DOCUMENT RESUME

ED 413 248 SE 060 858

AUTHOR	Groves, Susie
TITLE	Making Progress through Scientific Dialogue.
PUB DATE	1997-03-00
NOTE	13p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March, 1997). For related documents, see SE 060 856-857.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Classroom Environment; *Concept Formation; Constructivism (Learning); Creative Teaching; Dialogs (Language); *Discourse Analysis; Discussion (Teaching Technique); Educational Research; Elementary Education; Epistemology; Experiential Learning; Foreign Countries; *Group Dynamics; Interpersonal Communication; Learning Processes; Learning Strategies; Philosophy; Science Activities; Science Education; Small Group Instruction; Student Behavior; Verbal Communication
IDENTIFIERS	*Cognitive Conflict; United Kingdom

ABSTRACT

Discussion about and reflection upon observations which produce cognitive conflict have frequently been promoted as a strategy to enhance conceptual development in science classrooms. As part of the Practical Mechanics in Primary Mathematics project, teachers were urged to elicit children's views and attempt to establish what is now called scientific dialogue in their classrooms. This paper analyzes a segment of a videotape showing a group of upper elementary children discussing data obtained from a practical activity where the data conflict with their intuitive models of motion. The analysis attempts to demonstrate the extent to which the dialogue is an example of "progressive classroom discourse" in terms of the notion of generating new understandings for participants. Evidence of such progress is seen as an important issue when teachers, regardless of their stated theoretical frameworks for teaching and learning, are seen to be generally uncomfortable with the notion that there may be no closure at the end of a lesson which is based on genuine dialogue. Contains 21 references. (Author)

Making progress through scientific dialogue

Susie Groves

Deakin University — Australia

grovesac@deakin.edu.au

A paper presented at the
Multiple perspectives on scientific dialogue: Implications for classroom practice **symposium of the**
Annual Meeting of the American Educational Research Association
Chicago — March 1997

Related papers:

What makes scientific dialogue possible in the classroom?

Brian Doig, Australian Council for Educational Research

doig@acer.edu.au

Scientific dialogue as evidence of learning

Julian Williams, University of Manchester, UK

jwilliams@fs1.ed.man.ac.uk

Making progress through scientific dialogue

Susie Groves

Deakin University

Discussion about and reflection on observations which produce cognitive conflict have frequently been promoted as a strategy to enhance conceptual development in science classrooms. As part of the Practical Mechanics in Primary Mathematics project, teachers were urged to elicit children's views and to attempt to establish what we are now calling scientific dialogue in their classrooms. This paper analyses a segment of video-tape showing a group of upper elementary children discussing data obtained from a practical activity where the data conflicts with their intuitive models of motion. The analysis attempts to demonstrate the extent to which the dialogue is an example of "progressive classroom discourse" in terms of Bereiter's (1994) notion of generating new understandings for participants. Evidence of such progress is seen as an important issue when we see that teachers, regardless of their stated theoretical frameworks for learning and teaching, are generally uncomfortable with the notion that there may be no closure at the end of a lesson which is based on genuine dialogue.

Introduction

> A good discussion occurs ... when the net result ... is discerned as marking a definite progress as contrasted with the conditions that existed when the episode began. Perhaps it is a progress in understanding; perhaps it is progress in arriving at some kind of consensus; perhaps it is progress only in the sense of formulating the problem — but in any case, there is a sense of forward movement having taken place. Something has been accomplished; a group product has been achieved (Lipman, Sharp & Oscanyan, 1980, p. 111)

This paper arises from collaborative research which is being carried out by the *Practical Mechanics in Primary Mathematics** project in Melbourne, Australia, and the *Mechanics in Action Project*† at the University of Manchester in the United Kingdom. The research is designed to investigate ways in which practical activities can be used to foster links between upper elementary children's spontaneous concepts and Newtonian mechanics.

As part of our work, we have been investigating the role of dialogue in supporting children's theory building. A video-tape recorded in the United Kingdom, showing one of the researchers, Julian Williams, working with a small group of grade 6 children, contains a segment which we (and others) regard as exemplifying some of the characteristics of scientific dialogue which we would like to see occur in classrooms.

* The *Practical Mechanics in Primary Mathematics* project is funded by the Australian Research Council. The Chief Investigators are Susie Groves and Brian Doig. Research assistance is provided by John Cripps Clark.

† Julian Williams is the Director of the *Mechanics in Action Project* at the University of Manchester.

In Australia, we have been working with a group of grade 5 and 6 teachers, using a program of practical activities which we had developed. While results, in general, have been very encouraging, we have found it extremely difficult to achieve genuine dialogue (as opposed to discussion) in the classrooms in which we are working — despite the fact that this segment of video-tape was enthusiastically received by project teachers when it was discussed in some detail early in their involvement in the project.

The motivation for the symposium at which this and the related papers (Doig, 1997; Williams, 1997) were presented comes in part from our realisation that in order to better understand the reasons why this video-tape so clearly resonates with a wide audience we need to analyse it in a way which will highlight its critical features for ourselves and others.

The three analyses contained in this and the related papers attempt to draw on work which examines the nature of dialogue in a range of disciplines, including not only science and mathematics, but also language and philosophy, in order to focus attention on what constitutes scientific dialogue and the means by which it can be implemented in the classroom. We see this as an opportunity to further develop our own theoretical frameworks regarding the role of dialogue in the science classroom, sharing the view of Cobb, Yackel and Wood (1992, p. 100) that "the goals of making sense of particular events in one classroom and of developing a more general orienting framework are interdependent".

Background

In common with Hewson (1996) and others, the *Practical Mechanics in Primary Mathematics* project has adopted a view of learning as conceptual change. According to Hewson (1996), the status of a conception for a learner depends on the extent to which they regard it as intelligible, plausible and fruitful. A possible impediment to conceptual change occurs when a new conception conflicts with an existing one which already has high status, with the learner being unable to accept the new conception until the status of the original one has been lowered.

Discussion about and reflection on observations which produce cognitive conflict have frequently been promoted as a strategy to enhance conceptual development in science classrooms (see, for example, Gunstone & Watts, 1985). However, as Thijs (1992) points out, while practical activities can produce empirical evidence which triggers reflection, meaningful conflicts do not ensure conceptual development.

In addition to conflict with empirical evidence, Konold (1991) identifies two further types of conflict which can occur for a learner: conflict with the beliefs of others and conflict between the learner's own inconsistent beliefs. According to de Lange (1993), the beliefs of others — especially one's peers when they are required to give explanations — are likely to provide more powerful sources of conflict than contradictions derived solely from facts confronting the solitary learner. Thus Hewson (1996) argues that, when teaching for conceptual change, it is necessary for teachers to elicit the views held by different people in the class (both students and the teacher) in order that learners encounter new views. Students need to make choices between the views put forward, with new views sometimes (but not necessarily always) being accepted as their status increases and the status of earlier views decreases.

This model of learning is consistent with a constructivist perspective. Communicating and constructing shared understanding are regarded as important parts of learning, with teachers and students needing to learn how to carry on scientific discussion in an environment which fosters theory building (Davis, Maher, & Noddings, 1990; Wheatley, 1991; Duschl & Gitomer, 1991; Splitter & Sharp, 1995). Furthermore, Champagne, Gunstone and Klopfer (1985) propose that the active mental manipulation of concepts in the formulation of arguments plays an important role in the restructuring of knowledge.

Scientific dialogue in the classroom

Greeno (1992) argues that the task of school learning in mathematics and science should be to enhance children's thinking and that, in order to achieve this, classroom activities should be organized as mathematical or scientific discourses. According to Bereiter (1994), progress in scientific discourse "arises from continual criticism and efforts to overcome criticisms by modifying or replacing theories" (p. 5). He claims that classroom discourse can be progressive in the same sense as science, arguing that the generation of new understandings requires a commitment from the participants to working towards a common understanding which is based on a growing collection of propositions which can or have been tested. In a similar vein, Cobb, Wood and Yackel (1991) contrast discussion in traditional mathematics classrooms, where the teacher decides what is sense and what is nonsense, with genuine dialogue, where participants assume that what the other says makes sense, but expect results to be supported by explanation and justification. Such "genuine dialogue" — in the sense of Cobb, Wood and Yackel (1991), Splitter and Sharp (1995) and as elaborated by Doig (1997) — will be referred to here as "scientific dialogue".

One of Splitter and Sharp's (1995) conditions for dialogue is that "conversation is structured by being focused on a topic or question which is problematic or contestable" (p. 34). It was the intention of our research that the practical activities used provide such a problematic focus. So, for example, in the activity which forms the basis of the video-taped segment analysed in this paper, a ball with an inbuilt stop watch — a *timer-ball* — is used to find the height required for a half second drop and then a quarter second drop. Based on this information, children are asked to predict and then find the height for a one second drop. It is the tension created here between the children's intuitive additive models and the observed data (see below) which "drives the dialogue and gives it a sense of direction and purpose" (Splitter & Sharp, 1995, p. 36).

In the *Practical Mechanics in Primary Mathematics* project, recognition was explicitly given to the fact that conceptual change is a slow and difficult process. Teachers were urged to elicit children's views and to attempt to establish what we are now calling scientific dialogue in their classrooms. As part of this process, we encouraged teachers not to think in terms of lesson objectives which every child would achieve by the end of the lesson. However, we were aware that teachers did not necessarily have either the content knowledge or the experience to do this without input from the researchers. A sequence of eight activities were planned for classroom use. Among the various forms of support provided for teachers were lesson notes for each activity. Typically, these lesson notes listed under separate headings concepts which might be "introduced", "revisited" or "established" through the activity — in the case of the timer-ball activity, these were "acceleration due to gravity", "acceleration" and "speed as distance per unit time", respectively.

We found that teachers, regardless of their stated theoretical frameworks for learning and teaching, were generally uncomfortable with the notion that there may be no closure at the end of a lesson. They clearly echoed what Bereiter (1994) describes as the "perennial concern that educators have about non-didactic methods ... . What if the outcome of classroom discourse is that students settle on the wrong beliefs, enshrining their own misconceptions?" (p. 9).

The analysis of the segment of video-tape contained in this paper has partly been motivated by the desire to respond to this concern of teachers by demonstrating the possibilities for making progress through scientific dialogue in the classroom.

The video-tape analysed

> Classroom discourse can be progressive in the same sense as science as a whole is progressive. Scientific progress is not one homogeneous flow; it contains innumerable local discourses that are progressive by the standard of the people participating but that, with respect to overall progress in science, may only be catching up or even may be heading in the wrong direction. The important thing is that the local discourses be

progressive in the sense that understandings are being generated that are new to the local participants and that the participants recognize as superior to their previous understandings. (Bereiter, 1994, p. 9)

The segment of video-tape which is the subject of this analysis shows a group of four grade 6 children, Stephanie, Kelly, Daniel and Richard, together with one of the researchers, Julian Williams, discussing the outcome of part of a version of the *timer-ball* activity described above.

The group had, as was usually the case, been asked to find the height from which to drop the ball so that it would take half a second to fall to the ground. On this occasion however, after the children found the height for half a second, for some reason they then found the height from which they got a consistent reading of 0.43 seconds — this height was 95 cm. They were then asked to find the height for which the time would be exactly double — that is 0.86 seconds. As might be expected, they predicted that this would be double the original height — that is 190 cm. However, when the ball was dropped from this height, the fall took only 0.63 seconds — a surprise for the children.

For the purpose of this analysis, we regard the problematic that is being addressed by the children as finding an explanation for their observed data.

The analysis attempts to "follow the flow" of the dialogue and identify the extent to which understandings that are new to the participants are being generated. In order to do this, the segment of video-tape will be divided into a number of sections which, in our view, constitute different phases of the process of reaching some consensus on finding an explanation of the data observed.

SECTION 0: BEFORE THE SEGMENT STARTS

The girls, Stephanie and Kelly, had done most of the measuring. Daniel had been so surprised that the time from 95 cm was only 0.63 seconds that he insisted on trying this several times himself to check. He had some difficulties producing consistent times when dropping the ball as he was holding the ball for a "pause" before letting go.

The segment of video-tape begins at the point where Julian summarises the activity and asks for possible explanations for the data obtained. Richard has just suggested that the timer ball has gone round a full ten seconds and gone back to zero (there are only 3 digits available on the display). However he immediately realises that this is wrong, as the fall obviously doesn't take 10 seconds.

SECTION 1: THE CHILDREN START WITH AN ADDITIVE MODEL AND ATTEMPT TO RETAIN IT BY QUESTIONING THE ACCURACY OF THE DATA

Most children (and in our experience many adults too) bring to this activity a strongly held intuitive model which is additive — that is "if you double the height you will double the time". This is an example of children's well documented spontaneous appeal to additivity in almost all ratio, fractional and multiplicative situations (see, for example, Vergnaud, 1983).

One of the real strengths of this activity is the nature of the problematic in the sense that this strongly held intuitive model conflicts so clearly with the observed data, which is also usually seen to be relatively accurate. Konold (1991, p. 154) contends that the "informative power of empirical observations" is weakened because people generally do not keep accurate records or look for data which is inconsistent with their beliefs. He concludes that classroom activities which are "meant to challenge students' beliefs should emphasize these two features".

However, making observations is an active process, influenced by the observer's conceptual frameworks, with observers often "seeing what they want to see" and hence focusing on irrelevant factors or neglecting relevant features (Driver, 1983; Duschl & Gitomer, 1991). As Konold (1991, p. 154) points out "the fact that what one observes is never independent of what one already knows or believes, means that data cannot serve as the final arbiter".

So in this case, the children start by questioning the accuracy of the data — e.g.

Daniel I think it's quite good because we was planning to get 60, um 86, so that's 20, 23 away which means that we should have gone a bit higher but we measured, we doubled it, but from here it doesn't look the same length from the 43 downwards.

Julian So you think the girls made a mistake when they measured the 95.

Daniel Yeah when they measured it, yeah.

There is evidence at this point that at least three of the children agree that the problem lies with the data and not with their model of the motion — Richard who had previously thought that the clock had gone all the way around 10 seconds, Daniel who firstly thought the data was fairly reasonable in that 60 and 86 are "close" but now thinks that the height was measured incorrectly, and Kelly who immediately after these comments explains the difficulty of measuring using a 1 metre tape measure.

In this case, there is no progress possible in "solving the problem" until the children move past the point of questioning the accuracy of the data. However it should be noted that the accuracy of data is a very tricky issue. In this case, the "scientific community" — which includes Julian — knows that the "correct" model implies that if you "double the time you quadruple the distance" and so he immediately "sees" the data as confirming this. In an earlier activity in the sequence, where a graph was produced showing the distance a ball rolled on a smooth flat track in successive seconds, the data was usually quite inaccurate. However, we, the researchers, could "see" that the graph showed either constant speed (or perhaps slight deceleration), while most children saw the data as representing the ball alternately slowing down and speeding up in a quite random (and unexplainable) fashion. (In fact, one child commented that what he had learnt from the lesson was that you could never trust your predictions!) So we would certainly agree with Konold's comment above regarding the impossibility of the data being the "final arbiter".

At this point in the video-tape, a transition occurs. This happens for two reasons: Stephanie has an idea which she sees as an explanation of the data and Julian doesn't allow Kelly to carry on with the measurement which she would like to make.

Julian So you'd like to rule that out. In a minute, but wait a minute [Kelly is about to get up and do the measuring] let's take all the possibilities because Stephanie has got another idea yet. What's your idea?

The question of the teacher's role in a classroom using scientific dialogue as a way of effecting conceptual change is a difficult one which cannot be addressed fully in this analysis. However it is important to note that, together with many others (see for example, Yackel & Cobb, 1996; Hewson, 1996; Splitter & Sharp, 1995; Bereiter, 1994) we believe that the teacher's role is critical in the process and that their voice will need to be heard in a way that supports the progress of the dialogue without the teacher's view being seen as the sole authoritative view which needs to be transmitted to the students.

SECTION 2: STEPHANIE'S EXPLANATION THAT GRAVITY IS PULLING IT DOWN MORE FROM "UP THERE" THAN "DOWN HERE"

Stephanie It's not really an idea it's an explanation why it's only 63 and that's 43. Because there it's not got a lot of gravity pulling it down but up there it's got quite a lot, so it's pulling it down a lot quicker, so it's gone a bit slow, so that'd be 63.

The content has shifted remarkably here! Not only does Stephanie accept that the data is "correct" but she has implicitly acknowledged that the data needs to be explained in terms of, firstly, the fact that ball must be going faster (although it is not clear where it is going faster) and, secondly, what has caused the ball to go faster. In our experience with many classes of upper elementary children these two ideas are not always necessarily linked. Moreover, it is frequently a major breakthrough for children to realise that the data (though not the motion itself) can be explained by the fact that the ball is accelerating.

Therefore, the mathematical and scientific content of this video tape needs to be analysed in terms of the children's concepts of a) motion, b) gravity and c) the links between them (i.e. the explanation of the causes for the motion) — although not necessarily in this order.

We will begin by looking at gravity.

Julian	You said a lot of interesting things there, but I need to take it a bit slower. What's gravity doing?
Stephanie	It's pulling it down.
Julian	And what's that got to do with it?
Stephanie	Like from 43 it hasn't got as much gravity as it has from ...

Stephanie *appears* to think that there is more gravity higher up. What do the other children think? They disagree! For example, Daniel immediately interrupts.

Daniel	Yes it has. It's got exactly the same!

Daniel's comment illustrates that he expects what Stephanie says to "make sense" — which at this stage, without explanation, it clearly doesn't. Furthermore, he shows that he expects to be able to participate in the sense-making by the group and not just leave this role to the teacher.

Daniel's interjection might be expected to create another of Konold's (1991) three types of conflict for Stephanie — namely conflict with the beliefs of others. However, at this stage, Stephanie apparently ignores the interruption and continues.

Stephanie	... as from 95 to 190 because there it's not got as far for the gravity to pull it but up there it has got. So I think that's just about right.

One could ask at this stage what role we actually expect conflict to play in conceptual change. Matusov (1996) argues that the traditional view of intersubjectivity places too heavy an emphasis on seeking consensus and views disagreement as "only the initial point of a joint activity that has to be resolved in the final agreement" (p. 25). Instead, he gives examples where "building on each other's ideas included a broad range of relations such as agreements, disagreements, elaborations and disjunctions. These relations constitute the process of meaning making and activity development" (p. 41). We would like to view the conflict or disagreement between the children's beliefs here as providing the impetus for Stephanie to re-examine her beliefs and clarify her thoughts. A question which can never be answered is whether or not she really believed that gravity is stronger "up there" — perhaps it is actually Julian who puts the words in her mouth.

Julian	So you think it's got more gravity up there so it goes *quicker*, than it would do down there. [Class teacher enters room and causes 3 second interruption] I've lost the train of my thought which was: Stephanie says the higher up the more gravity so the time goes quicker?
Stephanie	No, time doesn't go quicker, the ball goes quicker.

This is the first explicit mention of the fact that the *ball* is "going quicker" — and it was strongly suggested by Julian. This is an example of what Cobb, Yackel and Wood (1992, pp. 102–3) refer to as the "necessary power imbalance between the teacher and students in that the teacher is the only member of the classroom community who can assess which of the students' constructions constitute a productive basis for further learning".

At this point, Julian persists in trying to make progress in terms of the solution of the problem by trying to shift the dialogue towards exploring the links between the observed motion and gravity. He tries to draw attention to the fact that "the ball is going quicker" can give an explanation for the data — provided that "going quicker" is understood to describe acceleration.

Julian — The ball goes quicker and therefore you wouldn't expect it to take the same, er double the time. Is that the explanation?

However the children are not ready for this shift in focus and return to the discussion of gravity.

Kelly — It's about what Stephanie said. Well I don't think it's right because when people go to the moon and everything they don't say that gravity is different from the height. Like when one person stands on one foot it's not as much gravity pulling them down. Stephanie said that it's got more gravity than when it's up there, but I think that gravity is always the same.

So there is progress in one sense — Kelly re-affirms that gravity is the same. However it is difficult to interpret her comments about the moon and what can she possibly mean about standing on one foot? There appears to be some "local" progress in terms of the science concepts. But the real progress is in solving the problem, as Kelly's remark creates a conflict which is later recognised by Stephanie as requiring resolution.

SECTION 3: DANIEL AND KELLY RETURN TO THE DATA — A BACKWARD STEP!

Daniel (and Kelly) now try to revert to their earlier comments that the data is inaccurate — presumably because this is the way in which they believe they can "solve the problem" (i.e. resolve the conflict between their own beliefs and the empirical evidence of the data). They try to find a way of improving the experimental design — a useful skill in science, but not productive here since a necessary step in the solution of the "problem" is recognising the fact that the data obtained conflicts with their models of the motion.

In any case, Daniel and Kelly fail to find an acceptable alternative for releasing the ball, despite some creative attempts!

It is evident that Julian regards this discussion of the accuracy of the data as a backward step in terms of progress in solving the problem. He therefore attempts to focus discussion back onto gravity.

Julian — But I'm still interested in Stephanie's idea that the gravity is pulling it. Is it that gravity's pulling it quicker or ...?

SECTION 4: STEPHANIE'S NEW EXPLANATION THAT GRAVITY HAS "MORE TIME TO PULL IT"

And now Stephanie agrees that indeed gravity is "the same" and adds a powerful new idea in terms of the time for which the force is acting on the ball.

Stephanie — The gravity's the same all the time, but from up there the gravity's got more of a chance of pulling it. But from there it's got less chance because it's falling down.

Julian — So because it's moving down the gravity's different than when it's just stationary.

Stephanie — No, like I say the gravity isn't different. It's because up there it's got more time to pull it. From there it's got hardly any time to pull it, because it's going down. So it's not the gravity that's different.

Although Stephanie implies that she always intended her explanation to mean that gravity was the same but had more time to act from higher up, the others claim that this really is a new explanation on her part and that previously she did mean that gravity was different. After some considerable debate as to whether or not she meant it and a new commitment from Richard that gravity is the same everywhere, Stephanie finally gives in and agrees with the others that she said that there's more gravity higher up.

Daniel — You said there's more gravity when it's higher than when it's lower. That's what you said.

Stephanie — Oh yes, right. [Daniel and Stephanie laugh.]

Nevertheless she re-iterates her "new" explanation.

Stephanie — [Softly.] It's got more chance to pull it.

SECTION 5: RICHARD LINKS THE BALL SPEEDING UP TO THE INCREASED TIME AVAILABLE

Richard shifts the attention to the motion of the ball, linking the ball speeding up to the increased time available.

Richard — I think it'll go faster downwards if you lift it higher up because it's like someone running, they've got to get a further run up to speed up and that's [the ball is] speeding up.

Julian — Say that again. What's speeding up?

Richard — The ball is speeding up as it's going down because it's got a longer time to speed up.

All — Yes.

What is not clear from this and the ensuing exchanges is the extent to which both Richard and Kelly (who joins in the dialogue with enthusiasm) have an almost animist view of the ball speeding up. It should however be noted here that Julian almost encourages the expression of this animist view, partly based on his prior knowledge of Richard's views — see also Williams (1997) where this is expanded further.

However, in terms of progress in solving the problem, recognising change in speed (in this case acceleration) is a critical factor in explaining the data — although, of course, the reason for the change in speed itself is needed for a complete explanation. So, regardless of whether or not Richard has an animist view here, his comments represent real progress towards solving the problem.

SECTION 6: JULIAN ATTEMPTS TO FOCUS ATTENTION ON EXPLAINING THE DATA IN TERMS OF CHANGES IN SPEED

At this stage, as elsewhere, Julian uses his superior content knowledge to focus attention on what he sees as a productive line of argument. The critical role of the teacher has already been mentioned in this paper and will be discussed again later. It also plays an important part in the other two analyses of this segment of video-tape (see Doig, 1997; Williams, 1997). Here Julian ignores the animist notions and focuses attention on attempting to explain the data in terms of changes in speed.

Julian — So the ball's changing its speed. So how does that explain what we found?

He ignores Kelly's re-iteration of the fact that the ball is getting faster because there is more time and asks an even more focusing question.

Julian — So we think that because the ball speeds up it should take less than 86 or more than 86 to get to the ground from 190?

All Less.

Julian Why less, why not more?

SECTION 7: THE ROLE OF ACCELERATION

Daniel — despite the apparent tautological nature of his initial comments below — now supplies the first real mention of acceleration and links it back again to the time available.

Daniel Because when things speed up, when they're speeding up, they're going faster, not slower! When they go faster they move quicker. When they go slower, they move slower. So as it's coming down it's gradually speeding up and getting faster. So if it started from our first point, from there, it won't have as much time to speed up as it will from higher.

Stephanie now links this to an earlier experiment where strips of paper represented the distance travelled in successive seconds by a ball rolling uphill.

Stephanie It's like the ball experiment, it got — the strips got — shorter. So if we do it every second, if you imagine it stopped every second, and we measured that, it would be going longer, so it's like the other way round.

SECTION 8: A FULL EXPLANATION IS NEVER REACHED

The dialogue shows evidence of considerable progress in terms of the problematic — i.e. of explaining the conflict between the data obtained and the children's (implicit) predictions based on their model of "if you double the height you will double the time". However, there has been no full explanation in terms of linking the fact that the force due to gravity causes acceleration, which results in longer distances being travelled in successive time intervals.

At this stage, Julian sums up the discussion so far and attempts to get the children to make such further links.

Julian It takes longer to fall from higher up, but not as long as we thought and the reason it doesn't take as long as we thought it would, that's what I'm trying to get at. It's something to do with the ball speeding up and Stephanie thinks it's something to do with the strips and the rolling ball — and the strips of paper — but I don't understand the connection. Do you understand the connection?

Richard No.

Julian It was your brilliant idea that it was because the ball's going faster and that's why we were fooled.

Kelly I don't understand but I know the connection — the ball speeded up as it was going along and that [the timer-ball] speeded up as it was going down!

It therefore appears that, by the end of the video-taped segment, consensus has been reached that gravity "is the same everywhere" and that the ball is accelerating. However, the full explanation is never achieved — not even after the segment ends.

Conclusion

This analysis of the segment of video-tape has attempted to demonstrate the extent to which the dialogue under review is an example of "progressive classroom discourse", where progress is viewed in terms of Bereiter's (1994) notions of local discourses generating new understandings for local participants.

Progress here has been seen as having two dimensions: progress in terms of the scientific and mathematical content of the dialogue and progress in terms of solving the problem of explaining the observed data. Of course these two aspects are inextricably linked throughout.

In terms of solving the problem, the analysis shows that the first step was to establish that there was indeed conflict between the children's models of the motion and the observed data — this was something which was initially, and again later, challenged by those children who wished to question the accuracy of the data rather than their intuitive models.

Stephanie's attempt at an explanation of why the time taken was shorter than expected introduced gravity into the dialogue. This was clear progress in terms of solving the problem, however the dialogue then revolved for some time around the question of whether or not "gravity is the same everywhere", with progress being achieved in terms of the science concepts when Stephanie explicitly agreed that gravity indeed is the same "everywhere". Stephanie's "new" explanation that gravity has more time to pull the ball down when it is dropped from higher up took the argument further, both in terms of solving the problem and in terms of the science concepts.

After this, Richard linked the acceleration of the ball to the increased time available — however, he quite possibly sees this in animist terms rather than as the result of the force due to gravity acting. Julian, as the teacher, is aware that recognising change in speed is a critical factor in explaining the data, so he focuses on this. While a full explanation linking the force due to gravity to the time taken to fall from the two different heights was never achieved, all of the children made some links of their own between the acceleration of the ball and the time taken.

As stated earlier, one of the motivations for this analysis was to demonstrate to teachers the types of progress which can be achieved through scientific dialogue. It is clear from experience in a number of classrooms where the research has been carried out that the task in question often led to a much higher level of dialogue than other tasks. We believe that this is caused not only by the intrinsic interest of the timer-ball activity, but, much more importantly, by the collection of accurate data which clearly conflicts with the predictions children make on the basis of their intuitive models.

The issue of closure is another important factor for classroom teachers. Splitter and Sharp (1995) draw the distinction between procedural and substantive closure, where the former refers to "a group awareness of where the inquiry has gone so far and where it might go next", while the latter "involves a statement or summary of specific points and conclusions, without implying that the inquiry ... has concluded" (p. 133). Their suggestions for closure strategies of "asking such questions as 'What reasons were given and were they any good?', 'What concepts were developed, analysed, articulated and applied?' and 'What new meanings were constructed and conveyed?'" (p. 135) could well be transformed into questions teachers can ask themselves in order to "form judgements about the progress and value of the inquiry" (p. 135).

It is important to note also teachers' concerns regarding their role in conducting such dialogues in their classrooms and the potential for perhaps confirming "misconceptions". Many authors speak of the need to "strike a balance" between hearing the teacher's voice and eliciting student views (see, for example, Splitter & Sharp, 1995; Hewson, 1996; Bereiter, 1994). Teachers need to be recognised as participants in the dialogue — albeit privileged participants — whose views need to be supported by argument and explanation and can be accepted or rejected by students in just the same way as the views of fellow students.

References

Bereiter, C. (1994). Implications of postmodernism for science, or, science as a progressive discourse. *Educational Psychologist, 29*(1), 3–12.

Champagne, A.B., Gunstone, R.F. & Klopfer, L.E. (1985). Effecting changes in cognitive structures among physics students. In L.H.T. West & A.L. Pines (Eds.), *Cognitive structure and conceptual change*. London: Academic Press.

Cobb, P., Wood, T. & Yackel, E. (1991). Analogies from the philosophy and sociology of science for understanding classroom life. *Science Education*, *75* (1), 23–44.

Cobb, P., Yackel, E. & Wood, T. (1992). Interaction and learning in mathematics classroom situations. *Educational Studies in Mathematics, 23,* 99–122.

Davis, R.B., Maher, C.A. & Noddings, N. (Eds.) (1990). *Constructivist views on the teaching and learning of mathematics. JRME Monograph 4*. Reston, VA: National Council of Teachers of Mathematics.

de Lange, J. (1993). Innovation in mathematics education using applications: Progress and problems. In J. de Lange, I. Huntley, C. Keitel & M. Niss (Eds.), *Innovations in mathematics education by modelling and applications* (pp. 1–17). New York: Ellis Horwood.

Doig, B. (1997, March). What makes scientific dialogue possible in the classroom? Paper presented at the*Multiple perspectives on scientific dialogue: Implications for classroom practice* symposium, Annual Meeting of the American Educational Research Association, Chicago.

Driver, R. (1983). *The pupil as scientist?* Milton Keynes: Open University Press.

Duschl, R. & Gitomer, D.H. (1991). Epistemological perspectives on conbceptual change: Implications for educational practice. *Journal of Research in Science Teaching, 28* (9), 839–858.

Greeno, J. G. (1992). Mathematical and scientific thinking in classrooms and other situations. In D F. Halpern (Ed.), *Enhancing thinking skills in the sciences and mathematics* (pp. 39–61). Hillsdale, NJ: La wrence Erlbaum.

Gunstone, R.F. & Watts, D. M. (1985). Force and motion. In R. Driver, E. Guesne & A. Tiberghien (Eds.),*Children's ideas in science* (pp.85–104). Milton Keynes: Open University Press.

Hewson, P. W. (1996). Teaching for conceptual change. In D. F. Treagust, R. Duit & B. J. Fraser (Eds.). *Improving teaching and learning in science and mathematics* (pp. 131–140). New York: Teachers College Press.

Konold, C. (1991). Understanding students' beliefs about probability. In E. von Glasersfeld (Ed.), *Radical constructivism in mathematics education* (pp. 139–156). Dordrecht, The Netherlands: Kluwer Academic Press.

Lipman, M., Sharp, A. M. & Oscanyan, F. S. (1980). *Philosophy in the classroom.* Philadelphia: Temple University Press.

Matusov, E. (1996). Intersubjectivity without agreement. *Mind, Culture and Activity, 3* (1), 25-45.

Splitter, L. J. & Sharp, A. M. (1995). *Teaching for better thinking: The classroom community of inquiry.* Melbourne: The Australian Council for Educational Research.

Thijs, G. (1992). Evaluation of an introductory course on "force" considering students' preconceptions. *Science Education, 76* (2), 155–174.

Vergnaud, G. (1983). Multiplicative structures. In R. Lesh & M. Landau (Eds.), *Acquisition of mathematics concepts and processes*. New York: Academic Press.

Yackel, E. & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education, 27,* 458–477.

Wheatley, G.H. (1991). Constructivist perspectives on science and mathematics learning. *Science Education, 75* (1), 9–21.

Williams, J. (1997, March). Scientific dialogue as evidence of learning. Paper presented at the*Multiple perspectives on scientific dialogue: Implications for classroom practice* symposium, Annual Meeting of the American Educational Research Association, Chicago.

AREA 1997

SE060858

ERIC

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Making progress through scientific dialogue	
Author(s): Susie Groves	
Corporate Source: Deakin University	Publication Date: March 1997

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce the identified document, please CHECK ONE of the following options and sign the release below.

[✓] **Check here** Permitting microfiche (4"x 6" film), paper copy, electronic, and optical media reproduction

Sample sticker to be affixed to document

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Sample
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Level 1

Sample sticker to be affixed to document

"PERMISSION TO REPRODUCE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY
Sample
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Level 2

[ ] **or here** Permitting reproduction in other than paper copy.

Sign Here, Please

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Signature: Susie Groves	Position: ASSOCIATE PROFESSOR
Printed Name: SUSIE GROVES	Organization: DEAKIN UNIVERSITY
Address: 221 Burwood Highway Burwood Vic 3125 AUSTRALIA	Telephone Number: +61 (3) 9244 6405
	Date: 23 July 1997

OVER