Teacher-student dialogue during one-to-one interactions in a post-16 mathematics classroom

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Recent developments in mathematics education place an unprecedented emphasis on the role of discourse in developing students' conceptual understanding, with a corresponding de-emphasis on the use of 'telling': the stating of facts and demonstration of procedures. This action research study investigated teacher-student dialogue during one-to-one interactions in my post-16 mathematics classroom. The participants were four A-level students. Data sources included clinical interviews, student feedback interviews and an analytical log; and the data were coded using a framework of scaffolding categories drawn largely from current research literature. The findings suggest that, although I utilised more 'telling' than 'questioning' interventions, often these 'telling' actions served useful and necessary functions. They also indicate that my scaffolding skills developed as a result of the process of critical analysis; and that the scaffolding strategies valued by my students were those that they felt best promoted their independence. The study concludes by suggesting that context is a crucially important factor in addressing the dilemma of whether or not to tell.

Keywords: post-16 mathematics classroom, 'dilemma of telling', teacher-student dialogue, scaffolding strategies.

Introduction

Current reforms in mathematics education, influenced by a social constructivist view of learning, place dialogue at the heart of the development of conceptual understanding and mathematical thinking skills. Teachers are now seen as 'facilitators of learning' (Smith 1996; Lobato, Clarke and Ellis 2005) who manage discussion within a student's ZPD by employing suitable scaffolding and fading techniques (Wood, Bruner and Ross 1976; Vygotsky 1978). Underlying these ideas is a strong criticism of transmissive teaching styles, often referred to as 'teaching by telling'. However, there is very little in terms of *specific guidance* for teachers about how best to achieve these reform aims (Chazan and Ball 1995; Smith 1996; Baxter and Williams 2010). This has led to what Baxter and Williams describe as the "dilemma of telling: how to facilitate students coming to certain understandings without directly telling them what they need to know or do" (8). This has been a recurring dilemma in my own practice at an English 13 – 18 comprehensive school.

Research Literature

Kyriacou and Issitt (2007) note that research on teacher-student dialogue in this country is scant, especially so at the local level of one-to-one interaction. What research there is into whole-class teaching generally reveals a prevalence of transmissive 'teaching by telling', and little evidence of effective scaffolding that

might effect a handover to independence (Myhill and Warren 2005; Kyriacou and Issitt 2007). Reasons proposed for the prevalence of the transmission model include acknowledgement that scaffolding can be a difficult and uncomfortable task, carried out in a pressured environment; and that teachers' beliefs about the nature of mathematics, as well as their own schooling, can affect their competence at scaffolding (Schoenfeld 1992; Myhill and Warren 2005). When effective scaffolding was observed, teachers were seen to hold back from telling, instead eliciting student thinking through the use of probing questions, along with carefully tailored questions and prompts that provided just enough guidance for breakthrough (Tanner and Jones 2000; Goos 2004; Cheeseman 2009; Ferguson and McDonough 2010).

But is achieving effective teacher-student dialogue in mathematics teaching as simple as striving to eliminate an ingrained habit of telling? Chazan and Ball (1995) propose that a blanket exhortation to avoid telling is inadequate because it ignores the importance of context. Lobato, Clarke and Ellis (2005) point out that many kinds of telling perform useful functions in the development of conceptual understanding, and can thus be reconciled with a constructivist viewpoint. These two sets of researchers, along with Baxter and Williams (2010), suggest that it is important to gain further understanding of the *function* of teacher actions through analysis of the intentions behind their scaffolding decisions.

Research Questions

Having decided that the aim of my research was to improve the quality of the teacher-pupil dialogue in my A-level classroom through a process of critical reflection, I formalised the following research questions:

RQ1: What does a critical analysis of the form and function of my utterances reveal about the nature of my scaffolding strategies?

RQ2: Can the form and function of my scaffolding interventions be changed as a result of investigation on my part?

RQ3: What does student feedback reveal about what students valued about the scaffolding strategies I employed?

Research Design and Participants

My formalised RQs, with their emphasis on reflective action, arose out of an interpretivist viewpoint and led quite naturally to the use of an action research methodology. The small scale of my study and the time constraints placed upon it, restricted the number of action research cycles to two. After outlining my research aims to the 12 students in my Year 13 core maths group, six male students volunteered to take part. As a small sample was sufficient for the introspective, in-depth nature of my study, I used purposive sampling to select four participants.

Data Collection Tools

Clinical Interviews

In order to answer RQ1 and RQ2 I decided that audio recording would provide the clearest data set. I also decided that it might be best to record myself interacting with a single student in a one-to-one situation *outside* of the bustle of the classroom – 'in vitro' rather than 'in vivo'. I therefore opted to use a clinical, task-based interview, of

the type closely associated with Piaget's work, in which the interviewer's responses are contingent on the subject's reactions to the task (Rowland 2000). This means of eliciting student thinking by contingent prompting and probing is a similar discourse model to that involved in the type of local level on-the-fly scaffolding (van Lier 1996; Brush and Saye 2002) that I wished to develop in my own practice, and therefore seemed to provide a rich means of analysing my performance. Interviews took place during those lessons when an adjoining classroom was vacant for interview use, with both classroom doors remaining open. In order to maintain further links with a familiar setting, I used questions from the A-level textbook, selecting two for each cycle of intervention: questions that were sufficiently challenging for the participants to require assistance. Transcription, including paralinguistic messages (pauses, interruptions and heavily stressed words), was carried out promptly to minimise data loss.

Student Feedback Interviews

In order to answer RQ3, participants were interviewed immediately after their clinical interview, using the same recording method. The following open questions were devised to enable the participant to reply without restriction, and to allow me to probe more deeply or clear up misunderstandings if these arose:

Q1   Did you find any aspect of the teacher input helpful?
Q2   Was there anything that wasn't helpful?
Q3   Is there anything that might have been more helpful for me to do?
Q4   Is there anything you would like to add?

Analytical Log

In order to carry out the process of critical reflection inherent in the two action research cycles, I used an analytical log in which to record my evaluation of the clinical interviews. I also recorded the thoughts, feelings and insights that arose during the process of analysing the interview transcripts. As a result, the log had a narrative quality more characteristic of a journal of reflection. In this way I hoped to bring my own subjectivity to bear on the analytical process, and to unearth the intentionality behind my utterances.

Data Analysis

On one level I wanted to identify the *form* of my dialogic interventions. I therefore colour-coded the text of the transcript using green font for questioning and red font for telling. However, following Lobato et al (2005), I also wanted to identify the *function* of my utterances. I began with 6 categories borrowed from Anghileri (2006), but it soon became clear that my coding framework needed to be more fluid, and I ended with a total of 12 categories, a mixture of predetermined and emergent codes: *Checking, Confirming, Convention, Demonstrating, Directing, Explaining, Focusing, Funnelling, Parallel modelling, Probing, Prompting* and *Rephrasing*. Each category was colour-coded, and the transcript was then colour-highlighted accordingly.

Transcripts from the student feedback interviews were coded in the first instance according to the participant's perception of the 'helpfulness' or otherwise of a particular scaffolding intervention. The above function codes were then applied.

The analytical log was coded according to whether I had criticised or approved each scaffolding intervention, and both form and function codes were applied.

Findings

RQ1: What did a critical analysis of the form and function of my utterances reveal to me about the nature of my scaffolding strategies?

Analysis of the *form* of my scaffolding interactions in the first cycle suggested that I overwhelmingly relied on telling (113 out of 170, with the remaining 57 coded as questions). However, analysis of the *function* of those interactions revealed that a large proportion of the telling actions were simple confirmations of the rightness or wrongness of student ideas. With *confirming* excluded, the most common telling categories were *explaining* conceptual content; *demonstrating* a procedure; *directing* by providing instructions, advice or suggestions; and outlining a *convention.*

Analysis of the 'critical' content of my analytical log revealed that I was dissatisfied with instances where I employed telling to *demonstrate*, *direct*, *explain* or *funnel*, and where I used questioning to *funnel*. In cases where a student was unable to recall a procedure, I felt that *parallel modelling* would have been a more useful strategy than *demonstrating* using the question itself. In the cases where I was critical of my *explaining* interventions, I felt that it would have been more beneficial to have assisted the student with *probing* and *prompting* guidance. I also noted that there was a controlling element to my *directing,* sometimes due to lack of confidence. With regard to the *funnelling* instances, I reflected that I seemed to be hurrying the student towards the answer instead of allowing him more time to respond to my questioning.

Analysis of the 'approving' content of my analytical log revealed that I was more satisfied with instances where I employed telling to *confirm*, discuss *convention*, and *parallel model*, and when I used questioning to *probe* and *prompt*. I felt that *confirming* was a necessary part of my scaffolding strategy. I also felt that '*telling to share a convention'* was the only way to impart arbitrary mathematical knowledge, and hence was a necessary intervention. I approved of one instance in which I *directed* the student on how to set out his work, as I felt this also involved the sharing of a conventional norm. I noted that *probing* questions revealed student thinking, and, in the case of one individual, elicited his longest responses. And finally I reflected that *prompting* questions enabled the student to work through problems more independently, whilst also allowing for the possibility of internalisation for future independent use.

RQ2: Can the form and function of my scaffolding interventions be changed as a result of investigation on my part?

Analysis of the *form* of my scaffolding utterances in the second cycle of clinical interviews revealed that I used a greater proportion of questioning interventions than pre-investigation (telling accounted for 79 out of 134 coded utterances, with the remaining 55 coded as questions). There were some notable changes in the *function* of my scaffolding interventions that may have resulted from my investigation. I *demonstrated* and *explained* a good deal less, having been critical of my use of those interventions previously. I *parallel modelled* more often, and also *probed* more often and more directly. The final observed change was that I was now utilising *indirect prompts* – a form of fading – which I had not done in the first cycle of clinical interviews.

Analysis of the critical content of my second cycle analytical log revealed that I was dissatisfied with instances where I used questioning to *focus*, *funnel*, *probe* and

prompt. A common theme underlay these criticisms: the observation that I was not giving the students sufficient time to think. Finally I noted that my lack of confidence with using an untried method had caused me to intervene and change the way the student was approaching a particular question.

Analysis of the approving content of my analytical log revealed that I was satisfied with many more of my scaffolding interventions that I had been previously: specifically instances where I employed telling to discuss *convention*, *direct* (when procedural content was involved), *focus*, *parallel model* and *probe*; and where I used questioning to *focus*, *parallel model*, *probe* and *prompt*. I was also pleased with my use of *indirect fading prompts*.

RQ3: What did student feedback reveal about what students valued about the scaffolding strategies I employed?

Analysis of the feedback interview responses from the first cycle of clinical interviews revealed that *discussing a conventional norm*, *explaining* and *prompting* were valued strategies. And interestingly, one student made the suggestion that *parallel modelling* would have helped him more – exactly mirroring the conclusion I had reached myself.

Analysis of student responses from the second cycle of clinical interviews revealed that *prompting*, *parallel modelling* and *confirming* were valued scaffolding strategies. One student also suggested that more use of *demonstrating* would have helped him, specifically the use of diagrams to enable him to visualise the situation more easily.

Conclusion

What has emerged from the analysis of my utterances is that the situation is far more complex than the widespread notion, cited in Baxter and Williams, that "teachers should not lecture, demonstrate or 'tell'" (2010, 8). My findings are consistent with Chazan and Ball's (1995) argument that context is all-important, and is a crucial consideration in the management of the dilemma of telling. This discovery, coupled with the realisation that I had, indeed, been able to develop my scaffolding skills – to tell more selectively and question more skilfully – has made me a more confident practitioner; and my coding framework continues to serve as a useful reflective tool.

Such is the paucity of research into teacher-student interactions (Kyriacou and Issitt 2007), particularly at secondary level, that there is abundant scope for teacher-researchers to undertake studies into 'on the fly' teacher-student interactions in their classrooms. In this regard, the coding framework I have devised may prove a useful tool to others wishing to examine and develop their scaffolding strategies. The impact of classroom pressures on scaffolding strategies – something that policy makers often seem to overlook – is a further topic that may be of interest to the teacher-researcher.

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