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## **Instructional Conversation in the Classroom: Can the Paradox be Resolved?**

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Derived from an interpretation of Vygotsky's writings about instruction and the zone of proximal development, the concept of Instructional Conversation constitutes a paradox, as Tharp and Gallimore (1988) fully recognize. "Instruction' and 'conversation' appear contrary, the one implying authority and planning, the other equality and responsiveness. The task of teaching is to resolve this paradox" (p.111). The questions we wish to address here are: Can this aim be fully achieved? and, If so, under what conditions?

Most discussions of instructional conversation concern use of this practice in formal educational contexts, where it is recommended as a means of "teach[ing] students to engage in thoughtful and accountable conversation about cultural artifacts" (Dalton and Tharp 2002). However, as Dalton and Tharp go on to state, "typical classrooms provide infrequent occasions for sustained conversation, and rarely arrange for it to occur on a regular schedule" (p.191).

The major problem arises from the imbalance in the participants' understanding of the purpose of the IC and hence in their differential ability to control its progress in a collaborative and productive manner. Since students are rarely the initiators or the managers of ICs, it is clearly very difficult for them to be truly equal participants. Goldenberg and Gallimore (1991), for example, propose ten elements necessary for an effective IC; five of these concern the teacher's goals and the other five describe what the teacher should or should not do. Here the IC is seen from the instructional – or, at least, the instructor's – perspective; significantly, they offer no matching student perspective. On the other hand, if the idea inherent in "conversation" is honored, there cannot be a predetermined goal to be met. Neither can there be a guarantee that the talk will be progressive (Bereiter, 1994), since one of the expectations of spontaneous conversation is

that no one participant should assume the right to control the floor. It seems, therefore, that if an IC is to be successful, ongoing negotiation of purpose and direction is essential.

Over and above the uncertain outcomes of carrying on an instructional conversation in a class of 30 or so students, a further reason for the lack of IC in the early grades is often said to be that teachers believe that IC is not possible with young children because they are not able to engage in sustained conversation about a particular topic without going off on irrelevant side-tracks. However, this is certainly not the case in their home surroundings, as is clear from the recorded observations made in the Bristol Study of Language in the Pre-school Years (Wells 1986) and by Hasan (1986, (2002) in her study in Australia. Consider the following example. (Much longer examples are cited by Hasan.)

*Elizabeth, age 4, is watching her mother shovel wood ash from the grate into a bucket.*

Elizabeth: What are you doing that for?

Mother: I'm gathering it up and putting it outside so that Daddy can put it on the garden

Elizabeth: Why does he have to put it on the garden?

Mother: To make the compost right

Elizabeth: Does that make the garden grow?

Mother: Yes

Elizabeth: Why does it?

Mother: You know how I tell you that you have to eat different things like eggs and cabbage and rice pudding to make you grow into a big girl?

Elizabeth: Yes

Mother: Well, plants need different foods too. and ash is one of the things that's good for them

(Wells, 1986, p.59)

This example was by no means unique; many children showed a similar ability to engage in this sort of instructional conversation when the topic was one that interested them. It is therefore worth looking more closely at this example in order to try to determine why it was successful. Several features seem to be important. First, the conversation occurs in the context of an activity in which both participants are involved. Second, Elizabeth is clearly interested in the reason for her mother's actions and it is she who starts the conversation. Third, while the mother offers instruction, she does so in response to her interpretation of her daughter's questions; this is what might be called "just-in-time" instruction and, because it is offered in the child's zpd, it enables her "to go beyond herself" (Vygotsky, 1987) in understanding the relation between nutrition and growth. In other words, although the mother has the authority of greater understanding, she does not invoke her authority in her role as mother to control the direction that the conversation takes.

The importance of these features becomes apparent when the preceding conversation is compared with the following example, in which most of these features were absent.

*Thomas (age 25 months) has seen a plate of biscuits (cookies) on the table. His first utterance consists of three words, but only the third is intelligible.*

*Thomas:* \* \* biscuits

*Mother:* Those were got specially 'cos we had visitors at the weekend  
Who came to see Tommy? who came in a car?

*Thomas:* See Grannie Irene uh car

*Mother:* Grannie Irene's coming next weekend . but who came last weekend?

*Thomas:* Auntie Gail in a train

*Mother:* Auntie Gail's coming . they're coming on the train, yes

*Thomas:* Colin uh Anne a train

*Mother:* Colin- Colin and Anne came in the car, didn't they?

*Thomas:* Colin uh Anne . Colin uh Anne

*Mother:* Yes

*Thomas:* Colin uh Anne . Colin uh Anne  
*Mother:* Colin and Anne came in the train  
*Thomas:* In uh train . auntie train  
*Mother:* No, not Auntie train, darling . Auntie Gail and Grannie Irene  
are coming on the train on Friday  
*Thomas:* Auntie Gail in uh train  
*Mother:* That's right

(Wells, 1986, p.49)

Here, there was no attempt to clarify Thomas's intention (probably a desire to eat one of the biscuits); instead, it was overwhelmed by his mother's insistence on accuracy about the various relatives' days of arrival and means of transport. Thomas was clearly not an equal participant in this conversation and his mother's final utterance, "That's right" is symptomatic of the overall tenor of the conversation.<sup>1</sup>

It is also all too characteristic of the conversations that occur throughout the day in the early years in school, whether in one-on-one interactions between teacher and child or in teacher-led whole class "discussion" (Heath 1983; Wells 1986). And, once this pattern of inequality has been established as the norm in school, older children accept and even collude with it, becoming unwilling either to ask the sort of questions that might lead to a genuine instructional conversation or to go beyond giving minimal answers, even when a teacher's question calls for an expression of their own opinions or an account of their personal experience. Given this state of affairs, it seems that in order to succeed in creating a different kind of interaction as the medium of learning and teaching in schools – one based on the goals set out by Dalton and Tharp above – it is necessary to start by trying to understand what militates against such a change.

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<sup>1</sup> It is perhaps significant that Thomas's mother was a teacher.

## **Questioning the Purposes of Formal Education**

To understand the current organization and practices of public education, it is instructive to look at its history. As Cole (1996) points out, the earliest schools were training institutions. In order to administer their kingdoms, rulers needed a bureaucracy of “educated” individuals to collect taxes and keep records. To this end, schools were invented as a means of maintaining a pool of individuals who were skilled in reading writing and arithmetic. Several thousand years later in Europe, the basic reason for the establishment of public schools remained very much the same: to train young people in the skills that were necessary to succeed in the family trade or business or to perform some local administrative function. And to achieve these ends, instruction was mainly didactic and learning was largely conceived of as practice and memorization.

From the Renaissance onward, on the other hand, a rather broader conception of education began to emerge – at least for those students whose families could afford to pay for them to attend a “grammar” school. Here, in addition to mastering the three Rs, young people (largely male) also received instruction in classical languages, history, and more advanced mathematics, an acquaintance with which was considered necessary for one to be accepted as a member of the educated upper class, most of whom, of course, did not need to be gainfully employed.

Still later, as schools began to proliferate in the nineteenth century, another tradition began to emerge: that of philosopher/educators, who, like their forebears in classical Greece, had a much broader view of education and of how schools should be run. Indeed, some of them became involved in the actual organization of experimental or demonstration schools, for example Pestalozzi, Froebel, Tolstoy, Montessori, Steiner and, in the United States, Dewey. Although differing in their philosophical roots and in their vision of the ideal outcome, all these educators had a view of the purpose of education that went far beyond that of training for employment. For them, education involved the integrated development of the whole person, in which the intellect was not separated from the practical, nor knowledge from values and feelings. While each of these pioneers

had strong views about what should constitute the curriculum, they were even more concerned about how the relationship between the child and the curriculum should be enacted. Dewey (1916/1966), for example, believed that a child's learning should grow out of his or her experience in the community and, through inquiry, should be oriented toward understanding as the basis for effective and responsible action. In this tradition, the concept of instructional conversation would have been readily accepted.

By contrast, however, the development of universal, mandatory public schooling in the wake of the industrial revolution was less concerned with the development of the whole person than with the socialization of young people, particularly the children of the displaced rural poor and of recent immigrants, to fit the demand for semi-skilled workers in the increasingly industrialized countries of Europe and North America. In the face of the much larger number of children to be educated, there was a perceived need for greater standardization, both in organization and also in the curriculum to be taught and in the methods of instruction. Coinciding, to a considerable extent, with the advent of industrial mass production, schooling tended to be conceptualized as similar in its goals and procedures. Not surprisingly, therefore, schools were organized on the model of an assembly line and on the belief that learning, to be activated, required sequentially organized training through instruction, drill and practice.

To a large extent, this is still the basis on which most public schools are organized, but now with much more attention to "quality assessment" of the output (Oakes and Lipton 2003). In the United States and in the United Kingdom, laws have been passed that require students to meet age or grade-level standards and, in the U.S, a school or district's failure to improve students' results on standardized tests can lead to the imposition of scripted teaching programs and a narrowing of the curriculum to basic skills in literacy and numeracy and, if improvement still does not result, to a takeover by the state.

What emerges clearly from this brief history is the importance of the way in which the purpose of public education is conceived. When this is oriented to meeting externally set standards in the interests of training students to fill the hierarchy of niches in the

workforce, education becomes a matter of “covering the prescribed curriculum” at a predetermined rate and ensuring that students perform well on tests, with little concern as to whether they understand what they are memorizing. This is as true of those who are aiming to enter higher education as it is for those in the “lower tracks.” Although there is much emphasis on training “higher thinking skills,” there is little, if any, opportunity for students to bring these skills to bear on issues that are of genuine concern to them.

In such an intellectual climate, there is no time for practices such as Instructional Conversation, even if teachers believe it would be of value for students to “engage in thoughtful and accountable conversation about cultural artifacts,” as Dalton and Tharp put it. Nor is there time for students to plan and carry out investigations into issues that they find interesting or important, which would be the natural context in which such conversations would be most likely to develop. For these practices to flourish, it seems clear that a change in the generally accepted purpose of education will be required.

In the remainder of this paper, we report on a small-scale study in which an attempt has been made to bring about such a change, at least as far as the teachers and students are concerned. But first we will briefly outline the pedagogical theory that underlies this study.

### **A Sociocultural Theory of Learning and Teaching**

Since the heyday of behaviorism in the first half of the twentieth century, there have been some important developments in understanding about knowing and learning (Case 1996). In the 1950s, the cognitive revolution reintroduced a concern with mind and consciousness and, in addition to its emphasis on information processing, paved the way for the study of the relationship between the brain and mental activity. At the same time, Piaget’s (1970) study of cognitive development led to the theory of constructivism, with its emphasis on the active role of the child in learning and the cumulative manner in which new learning builds on prior learning with periodic reorganizations of the child’s meaning making in the light of challenges to his or her existing conceptual framework.

And with the more recent dissemination of Vygotsky's (1978, 1981, 1987) writings, recognition is now also given to the essentially social nature of learning and to the key role of semiotic mediation in development (Wells 2007). As a result of these various and, to a considerable extent, cumulative insights, educators today have a very different conception of learning and the role of instruction than that which held sway a century ago.

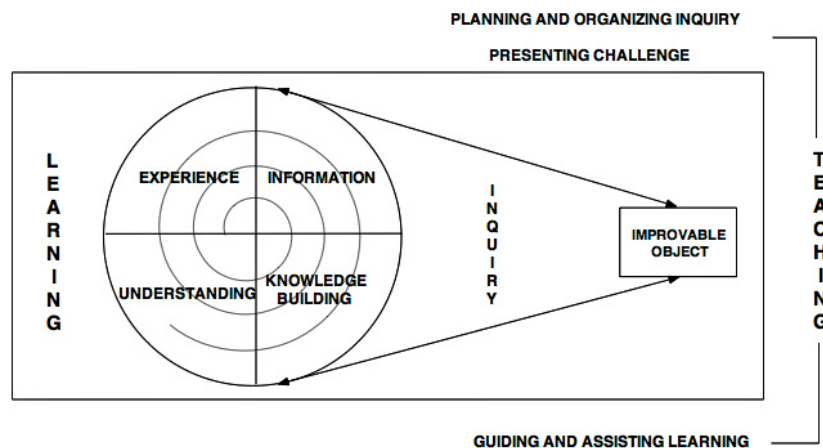
As a result, a number of "design experiments" have been carried out in recent years that attempt to devise classroom practices that honor this new conception of learning and teaching (Tharp and Gallimore 1988; Brown and Campione 1994; Scardamalia, Bereiter et al. 1994; Palincsar, Magnusson et al. 1998; Mercer 2000; Alexander 2006). Writing about learning mathematics, Lampert (1986) spelt out some of the key principles shared by most of these researchers in more detail:

What sort of help do children need from adults in order to do these things and to be confident of their ability to do them? I would suggest that they need to be asked questions whose answers can be "figured out" not by relying on memorized rules for moving numbers around but by thinking about what numbers and symbols mean. They need to be treated like sense-makers rather than rememberers and forgetters. They need to see connections between what they are supposed to be learning in school and things they care about understanding outside of school, and these connections need to be related to the substance of what they are supposed to be learning. (p. 340)

In our own work, rather than devising a pedagogical approach and then trying it out with volunteer teachers, we decided to engage in collaborative action research with teachers to explore how these principles could be enacted in their own classrooms. Combining Dewey's emphasis on inquiry with Vygotsky's ideas about learning through joint activity together with assistance in learners' zones of proximal development, we engaged in a long-term investigation entitled the *Developing Inquiring Communities in Education*

*Project* (Wells 1999; Wells 2001).<sup>2</sup> Over the course of our work together, we learned a great deal about what it is possible to achieve in “regular” classrooms, and on that basis we constructed a generalized model of learning and teaching through dialogic inquiry. This is shown in figure 1.

Figure 1. Learning and Teaching Through Inquiry



In this model, learning is conceptualized as a continuing spiral, where, in each cycle, the learner approaches a new problem armed with some relevant experience and gains new information from feedback from his or her own actions and from other sources, such as teacher talk or printed material. However, for this information to lead to enhanced understanding, which is the goal of each cycle, the learner needs to engage in active knowledge building, either through further, thoughtfully planned action, or through dialogue with other people – or through a combination of both modes.

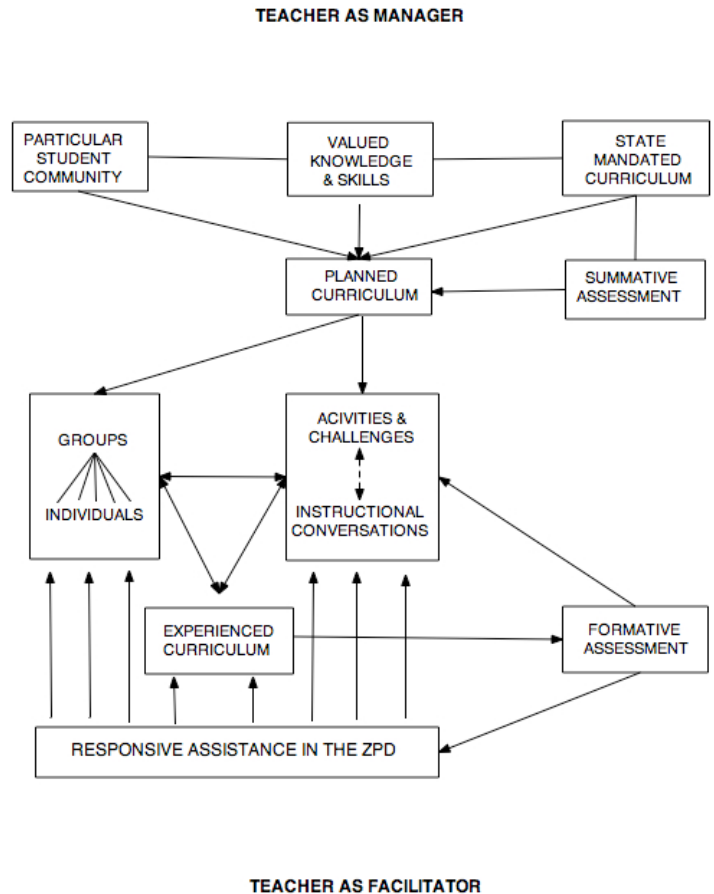
As we have discovered, this cycle is likely to be most successful when there is a clear object in view that the learner(s) want to create and/or improve. This object may range from a three-dimensional model to a poster or project report, or to a work of art, such as a story or a musical composition. On some occasions, it may be appropriate for students to work individually on such an object, but much is to be gained by students with similar interests working as a group, since as they work together they will need to explain and

<sup>2</sup> This project was funded by the Spencer Foundation 1991-2001.

justify proposals about how to improve the object. In other words, working on an improvable object necessarily involves them in knowledge building, through which they arrive individually as well as collectively at a deeper understanding of the issues involved. A further advantage of students working in groups on similar or related aspects of an overall theme is that whole class discussion is enriched by the different perspectives that are developed by the different groups.

In this model, the teacher has two major roles (see figure 2): the first is to select and introduce the overall theme for inquiry, provide access to the necessary resources, and negotiate with the learners the challenges they will take on; the second is to monitor the progress of individuals and groups and to provide guidance and assistance as appropriate, working, as Vygotsky (1987) put it, in their zones of proximal development.

Figure 2. The Roles of the Teacher



This latter responsibility includes engaging individuals and the whole class in instructional conversations, which also involve “metacognitively” reviewing the objects they have produced as well as the processes of their learning in order that they may take greater control over, and responsibility for, their efforts to achieve understanding (Olson and Bruner 1996).

This model is very schematic, of course, and no attempt is made to propose a single best way of enacting it. This, in our view (as figure 2 makes clear) is dependent on the people involved and on the wider context in which their classroom community is embedded. For the teacher, therefore, how best to achieve a satisfactory solution is ideally a process of ongoing inquiry.

In the next section of this paper, we present a case study of a fourth grade classroom at Shoreline Public School in the Central Coast region of California that contains a significant proportion of English language learners. Over a period of several years, Buzz, the teacher of this class, undertook collaborative action research with one of the authors to explore how to adapt this model to his particular situation. A key part of the approach that he adopted involved regular whole class discussions that, as we argued in an earlier paper (Wells and Haneda 2005), meet many of the criteria for instructional conversations. Here, we focus on the way in which Buzz managed these conversations.

### **A Practical Investigation of the Physics of Motion**

The project we are reporting here began in 2003 with the end-of-term ritual of the Lunch-box Derby. Students had made “cars” of fruit and vegetables held together with wooden skewers and competed to see whose car would travel farthest when launched down an inclined ramp (see figure 3). After the holiday, the first author approached the teacher with the suggestion that the Lunch-box Derby be treated as the “launch” for a more extended investigation of the factors that affected how far a more durable vehicle could travel when launched down a similar ramp. Our aim was, first, to investigate the

effectiveness of the unit in engaging the students in understanding the physics of motion while mastering the practical skills involved in the inquiry, and second, to discover whether and how this approach could promote exploratory talk (Barnes 1976).

Figure 3. The Lunchbox Derby



Each year, the project had a similar overall structure. Students first built their own individual vehicles at home, often with parental help, and the unit was launched with a competition in which each student released her or his vehicle from the top of the ramp and measured the distance it traveled across the floor from the bottom of the ramp. All results were entered on a chart on the whiteboard and a discussion then followed about the features of the cars that seemed to be associated with the differences between them in

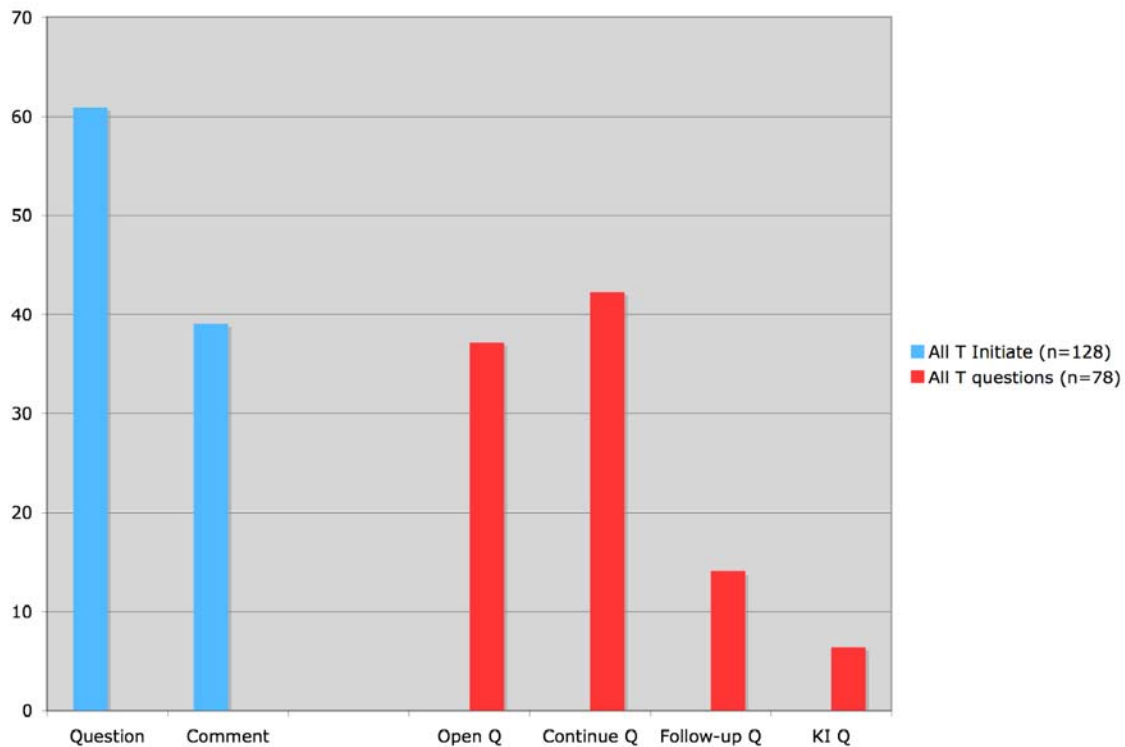
the distance traveled. The remainder of the unit was then spent in testing the effectiveness of modifications made to the cars in the light of the hypothesized critical features. Lessons occurred once a week for about ten weeks and typically lasted between one and one and a half hours.

While the general approach remained the same over the four years, a number of changes were introduced in the light of experience. In the first year, student groups had an assortment of “junk” materials from which to build their cars. This was an excellent opportunity for them to use initiative and to develop skills in construction; however, the variability of their designs made it impossible to carry out systematic investigations of the effect of changing hypothesized variables, such as weight, wheel diameter and wheel texture. By the third year we had overcome this problem by providing each group with an identical kit that included a chassis, two sets of wheels of different sizes and a container to which weight could be added. A second change was the increasing significance given over the four years to the role of writing in a science journal each week and to selected students reading their journal entries to the rest of the class. In addition, between year two and year three, the school district closed a neighboring school and reassigned many of the students to Shoreline. Since many of these reassigned students were ELLs, whose families spoke only Spanish at home, Buzz modified the organization of the project in a number of ways that he believed would enable these students to participate fully in the project. All these changes can be seen as the teacher attempting to improve the object of his inquiry, namely the organization of the project.

Because of space limitations we shall limit discussion to the second and fourth years – before the change in classroom demographics and after Buzz had adapted to them. First, we shall give some statistics from the second year that capture the overall quality of the discussions (analysis of the fourth year is still in progress, but seems quite comparable); then we shall analyze some extracts in detail.

Each lesson was videorecorded in full, but since a considerable portion of time was devoted to engineering modifications needed to test particular variables and then to carrying out the tests, only those portions devoted to discussion have been submitted to discourse analysis. The underlying structure of the discussions followed the basic IRF format – although with some significant departures, as will be described below – and so the first analysis was concerned with the proportional distribution of the different functions performed in these three slots, Initiate, Respond and Follow-up. Figure 4 shows the proportional distribution of Teacher Initiating moves.

Figure 4. Proportional Distribution of Teacher Initiating Moves



At the highest level, these either Requested or Gave Information (Halliday 1984), coded respectively as Question or Comment. Questions were further subdivided into Questions for Known Information (KIQ), Open Questions to which many answers were possible, Continuing Questions (Cont Q) which occurred when either explicitly following nomination or implicitly the same question was answered by a second or subsequent

student, and Follow-up Question (Fup Q), which, following a student contribution, was a request for additional information addressed to the whole class.

There are two interesting features of this distribution. First, although many teacher initiations asked for information, a very substantial proportion (38%) were comments that gave information that the teacher considered would enrich the discussion (see examples below). Second, only 6% of all the questions asked called for information that the students were expected to know, and some of these were requests to be reminded of results of tests already reported. The most frequent type of question (Cont Q) was, in fact, not actually asked but was assumed to be still in play following one or more student responses to the original posing of the question.

Figure 5. Proportional Distribution of Student Substantive Contributions

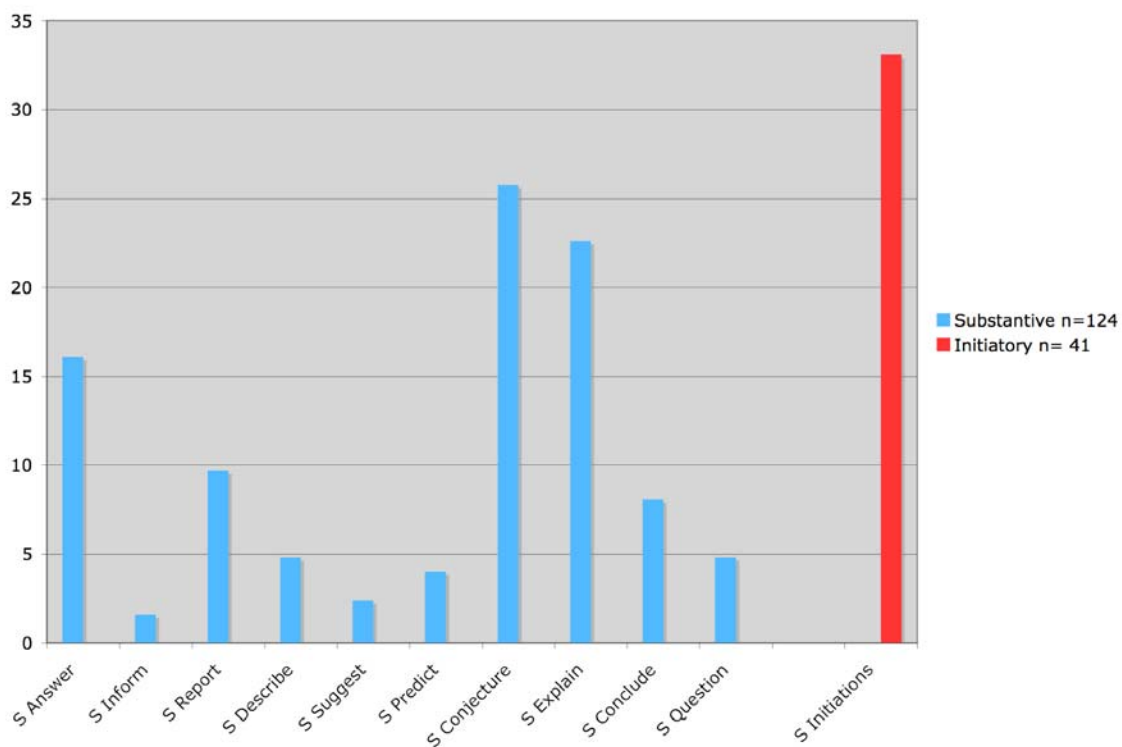
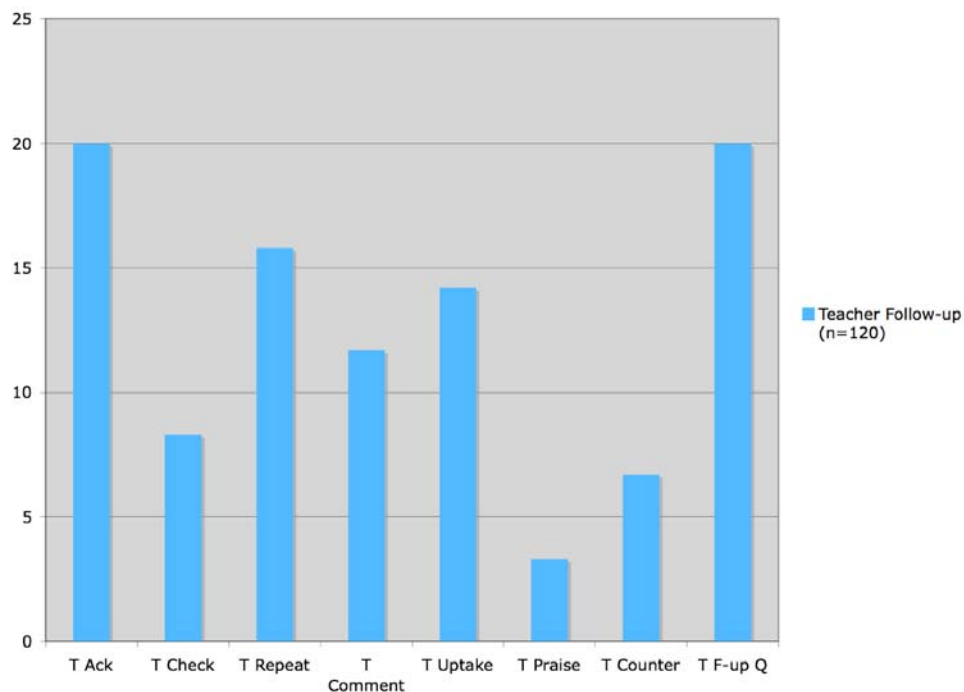


Figure 5 shows the proportional distribution of students' substantive contributions to the conversation. These are described as "substantive" because unsolicited comments that received no response and brief expressions of agreement or disagreement with what had just been said were excluded. As can be seen from figure 5, a high proportion of student

contributions had a broadly explanatory function: conjecture, explain, conclude. On the other hand, short answers were relatively rare (16.1%), in part because few questions were asked that called for known information (KI Q). Students also asked questions of their own. In addition to these questions, approximately 30% of student contributions in the other categories also initiated new exchanges.

As might be expected of discussions conducted in the IRF format, a high proportion of student contributions received some form of Follow-up response and sometimes more than one (see figure 6). The two most frequently occurring types were simple Acknowledgements (Ack) and Questions that requested further information (T F-up Q). Following Nystrand (1997), we were particularly interested in the proportion of follow-up moves that showed “uptake” of the preceding student contribution. Here, in addition to explicit Uptake, we also included Comments, which implicitly built on the preceding student contribution, and also Follow-up Questions, which asked the student to provide further information. Calculated in this way, almost half of teacher follow-up moves (45.9%) built upon the preceding student contribution.

Figure 6. Proportional Distribution of Teacher Follow-up Moves



Thus the overall pattern of these discussions, while certainly being instructional, came very close to being a multi-person conversation in which all participants had a degree of control over the course it took. This impression was confirmed when a comparison of the duration in seconds of the all teacher initiations and all substantive student contributions in the final discussion were compared. Excluding two exceptionally long turns, in which the teacher explained the effect of wind resistance on performance in competitive cycling, such as the Tour de France, the average duration was identical for teacher and students: 8.1 seconds.

The claim that the discussions that took place in Buzz's Grade Four class during the investigation of the forces affecting the distance a car would travel from the bottom of the ramp was both instructional and conversational tells little about the quality of the discussion. In the following section we shall illustrate its success in meeting the dual goals of Instructional Conversation by discussing a number of extracts.

### **Year Two: Unexpected Results and Their Consequences**

Quite early in the project, there was considerable interest in the possible effect of adding weight to the cars. Generally, it was thought that extra weight would make them travel further from the bottom of the ramp. As one student put it, "I think heavier cars will go faster because gravity pulls down weight so the more weight the more gravity will pull it down making it go faster." Accordingly, keeping all other design features constant, every group ran trials without and then with added weight.. However, when the results were compared, it was found that no car had traveled farther when weight was added. As one student observed, "It doesn't help. It's worse." This finding was unexpected and immediately gave rise to a host of explanatory conjectures.

Bodey: Well I think it's the weight... like when it hits the flat on the - on the carpet .. it like sorta like is a weight its like it like umm... the um the ah chassis – we don't have one on ours- but all that connects (indicating plastic connector rods)- the pennies is like pushing it DOWN so like the

wheels kinda STOP and slow down

T: So the weight coming down the ramp - pushing your car down - as soon as you hit the flat . it kind of pushes it DOWN . it's not pushing it down the ramp any more, it's weighting it down on the carpet that slows the wheels down?

This exchange developed in two ways: first, the discussion addressed the issue of the change of direction that the cars made when they transited from the inclined ramp to the horizontal floor, and second, the issue of the friction affecting the wheels as they moved across the carpeted floor. In both cases, it was conjectured, the force acting against the momentum gained by the cars as they traveled down the ramp was greater with added weight. Over the following weeks, both these hypothesized effects were systematically tested. Taping a large piece of flexible laminated card over the angle between ramp and floor certainly increased the distance all cars traveled, but it did not change the relationship between cars with and without added weight. To test the hypothesis concerning the greater effect of friction when weight was added to the cars, a comparison was made between two surfaces: the classroom floor and the asphalted school yard, with the ramp at the same angle in both conditions. On the asphalt surface, all cars traveled further, which confirmed the hypothesis about differential amounts of friction created by the two surfaces. However, the results of adding weight outside on the asphalt were inconclusive, probably because the yard was not absolutely level and this affected the distances some cars traveled. Nevertheless, Jerry, representing his group, whose car had traveled further with added weight, had this to say:

Jerry: Well, er- . this is my theory of why weight helps when you're on the asphalt-

T: What do you mean, theory?

Jerry: My theory' like- . well it's not really xxx but it's like weight- why weight causes x the asphalt- . cos the asphalt has little bumps which xx - the little bumps make the cars go UP a little bit and that slows them down . but with weight . um it keeps the car um . going to- going THROUGH the <bumps> like the bumps aren't even there

By the end of the project it was clear that, despite the conversational nature of all the discussions in which decisions were made about what variables to test and about the conclusions that could be drawn from the results, the students had come to understand quite a lot about the forces at work in their investigation; they had also understood, in practice, some key features of carrying out an investigation in a scientific manner. All these issues re-emerged in the final discussion, which started by Buzz asking what conclusion the class could draw on the basis of their various tests. Here is a the transcript of a continuous extract from the middle of the discussion. Buzz has just illustrated the importance of wind resistance in competitive cycling by describing the year in which the winner of the Tour de France made better time because he was the first to wear an aerodynamically designed helmet.

Table 1. Year Two Coded Extract

00:22:57:90	Harriet	Sometimes when I'm driving um I look into the mirror of- well my cousin's car . and I put- and I can feel wind resistance against my hand but if I like . put my hand really close to the mirror . then there's not as much wind pushing against my hand [TB: yeah] if I bring it out a little bit more it does	S Describe (Explaining) S Offer
00:23:18:00	TG	What d'you think makes it less when it's close to the mirror?	T Follow-up Q
00:23:21:26	Student	(inaudible)	S Explain
00:23:26:21	TB	Well that's it, yeah Steven	T Ack T Cont Q T Nom
00:23:28:87	Steven	I was going to answer that question	S Answer
00:23:30:82	TB	Oh OK Harriet	T Ack T Cont Q T Nom
00:23:32:65	Harriet	Well if you're in a car- it's sort of a thing- but if you're in a car and then you close your hand like this (curls hand) and you're going really fast and you can- it feels like (hits right fist into left hand) all this air it's pushing- it's almost pushing back your hand so it's [?: I always put*** } and then if someone <slaps> your hand behind here then you would really go- feel **	S Describe (Explaining)
00:23:55:27	TB	Yeah, if people come up behind you . It's the same thing if you put your hand out this way (horizontal) and then turn it over this way (vertical)	T Uptake T Comment

		[Ss: Oh yeah] . because there's not as much surface Um. Kara, what were you going to say?	T Nom
00:24:06:68	Kara	Um when you have ** (inaudible)	S Describe (Explaining)
00:24:16:63	TB	And did you know that it's the same in the water . although it's like four times more resistance - water than air - but you can draught behind somebody swimming if you get right on their feet . they push the water and it goes around them and you and so you can swim a lot easier too so . there's really a lot to that resistance that comes in your water or the air . but the thing about the AIR is you just can't see it . and you just wouldn't think it was there but it's a HUGE factor Jorge	T Uptake T Comment (Inform)  T Nom
00:24:46:16	Jorge	It's like in the freeway when you're really going really fast and you stick your head out and you can feel the wind **	S Describe (Explaining)
00:24:53:64	TB	Yeah. and when my dog sticks her head out her lips flap uh-uh-uh-uh [Ss: laugh] Christina	T Uptake  T Nom
00:25:01:32	Christina	Is that why geese fly in a V and they take turns being in front?	S Question
00:25:07:14	TG	Ah . that's a really interesting question [TB: Excellent question] I wonder . do you think they're close enough together [S: What?] to-	T Praise  T Follow-up Q
00:25:16:74	TB	Say it again, Christina	T Request Repeat
00:25:18:33	Christina	Why geese would take turns being in front [Ss: Oh]	S Repeat Q
00:25:23:17	TB	I know why they take turns being in front . they- they trade off . yeah . that's exactly right . by the way, a little aside, there's a movie out now it's a documentary called um . {Ss: Winged Migration] Winged Migration	T Answer T Comment (Inform)
00:25:37:12	SS	Oh I've seen that	SS Comment
00:25:38:77	TB	Excellent movie . it's just about migratory birds and they fly THOUsandS of miles a year . but anyway its shows and you can see how aerodynamic- you know some of these geese have necks that are this long (demonstrating, hands apart) . but they never fly with the head up . they're always pointed staright down like that (demonstrates) with their beak forward to break that wind (points to student)	T Inform  T Nom
00:25:56:35	John	Maybe we should try putting two cars that can go exactly in a straight line and put one behind the other	S Conjecture S Offer
00:26:05:34	TG	The other thing we could do is put a [Ss: **] is put a- something like a sail on top of one . and not on the other and let them go at the same time and see whether having the . sail on top	T Comment (Suggest)

		[P: Yeah that was***] . would slow it down	
00:26:18:83	TB	That's a good idea, John, either one of those is- yeah	T Uptake
00:26:22:67	Emmanuel	Well if- if- if one went behind the other it might hit [* (gestures bumping)]	S Conjecture S Offer
00:26:27:29	TG	Yes, I think [that-	
00:26:28:31	TB	[That might be hard to do . but I- your idea is a good one {S: * going faster} but we could try it a different way	T Uptake

In addition to the free-flowing conversational nature of this discussion, several points deserve mention. First, the students were clearly making connections between the rather abstract topic of (invisible) wind resistance and their own out-of-school experiences. Second, Buzz, as more expert instructor, was drawing on similar real-life experiences to illustrate the significance of wind resistance in sporting events. And third, the combination of these two features gave Christina, an English language learner, the courage to ask a question, the consideration of which significantly enriched everyone's understanding of the role of wind resistance in the natural world as well as in the technologically-enhanced world of their scientific investigation.

#### **Year Four: Bringing in Newton and Cynthia Clarke**

By year four, the demographic composition of the class had changed significantly: more than half of the students were ELLs, some of them still being withdrawn for a period of ESL instruction each day. As a result of his experience in the previous year when he had first had a similarly composed class, Buzz decided to make a number of significant modifications. The first, was to launch the project by having students release balls of different sizes, weight and composition down the ramp in order to get them thinking about the variables that might determine the distance they traveled. Then, the second week, he introduced two outside experts into the community. The first was Newton, whose first law of motion Buzz read to the class at the beginning of the lesson. The second was Cynthia Clarke, a fictitious student at the university who happened to be investigating rather similar issues concerning skateboarding. Buzz had managed to obtain

Cynthia’s science notebook, in which she had recorded her questions and conjectures on the basis of which she planned to carry out some practical experiments.<sup>3</sup>

First Buzz read Newton’s law, which was immediately followed by student conjectures about what might constitute a force that would act on a stationary or a moving object to change its speed or direction. However, it was Cynthia’s questions about skateboarding that really got the discussion going. Apparently, she had been cycling past a skateboard park that was familiar to most of the students when she stopped to watch. What she saw provoked a number of questions, which she had written down. Here is part of the discussion that followed.

00:00:26:36	T	Number one . Why- why did some skaters- why did SOME skaters seem to go faster than others? Do you guys want to take that one on?
00:00:36:30	Ss	[many speak at once]
00:00:40:09	S1	The material
00:00:42:11	T	What material?
00:00:42:63	S2	The wheels
00:00:44:03	T	The material of the board or the wheels?
00:00:46:76	S2	The wheels
00:00:47:90	T	Are all skateboard wheels the same?
00:00:49:84	Ss	No [several speak at once]
00:00:58:75	T	Were there any reasons you guys thought that some skaters go faster than others?
00:01:04:59	S3	**** [inaudible]
00:01:06:72	T	The material the skateboard's made out of . OK Teryama
00:01:11:68	Teryama	*** when they go down the ramp

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<sup>3</sup> This new feature occurred after Buzz had read Palincsar and colleagues’ (2001) work on “second-hand investigations.”

00:01:14:86	T	Yes . why do some go faster than others?
00:01:16:88	Teryama	Oh . oh . I know why but ***
00:01:20:54	T	OK OK so . hang on . so the rider- him or herself- whatever they weigh might <depend> on whether they're going faster or slower
00:01:29:76	S4	And how many times they kick their foot on the ground to-
00:01:35:45	T	Oh, so the pushoff they give at the start might be strong - the force .
00:01:37:12	S5	***
00:01:38:27	T	What did you say?
00:01:38:85	S5	The force
00:01:41:20	T	"Force" . there's a cool word . the force at the start might be different Tyson what do you think?
00:01:47:31	Tyson	How high the ramp is that they're going up
00:02:01:59	T	Oh they're on different size ramps? OK . I didn't think about that . I was thinking of them all on the same one . but that would make a difference . so how high ...
00:02:03:45	T	What else about ramps? .. And Zoe you were going to say something
00:02:05:50	Zoe	It's maybe like there are . how much difference *** experience . because if they were really really really good they could * go really fast *****
00:02:18:17	T	Oh, so the inexperienced person wouldn't want to go fast
00:02:21:99	Zoe	Yeh so the inexperienced person would probably- wouldn't really want to go very fast because they couldn't really control the skateboard so they'd want to go **
00:02:31:91	T	Oh that's good thinking .. Daisy
00:02:34:33	Daisy	How steep it is
00:02:35:56	T	How steep the ramp is would make a difference on speed down

		. but if it's all the same I was thinking there's ***
00:02:42:28	C5	But everything can be ***
00:02:44:48	C6	There are some small ramps and big ramps
00:02:47:89	T	I think that Zoe's talked about momentum earlier on
00:02:51:74	Ss	[several overlapping utterances]
00:02:41:03	T	We've heard "force" "momentum" gravity . a lot of pretty big words here today . she hasn't used any of those yet but . you guys are coming up with them

Buzz's new strategy of introducing the fictitious undergraduate researcher who already had questions about phenomena with which most of the students were familiar was clearly successful in engaging them with the problem situation. Their conjectures not only drew on their own experiences but also prefigured the variables that might be relevant in their upcoming investigation of how to make their cars go further when launched down the ramp. And by accepting, and thus validating, all their contributions, he provided a safe space for the more reticent ELL students to offer their ideas as well.

In the following weeks, Buzz capitalized on the interest generated by Cynthia's research by getting the students to write letters to her about their own investigations, to which she duly responded. In this way, reading and writing individually about their groups' findings and further hypotheses added a further dimension to their collaborative knowledge building, as Palincsar et al. (2001) had argued.

Over the following weeks, as in year two, the students continued to work in groups to investigate the effects of changing their cars in the light of the opening and later discussions of the forces at work. The final test involved comparing the distance traveled on the carpeted classroom floor with the distance traveled on the polished wooden floor of the school hall. The results were quite conclusive. All cars traveled further on the wooden floor and adding weight made them go even further. In the final discussion the following week the students continued to wrestle with the relationship between the effects of gravity and friction, recognizing that gravity is always at work and that it

interacts with friction in causing the cars to lose the momentum they gathered as they traveled down the ramp and eventually to stop them moving across the floor.

### **Instructional Conversation in an Era of High-Stakes Testing**

There is no doubt in our minds that the whole-class discussions that took place during the grade four “Cars on Ramps” project at Shoreline Public School were successful in engaging the students in acting, thinking and talking about some of the scientific concepts that Newton and others developed to explain the physics of motion and in deepening their understanding of them. In our view, the inquiry orientation of this curriculum unit was in large part the reason for this success. As Popper argued:

We can grasp a theory only by trying to reinvent it or to reconstruct it, and by trying out, with the help of our imagination, all the consequences of the theory which seem to us to be interesting and important . . . . One could say that the process of understanding and the process of the actual production or discovery [of theories] are very much alike. (Popper and Eccles 1977) p. 461.

Popper was, of course, writing about professional scientists. However, in this school classroom, the students worked toward an understanding of the theory on the basis of their first-hand investigations, supplemented in the fourth year by their reading of a somewhat more expert student’s similar attempts. In these ways, , through working on an improvable object by testing those modifications to their cars that they hypothesized would make them travel further, they too were “reinventing or reconstructing” the concepts involved (Wells 2008).

On our interpretation, the discussions also met the criteria that Tharp and Gallimore (1988) proposed for Instructional Conversation. These authors envisaged ICs taking place in the context of a teacher working with a small group of students but, we would argue, Buzz succeeded in achieving the same sort of results in a whole-class setting. It is worth asking therefore, what it was about the way in which these discussions were

organized that enabled them to be so successful, bearing in mind the prevailing pressure from the school district to improve students' scores on standardized tests of literacy and mathematics.

The answer, we believe, needs to be given on two levels. First, as an experienced teacher, Buzz intuitively agreed with Dewey's argument that what students learn should be of significance for them in the present and not simply for their possible futures. He also agreed with Vygotsky that "teaching should be organized in such a way that reading and writing are necessary for something ... Writing should be incorporated into a task that is relevant and necessary for life" (1978, pp.117-118). By starting with the cars that they had made themselves, the students were motivated to investigate the forces that could be harnessed – or partially overcome – in their project to make their cars travel as far as possible from the bottom of the ramp; and in this context, writing in and reading from their science notebooks played a significant part in helping them to make personal sense of their practical investigations.

At the present time, it takes both conviction and courage to resist the pressure to focus directly on raising test scores. But Buzz had few qualms, as he knew that by engaging students in purposeful, intellectually demanding projects that incorporated the skills of reading, writing and carrying out mathematical operations such as measuring, calculating averages, and graphing results, he was not only having them practice those skills but was also enabling them to learn when and how to use them.

However, that does not fully explain why the class discussions were so successful. To explain that, it is necessary to revisit the theory of learning and teaching that was sketched in an earlier section of this paper. There it was suggested that, for information to be transformed into understanding, there needs to be opportunity for collaborative knowledge building around an object that a group is trying to improve. Here it was the groups' cars that functioned as the improvable object and it was on making sense of the results of attempts to improve them that the class discussions focused, with the teacher facilitating the discussion rather than insisting on his own view of the sense to be made.

This was the second level on which Buzz was so successful. Instead of telling the students what variables to test and what their conclusions should be, Buzz asked open-ended questions and acknowledged the multiple conjectures and explanations that students offered, often publicly valuing them by incorporating or building on them in his follow-up moves. At the same time, he provided “just-in-time” instruction in the form of relevant anecdotes that made connections to his own as well as the students’ experiences. Despite the size of the group and the more formal context of the classroom, he behaved very similarly to the parents of the children described in Wells’s (1986) study of children learning to talk. And, as in that study, the students did learn to talk – not only appropriating “academic” vocabulary, but also gaining confidence in their ability to contribute relevantly to the topic with conjectures, explanations and suggestions. Equally important, although they did not fully resolve the relationship between the forces that affected the distance their cars traveled, they did discover that science is not limited to a set of facts to be taken on authority but can be a way of thinking and acting that has relevance for their lives beyond the classroom.

## **Conclusion**

In this paper, we have argued that the purpose that currently drives public education – efficient training of young people to fit the needs of the economy – is not only severely limited as an education for full participation in a democratic society, as Dewey argued a century ago. It is also ineffective in nurturing students’ development as self-directed learners and in encouraging them to collaborate in knowledge building in order to solve real-life problems of a practical as well as an intellectual nature. Like many other educators, we believe that a radical change is required in the organization of public schooling and that this will best be achieved, first, by helping teachers to understand how the new ideas about learning and teaching can be brought to bear on in the ways in which the curriculum is planned and enacted and, second, by persuading those in administrative positions to assist teachers in exploring new ways of teaching through collaborating with

their peers in finding out about what other teachers have learned and through their own classroom-based research.

Instructional conversation has an important role to play at both these levels – among students and teachers in the classroom, and among teachers, administrators and teacher educators in the various venues in which provision is made for teacher development. It has been suggested that IC is most effective when conducted in small groups. We would certainly agree that this is a very effective format for ensuring that each student can be a full participant. However, as we have shown, large group discussions can also function effectively as occasions for participatory instructional conversation, once appropriate “ground rules” have been established (Mercer 2002).

One of the most important prerequisites for ICs to realize their educative potential, we have suggested, is for the conversation to be concerned with an improvable object which is the focus of inquiries in which the students and teacher are engaged together. Where this is the case, students have ideas that they think are important to contribute and that they hope others will take seriously and to which, if appropriate, they will provide feedback. This is what makes it truly conversational. But, for students to feel confident in expressing their ideas, equally important is the achievement of an appropriate balance between “authority” and “equality.” On the one hand, this means everyone recognizing that learning is a collaborative undertaking, which benefits from the diversity of perspectives that will be found in any group. However, as the leader of the group, the teacher is responsible for ensuring that the IC is productive in achieving enhanced understanding. Nevertheless, this does not mean he or she has to steer the conversation in a unilateral, authoritarian manner. As was seen in the case study presented above, leading can be performed indirectly, through the strategic use of follow-up moves and by offering relevant information as a well-informed co-participant. This form of “just-in-time instruction” does not interrupt the flow of the conversation and effectively sustains the collaborative attempt to construct knowledge together – which is the goal of all instructional conversation.

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