CHAPTER 4

Engaging with a group's space of meaning

The tutor's role in small-group didactics

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A common feature of classrooms is that students are expected to work in groups, both for the expedient reasons of space, time, and resources, and didactic assumptions that talking to one another, articulating problems, and engaging with ideas will support students in their learning (see Freeman et al. 2014). Small groups are common features of the learning and teaching modes at all educational institutions, from pre-school to higher education. While lectures are the main feature of physics courses at university, which form the background to this essay, there are nevertheless small groups in traditional tutorial problem-solving classes and laboratory work, as well as in pedagogical trends such as problem-based learning, the flipped classroom, and other forms of interactive engagement (see Hinko et al. 2016, Hake 1998). And while lectures proceed on the assumption that knowledge can be transmitted from the lecturer to the learner using such resources as language, representations, and demonstrations, working in small groups assumes that engagement with the knowledge by students working together is at least complementary to lectures, and at best improves learning (see Larson 2010). The lecturer now takes the role of designer of the situation and tutor or mentor for the groups as they work. It is this didactic role that is the focus of this essay.

The aim of the study we draw on here has been to develop an analytical understanding of learning in small groups within the research paradigm of phenomenography and the variation theory of learning (Marton & Booth 1997; Marton & Tsui 2004; Marton 2015; Rovio-Johansson & Ingerman 2016). This approach enables us to address questions related to what constitutes the quality of a group discussion in terms of what is discussed, the character of the discussion, and the appropriate, effective didactical framing of group discussions. In particular, we ask what different approaches employed by tutors can support or hinder different groups in their discussions. In short, we ask three questions. What is the variation in what is discussed in the groups? What is the variation in how the students in the discussion attend to what is discussed? And what distinct tutor intervention approaches can be identified that can have bearing on the results with respect to the what and how of group discussions?

Whereas the archetypal phenomenographic study aims to describe learners' ways of experiencing a particular phenomenon they encounter in their education, generally with semi-structured interviews to generate data, here we take the variation theory of learning as our framework, in which observations of tutorials are appropriate sources of data. We do not ask how students experience their discussions in the group, or how they experience the tutor's interventions, but rather we draw on the theoretical development to address the issues of how the students together create a space in which meaning-making can take place, and by the end of the essay we will be able to address the question of what it takes for the tutor to be able to engage with that space in order to support the students' productive exploration of it.

The research approach adopted in this essay seeks to maintain the complex relationship between learners, teachers, and content matter, in the tradition of European didactics. The unifying concept is the space of meaning that the students form in their discussions around a simple but unusual problem in mechanics. The teacher, here a tutor who interacts with the groups, is able to engage with this space in one way or another, and that is the focus of the analysis offered here. In line with the relational view of knowledge and knowledge production that phenomenography espouses, we too take a relational view of the didactical triangle of learners, teachers, and content matter. All three nodes of the didactic triangle play a role in our study, and we return to them in our analysis.

Empirical design

The empirical data is taken from a study of seven groups of first-year students at a Swedish university, from one of two programmes—engineering physics or bioengineering—both of which have an equivalent physics course, partly with the same lecturer. The data has been analysed from various perspectives: gender (Berge & Danielsson 2013), problem-solving (Berge et al. 2012), group dynamics (Berge & Weilenmann 2014), and group work (Berge 2011; Berge et al. 2009).

Self-selected groups of three or four students were asked to solve a problem in Newtonian mechanics while being video- and audio-recorded in an otherwise naturalistic setting, in as much as a tutor known to the students dropped in a couple of times during the session to offer help and advice. The size of the groups was chosen to maximise the potential for both interesting group dynamics and engagement with the problem. The discussion was limited to 60 minutes, during which time the students were seen to be at ease during the discussions while retaining a clear focus on the physics problem-solving and discussions. Subsequent analysis relies on detailed transcriptions and the students' notes as well as the original recordings, the audio recordings being supported by video in order to distinguish speakers and follow gestures.

The physics problem the students were asked to work with concerned an ox dragging a box along the ground, and was intended to support the development of the conceptual understanding of force and friction in Newtonian mechanics while at the same time encouraging the students to talk and interact with one another. The intention of developing conceptual understanding was realised through presenting the students with two open questions: Which forces are acting on the ox and the box, and how are they related to

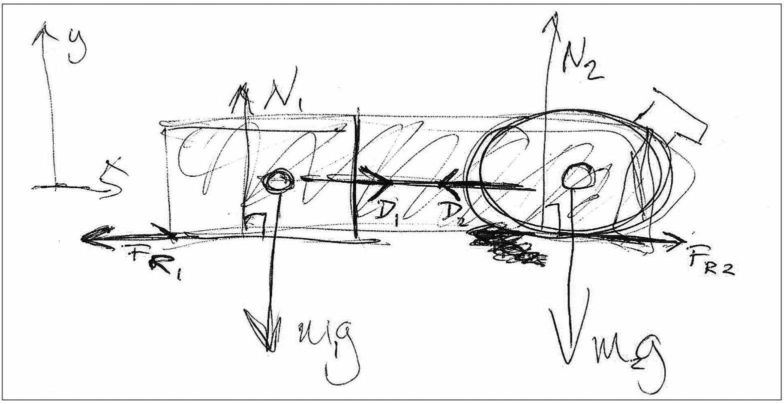

Figure 4.1. Example of students' force diagram. It was altered during the discussion from one to two systems. Note the correction of the friction force to be directed forwards.

one another? And which of these forces affect the movement of the ox and the box? The second intention, of encouraging discussion, was met by the deliberate exclusion of any numerical or mathematical features. Students might at first think, partly for this reason, that the problem is simple, but it comes with several well-known conceptual difficulties.

An acceptable answer to the first part of the problem is to draw the system—the ox and the box—with arrows to show the forces that affect it, and are of external origin, as that shown in Fig. 4.1. This is the force diagram of the system, one of the first things to be taught in the routine of solving such a problem (see Heckler 2010). Here, the relevant forces in the horizontal direction are the friction force acting on the ox's hooves and the friction force acting on the box. The vertical forces are the gravitational forces and the normal forces on the box and the ox. If the system moves with constant velocity, then Newton's second law tells us that in the direction of motion the total forces in opposite directions are equal in size—they balance one another. The Newtonian approach to understanding force is a major difficulty for students in grasping mechanics, as has been described in detail (see, for example, Trowbridge & McDermott 1981; Clement 1982; Johansson et al.

1985; Bowden et al. 1992; McDermott 1997; Palmer 1997). The widely used Force Concept Inventory (Hestenes et al. 1992) is grounds for the research-based, systematic development of forms of teaching (see, for example, Redish 2003), clearly indicating that 'active engagement' is thought to be very important, without clearly explaining what it means (see Hinko et al. 2016).

The key conceptual difficulty in this particular problem is to realize that balancing the friction force acting backwards on the box there is a friction force *forwards* on the ox's hooves, which is counter-intuitive (see, for example, Besson et al. 2007 for a discussion of the conceptual challenges associated with friction). Tutors in such a situation have a difficult task, for they need to engage with the ongoing discussion, interact in what is thought to be an appropriate way, and wind up the interaction in such a way that the group can continue, before they move on to another group. Their time is limited—in the case of this study, the tutor spent between 2 and 8 minutes with each group—and on entry they have no detailed insight into the direction and progress of the discussion. They have to engage with the meaning-making that the groups have embarked on and develop an approach that supports the group in exploring it productively.

Analysing group discussions

Before moving on to the work of the tutor, we will look at the ways in which the groups were found to discuss the problem and create spaces of meaning of differing quality. Our approach to the analysis characterises the students as constituting and experiencing a shared space of meaning, related to the pedagogical situation, primarily in terms of the design of the task and the group discussion format, taking variation as the basic mechanism for learning. We draw heavily on variation theory as the lens through which to inspect the group discussions, using tools that originate in the phenomenographic research tradition—for example, experience and learning (Marton & Booth 1997), dimensions of variation (Booth & Hultén 2003), the variation theory of learning (Marton & Tsui 2004), and threads of learning (Ingerman et al. 2009b). But in contrast to phenomenographic and variation theory studies of classrooms, where the teacher is thought to be the agent for learning, in our study the groups have their own agency.

The key concepts in variation theory concern the object of learning and the aspects of it that are critical for learning or understanding it in a particular way. In previous work on individual learning in group discussions we have characterised the process in relation to the variation around critical aspects of the object of learning as constituted in the course of the discussion (Booth & Hultén 2003; Ingerman et al. 2009a; Ingerman et al. 2009b). In this analysis, rather than focusing on individual learning, we are interested in portraying collaborative meaning-making, as manifest in the quality of the unfolding conversation and the space that is thereby being formed in which the meaning of the Newtonian concepts relating to friction and the problem can be explored. This leads to our first two research questions in analysing the qualitative variation between different discussions—what variation is to be seen, the ways the object of learning is handled, and what characterises the differences between discussions that handle the object of learning with varying degrees of sophistication?

Objects of discussion

One feature of the phenomenographic studies that inform the present work is to make an analytical separation between *what* is being learnt and *how* it is being learnt. Of the first, we could ask '*What* phenomenon are the students learning about?' or 'What is the object of learning that is being handled?', thus drawing on phenomenography or variation theory respectively. Here we investigate the space of shared meaning that is constituted in the groups' discussions, which we hold to be a series of episodes, each of which addresses a specific feature of the problem, involving a complex of related phenomena. It is possible to determine a small number of distinct categories of episode in a thematic analysis, each focusing on a distinct complex of phenomena with respect to the problem. Doing so results in five categories, which we are calling *objects of discussion* (Fig. 4.2).

- the system/systems to be used to identify external forces
- the relationship between force and motion
- the characteristics of friction forces
- recontextualisation of the problem in other settings for comparison
- recontextualisation of the discussion in formal mathematical and symbolic terms

Figure 4.2. The five categories of episodes with the object of discussion.

The first three objects of discussion concern the specific problem, while the last two reflect more generic problem-solving tactics. They are related to three principal phenomena: Newton's first law of motion (that in an inertial frame of reference an object either remains at rest or continues to move at a constant velocity, unless acted upon by a force), friction (whether static or kinetic), and mathematics. When the 'what' of the discussions is analysed, episodes concerning these five themes occur repeatedly, whether in a single group of students or from group to group, in different patterns that are complicated by shifts in focus: the problem in question is focused yet open, and students move from phenomenon to phenomenon, topic to topic, theme to theme. One could analyse the discussions from a normative perspective of physics, but that would not tell us much about our students as learners or what they are learning. To progress in our didactical thinking, it is important to identify the *meaning* that emerges, and to do that from the perspective of the students. This may still be underpinned by a normative goal of understanding the physics of the problem. One of phenomenography's main aims is to capture the students' perspectives on a specific phenomenon. This work differs from the mainstream by having complexes of phenomena in each identified episode.

Next in our general analysis, we identify and analyse the objects of discussion where the *same* object of discussion was seen to be in focus. Taking our cue from phenomenographic studies (for example, Johansson et al. 1985), as well as relevant studies using other methods (for example, Trowbridge & McDermott 1981; McDermott 1997) we can expect the students to assume qualitatively different ways of understanding features in the discussion, and hence an object of discussion can also be expected to show a qualitative variation. And in the body of this essay it is the third of the objects of discussion, the characteristics of friction forces, that we focus on.

Focusing on one object of discussion

Here we draw on the theory derived from phenomenographic studies, that a phenomenon is experientially constituted of a number of dimensions of variation, and we studied the objects of discussion to see that they too can be thus expressed. That is to say that an object of discussion can consist of a small number of dimensions and different values for these can account for the overall variation. This amounts to the core of the discussion, giving meaning to what the object of discussion is, and is not, in the variation of the discussants' experience of the world—here Newton's first and second laws and the concepts involved in the problem of the box and the ox. In this phenomenographic analytical framework, learning requires that the learner comes to discern new dimensions of variation, thereby developing the capability of experiencing the phenomenon in qualitatively different, more complex and powerful ways (Marton & Booth 1997). Even in the case of discussions in a group, dimensions of variation will be opened and scrutinised by the participants in the group, thereby creating and developing the shared space of meaning and the potential to experience the objects of discussion in qualitatively new ways.

In this phase of analysis, four dimensions of variation concerning the characteristics of friction forces were identified in the empirical material as being distinctly different, meaningful, and relevant (Fig. 4.3). First, friction as *a distinct kind of force* is primarily related to the fact that a friction force is a response to the movement of the system through its interaction with what is external to it (in accordance with Newton's third law). Second, the *point of the application of friction* is that friction is not a force internal to a system, but it acts at system borders, in accordance with which system borders are to be considered. Third, the *magnitude of a friction force* is

Friction: a distinct kind of force
Friction: its point of application
Friction: its magnitude
Friction: its situation dependency

Figure 4.3. The four dimensions that are the object of discussion about 'the characteristics of friction forces'.

dependent on the specific features of, on the one hand, the system border, and, on the other hand, the kind of movement of the system. For example, the friction on a cartwheel is different in magnitude from the friction on a box that is being pulled, and it is different in magnitude if pulled on ice or on gravel. Fourthly, friction forces *depend on the situation* for they may have different behaviour and dependencies in different situations; for example, friction may be kinetic or static when something is pulled, or if the movement is fast then air resistance may appear as a friction force. Identifying these dimensions relied on an analysis of the students' articulation of different ways of understanding friction during their discussions. Now we are able to track the dimensions of variation concerning the characteristics of friction that were opened during and between episodes, singling out episodes where one or other of the dimensions was being treated in the discussion.

Constituting the space of meaning

When the students study the problem at hand, they pick up on specific points and articulate them, they respond to one another, they change the force diagram in front of them, they sigh and joke. All the time, a space of meaning is forming and reforming, and the potential for learning is created because a new dimension of variation is opened, or because one value in a dimension of variation is compared and contrasted with another (Booth & Hultén 2003). The formation of a space of meaning can have different qualities, depending on the patterns in which dimensions of variation are handled in the discussion. The least valuable pattern occurs when (A) the group members talk outside the dimensions related to the characteristics of friction—talking about the likeness of different students' drawings to an actual ox for example, or why an ox should pull a box anyway.

Then there are two engaged forms of discussion (B) where a single dimension of variation is held open and different potential ways of seeing that variation are articulated; and (C) where more than one dimension of variation comes into focus and they are put into relation with one another. While (A) has its social uses in the group dynamic, (B) leads into a deeper understanding of some aspect—in this case, an aspect of the characteristics of friction—and (C) leads to a deeper understanding of friction forces in the problem of the ox pulling the box. Patterns (B) and (C) can be seen as lending structure in the space of meaning that is forming, (B) in a linear manner and (C) in a multi-dimensional manner.

The tutor interacts with the group

Now we turn to the tutor who meets a group, which is busy creating the space of meaning, following one of the three patterns described above, with a variation in understanding of the concepts involved, here primarily friction forces. The tutor who meets the students during the session, for only a few moments, needs to be aware of potential conceptual and representational difficulties in the problem, and to be able to interpret what students tell her about their progress or lack of progress. At the same time, the tutor needs to take the learning goal of the problem into account, in the context of the course goals as a whole, when leading students towards a productive line of reasoning. And ideally, the tutor needs to be appraised of the variation in behaviours of problem-solving groups that we have shown here when devising tactics for support.

What might constitute didactical strategies to achieve a productive meeting between a tutor and a group? We will look more closely at two examples of how the tutor in this study met two small groups of students, both of which were stuck in the initial stages of reasoning on the problem, and we see first how the meetings differ and second what the didactical consequences might be. Thus the first example comes when the tutor enters the room where one group is meeting.[1]

The tutor enters the room as the students Leo, Mary, and Noah are completing their force diagram, a few minutes after the session started. She inspects it, confirms that they are on the right track, and asks a question about a force that had been entered as acting on the ox in the direction of motion: 'What might that be, in the horizontal direction, what could that be?'

The students pause, Noah confirming it was a good question! Mary starts to reason, 'But it must be that he sets his feet down on the ground… so that …' The tutor encourages this with a nod and Noah adds, 'I was also thinking of some sort of friction force … between the ground and … yes …'

More encouraging sounds from the tutor lead Leo to add, 'because if it is a smooth surface, then it's hard to move forward'. To which Noah responds: 'then it would slip, of course … it wouldn't get anywhere'.

Leo sums it up with 'so it is optimal for the ox if there is a certain degree of friction' with which the tutor agrees. 'There has to be a certain friction force, yes?' she says, and Leo agrees too.

Now the tutor puts the question, 'How does that act on the ox?' followed by a lengthy pause.

Leo starts by reasoning about balance of forces. 'I suppose it should be the same as that on the box, or … if it isn't so, except on each foot'. The tutor doesn't interrupt and Noah takes up the argument—'but the friction between the ground and his hooves must be quite great since he doesn't slip'.

Leo and Mary agree, thoughtful, and Noah says 'So it must be greater than… Well I don't know' he sighs.

The tutor now leads on by saying: 'Yes, right, he doesn't slip and that is the important thing'.

The discussion continues for a moment in this vein, and the tutor patiently lets it continue before asking another question: 'How great is the static friction on the ox then, the force of friction at rest? Can you draw it on your diagram?' she asks. This amounts to getting the students to see the main point she wants them to see, that the friction is acting in a forward direction when the ox is in motion.

Noah starts this time with 'the question is if….' Mary breaks the silence that ensues, saying 'the static friction, it should stand still then shouldn't it?'. The tutor now brings motion into the argument: 'then, the ox, when it moves then, there is no friction between, at the surface there is no movement then, it does not move.'

Leo sees an apparent contradiction and says 'No, it [the friction force in the diagram] should be backwards', to which Noah agrees, and Leo continues, 'or … because it must be in the *x*-direction' which is echoed by the tutor: 'It must be in the *x*-direction'.

The group, where Mary now also takes part, turn their attention to the way in which the ox moves, how it puts its feet down and bends its legs, and what the consequences would be if the leg bent forward. Leo points out, 'no, it must be the other way around, because otherwise it would slip backwards if it were to bend in that direction … 'cos they press down'

Mary and Leo start to discuss the ways in which feet enter into walking, Mary starting with 'But if it puts its foot forward, or when you put a foot forward, you have static friction that pushes you, against you, for otherwise the leg would' and Leo completes it, 'slip forwards'. And the tutor confirms that, but continues, 'Yes, but when you put it down, but when you push yourself forwards' and Mary breaks off 'Aha! So then [the force] is acting backwards', to which Noah agrees.

The tutor asks, 'Which force is acting backwards?' and Mary replies, 'The friction force isn't.'

Leo brings this to a head: 'So then the ground must push back at me.' Noah agrees, and the tutor brings it into physics terms: 'According to Newton's third'.

The tutor stays a moment or two, listening to the ensuing discussion, and quietly moves on.

Here we can see that the tutor engages in a process of drawing out the fact that the friction force, acting on the feet of the ox in a forward *x*-direction when the ox is at rest, is responsible for the motion of the ox pulling the box. She does not directly contradict the assertion that the friction must act in the opposite direction, but challenges the students to consider different scenarios.

Here is another extract when the same tutor enters a room where another group of students—Harry, Ingrid, John and Kathy—are working on the same problem, experiencing similar issues with how to account for the force on the ox and the box in the *x*-direction. They are in a similar space of meaning as the previous group, but observe what the tutor takes up with them:

> The tutor enters the room and her greeting is met with a nervous laugh. Kathy starts the conversation with 'Well, I don't know' and Ingrid follows with 'You realise now how little you know about these things.' The tutor says sympathetically, 'It looks so innocently simple, doesn't it?' to which the students agree.
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> Kathy explains 'Well, we know there should be a force that acts on the box, don't we', to which Harry and Ingrid add, talking over each other, 'The tension in the rope should certainly be the same… the same in both directions… yes, but, er, driving force, shouldn't that mean that the ox has more friction than the box has?' and they immediately disagree with themselves, 'No!' at which everyone laughs, and some joking banter follows.
>
> Now the tutor starts a new thread. 'If we start with the rope, why is the force the same in both directions? We don't always talk about that, we just state it—have you thought about it?' There follows a discussion among the students on this new issue, putting forward aspects of the tension in the rope—admitting that they could not explain it even though they understood it to be so.
>
> The tutor persists. 'Have you even thought about the tension?' John puts it clearly, 'Well, I also have a feeling that they must be the same; it is one rope after all, it has to be the same force'. Both Kathy and John claim 'they oppose one another', to which Ingrid responds, 'If it had been a spring it wouldn't have needed to be so, because then one part can be more extended than the other', and the students discuss briefly what that would imply.
>
> Now the tutor starts to explain. 'You generally consider a little piece of the rope in the middle, and consider the forces on it; you have a force to the right from one part of the rope and a force to the left from the other part of the rope and those forces oppose one

> another', interspersed with 'mmm' from the students. She continues, 'And that little bit of rope in the middle weighs nothing of course, that's the way it is in such an example'. But here Kathy breaks in 'No!' and they laugh, but Ingrid returns to the point—'It has zero mass'—and the tutor finishes: 'So there wouldn't be a net force on it even if it accelerates, therefore the forces must be equal.'

In the first example, we saw the tutor pick up on the students' current state of confusion, entering their space of meaning-making, and with her knowledge that friction, whether static or kinetic, is problematically counter-intuitive, she engages in a process of drawing out a fruitful understanding in the context of the problem. She does not directly contradict the assertion that the friction must act in the opposite direction, but challenges the students to consider different scenarios. With them she maintains both a focus on the characteristics of friction and explores friction in and across the dimensions of variation. First, she concentrates on drawing out the presence and importance of friction in resolving the problem, the first dimension of variation (see Figure 4.3), friction as a distinct kind of force, then she relates friction to the ox, the second dimension of variation, friction at the point of application. The third dimension of variation, friction's magnitude, enters immediately afterwards when the specific aspect of the problem—that the ox is pulling the box with a constant velocity—implies that the forces in the x-direction are in balance. This leads to introducing the fourth dimension of variation, the situational dependency, when Mary and Leo make the observation that the force on the ox is forwards when it pushes against the ground. This episode sees the tutor engaging with the problem and the students so that they work in the multi-dimensional mode of pattern C, as described earlier.

In the second example, where the students are grappling with the same issues as those in the first example, she appears to ignore the cause of confusion when they agree that they 'know nothing'. When Kathy says 'Well, we know there should be a force that acts on the box, don't we,' the tutor leads the group into a basic discussion of one of the forces that is acting on the box, namely the force exerted in the rope. Rather than entering their tentative space of meaning, she leads them into a different space; rather than taking up the concept of friction which is mentioned by Harry and Ingrid, an understanding of which is central to the goal of the problem, the tutor proceeds to show from first principles that the force on the ox caused by the rope is equal and opposite to the force on the box, maintaining a single focus divorced from friction. The transfer of force from the ox to the box is brought into focus, but not the origin of that force—not the friction that acts on the ox's hooves as it moves forward. While the characteristics of friction are one of the learning goals of the problem, on this occasion the tutor has turned the group's attention to quite a different aspect of the system and created a new space of meaning for them.

We can introduce the notion of *critical* variation, which implies that the discernment of new values in dimensions of variation in what is being discussed amounts to a change in meaning, in contrast to *non-critical* variation, which does not amount to such change in meaning. In relation to the problem given to the students, one example of critical variation is different possible ways of delimiting the system, another is whether the sum of forces equals zero or not. Examples of non-critical variation are the colour of the ox and the time of day. With respect to friction, in the first example above, the tutor takes up and enhances the critical variation in and across relevant dimensions, while in the second example, the tutor rather brings out variation with respect to the problem or the course aims in general, which is hardly critical in the context of the ongoing discussion.

Two possible explanations for this particular tutor's two different patterns of intervention approach come to mind. First, maybe she is so familiar with the two groups that she understands their patterns of behaviour. We can speculate that the first group is known to grapple, or is seen to be grappling, with a problem in a disjointed manner, and that a carefully crafted discussion with them is necessary to keep the goal of understanding friction to the fore. Conceivably, the second group is known to handle problem-solving as an effective team, with a structured manner of type C, and with them the tutor feels free to delve into an unconsidered feature of the mechanical properties of the problem, in the expectation that they will cope well with their own solution tactics. These two didactical strategies, hypothetical strategies in this case, would be justified given experience of the students involved and an understanding of the potential consequences.

However, the second possible explanation is more directly in line with what we consider to be the didactic consequence of our argument. While in the first episode the tutor clearly enters and engages with the students' ongoing space of meaning-making, in the second she instead initiates her own track of thought and diverges from the students' concerns. In order to ensure a didactically viable intervention the tutor needs, in the first instance, an enquiring approach in order to rapidly gauge the students' object of discussion, and then to relate it to the salient features of the problem at hand through the relevant dimensions and critical variation. This implies that while we can say that the first example is in all likelihood going to take the students along a line of reasoning that illuminates the forces of friction that are involved in the problem, whatever the state of the group's interaction, the second example would be liable to add to the confusion of a less coherent problem-solving group. The tutor needs to know or intuit her students as learners and the group as a problem-solving team if an appropriate intervention approach is to be employed.

Three pointers we can deduce from these examples to productive tutor intervention are preparation, interaction, and exit, a proto-model for tutor intervention. In preparation, the tutor needs to be aware of the learning goals of the session, potential difficulties students are likely to encounter, and the variation in what they might understand of the subject matter involved, as well as how they might be going about their discussions. In interacting with the groups, it is clear that entering their space of meaning is important for leading them in a productive direction, as well as modelling a clear focus on the dimensions of variation, both individually and as interrelated. The exit from the group should ensure that they continue in a meaningful direction, with the promise of further intervention if necessary, although a subtle departure is appropriate if all is well.

Conclusion

We referred earlier to the relational nature of the didactic triangle relating learners, teachers and content matter, and different relations are seen in the phases of the discussion and our analysis. The content matter, or knowledge, that is inherent in the problem is at the centre of, first, the students' discussions as challenged by the (absent) tutor. Then, the content matter is at the centre of the students' discussions among themselves. Thirdly, and central to our argument here, the content matter is at the centre of the meeting between students and tutor, as the tutor intervenes to interact with the on-going discussions.

The conclusion we are able to draw from this study and analysis is that, not only do groups of students display a variation in ways of going about problem-solving, with varying degrees of success, but also that tutors charged with advising intermittently also display variations in their approaches. Thus, we would suggest that a discussion of high quality can in some cases depend simply on the students involved, working with a relevant and well-designed task. To systematically support the most articulate patterns of discussion in all groups, however, is a non-trivial didactical challenge, as it also includes handling factors such as the allocation of time, timely support, and balancing group discussions with teaching more generally. This essay has contributed by articulating some of these dilemmas and by offering a model of the reasoning that can support tutors in their complex task.

Note

1 The dialogues given here use pseudonyms and are somewhat simplified from the detailed transcriptions that have been analysed, to aid clarity.

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