COGNITIVE ACADEMIC LANGUAGE PROFICIENCY IN PRIMARY MATHEMATICS CLASSROOMS

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THEORETICAL CONSIDERATIONS: CALP, REGISTER, AND CODE

Language factors play a double role in the learning of mathematics at school. First, the subject, school mathematics, is developed mostly by means of spoken language. Second, students are introduced, although often implicitly, to the linguistic features of the language in which mathematics is taught. The command of a specific kind of language proficiency is a condition for becoming a prosperous student in the mathematics classroom. As mathematics education is increasingly emphasizing argumentation and reasoning, this issue is of vital importance. However, a precise and detailed description of this specific kind of language proficiency is still lacking.

It would be too simple an answer to take the linguistic demands that students face in mathematics education as a conglomerate of 'good German', or 'good English', and mathematical terminology. Students need to develop a complex linguistic competency in order to participate successfully in the mathematics class. On one hand, this competency is bound to the particular situation in which it is developed, that is, the particular interaction of a teacher and the students in the mathematics classroom. On the other hand, this interaction is linguistically orientated at a model of an exalted form of speech, which, according to Jim Cummins (e.g. 2000), is characterized by its tendency to be lexically and grammatically similar to writing, and which Cummins, referring to the underlying mental processes, has termed cognitive academic language proficiency (CALP):

> Oral classroom discussions do not involve reading and writing directly, but they do reflect the degree of students' access to and command of literate or academic register of language. This is why CALP can be defined as expertise in understanding and using literacy-related aspects of language. (Cummins 2000, p. 70)

In this perspective, which has been developed in the frame of bilingual education, being educated, and being mathematically educated as part of it, is first of all a matter of language proficiency. It is highly important for access to and success in higher educational institutions to show this particular proficiency.

In mathematics education, a subject-specific occurrence of CALP can be observed. In schools, mathematics-specific CALP is recurring on the particular vocabulary made of school mathematical concepts, and the respective symbolism, as well as on linguistic devices that aim at rendering a text coherent. By mentioning the notions of literacy and academic *register*, Cummins emphasizes that the concept of CALP is not restricted to syntactic features of language but includes semantic and structural aspects that refer to the social and institutional particularities of classrooms and

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schools – a perspective which has been developed extensively by linguist Michael Halliday (e.g., 1978).

It is well within the scope of this characterisation to take CALP, and particularly the mathematics-specific variation of it, as an expression of structural relationships between elements such as position, power, status, and control. A consideration of these elements, and of the relationships between them, draws the attention to a *socio*linguistic, rather than linguistic, theorisation of academic language proficiency within classrooms. Such a focus would be typical for sociologists of education. The work of Basil Bernstein (1990, 1996) on *codes* is well appreciated in this respect. For Bernstein, code is not a metaphor but a “regulative principle, which selects and integrates relevant meanings, the forms of their realizations and their evoking contexts” (1990, p. 101). Bernstein’s code theory “draws attention to the relations between macro power relations and micro practices of transmission, acquisition and evaluation and the positioning and oppositioning to which these practices give rise” (1990, pp. 118-119). In this view, the practice of mathematics education in school is regulated by implicit rules. Although mastery of these rules is a precondition for success, not all of the students are familiar with them.

According to Bernstein, relations of power and control correspond to the codification of what, and what not, pertains to a particular discourse, and how this discourse is produced and legitimated by classroom talk. Mathematics as a school subject is characterized by internal boundaries between mathematical domains, such as geometry, arithmetic, chance and data. In each domain, specific forms of discourse are appropriate, with respect not only to terminology and symbolism but also to typical forms of concept formation, abstraction and generalisation. Externally, school mathematics is thematically insulated (1) from other school subjects as well as (2) from everyday knowledge and out-of-school experience. There is empirical evidence that this second insulation is particularly difficult to capture for children starting school. However, not only for first graders, it is extremely important to recognise and internalise what counts as relevant contribution to classroom talk and how out-of-school experience can be brought into the classroom. Those, who do not become familiar with these insulations, who (in Bernstein’s terms) do not command the *recognition rule* of classroom discourse, cannot contribute substantially to classroom talk and are threatened with failure.

INVESTIGATING SCHOOL STARTERS’ CALP

Since subject-specific academic language proficiency is regarded as of crucial importance for participation in mathematics classes *from the beginning of schooling on*, a detailed description of its linguistic characteristics would be useful for supporting students’ acquisition of CALP. However, theoretical and empirical work on CALP has mainly been done in the area of first and second language acquisition. Few studies have drawn on linguistic elements of mathematical language proficiency, such as the use of ‘equal’ (Warren 2006) or relational complexity between ‘more’ and ‘bigger’ (Halford 1993), but a comprehensive categorisation of linguistic elements is still lacking. Yet the setting up of such a catalogue of linguistic means is a problematic endeavour, because of tensions between theory-inspired collections of criteria and rather heterogeneous pedagogic practices in mathematics education.

Nevertheless, without exposure of CALP elements, mathematics education remains a socio-linguistically invisible practice, and discriminates all those with low CALP. Hence, I am currently approximating this issue by means of a descriptive-analytic categorisation of school starters’ mathematical academic language proficiency. The strategy is to engage school starters in a narration that is explicitly drawing on their mathematical linguistic resources. On the grounds of these narrations, the linguistic variety in terms of syntactic and semantic elements and of text structure is analysed, aiming at a multidimensional categorisation of school starters’ mathematical academic language proficiency.

First analyses show, that the school starters’ (audio-taped and transcribed) narrations differ substantially in length, focus, and language use. Not unexpectedly, it is viable to identify a variety of CALP elements. However, the most striking result is, that students’ differential production of school mathematical speech is apparently dominated by their differential command of the *recognition rule*. Bernstein’s theoretical claim is empirically manifest. This is particularly evident in the case of some school starters who, over a period of two weeks, have repeatedly responded to the prompt to narrate a mathematical story. The same six-parts picture story has been presented to them four times, showing a girl and a boy constructing towers with building bricks. The prompt has been given in identical word order: *Please, look at the six pictures and tell me a detailed mathematical story of what is happening there!* No feedback has been given to the children.

However, some children “improved” their mathematical narration. Apparently, these children developed a keen sense of the challenging situation and of the kind of production of speech that is favoured – without having received any response to their first narrations. This observation is overtly supported by the case of one seven-year-old girl that, after telling the story for the third time, approaches the interviewer:

Girl: But, actually, I didn’t really tell a *mathematical* [emphasised] story.

Interviewer: You want to tell the story once more?

Girl: Um, yeah, … [starts telling the story]

This girl did not only develop a sense of what the interviewer tries to achieve. In her fourth version of the story she uses more, and more frequently, elements that meet the demands of mathematics-specific academic language proficiency in school. Hence, by improving her command of the recognition rule, she was able to demonstrate a higher level of proficiency with respect to mathematical academic language.

Thus, the command of the recognition rule and the quality of mathematical academic language production are closely related. From a socio-linguistic perspective, command of the recognition rule can be interpreted as *a fundamental part* of CALP. If this is a sound interpretation, then two consequences can be sketched:

- Any attempt to investigate students' subject-specific CALP will face the problem of the differential command of the recognition rule blurring or generating the differences that a linguistic analysis of students' speech may detail.
- Students' acquisition of subject-specific CALP will be significantly enhanced, when not only the linguistic elements are considered a matter of instruction, but also the socio-linguistic codification of discourse.

REFERENCES

Bernstein, B. (1990). *The structuring of pedagogic discourse*. London: Routledge.

Bernstein, B. (1996). *Pedagogy, symbolic control and identity: Theory, research, critique*. London: Taylor & Francis.

Cummins, J. (2000). *Language, power and pedagogy: Bilingual children in the crossfire*. Tonawanda, NY: Multilingual Matters.

Halford, G. (1993). *Children's understanding: The development of mental models*. Hillsdale, NJ: Lawrence Erlbaum.

Halliday, M.A.K. (1978). *Language as social semiotic: The social interpretation of language and meaning*. London: Edwald Arnold.

Warren, E. (2006). Comparative mathematical language in the elementary school: A longitudinal study. *Educational Studies in Mathematics*, 62, 169-189.