

# **DIFFERENTIAL ACCESS TO VERTICAL DISCOURSE – MANAGING DIVERSITY IN A SECONDARY MATHEMATICS CLASSROOM**

Uwe Gellert & Hauke Straehler-Pohl

Department for Educational Studies and Psychology

Freie Universität Berlin, Germany

*Abstract: Crucial to the reading of our paper is the assumption that students enter school with diverse experiences with language and diverse experiences with construing meanings through language. We will argue that teacher-student interaction in secondary mathematics classrooms often is realised to the effect that only for those students, who have already been introduced to the linguistic qualities of academic or institutionalised discourse, further access to it is provided in schooling. Central to our argument are the notions of vertical/horizontal discourse, of contextualised/decontextualised language and of grammatical metaphor. We discuss these concepts before illustrating their power by an analysis of a transcript on the introduction to algebra in a sixth grade mathematics classroom. The focus of the analysis is on the strategies by which the teacher manages to cope with the diversity of students' sociolinguistic orientations to meaning.*

## **1. CHARACTERIZING VERTICAL DISCOURSE**

As has often been said, schooling acts as a mediator of two major societal functions. Schooling provides access to particular discourses and hence to particular forms of knowledge while, at the same time, regulating this access and hence socialising its students into differing positions of power. In this context, some groups of students have been described as privileged and others as marginalised – although in many cases the marginalised build the majority. In research in mathematics education, the issue of privilege and marginalisation has been discussed in terms of social class (e.g., Cooper & Dunne, 2000), race (e.g., D. Martin, 2010), and migration (e.g., Gorgorio, Planas & Vilella, 2002). For many students, these conditions coincide and their marginalisation is exacerbated by an interaction of migration, race and social class issues. In many situations it is difficult to adequately express the complexity and diversity of marginalisation. Thus our focus is on the commonalities and, as we will argue, on the theoretical core of privilege and marginalisation: the differential access to a particularly powerful discourse – vertical discourse.

The particularities of the discourses of power to which students are differentially introduced in school have been described differently, though mostly in form of dichotomies. We will briefly reconsider the most relevant concepts for our analysis that have been constructed in Sociolinguistics and Systemic Functional Linguistics (SFL). For further concepts of other academic disciplines, that we consider relevant,

but that we are not actively applying in this paper, see Cummins (1996) and Koch and Oesterreicher (1985). All concepts taken together, serve as the theoretical grounds for the subsequent analysis of an interactional mechanism that regulates the differential access to powerful mathematics provided by instructional practice:

As a sociologist of education, Bernstein (1999) is concerned with the differences between horizontal and vertical discourse, where the concepts of discourse and knowledge are closely interrelated. Horizontal discourse “is likely to be oral, local, context dependent and specific, tacit, multi-layered, and contradictory across but not within contexts. However [...] the crucial feature is that is it [sic] segmentally organized” (p. 159). Knowledge and strategies of the horizontal discourse have the aim to maximise encounters with persons and with habitats. Vertical discourse, in contrast, “takes the form of a coherent, explicit, and systematically principled structure, hierarchically organized as in the sciences, or it takes the form of a series of specialised languages with specialised modes of interrogation and specialised criteria for the production and circulation of texts, as in the social sciences and humanities” (p. 159). The contemporary dominant ideology of the life-long learner, making use of knowledge in differing contexts, is privileging vertical forms of knowledge and hence privileging those with access to vertical discourses. But how can access to vertical discourse be provided? On what kind of students’ resources can access to vertical discourse be based? It is a core problématique of pedagogy to recontextualise horizontal discourse in school as a means to make institutional, vertical discourse more accessible for all.

Hasan (2001) draws on Bernstein’s distinction of horizontal and vertical discourse. For Hasan, horizontal and vertical discourses differ mainly in their relation to contexts. She sees the natural condition of human discourse as being contextualised language, concise a language with a close connection to the material situational setting of the interactants. Decontextualised language in contrast has a loosened or even detached connection to the material setting. However, it is decontextualised language, which is connected to positions of power: “what is remarkably pervasive today is the kind of language use that is known as context independent, disembedded or decontextualised, especially in the sorts of societies spawned by the so-called progressive Western world. [...] After all, among other things, decontextualised language is the voice par excellence of official ideology” (Hasan, 2001, pp. 48-49). The distinction between contextualised and decontextualised language is organised along the terms of actual and virtual reference. Actual references have the potential of being physically sensed by the interactants. These references may be immediate as well as displaced in time or space, however they need to be potentially sens-ible. Virtual references lack this potential. They are “non-material and removed from situational realities, they simply cannot be directly and physically experienced: they are intellig-ible, not sens-ible” (p. 54). For participation in horizontal discourses, contextualised language may well be a totally sufficient base. However, in the

vertical discourse knowledge is not structured through the sensible context, but through the internal logic of a specialised practice. It is obvious that this internal logic is only intelligible and far beyond material situational realities. In the case of academic mathematics, it is evident, that we deal with a highly intelligible discourse, far from being sensible. No matter how much contemporary school-mathematics is organised around sensible actual experiences, its end is the vertical discourse of virtual ideas: “the mastery of disembodied language will consist in feeling at home with reality that is not sensuously mediated” (p. 57). Hence, the orientation towards decontextualised language is a crucial condition for participation in the mathematics classroom.

As Bernstein and Hasan, J.R. Martin (2007) sees horizontal discourse as the original and intuitive mode of discourse. However through the perspective of SFL his concerns include the lexico-grammatical qualities of discourse, that is the make-up of utterances. He describes horizontal discourse as characterised by a harmony of the semantic and the lexico-grammatical stratum (see Fig. 1): Taking the sentence “I love my mummy and my mummy loves me.”, semantics and grammar are in complete harmony: participants (mummy, I, me) are described by (pro)nouns, processes by verbs (love(s)), and logical relations by conjunctions (and). Presumably, someone with a more elaborated use of language would rather express the same feelings in a sentence like: “My mother and I have a good relationship.” Now semantics and grammar have created a tension: the noun “relationship” is not expressing a participant, but a process (loving each other). Moreover, it gains further meaning, as through social everyday discourse different kinds of qualities implicitly got attached to it. Martin calls this tension of the semantic and lexico-grammatical stratum *grammatical metaphor*. However, although being more elaborated, the sentence quoted above remains part of horizontal discourse. Applying Hasan’s perspective, the orientation to meaning is still contextualised. As we will argue, the key to vertical discourse lies in grammatical metaphor acting on decontextualised language, or as Martin puts it, in “abstractions acting on abstracts” (p.54).

As can be seen in Figure 2, the major characteristic of grammatical metaphor is a tendency to express all kinds of semantic categories in nouns, a process Martin calls *thingification*. From a multisemiotic perspective, O’Halloran (1999, p. 382) concludes: “The analysis of mathematical pedagogical discourse indicates that nominalization and extended nominal group structures are a feature of mathematical discourse.” Martin (2007), summarising extensive research on both scientific and human-scientific texts, claims: “if no grammatical metaphor, then no verticality” (p. 54). Concerning the social ramifications of grammatical metaphor, Martin holds, “from a functional linguistic perspective, access to vertical discourse is bound up with control of grammatical metaphor, which in western societies students are expected to master in secondary school. Failure to access this recourse entails

exclusion from [academic] knowledge structures. Here lies the social semiotic nub of institutionalized learning, educational failure and the distribution of knowledge in our expiring world” (p. 55).

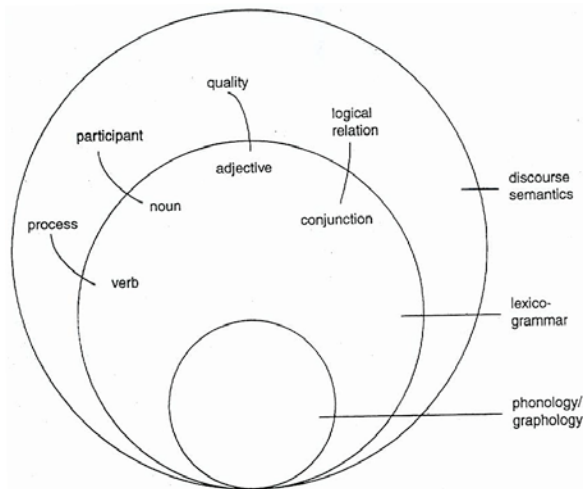


Fig. 1 Stratal harmony – grammar matching semantics

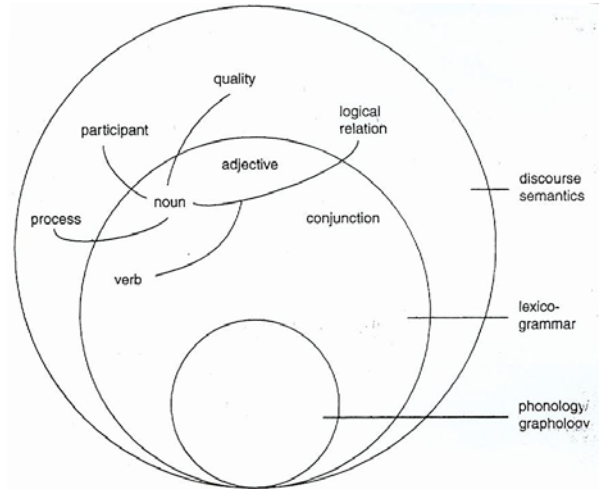


Fig. 2 Grammatical metaphor as stratal tension semantics

## 2. NEGOTIATING MEANING: A MECHANISM OF APPEASEMENT

Our issue is interaction in the mathematics classroom. We focus on the interactive mechanism by which one teacher deals with the diversity of his students in terms of their access to mathematics related vertical knowledge. As we will see, the concepts of (de)contextualised language and grammatical metaphor provide powerful tools for analysing the amplification of differential access to the vertical discourse. For a detailed description of the empirical research, see Knipping et al. (2008).

The setting is a 6<sup>th</sup> grade mathematics class in Nova Scotia, Canada. It is the very first lesson after the summer holidays, in which the teacher and the students engage in teacher-student interaction. The 6<sup>th</sup> grade is the beginning of secondary schooling in that region, thus no hierarchy of achievement has yet been established among students. It is a rural area and the social background of students is quite diverse.

Kevin's Grade	Alice's Age
6	4
7	5
8	6
9	7
?	?
?	?
?	?

Kevin uses a pattern. He predicts how old his sister will be during each of his school grades.

Kevin	Alice
6	4
7	5
8	6
9	7
10	8
11	9
12	10

Fig. 3 Mathematics task

Fig. 4 T-table at the whiteboard

The students are sitting at group tables. At home they have solved the task displayed in Fig. 3. Our analysis starts in the moment when a student is filling her solution into a T-table provided by the teacher at the whiteboard (see Fig. 4). We split the following ten minutes of classroom interaction into six episodes, which we consider as functionally distinct for the interactional mechanism. We shall demonstrate each episode and its relevance for the negotiating of meaning in that classroom.

### **Episode 1: Introducing the context (10:32-12:38)**

In the first episode Alicia is filling the missing numbers in the T-table at the whiteboard. Her classmates are encouraged by the teacher to help her out. Regarding the use of language, the whole episode is characterised by harmony of semantic and lexical strata, hence no grammatical metaphor is employed. Further, there is an extensive presence of physical resources (e.g. the teacher invites his students to refer to the T-tables they have in their textbooks). The language is contextualised and the discourse tends to be horizontal. The function of this episode may be best described as a smooth introduction into the emerging discourse, emphasizing the affective security necessary for the students to actively participate.

### **Episode 2: Common negotiation of orientation (12:38 – 13:45)**

10 12:38 T Is there anybody from her group, as well as Alicia, who can tell us how those numbers fit in the way they do? What did you do?

In (10) the teacher, for the first time, goes beyond discussing particular numbers and by his elicitation indicates that there is a pattern, a principle structuring the T-table. He does that by using the conjunction “how”. The semantic and grammatical strata are still in harmony, though at the same time a first insertion of decontextualised language can be observed: “How” is accompanied by a (semantic) metaphor “fit in the way they do”. Here, “Fit in” does not mean a potentially sensible way of fitting. It refers metaphorically to the above-mentioned structuring principle. However, this question is followed by an alternative one: “What did you do?” This refers back to previous actions and illustrates the ambivalence of the word “how”, as the students may either describe their experience or their reasoning. Hence, the teacher provides two different discourses within one utterance: a vertical discourse of reasoning and a horizontal discourse of experience. At this time, no preference can be observed: both discourses appear legitimate.

In the following, a dialogue evolves between the teacher and Mike. Mike seems to have identified the discourse as a discourse of reasoning and explains his considerations, using the conjunctions “because” and “so”. The teacher in reaction always links Mike’s answers back to the particular numbers on the board and hence seems anxious about keeping the discourse overt for horizontal discourse and contextualised language. In summary, this episode is characterised by its tendency to verticality through a smooth and partial introduction to decontextualised language

remaining, at the same time, open for contextualised meanings. It is remarkable that Mike is the propulsive force in the negotiation and, further, that he is the only student taking part in it.

### **Episode 3: Practice of a vertical discourse (13:45-14:30)**

After having – under apparent leadership of Mike – negotiated the orientation towards a more decontextualised language and a more vertical discourse of reasoning, the teacher now comes to the core of vertical discourse: He introduces the term of “relationship”.

27 13:45 T I have a question. This can come, the answer may come from any group. You may look at the T-table here or you may look at the one you’ve created in your notebook. Can anybody figure out or tell me the relationship between the left side of this T-table and the right side of the T-table.

28 (Mike is the only student who raises his hand.)

29 14:14 T OK.

30 M The difference between the numbers, there’s a difference of two on each number.

31 T A difference of two. How do you mean difference?

32 M There is, one is two higher.

33 14:28 T So in other words, this one is two higher.

By this he is making use of a grammatical metaphor. Semantically, “relationship” is not a participant. In contrast, it rather expresses qualities, a process and logical relation. Hence, there is a tension of the semantic and the grammatical stratum; qualities, process and logic relation are *thingified*. Accordingly, to successfully understand the teacher’s elicitation one has to decode both grammar and context. The discourse has reached verticality in its linguistic orientation and the term “relationship” entails the mathematical core of the talk. What students can learn here is the fact that T-tables materialise relationships, as the teacher quotes later on (48, episode 6). As expressed by Martin (2007), the core of vertical discourse goes along with the use of grammatical metaphor. But again – as in episode 2 – it is only Mike who is able to recognise and realise this orientation. As by “difference” he autonomously employs a grammatical metaphor, he seems comfortable with its use. All other students remain silent, hence are not yet actively participating in the vertical discourse.

### **Episode 4: Re-linking to the horizontal discourse**

In line 31 the teacher starts coming back to a more harmonic use of semantics and grammar. There, he is demanding to express logic relations by the use of the

conjunction “how”. In line 32 and 33 Mike and the teacher are stepwise coming back to the visible and particular T-table, thus orienting towards contextualised language and horizontal discourse. The function of this short episode may well be assumed as making the discourse more accessible to all.

### **Episode 5: A second try of common negotiation of orientation**

35            **T** I have a question. How do you go from this number to this one? Remember you said that we added down or you folks added down. How do we get from this side if you were looking at these numbers and if you say they sort of, they sort of seem to match up in a way? How do we get from this side to this side? Karsten, can you figure it out?

In some way, this elicitation resembles utterance 10 in episode 2. The teacher is reconstituting the harmony of semantics and grammar. His tool for asking for logical relation again is the conjunction “how”. This is accompanied through processes (go, added, get, etc. ) which are expressed through verbs. But as the “how” is clearly related to processes, it - this time - is not ambivalent (compare to episode 2). He is really asking for “How do you go from this number to this one?” instead of “why”. Hence the use of language is more contextualised, more bound to the experiences, the students have made in their work. However, he is not entirely coming back to a contextualised discourse, but still offering a decontextualised alternative, asking for how “they sort of seem to match up in a way”, which is equivalent to “how those numbers fit in the way they do?” (10). While marking horizontal discourse as legitimate, there remains an implicit tendency towards the vertical decontextualised discourse. But again, he is offering alternatives and accordingly giving apparent control to the students over which discourse they like to refer to. The function of this episode can be regarded as another strive for a common negotiation of orientation. However, this strive remains unsuccessful and the teacher goes on to revise his strategy.

### **Episode 6: Apparent unification of horizontal and vertical discourse**

37            **T** Is there anybody else or is there anybody else who can see anything else here that goes from here to here as far as relationship? How do we compare this number with this number?  
(*T waits two seconds.*)

Similar to Episodes 2 and 5 the teacher is offering two alternative questions differing in their degree of verticality. Apparently, the teacher still follows his strategy of negotiation. However, a more detailed look at the first and more vertical of the two questions indicates a modification of the strategy. He is firstly asking for a process expressed in a verb (goes) and then links it in some unhandy way to the grammatical metaphor of relationship. The use of “as far as” implies that there is something

beyond the demanded process which is not expressible in a way that students can access. The difference to line (10) and (35) is in the direction towards which the discourse is oriented. While in line (10) and (35) the aim could be expressed as drilling the seeds for the orientation towards the decontextualised vertical discourse, the aim now is to re-establish the students' feeling of comfort, neglecting the relevance of participating in vertical discourse. The following four and a half minutes of the discussion confirm this view. The teacher is limiting teacher-student-interaction on arithmetical questions as:

53           **T**   Wayne, are you with us son? What's ten minus two buddy?

54           **W**   Eight.

The focus is on the affective outputs of the discussion rather than on the content. There are several examples of the teacher's strategy of re-establishing the students' comfort in the discussion. An analysis of one of these examples may provide a good insight in the function of this strategy.

48           **T**   Because guess what, a lot of T-tables work in a pattern something like this where you can fill in a little tiny equation. If you understand that with this one you'll understand most of what happens in most of the rest of the T-tables. See this little equation here? It gets a little bit harder but they work basically the same way.

The teacher highlights the exemplarity of the T-table and outlines the relevance of the discussion in the vertical discourse. In addition with his behaviour of eliciting simple arithmetic results and positively evaluating the answers, he is establishing a straight logical chain from filling out spaces in this particular T-table to understanding algebraic structures in T-tables in general, that is, a (false) progression in verticality: If you are able to answer "ten minus two buddy?", then you "understand that with this one" and "you'll understand most of what happens in most of the rest of the T-tables." His use of the notion "little tiny equation" is illustrative for this strategy of appeasement: Through the qualities of "little" and "tiny" the term "equation" shall lose the scare of an academic grammatical metaphor.

50           **T**   Now all of a sudden you are into real simple arithmetic. You did this ages ago so guess what? We made the math look a little bit hard, now we're trying to make it look easy.

Of course, the teacher does not have the power to tear down the boundaries between horizontal and vertical discourse. Arithmetic serves as a tool in algebra, but factually it will remain a different discourse. Hence, the teacher is only able to mask the boundaries and consequently to render them invisible for the students.



## DISCUSSION

The analysis illustrates how our chosen theoretical framework allowed us to identify an interactional mechanism, which bares the potential of amplifying the students diversity resulting from their differential linguistic socialisation in early childhood and primary school. Bernstein, Hasan and Martin all make us aware that this differential socialisation is closely connected to the issue of privilege and marginalisation. The ongoing research indicates that the mechanism observed is not a singular phenomenon.

The interactive mechanism the teacher is using to negotiate mathematical meaning on two different discursive levels effects a differential provision of access to valued forms of mathematical knowledge. As Martin (2007) and O'Halloran (1999) have argued, without grammatical metaphor and decontextualised language there is no vertical school mathematics discourse. Those students who are already prepared for decoding and using grammatical metaphor experience opportunities to further access the legitimate discourse of secondary school mathematics. Those who are only used to horizontal discourse are not challenged by new forms of knowledge. There is no attempt to make the different orientations to meaning visible. Instead of generating linguistic conflicts, the teacher establishes horizontal discourse as legitimate and blurs the boundaries between horizontal and vertical discourse. Hence, the teacher appeases rather than challenges those students who most need an explicit introduction into vertical discourse.

Atweh, Bleicher and Cooper (1998) report on the differences of register of two mathematics teachers working in schools with disparate student population. Where students are expected to aspire future university studies the teacher challenges them constantly with decontextualised language. In contrast, in a working class suburb the focus of the mathematics teaching was to develop skills useful in a consumer society, resulting in a more intuitive and less systematic use of language. Here again, we see how the teacher's peception of low educational ambitions and aspirations limits the students' access to valued forms of mathematical knowledge.

However, these teachers work with either positively pre-selected or socially marginalised groups of students. Their discursive practices are characterised by a high degree of internal consistency: either aiming at vertical *or* at horizontal discourse. The interactive mechanism of negotiating meaning on two different discursive levels *within one classroom* seems to be particularly important in unstreamed and inclusive school systems as student heterogeneity with respect to orientation to meaning is greater. In inclusive school systems, all students *potentially* access vertical discourse. In our illustrative case, however, interactional mechanisms translate student diversity into disparities of achievement. *Actually*, through appeasement, the characteristics of vertical discourse remain masked for the non-privileged.

## NOTES

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## REFERENCES

- Atweh, B., Bleicher, R.E., & Cooper, T.J. (1998). The construction of the social context of mathematics classrooms: A sociolinguistic analysis. *Journal of Research in Mathematics Education*, 29(1), 63-82.
- Bernstein, B. (1999). Vertical and horizontal discourse: An essay. *British Journal of Sociology of Education*, 20(2), 157-173.
- Cooper, B., & Dunne, M. (2000). *Assessing children's mathematical knowledge: Social class, sex and problem solving*. Buckingham: Open University Press.
- Cummins, J. (1996). *Negotiating identities: Education for empowerment in a diverse society*. Los Angeles: California Association for Bilingual Education.
- Gorgorió, N., Planas, N., & Vilella, X. (2002). Immigrant children learning mathematics in mainstream schools. In G. de Abreu, A.J. Bishop & N.C. Presmeg (Eds.), *Transitions between contexts of mathematical practices* (pp. 23-52). Dordrecht: Kluwer.
- Hasan, R. (2001). The ontogenesis of decontextualised language: Some achievements of classification and framing. In A. Morais, I. Neves, B. Davies & H. Daniels (Eds.), *Towards a sociology of pedagogy. The contribution of Basil Bernstein to research* (pp. 47-79). New York: Peter Lang.
- Knipping, C., Reid, D.A., Gellert, U., & Jablonka, E. (2008). The emergence of disparity in performance in mathematics classrooms. In J.F. Matos, P. Valero & K. Yasukawa (Eds.), *Proceedings of the Fifth International Mathematics Education and Society Conference* (pp. 320-329). Lisbon: Universidade de Lisboa.
- Koch, P., & Oesterreicher, W. (1985). Sprache der Nähe – Sprache der Distanz. Mündlichkeit und Schriftlichkeit im Spannungsfeld von Sprachtheorie und Sprachgeschichte. In O. Deutschmann et al. (Eds.), *Romanistisches Jahrbuch, Band 36* (pp. 15-43). Berlin: de Gruyter.
- Martin, D.B. (2010). Not-so-strange bedfellows: Racial projects and the mathematics education enterprise. In U. Gellert, E. Jablonka & C. Morgan (Eds.), *Proceedings of the Sixth Mathematics Education and Society Conference*, 2<sup>nd</sup> edition (pp. 57-79). Berlin: Freie Universität Berlin.
- Martin, J.R. (2007). Construing knowledge: A functional linguistic perspective. In F. Christie & J.R. Martin (Eds.), *Language, knowledge and pedagogy: Functional linguistics and sociological perspectives* (pp. 34-64). London: continuum.

O'Halloran, K.L. (1999). Classroom discourse in mathematics: A multisemiotic analysis. *Linguistics and Education*, 10(3), 359-388.