learning.

An analysis of a vignette (chosen at random) from each teacher's classroom showed that all teachers engaged in dialogic interactions with the students as they worked cooperatively in their groups, and although each did it in a slightly different way, many of the questions they modelled to prompt and mediate students' thinking and learning were similar. For example, they posed questions that focused students' attention on issues, probed to elicit additional information, challenged students to provide reasons for their positions, and scaffolded connections to help students construct new understandings. In turn, the students were actively involved in their group discussions, offering suggestions, explaining or elaborating on ideas, asking questions, rebutting suggestions, and providing reasons for their positions on different topics. In effect, Gillies (2016) noted that the students drew upon an inventory of linguistic tools or ways of talking that their teachers had modelled that enabled them to respond to others' questions, statements, reasons, challenges, and propositions. Moreover, it is the recursive nature of these dialogic exchanges that Michaels et al. (2008) argue contributes to academically productive talk.

5. Dialogic teaching and enhanced cognitive understandings

Evidence exists that certain forms of dialogic talk facilitate problem-solving and reasoning across different disciplines and, in some instances, transfer to standardized tests. Mercer et al., (e.g., Mercer, Wegerif, & Dawes, 1999; Rojas-Drummond & Mercer, 2003; Wegerif et al., 1999) investigated the effects of Exploratory Talk on students' collaborative reasoning and problem-solving capacities and found that students who had been taught to use this linguistic tool to dialogue together made significantly greater gains on their individual scores on the Raven's Progressive Matrices and Vocabulary Scales (Raven Court, & Raven, 1995), a standardized test of non-verbal reasoning, than peers who had no such teaching.

Similarly, O'Connor et al. (2015) and Resnick et al. (2010) found that providing students with opportunities to engage in discourse-intensive instruction around cognitively challenging tasks was critically important if academically productive talk was to emerge. The protocols for such instruction, which is commonly called Accountable Talk, involved not only teaching students to master a body of discipline knowledge (e.g., math, science) but also how to reason with the ideas and tools of others. In so doing they learn to interrogate others' claims, justify their own positions, and rebut and reconcile anomalous positions until an agreed position is accepted. The discourse that occurs is often deliberative and discursive, involving extended exchanges among participants as students seek to clarify their thoughts, consider the reasoning of others, and explicate their own thinking. When students have opportunities to engage in this type of dialogic exchange, Resnick et al. (2010) argued it not only supported the growth of disciplinary knowledge and a deeper understanding of complex concepts but it also led to improved cognitive performances on a standardized test of mathematics achievements.

Others who recognise the value of language as a tool for reasoning in promoting the development of critical and creative problem-solving skills and enhanced cognitive ability and social competencies in students include Trickey and Topping (2004, 2006) and Topping and Trickey (2014, 2007) who reported on a series of studies where they used Philosophy for Children (P4C) (Lipman, 1988) to teach students how to think for themselves and make informed choices as they engaged in collaborative discussions on socially-relevant topics. The goal of P4C is to improve children's reasoning abilities and judgements by encouraging them to reflect on their thinking as they discuss issues that are important to them. During this process, the class acts as a community of enquiry as the children and their teacher share a story or event that has currency for the students, the students reflect on the topic, and think of some interesting questions they can pose to find out more about the topic. The teacher's role in the discussion that follows is critical in helping students' build on each other's ideas while ensuring that related lines of enquiry are pursued. Trickey and Topping (2004, 2006) and Topping and Trickey (2007) found that not only did social, emotional, and cognitive gains emanate from participating in P4C but these gains were sustained and transferred across contexts and school settings.

The success of discourse-intensive instruction such as Exploratory Talk, Accountable Talk, and Philosophy for Children in raising students' cognitive ability and academic achievements, Resnick and Schantz (2015) maintain, can be attributed to the way students are actively involved in constructing knowledge rather than displaying knowledge as often occurs in teacher-centered classrooms. In knowledge-construction classrooms, students engage actively with content rather than sitting passively so that over time as they are encouraged to seek solutions to problem-based tasks, they learn to develop a repertoire of reasoning and argumentation skills that have been demonstrated to transfer to other subjects and contexts (Adey & Shayer, 2015). Moreover, Kuhn and Zillmer (2015) reported that as students become more proficient at developing these skills, they engage in meta-talk. In meta-talk, students demonstrate an understanding of the concepts and norms of meta-argument where they learn to promulgate an argument and receive feedback from others on their procedural skills and epistemological understandings of the discussion topic.

Furthermore, Resnick and Schantz (2015) argue that when students have opportunities to engage in discourse-intensive classrooms, they realise that the thinking process itself is valued and their comments are important even if they are incorrect or inconclusive. In such classrooms, students learn to develop a 'growth mindset' where "working hard to learn new things makes you smarter- it makes your brain grow new connections" (Dweck, 2010, p. 28). In fact, Resnick and Schantz argue that intelligence is more than acquiring a fixed body of knowledge – it is 'the ability to reason, process, interpret, and ultimately do something new with information. We claim that intelligence can grow' (p. 341).

6. Future directions for research

One possible direction for research involves determining how discourse-intensive instruction leads to enhanced cognitive abilities (i.e., intelligence). While it is widely accepted that certain forms of discourse instruction contribute to enhanced cognitive capacities in students, and in the case of Exploratory Talk significant gains were obtained on measures of fluid intelligence using the Raven's Progressive Matrices Test (i.e., a non-verbal test of reasoning), concern has been expressed that there is often not a concurrent rise in measures of crystallized intelligence (i.e., vocabulary, reading comprehension, general information) (Blair, 2006; Burgess, Braver, & Gray, 2006; Cowan, 2006); a key component of general intelligence.

In a recent review of research on findings and theoretical developments in intelligence, Nisbett et al. (2012) reported that training in executive functioning and working memory (i.e., measures of fluid intelligence) have been shown to only improve fluid intelligence performance and have little or no effect on crystallized abilities or verbal reasoning; adding weight to Flynn's thesis (Flynn, 1999) that increases in fluid intelligence do not lead to concurrent rises in crystallized intelligence.

The debate is contentious with Thorsen, Gustafsson, and Cliffordson (2014), in a study that investigated the influence of fluid intelligence and crystallised intelligence on the development of knowledge and skills in a sample of over 9000 children in compulsory schooling (who were homogeneous with regard to level of education, age and cultural background), finding support for the continuous influence of fluid intelligence on crystallised intelligence across grades 3, 6, and 9, although no direct influence of fluid

intelligence on the subject grades could be identified. Similar findings were reported by Blanch (2015) who found support for the interrelationship of fluid intelligence and crystallized intelligence with fluid intelligence having a higher influence on the rate of learning than crystallized intelligence and an indirect effect through crystallized intelligence on learning performance.

Given the claim that intelligence can grow (Resnick & Schantz, 2015) and the apparent support that certain types of discourse-intensive instruction have led to cognitive gains on standardized tests, future research needs to investigate the mediating role both fluid and crystallised abilities play in contributing to these gains. In so doing, it may help to provide a clearer understanding of how discourse-intensive instruction enhances cognitive abilities and learning.

A second direction for research involves examining the role of interpersonal synchrony in promoting prosocial behaviours and social interactions. Rogoff and Toma (1997) argue that shared thinking aids cognitive development when students are actively engaged in social interactions with each other where they challenge others' understandings, share their own perspectives, and actively attempt to reconcile anomalous insights. Similarly, Mercer and Littleton (2007) propose that talk as social interaction is not only how students learn but it is also valuable as a social mode of thinking. Moreover, Gillies (2007) reported that when children work cooperatively together, they often develop an implicit understanding of the needs of others and will offer assistance and help even when it is not requested. In short, when students recognise they are connected to each other, they realise they must coordinate and synchronize their actions if they are to achieve their group's goal.

Interestingly, Manson, Bryant, Gervais, and Kline (2013) found that behavioural coordination, evident when students cooperate, is a form of interpersonal synchrony and that greater synchronization in speech events (i.e., language) appears to facilitate prosocial behaviours and language development when students cooperate. There is also evidence that individuals do communicate with their bodies, voices, and language in order to develop mutual understandings with Reuzel et al. (2013) finding that rapport and cooperation between individuals is related to the level of non-verbal synchrony they achieve in their interactions with each other. Hove and Risen (2009) also found that interpersonal synchrony increased affiliation. In short, interpersonal synchrony, whether it is in verbal or non-verbal communication, facilitates cooperation and language development. Given the key role language plays in shared thinking and cognitive development, understanding how interpersonal synchrony may enhance different aspects of language development warrants further investigation.

7. Conclusion

This paper has discussed the research that highlights the key role talk plays in the construction of knowledge, understanding, and learning and how teachers can use this information to structure classroom experiences to promote student engagement and productive academic dialogue. The importance of structuring collaborative learning experiences that challenge students' thinking and scaffold their learning to promote critical and creative problem-solving and enhanced cognitive understandings is also highlighted. Future research includes investigating changes to students' cognitions as a consequence of specific types of dialogic interactions and the role of interpersonal synchrony in promoting prosocial behaviours and student interaction.

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