Pedagogies in action: the role of mathematics teachers' professional routines

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Abstract: During the last eight years, in the context of ‚mathematical literacy' as proclaimed by the OECD (2003), TIMSS and PISA have led to an intensive discussion in Germany about the concept of learners' competency, thereby opening the question of its dual for teachers. Attempts at constructing the latter have mainly built on the early seminal work of Shulmann (1986) and Bromme (1994, 1995, 1997). The authors believe that the theorizing around this concept, by not paying sufficient attention to teachers' professional action schemes (cf. Tenorth, 2006), has unduly pushed certain aspects of their scope of action into the background. We shall see that long stretches of teaching are driven by well-executed professional routines while performance in class is a more elusive but equally decisive parameter.

Motivation

In the aftermath of Germany's poor performance in TIMSS and PISA, a flurry of debates and discussions concentrated on students' mathematical knowledge and skills, i.e., *competencies.* Without going into detail, we can say that, in spite of their often hasty conclusions, these impinged on German educational standards via the so-called KMK-Agreements and in particular made new demands on school mathematics (cf. Blum et al., 2006). At the same time, the dual concept for teachers drew little attention, although, again under the influence of PISA, fundamental work in this area was being initiated by analyzing differences across countries (Lipowsky et al., 2003).

In most discussions of teachers' competence, Shulman's venerable paper "*Those who understand: Knowledge growth in teaching"* (1986) remains central, and in German speaking countries, his notions of '*subject matter knowledge'* and '*pedagogical content knowledge'* were extended and refined by Bromme (1994, 1995, 1997). The categories developed in these articles have, among other things, clarified the overly broad definitions of '*mathematical literacy'* found in the early PISA discussions.

It can be considered basic progress that in the last ten years, the discussion of competency models (c.f. Baumert & Kunter, 2006) has produced a substantial theoretical background, on both the student and the teacher level. Even though it may seem obvious that teaching to enhance students' competence demands special teacher qualities, the question of how sheer teacher knowledge sparks its counterpart in students still remains mostly open. In this respect, the efforts of Tenorth (2006) to moderate in the current German debate on teachers' professional development are

particularly noteworthy. While the emphasis of this debate has been on competency models, Tenorth tries to draw more attention to teaching *practice* and its associated essential routines. He points out that it is not sufficient to focus on knowledge and derived competencies but also necessary to consider professional schemes, which represent the practical organization of teaching for a live in-class performance. The provocative subtitle of his paper "*Theory stalled but practice succeeds*" does not herald an argument against knowledge (which must, if anything, be stronger in practice than in theory!), but one against abstract theorizing about knowledge. To be honest, the authors find echoes of scholastic disputation in the current discussions, in which taxonomies of competencies for teachers and students are as earnestly drafted and pondered as the taxonomies of goals in the seventies. To what avail?

Knowledge, Competencies and Routines

Within the last two decades, essential research in teacher education has focused on different accounts of teacher knowledge and its role for teaching mathematics (Shulman, 1986; Ball, 2002; Ball & Bass, 2000; Ma, 1999). In Germany, these aspects built the basis for a theory of professional knowledge which further led to a model of competence, characterized by a dynamic interplay of professional knowledge, beliefs, motivational orientations and self–regulative skills (Brunner et al., 2006). To be sure, there is some value in these considerations, but not all relevant teacher competencies are covered in this model. One can ask, for example, whether these categories catch the difference between a seasoned teacher and his novice colleague when the latter, lacking established routines, enlivens his classroom actions by improvisation.

During in-service courses led by one of the authors, conversation starters about mathematics like the following: *minus times minus equals plus, squaring a number can lead to smaller number,* or *multiplication with a negative number changes the sign,* tended to make many teachers slip into a kind of embarrassment. However, everyday teaching requires spontaneous reactions to that type of question and thus points to the importance of core teaching routines.

Some authors consider routines to be *knowledge-in-action* and therefore refer, in this context, to the dualism of knowledge and know-how (Baumert & Kunter, 2006). Thereby, knowledge-in-action is seen as a developmental goal that becomes particularly salient in praxis. Ball and Bass (2000), on the other hand, refer to the crucial role of *knowledge-in-practice* for teaching mathematics:

> Furthermore, the use of mathematical knowledge in teaching is often taken for granted. The mathematical problems teachers confront in their daily work - such as the simple case at the beginning of this chapter - are left unexplored, the occasions that require mathematical sensitivity and insight unprobed. Hence, the content and nature of the mathematical knowledge needed in practice is insufficiently understood. Moreover, the role played by such knowledge is also left unexamined. (pp. 86, 87)

More recently, Shulman (2005) argues that it is *signature pedagogies* which connect thought and action in the profession:

> The signature pedagogies of professions are designed to transform knowledge attained to knowledge-in-use, and to create the basis for new kinds of understanding that can only be realized experientially and reflectively. [...] A professional has to be prepared to act, to perform, to practice, whether they have enough information or not.

Finally, Tenorth (2006) claims that *professional routines* are the decisive characteristic of professionalism in teaching. Routines were studied in the nineteen-eighties in connection with patterns of interaction by the school of Bauersfeld (cf. Voigt, 1984) and others (cf. Leinhardt & Greeno, 1986), and though there exists some more recent work concerned with describing the knowledge of experienced teachers in these terms (cf. Sherin, Sherin & Madanes, 2000), routines tend to be relegated to the status of mechanical skills or technical trappings. With regard to the aforementioned aspects, we shall elaborate on professional routines as encapsulating the essential wisdom of teaching practice, thereby showing professionalism as resulting from well-established and experienced action schemes.

Routines in the Classroom

In mathematical research, repetition of received ideas is (if possible) to be avoided, and the word “routine” easily conjures up such associations. Good ideas are never copies; they should be brand-new and first-rate. Transferred to teaching, this would imply continuously new approaches and procedures instead of established routines. In this sense, teaching based on so-called rote learning, where a type of argument or calculation is met again and again, is quickly judged to be distasteful. Life, on the other hand, consists of a continuous stream of related routines, without which its complexities could never be adequately reduced.

If, as is often said, teaching is an art, it must surely be counted among the performing ones. All performers know that their craft is built (a) on a thorough knowledge of their subject -- e.g., music -- and (b) on a specific know-how, made up of a vast set of routines which have been practiced so as to become second nature. It is through them that knowledge expresses itself, and every performance rests on a more or less skillful concatenation of them. Each consists of a relatively fixed schematic core, which provides stability, and a variable shell, which allows response to demands of the moment, including links with other routines. In the debates among math-educators -- to the extent that they have not veered off into realms far removed from mathematics -- it is not uncommon to view professional routines as quasi-robotic, mindless procedures, best left to machines rather than people.

Because of the constraints on its length, this article can list only a few routines that appear to be crucial in teaching mathematics and of isomorphic character: fishing for correct answers (e.g. by leading questions), initiating and supporting group work, inserting subtle hints, handling unexpected questions (“curve balls”), providing quick

reinforcement, posing and developing a problem or example, preparing the ground for introducing a concept/technique, inventing an example on the fly, probing and extending student reasoning, coaxing volunteers to explain results to class, explaining situations from various angles, recovering from a flub. These routines are often grafted on patterns which are isomorphic in nature and, as Bauersfeld (1980) pointed out, can act as hidden dimensions in the classroom reality. In recent work, we explored how these habitual routines, for example fishing for correct answers, interfere with a teacher's good intention to apply new pedagogical approaches learnt during an in-service training course (Törner, Schoenfeld, Rolka and Rösken, 2006).

Holding Learners' Attention

However, it is true that the most complete command of the relevant knowledge, paired with a perfect mastery of the required know-how, might still result in a lack-lustre performance, one that fails to hold the audience's attention.

> And we all know that you could have the most skilled classroom teacher who understands their subject matter deeply. But if they are not a person of character, there's something deeply deficient here. (Shulman, 2005)

An actor, for instance, must engage the spectator's sympathy with the character portrayed. The audience must think and feel for the character. Likewise, the teacher must elicit the learner's sympathy (call it "curiosity", "interest", etc.) for the subject of the lesson. This can be done only if she -- like the actor -- *lives* it as though it were for the first time. In preparation for such a lesson, she would not only review the appropriate sequence *(con variazioni)* of professional routines, but revisit the subject itself like a novice, unarmed and willing to be surprised. In other words, she has to practice what she preaches -- live, real-time understanding.

References

Ball, D. L & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J. Boaler (Ed.), *Multiple perspectives an mathematics teaching and learning*. pp. 83 - 104. Westport, CT: Ablex Publishing.

Ball, D. L. (2002). What do we believe about teacher learning and how can we learn with and from our beliefs? In Mewborn, D. et al. (Eds). *Proceedings of the 24. Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (October 26 - 29, 2002) at Athens (Georgia). Volume 1 (pp. 3 - 19). Columbus, OH: ERIC Clearinghouse for Science, Mathematics and Environmental Education.

Bauersfeld, H. (1980). Hidden dimensions in the so-called reality of a mathematics classroom. *Educational Studies in Mathematics 11*, 23 - 41.

Baumert, J. & Kunter, M. (2006). Stichwort: Professionelle Kompetenz von Lehrkräften. *Zeitschrift für Erziehungswissenschaft 9* (4), 469-520.

Blum, W., Drüke-Noe, C., Hartung, R. & Köller, O. (Hrsg.) (2006). *Bildungsstandards Mathematik: konkret. Sekundarstufe I: Aufgabenbeispiele, Unterrichtsanregungen, Fortbildungsideen*. Berlin: Cornelsen Scriptor.

Bromme, R. (1994). Beyond subject matter: A psychological topology of teachers' professional knowledge. In Biehler, R.; Scholz, R.W.; Strasser, R.; Winkelmann, B. *Didactics of Mathematics as a Scientific Discipline* (pp. 73 - 88). Dordrecht: Kluwer Academic Publishers.

Bromme. R. (1995). Was ist 'pedagogical content knowledge'? Kritische Anmerkungen zu einem fruchtbaren Forschungsprogramm. In S. Hopmann & K. Riquarts (Hrsg.), Didaktik und / oder Curriculum: Grundprobleme einer international vergleichenden Didaktik. *33. Beiheft der Zeitschrift für Pädagogik* (S. 105 - 115). Weinheim: Beltz.

Bromme, R. (1997). Kompetenzen, Funktionen und unterrichtliches Handeln des Lehrers. In: Weinert, F.E. (Hrsg.): Enzyklopädie der Psychologie. *Pädagogische Psychologie. Bd. 3: Psychologie des Unterrichts und der Schule*. - Göttingen, 5. 177-212.

Brunner, M. et al. (2006). Welche Zusammenhänge bestehen zwischen dem fachspezifischen Professionswissen von Mathematiklehrkräften und ihrer Ausbildung sowie Fortbildung. *Zeitschrift für Erziehungswissenschaft 9* (4), 521 - 544.

Leinhardt, G., & Greeno, J.G. (1986). The cognitive skill of teaching. *Journal of Educational Psychology 78*, 75--95.

Lipowsky, F.; Thusbas, C.; Klieme, E.; Reusser, K. & Pauli, C. (2003). Professionelles Lehrerwissen, selbstbezogene Kognitionen und wahrgenommene Schulumwelt - Ergebnisse einer kulturvergleichenden Studie deutscher und Schweizer Mathematiklehrkräfte. *Unterrichtswissenschaft 31* (3), 206 - 237.

Ma, Liping. (1999). *Knowing and Teaching Elementary Mathematics: Teachers' Understanding of Fundamental Mathematics in China and the United States*. Hillsdale (NJ): Lawrence Erlbaum Associates.

OECD (Hrsg.) (2003). *The PISA 2003 Assessment Framework: Mathematics, reading, science and problem solving knowledge and skills*. Paris: OECD.

Sherin, M. G., Sherin, B., & Madanes, R. (2000). Exploring diverse accounts of teacher knowledge. *The Journal of Mathematical Behavior*, 18(3), 357-375.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15* (2), pp. 4-14.

Shulman, L.S. (2005): *The Signature Pedagogies of the Professions of Law, Medicine, Engineering, and the Clergy: Potential Lessons for the Education of Teachers*. Talk Delivered at the Math Science Partnerships (MSP) Workshop: "Teacher Education for Effective Teaching and Learning" Hosted by the National Research Council's Center for Education February 6-8, 2005, Irvine, California.

Tenorth, E. (2006). Professionalität im Lehrerberuf. Ratlosigkeit der Theorie, gelingende Praxis. *Zeitschrift für Erziehungswissenschaft, 9* (4), 580-597.

Törner, G.; Rolka, K.; Rösken, B.; Schoenfeld, A. (2006). Teacher monologue as a safety net: Examining a German mathematics classroom situation through the lens of Schoenfeld's theory of teaching in context. *Paper presented at the 2006 Annual Meeting of the American Educational Research Association*, San Francisco, USA, April 07-11, 2006.

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Voigt, J. (1984). *Interaktionsmuster und Routinen im Mathematikunterricht.* Weinheim: Beltz.