

MENTORING TEACHING OF MATHEMATICS IN TEACHER EDUCATION

Vivi Nilssen

Faculty of Teacher Education and Deaf Studies, Sor-Trondelag University College,
Trondheim, Norway

The paper is based upon a case-study of mentoring in teacher education in Norway. It describes the practice of the cooperating teacher and how mentoring in the practice-field contributes to student teachers learning. The main focus is how student teachers develop pedagogical content knowledge in mathematics through reflections with the mentor about their teaching episodes. The study draws attention to how Vygotsky's and others ideas about scaffolding and assisting in the Zone of Proximal Development (ZPD) can be useful in understanding how student teachers learn to teach mathematics. This paper specially focuses the role of imitation and modelling.

INTRODUCTION

This case study tells the story of a cooperating teacher¹ named Erik and his student teachers². It is interesting to see how these student teachers plan for interactive teaching over and over again. We know that student teachers have problem with handling this interactivity (Doyle 1977, Nilssen, Gudmundsdottir & Wangsmo-Cappelen 1996) and that mentors contribute to avoiding them because they are eager to ensure that the student teachers' lessons go smoothly (Edwards 1998). A hundred years ago Dewey (1904/1965) gave a warning about letting immediate skill be got at the cost of power to go on growing.

Though interactive teaching is difficult for novices in any subject, it seems to be even more true in mathematics. Several studies show that student teachers try to avoid interactivity, or even worse they think such teaching strategies do not belong in mathematics lessons. Those lessons should be quiet places where the teacher first explains what to do, and then the pupils work individually solving problems the way the teacher wants them to (Ball 1988, 1991, Calderhead & Robson 1991). Such working methods are far from both The Norwegian National Curriculum (L-97) and from the mathematics teaching the student teachers meet in Erik's classroom.

The essence of Erik's teaching method is that children solve problems using their knowledge and experience, that is, they develop their own strategies for solving math problems. The children explain their strategies to the teacher and to each other, and all strategies are accepted. Gradually they develop a common understanding and an effective way to handle problems. When studying mathematics at the teacher training college, the

¹I will use the word mentor when I talk about Erik because we can think of mentoring as helping someone to learn to teach in the context of teaching (Feiman Nemser & Beasley 1997, Collison & Edwards 1996).

²In Norway the students in the first year of the Teacher education programme for primary schools, practise in a school for two periods, each of them consisting of three weeks. 4-5 students are in the same class and have the same cooperating teacher. The cooperating teacher functions as their supervisor or mentor. During this period they have little contact with the teachers at the teacher training college.

students meet this new way of seeing the subject. It is not guaranteed that they will do so in their field practice though The ministry of education emphasise that it is necessary to ensure a good connection to the practice field.

METHOD

The field work in this study is done during a three week period in the practice field³. Erik and his student teachers were followed both in the classroom and in the mentoring processes. Data were collected in different ways, observations in the classroom, video recordings of the mentoring processes and interviews with the mentor and the student teachers. Some of the interviews were video interviews. That is interviews taking place while the mentor and I are looking at the video recording of the mentoring. Both interviews and the video recordings were transcribed. The compiled data were categorized through analysis and interpretation. In this process the use of theory plays an important role. Below I present one of the categories I've found regarding Erik's mentoring, the category of *modelling*.

THEORETICAL FRAMEWORK

The work of Vygotsky is well known, and in my opinion it offers a frame of reference to understand mentoring as well as teaching. Vygotsky argues that teaching (or mentoring, my comment) is good only when it "*awakens and rouses to life those functions which are in stage of maturing, which lie in the zone of proximal development*"⁴ (1956, p.278, here in Wertsch and Stone 1985, p.165). Vygotsky has defined this zone as "*the distance between the actual development level as determined by independent problem solving and potential development as determined through problem solving under adult guidance or in collaboration with more capable peer*" (1978, p.86).

In informal situations we learn a lot from imitations. According to Vygotsky "*a full understanding of the concept of the zone of proximal development must result in reevaluation of the role of imitation in learning*" (1978, p.87). We have to reconsider imitation as a starting point for learning. It is a sign of development when one imitates and get help from others. Imitation can be understood as a constructive process because what is imitated is chosen by the individual, it is something the individual wants to do. This aspect of Vygotskys theory is a useful way of approaching mentoring in the practice field because the student teachers often imitate methods they see in use by others (Ball 1991). Often they experience that they do not succeed because of lack of necessary knowledge (Nilssen et.al 1996, Campbell & Kane 1996).

Several studies show how student teachers develop their pedagogical content knowledge through reflection on episodes together with more capable persons. (Feiman-Nemser 1983, Grossmann 1989, Grossmann & Richert 1988, Shulman 1987). Mentoring in the practice field is a part of the Teacher education programme which is performed by a more capable person. The intermental process which takes place between the student teachers

³ Erik is one of three cooperating teachers participating in the study.

⁴ ZPD

and their mentor is of crucial significance to how the student teachers manage to bring their potential in use and make it part of their own teaching.

Tharp and Gallimore (1988, p.31) derive from Vygotsky that “*Teaching (or mentoring) consists in assisting performance through the zone of proximal development. Teaching (mentoring) can be said to occur when assistance is offered at point in the zone of proximal development at which performance requires assistance.*” Assistance of performance in the ZPD has been described as *scaffolding* by Wood, Bruner and Ross(1976). Scaffolds enable novices to perform a task which lies in the ZPD. Building scaffolds around a student teacher’s learning process is a balancing act between giving them real challenges, and ensuring that they can meet the challenges and not give up. But first of all the student teachers need to get interested in the task, called *recruitment* by Wood, Bruner and Ross (1976). Tharp and Gallimore (1988) have identified a similar form of assisting, the process of offering behaviour for imitation which they call *modelling*⁵. The understanding of the ZPD has been strengthened by the work of Wertsch (1984) and his identification of important conceptions. *Situation definition* is the way a situation is defined and understood. When persons share the same definition and are aware of it *intersubjectivity* occurs. This creates a common basis for communication.

RESULTS

Ole has finished his first lesson with division in class five (the pupils are 10 years old), and in the post-conference⁶ his first comment is that he felt it difficult because “I’m not feeling confident enough, and the pupils? – I thought they were restless”. Erik follows up by asking if there was something he felt was a success. Ole finds it difficult to answer, but by pushing him a bit Erik gets an answer, “I got them quite active, they took part in the learning”(vidobs3).

Erik’s next answer leads to this dialogue (1):

Erik: Aren’t we now talking about the same thing you thought were difficult? That’s when you thought the children were most active?

Ole: Yes, it was when I should explain this I thought it was hard

Erik: If we look at the children’s experience from the lesson, how do you think it was?

Ole: Probably it was fun

Erik: What made it fun?

Ole: Maybe that they could participate themselves?

Erik: Why did you experience that as difficult, their own participating?

Ole: No, it was not their participating which was difficult

Erik: I see, it was during the summary when they should explain their methods?

Ole: Yes

What Ole is describing here is a situation he will often meet when he is following his view on children and mathematics. How did he get into this situation? I think I will go back to the beginning.

⁵ Both Tharp & Gallimore (1988) and Wood, Bruner & Ross (1976) have identified several ways of assisting in the ZPD. In this paper I focus on imitation and modelling. In a paper presented at AERA 2002 I discuss other ways of scaffolding in the ZPD.

⁶ Erik is using a model for mentoring with pre-conference before the teaching and post-conference afterwards

Two of the student teachers have made a sketch for the division topic which they present to Erik and the other two students. Through comments like “We’ll let 20 other be part of the discussion, too” (vidobs2) Erik reveals that the pupils are important. Erik stresses this because his experience is that the student teachers are so concerned about their own achievements that they forget the pupils (aint20.3.). When the student teachers were in Erik’s class half a year earlier they observed what he was doing in the class. He talks about his first meeting with them this way:

They were incredibly nervous, they were really scared when they arrived, and in the first lesson I did it this way: I had a lesson where I made a good planning document and talked about the background ...and when they got a topic so firstly, they could in a way copy some, they could choose to, new topic, yes, but it could be put in the same pocket, they could use some methods, the sequence of operations, and they did and then they succeeded, it is not sure they will succeed but they’ll feel safer and they don’t have to plan from nothing....(aint20.3.,avint22.3.)

The student teachers’ planning this period shows that they have seen ways of teaching mathematics, ways that they are eager to test. Erik asks if Ole wants to take the first lesson because he has been thinking through the division topic. Ole agrees, and so he gets into the experiences that I reported in the beginning of the text (vidobs2).

In the class room Ole places the pupils on benches with their faces towards the blackboard. First Ole has a conversation with the pupils making attempts to capture what they know about division. They talk about the sign and what it is all about. Ole then gives groups of pupils (3 in each) 21 cubes and tells them to share. After doing this he tells them to explain how they did it. Here are some of the answers and Ole’s responses:

Group 1: We remembered that 7 times 3 is 21 and it is 21 here (On the board Ole writes $3 \times 7 = 21$)

Group 2: First we took three, then three, and so on

Group 3: Vi tried first, 6 and 6, 6 and 6, that is 24, too much

Ole: By trial and error?

Group 4: We counted like 3,3,3,3 (A girl is asking if it is suitable to use the square root)

Ole: You divided into parts of three? If I’ve understood it right two of the groups did the same? (He shows by splitting into parts of three)

Group 1: We did not divide like this, no, we divided into parts of seven

Ole tries to summarise by saying that both are right, it depends upon the question being asked⁷ He gives more exercises by increasing the amount of cubes, 25 cubes, 26 cubes and at last 30. In answering how they did it some of the groups use the same strategies as with 21 cubes. Some of the pupils begin to talk about fractions and decimals, and ask if they can write on the board. Ole allows them to do so. He sees that it is not correct, and tries to explain, but suddenly he tells them to do exercises (obs20.3.).

Now we are back where we started. Ole’s feeling of not being successful comes from the part of the lesson where the children show how they find the answer on problems by dividing cubes. In the post-conference Erik follows up dialogue (1) by saying:

I think you did this quite well, you are a first grader, you know. The children are active and that makes it difficult. Then they are going to describe a method and that is not easy for the

⁷ Ole means the difference between $21:7$ and $21:3$, but he doesn’t show the pupils what he means

teacher to understand, to grasp, and then you are going to explain back and that is difficult, too. It is a difficult way of working. I'll give you a tip, observe the children when they are working. You can observe some of the groups, and after a while you'll manage to observe some more. If you have looked at them you will understand better what they are telling you. (videobs3)

Erik asks the other students about their opinion of the way Ole introduces division (Dialogue 2).

Sara: Nice to do by themselves...find out...they have to think and not just sit watching, repeating it (for the other pupils) will make them more conscious.

Erik: How do you think this will affect their mathematical learning?

Sara: They have to understand what is going on.

Mari: Get it into fingers and head will make it their own before they get to the algorithm, but I can see that using concretes create restlessness,

Erik: I did not experience the situation as chaotic, I experienced it as activity...(to Ole) I see that there is the part you feel you did not succeed, but you did not master it badly...it is difficult because the pupils didn't explain that well and you haven't seen it... so what could Ole have done? To make sure he gets the right description?

Mari: Did they just talk? (Mari did not follow the lesson) They could have used concrete materials.

Erik: Like "Come here and show me"? That would have been a way of ensuring your understanding. Another thing you manage very well, when they explain and you don't understand, you don't give up at once, you really wanted to understand, and when you don't you get distressed. That is an important attitude

Ole: I couldn't ask once more, that would be embarrassing.

Erik: That's when you next time says, come up and show me.

Ole: Yes, I should have done so

Erik: That's things you have to learn...I think you managed to catch many different ways of solving the problem (vidobs3).

DISCUSSION

Wood et al. (1976) point out that the first step of scaffolding is *recruitment*, it is necessary to get persons interested in the task. Erik manages to get them interested by giving student teachers the opportunity to watch him and his class. They get a chance to see how teacher and pupils react upon each other, or as Dewey says, how mind answers to mind (Dewey 1904/1965). Erik has thus been offering behaviour for imitation, defined by Tharp and Gallimore (1988) as *modelling*. They draw attention to modelling as an important part of the scaffolding process. Both recruitment and modelling have the same function, a possibility of imitation. Erik is not only offering behaviour for imitation. By inviting them to take part in his planning, they also learn about the ideas lying behind, why he teaches the way he does and what his aim is. They gain access to his pedagogical reasoning. Dewey stresses the importance of giving the student teachers the possibility to observe not only the technical aspects of teaching, not only observe that this method works, but to know how and why it works (Dewey 1904/1965). This is necessary for student teachers to understand and to overcome the apprenticeship of observation (Lortie 1975). The student teachers imitate what they have seen, and according to Vygotsky (1978) it must be seen as a constructive and selective process as well as a sign of a developmental process. This is an important part of Erik's assisting performance.

As pointed out by Wertsch (1984) establishing a joint *situation definition* is crucial for the further dialogue. We can see how Erik is doing so by drawing attention away from the restless problem and focusing on the childrens learning in dialogue (1) . First of all it is important to ensure that they are talking about the same, that they share the same understanding and know that they do. But Erik also wants to draw attention to the children, an important aspect of pedagogical content knowledge (Shulman 1987). Erik chooses to have focus on the pupils' learning and in dialogue (2) we can see how he reinforces this. He also wants Ole to feel the success he deserved. Erik has offered teaching for imitation, and it is his job as a mentor to give support in a way that the student teachers can meet the challenges and not give up. When the student teachers are able to see the situations from outside and not so emotional, often negative, they will be in a better position to analyse what is really happening. Erik helps Ole to see that the pupils were active and not restless. This opens up for another conversation. Edwards and Collison (1996) strongly recommend to de-centre the student teachers' performance.

In the post-conference Erik tells the student teachers what *he* did in Ole's lesson. He *demonstrates* (Wood et al.1976) how he acts while pupils work to ensure he is capable of understanding their explanations. Afterwards Eriks asks if there are other suggestions to how Ole can get some more information from the pupils. In dialogue (2) we see the other student teachers take part in the discussion, and come up with other suggestions.

Maynard (1996) found that mentors often lack subject knowledge in certain curriculum areas. The mentors expressed that their contribution would be on developing student teachers understandings of child-centred approaches to teaching and pupil learning in the subject. That is no doubt an important part of pedagogical content knowledge. Through this study we can see how Erik manage to help student teachers make important experiences of a difficult teaching method in mathematics. He uses various kinds of scaffolding techniques⁸, but through the whole process he *models* a teaching mode where he is focusing on the pupils' learning of mathematics. And by using and managing such an interactive teaching mode the student teachers can learn much about differences in children's problem solving.

The cooperating teacher as a role model or a basis for imitation has not been well accepted in the teacher education programme in Norway during the last two decades (Skagen 2000). This study shows the importance of giving the student teachers the possibility to imitate teaching methods which is more than "seen-in-use", more than teaching which can be experienced through apprenticeship of observation (Lortie 175). They need to get into the ideas and knowledge behind what they imitates. Tharp and Gallimore (1988) state that the teacher must know about the task and the topic before she can scaffold the pupils in their work. As the mentor is in a role between the pupils and the student teachers, he also has to know about what the student teachers bring to the situations (Campbell & Kane 1996). It implicates that not all good teachers are good teacher educators. Edwards and Collison (1996) find that students rarely see themselves as learners in classrooms full of pupils. They are eager to be seen and act as competent

⁸ Discussed in the AERA paper

practitioners. I think my study shows the importance of regarding the learning aspect as an important one.

References

- Ball, D. (1988). American prospective teachers' images of mathematics teaching and learning and of students as learners of mathematics. Upublisert stensil, Michigan State University.
- Ball, D. (1991). research on teaching mathematics: Making subject matter knowledge part of the equation. I J. Brophy (ed.), *Advances in Research on Teaching*, vol.2. Greenwich:JAI Press, s.1-41.
- Calderhead, J. & Robson, M. (1991). Images of teaching: Student teachers early conceptions of classroom practice. *Teaching and Teacher Education*, 7 (1), s. 1-8.
- Campbell, A. & Kane, I. (1996). Mentoring and Primary School Culture. I McIntyre, D. & Hagger, H. (Ed.) *Mentors in Schools. Developing the Profession of Teaching*. London: David Fulton Publishers.
- Collison, J. & Edwards, A. (1996) *Mentoring and Developing Practice in Primary Schools. Supporting student teachers learning in schools*. Buckingham: Open university press
- Dewey, J (1904/1965). The relation between theory and practice in teacher education. In M. Borrowman (ed.) *Teacher education in America: A documentary history* (p.140-171). New York: Teachers college press.
- Doyle, W. (1977). Learning the classroom environment: an ecological analysis, *Journal of Teacher Education*, 28(6), s. 51-55.
- Edwards, A. (1998). Mentoring Student Teachers in Primary Schools: assisting student teachers to become learners. I *European Journal of Teacher Education*, Vol. 21, No.1. s. 47-62.
- L97, Læreplanverket for den 10-årige grunnskolen.(1996) Det kongelige kirke-, utdannings-, og forskningsdepartement. Utgitt av nasjonalt læremiddelsenter.
- Nilssen, V., Wangsmo-Cappelen, V. & Gudmundsdottir, S. (1996). «Dæm tenkt på ein heilt anna måte einn ka æ gjor». *En kasusstudie av en lærerstudents matematikkundervisning i 2. klasse*. Trondheim: Tapir
- Feiman-Nemser, S. (1983). Learning to teach. I L.S. Shulman & G. Sykes (red), *Handbook of teaching and Policy*. New York: Longman, s. 150-170.
- Feiman-Nemser, S. & Beasley, K. (1997). Mentoring as assisted performance: A case of co-planning. I Richardson, V. (Ed.) *Constructivist Teacher Education: Building New Understandings* London: The Falmer Press
- Grossman, P. (1989). Learning to teach without teacher education. *Teachers College Record*, 91 (2), s. 191-208.
- Grossman, P. & Richert, A. (1988). Unacknowledged knowledge growth: a re-examination of the effects of the teacher education. *Teaching and Teacher Education*, 4 (1), s. 53-62.
- Lortie, D. (1975). *Schoolteacher. A Sociological Study*. Chicago: The University of Chicago Press.
- Maynard, T. (1996). Mentoring Subject Knowledge in the Primary School. I I McIntyre, D. & Hagger, H. (Ed.) *Mentors in Schools. Developing the Profession of Teaching*. London: David Fulton Publishers.
- Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57 (1), s.1-22.
- Skagen, K. (2000). Norsk veiledningstradisjon i lærerutdanning – analyse og kritikk. I Skagen, K. (ed.). *Kunnskap og handling i pedagogisk veiledning*. Bergen: Fagbokforlaget.
- Tharp, R.G. & Gallimore, R. (1988). *Rousing Minds to Life. Teaching, Learning and Schooling in Social Context*. Cambridge: Cambridge University Press.

- Vygotsky, L.S. (1978). *Mind in Society: The Development of Higher Psychological processes*. Cambridge, Mass.: Harvard University Press
- Wertsch, J.V. (1984). The Zone of proximal Development: Some Conceptual Issues. I Rogoff, B. &
- Wertsch, J.V. (Red.): *Children's Learning in the "Zone of Proximal development"*. Jossey - Bass Inc., Publishers. San Francisco. s. 7-17
- Wertsch, J.V. & Stone, C.A. (1985). The concept of internalization in Vygotsky's account of the genesis of higher mental functions. In J.V. Wertsch (Ed.), *Culture, communication, and cognition: Vygotskian perspectives* (p.162-179). Cambridge University Press.
- Wood, D., Bruner, J. S. & Ross, G. (1976). The role of tutoring in problemsolving. I *Journal of Child Psychology and Psychiatry*. Vol.17, 1976, p. 89-100.