#### Working Group 12

# DEVELOPING STRATEGIES AND MATERIALS IMPACT ON TEACHER EDUCATION

### Marie Hofmannová, Jarmila Novotná

### Charles University in Prague, Faculty of Education, Czech Republic

The paper concerns research of pre-service teacher training. The text deals with attempts to raise the trainees' awareness of the polarity between the transmission and interpretive models of teaching. It is based on the teaching of mathematical content through English to Czech learners (CLIL). Therefore the framework of reference is the didactics of mathematics coupled with methodology of teaching English as a foreign language. In order to adopt and develop good, up-to-date practices, the trainees need to be guided towards more flexibility. This is demonstrated on materials adaptation and use.

#### **INTRODUCTION**

In the last decades, we can notice dynamic development of teaching mathematics at primary and secondary schools. Improvement can be facilitated by changing the content of school mathematics and also through the work of teachers. Their approaches can develop only through personal teaching experiences (Hejný, Novotná, Stehlíková, 2004). Related to this concept of active engagement, is the concept of learning as the construction of personal meaning. In this view, the teacher trainee does not learn solely by acquiring new information or knowledge about teaching, but also through thinking about new ideas, discussing them in the light of the past experience, and reappraising old assumptions in the light of new information.

Traditional concept of education perceived learning as the process of accumulating bits of information and isolated skills. The teacher's task was to transfer knowledge to the students (*transmission model*). The dominating type of interaction during the teaching process was between the teacher and the whole class. Cultivation of the learners' mental representation of world is possible only by deepening their active interest in the subject. The situation where mathematics is taught only as a set of precepts and instructions which have to be learnt leads to ever deeper formalism in the teaching of mathematics, resulting in a lack of understanding of the conceptual structure of the subject and inability to use mathematics meaningfully when solving real problems (Novotná, 1999).

The contemporary view of education requires the students to actively construct meaning. The students are expected to make use of their prior understanding and thoughts. The teacher's task is to generate change in the students' cognitive structure (*interpretive model*). Recent development in general methodology is marked by the shift of emphasis from the teacher to the learner. Preferred behaviour is cooperation.

For this paper, the framework of reference is not only the didactics of mathematics. The authors' main area of research is teacher training for Content and Language Integrated Learning (CLIL), where mathematics taught through English is just one example out of many. This new educational trend is not related to one specific methodology (Pavesi et al., 2001). CLIL is looking for ways how to integrate didactics of content subjects and methodology of foreign language teaching. It requires active methods, cooperative classroom management and emphasis on all types of communication. So far, teacher training courses for CLIL are available in just a few European countries. Generally speaking, their curricula are more open, more flexible compared to those of classical teacher training courses. The authors of the article believe that such conditions provide a favourable starting point for a research experiment.

Educational research includes evaluation of teaching and learning approaches and materials (Duit, 2007). In spite of the fact that the present study comes out of specific conditions in a Czech teacher training course for CLIL, the findings are more general.

# THEORETICAL BACKGROUND

In teacher training, the view of mathematics which the trainees have built up during their school career, survives long after they leave school. Teacher training should therefore reflect the contrasting educational concepts and guide the trainees in such a way that they become consciously aware of the polarity in order to associate themselves with the new trends. (Novotná, 1999)

While looking for effective ways of bringing future teachers from theory to practice, the authors are interested in the components that facilitate this task. Doff (1991) states that the aim of teacher training courses is to develop a concept of *good practices* by making the trainees aware of the factors that affect learning and teaching.

Speaking about good classroom practices, we may be thinking of quite different things. We might judge how well the teacher knows the subject, how well s/he teaches the lesson, i.e. makes use of appropriate teaching strategies, or consider how well s/he manages the class – whether s/he involves all the students. This is the area described in teacher training as class management and classroom interaction. For successful teaching, one of the most important things seems to be the balance between teacher and student control. The teacher should not try to control and dominate every aspect of the classroom and the lesson. The purpose of the lesson is to allow learners to learn rather than to demonstrate the teacher's superior knowledge. This means that the teacher must allow the learners to control solving procedures, investigative activities, to ask questions, request further explanation etc.

The teacher's roles are yet another important means of shift of focus from traditional to modern classroom practices. Rogers (1996) places approaches to teaching on the continuum between autocratic and democratic, Wajnryb (1992) holds that the actual sequence, in which the various roles are adopted depend on the lesson plan, its

objectives and processes. Prodromou (1991) gives examples of good classroom activities associated to the following roles: manager, model, monitor, counsellor, informant, facilitator, social worker, and friend.

The role of the teacher is crucial in establishing the appropriate conditions for learner participation. Simon (1995) and Cobb et al. (1997) have shown that collective posing and solving of mathematical tasks, and teachers' facilitation of learners' reflections through reflective discourse lead to greater collective knowledge and development of mathematical thinking. Knowledge and understanding is socially constructed as a result of teacher – student and student – student interaction. Learning mathematics as a discursive activity in collaborative small groups is described e.g. by Forman (1996) or Edwards and Keith (1999). Based on interviews, Edwards and Keith showed the benefit of working together as a group, using different skills, listening to each other and respecting the others in the group. This helped to build confidence and motivation. The results indicated that "students across the attainment range come to appreciate the effectiveness and efficiency" (p. 2-281).

Research on teaching and learning includes empirical studies on various features of the particular learning setting. Research on trainees' perspectives including their preinstructional conceptions covers the use and adaptation of textbook and instructional materials. When working with textbooks, learning relies on making connections between ideas from the text and prior knowledge and experiences. As regards the innovative use of teaching materials, Candela (1997) found that students' questions and interventions resulted in the transformation of exercises or demonstrations into problem solving and had impact on the knowledge and meaning constructed from experimental activities.

Combining mathematical content with a foreign language brings a number of new learning opportunities. As regards language development, CLIL offers more exposure, thus creating an improvement in the foreign language competence. Second language acquisition (SLA) is made possible by focusing the learners' attention on the content matter. When mathematics is the subject being taught, learners can rely on a symbolic language as well, which helps them to gain more confidence; having a universal symbolic language provides a natural bridge between the language of instruction and the mother tongue. Moreover, CLIL has positive impact on conceptualization. Being able to think about mathematics in a language different from the mother tongue can enrich the learners' understanding of concepts, and help broaden their conceptual mapping resources. This allows better association of different concepts and helps the learners go towards a more sophisticated level of learning in general. (Marsh, Langé, 1999) The tools CLIL approach applies (brainstorming, problem-solving, induction, rule seeking, guided discovery, etc.) maximise the opportunities for the learners to become good, independent and successful. Furthermore, CLIL enhances study skills such as note taking, summarising and extracting key information from texts. Taking information from different sources and

in different languages, re-evaluating and restructuring information can help learners develop thinking skills that can be transferred to other domains.

# OUR RESEARCH

The present paper reflects the transition from theory to practice. At Charles University, Faculty of Education, pre-service teacher trainees are not in regular contact with schools. Most of the courses are theory-based which makes their first teaching placements very difficult. Therefore, participants in the CLIL teacher training course are provided with more space for teaching experiments. They are guided from short peer teaching episodes to full length CLIL classes taught in the school setting. Our research therefore includes interdisciplinary implications for the secondary school classroom. Balancing foreign language and mathematical content components is one of the main scaffolding strategies for the course.

Various empirical methods were employed to investigate the optimum educational environment. Our aim was to investigate reflective approach towards teacher training. The sequence of training units was based on materials adaptation and their use in a secondary school classroom. The adapted materials were to achieve equilibrium between mathematics and English. The final stage constituted the feedback session with all the trainees in the CLIL course. The aim was to investigate in what ways the newly adapted materials facilitate changes of teaching strategies, and class management towards more varied classroom interaction.

We were working with two target groups: There were 10 teacher trainees (Group A) and 14 lower secondary school pupils (Group B). Group A were participants of the pre-service optional teacher training course in CLIL, Faculty of Education, Charles University in Prague), Group B came from an affiliated school in Prague.

During the experiment, we made use of the following methods: video recordings of sessions with both Group A and Group B, pre- and post-lesson interviews with group A, analysis of additional data – written comments (reflection on the experiment) collected from Group A.

# **DESCRIPTION OF THE EXPERIMENT**

Since 1999 student teachers can enrol in an optional two-semester CLIL teacher training course integrating mathematics and English. The course combines educational theory and teaching practice, bringing students gradually from lesson observation, mastering subject specific vocabulary and specific knowledge and skills to microteaching of peers based on a variety of materials (e.g. textbooks, student-made worksheets) and concluded with a teaching module. Mathematical content covers mathematics for lower and upper secondary levels (Novotná, Hadj-Moussová, Hofmannová, 2001), the level of English ranges between C1 and C2 of the European Language Framework.

Teacher trainees (CLIL course participants) were asked to choose a mathematical topic to be developed at the lower secondary level. At first, they worked with traditional materials, later they decided adapt one of them and develop it into a lesson plan. The lesson was first simulated in the teacher training course in the form of peer teaching, and later taught in a real classroom.

Original materials come from Mathematical Rally Transalpine 2004. Here is an example of a problem<sup>1</sup>:



Mathematical topics were solving word problems, patterns combining arithmetic, algebra, geometry, combinatorics, etc. The training aimed at material development to enhance learners' motivation.

The first task in the CLIL course was to let the trainees solve the problem as if they were secondary school learners. They came up with a variety of solving procedures. They compared them and discussed the necessary knowledge and skills for each solution (from the learners' perspective).

The second task was to prepare a mock lesson plan for team/peer teaching. After trying and testing during the following seminar, the trainees suggested changes for the plan to be executed in real class conditions.

*The first phase* of the activity took place as team teaching in the training course with the participation of ten teacher trainees, 22-25 years of age. It took place in 45-minute training session during four successive weeks. The programme covered:

- a priori analysis of the text of the presented problem (discussion from the perspective of possible mathematical solutions and language of the assignment)

<sup>&</sup>lt;sup>1</sup> For more details, see (Favilli, 2006).

- preparation of the lesson in the following steps:

The trainers and trainees discussed how to best prepare the microteaching of peers. They assigned roles and prepared the first draft of lesson plan.

Peer-team teaching: One stage of the proposed lesson was taught by two student teachers, the remaining trainees played the roles of pupils. One trainer took notes on the blackboard for further feedback.

Reflecting and analyzing the training lesson: Trainees presented critical remarks both to the wording of the problem and the execution of the lesson plan. The necessity to change the assignment in order to fit real life was emphasized. The trainees volunteered to prepare a new teaching material that would better correspond with the learners' age and interests. For the result see extracts from "Fashion World Magazine" in the Attachment.

*The second phase* of the activity took place in the classroom in a secondary school in Prague. It lasted 45 minutes. The lesson was to be devoted to a foreign language, i.e. why trainees worked with half of the original group. Fourteen pupils, 15-16 years of age, participated in the lesson. The programme covered an ice-breaking activity "Name scrabble", revision of mathematical vocabulary (the lesson was conducted in English), solving the original version of the problem either individually or in pairs, pupils solving the "Fashion World Magazine" (the whole class, group and individual work was organized), and checking the results with the whole class.

*The third phase* - a posteriori analysis of the lesson - took place again in the training course. We believe that by means of classroom observations and subsequent analyses, the trainees are to be encouraged to look for important characteristics of good teaching strategies. The discussion was based on observations and the video recording of the whole lesson. The items discussed were: lesson analysis, comments, critical remarks, and suggestions for alternatives. Attention was paid to the following observation categories: teacher, learners, and materials.

During the process of material adaptation, the trainees modified both the context and assignment of the original problem. The new version differs from the original one for fantasy and originality: the idea of a contest based on a mathematical quiz to get great discounts or a free T-shirt makes the problem concrete, closer to real life. The innovative aspects of the material are dual-focused. They do not concern only mathematics. The "Fashion World Magazine" contains diverse language input.

# **CONCLUDING REMARKS**

It can be concluded that CLIL methodology stresses the interrelatedness of language, content and cognition of the learner, covering also the cultural dimension of learning. It is learner-centred and assumes a shift in a role of the teacher. Innovative CLIL teaching strategies applied were found motivating and useful by all the participating student teachers. This experiment was accepted as a pilot activity in LOSST-IN-

MATH Socrates Comenius 2.1 project. "In spite of differences in European mathematics teacher training systems the project aims at contributing to greater sharing of good practices in this field. In order to fulfil this task, changes in the curricula for lower secondary school mathematics teacher training are proposed as a result of the piloting of a number of educational modules." (Favilli, 2006).

Originally the text "Bizzare coulouring" was proposed in Italy as a means of presenting the Theory of didactical situations (Brousseau, 1997). The material was co-piloted in two countries. In the Slovak Republic, the same original text was used as an example of the development of learners' cognitive processes in mathematics.

To conlude, let us quote Favilli (2006): "The aim is to influence in a positive way not only teacher training, but also the school reality, through the development of mathematical education projects which intend to be more learner-friendly and attractive to pupils." (Introduction)

# REFERENCES

- Brousseau, G.: 1997, *Theory of Didactical Situations in Mathematics*. [Edited and translated by Balacheff, M. Cooper, R. Sutherland and V. Warfield]. Kluwer Academic Publishers, Dordrecht/ Boston/London.
- Candela, A.: 1997, 'Demonstrations and problem-solving exercises in school science: Their transformation within the Mexican elementary school classroom', *Science Education*, 81, 5, pp. 497-513.
- Cobb, P., Boufi, A., McClain, K. and Whitemack, J.: 1997, 'Reflective Discourse and Collective Reflection', *Journal for Research in Mathematics Education* 28, 3, pp. 258-277.
- Doff, A.: 1991, Teach English. A training course for teachers. Trainer's handbook, C.U.P.
- Duit, R.: 2007, 'Science Education Research Internationally: Conceptions, Research Methods, Domains of Research', *Eurasia Journal of Mathematics, Science & Technology Education*, 3, 1, pp. 3-15.
- Edwards, J.-A. and Keith, J.: 1999, 'Students' views of learning mathematics in collaborative small groups', in O. Zaslavsky (ed.), *Proceedings of the 23th PME*, Haifa, Vol. 2, pp. 281-288.
- Favilli, F. (ed.): 2006, LOSSTT-IN-MATH Lower Secondary School Teacher Training in Mathematics. Towards a European teacher training curriculum. PLUS, Pisa.
- Forman, E.: 1996, 'Learning mathematics as participation in classroom practice: Implications of sociocultural theory for educational reform', in L. Steffe, P. Nesher, P. Cobb, G. Goldin and B. Greer (eds.), *Theories of mathematical learning.*, Lawrence Erlbaum Associates, Inc., Mahwah, NJ, pp. 115-130.

- Hejný, M., Novotná, J. and Stehlíková, N.: 2004, 25 kapitol z didaktiky matematiky [25 Chapters from Didactics of Mathematics] (2 volumes.), UK-PedF, Praha. (In Czech.)
- Novotná, J.: 1999, 'Učitel v roli žáka součást profesní přípravy učitele', *Pedagogická orientace* 1999, No. 3, pp. 28-32. English translation: 'Teacher in the role of a student a component of teacher training', http://www.pedf.cuni.cz/svi/vydavatelstvi/ucitel/konfaj.htm.
- Novotná, J., Hadj-Moussová, Z. and Hofmannová, M.: 2001, ,Teacher training for CLIL Competences of a CLIL teacher', in J. Novotná and M. Hejný (eds.) *Proceedings SEMT 01*, UK-PedF, Praha, pp. 122-126.
- Pavesi, M., Bertocchi, D., Hofmannová, M. and Kazianka, M.: 2001, *Insegnare in una lingua straniera*. Gen. ed. Langé, G. Milan: M.I.U.R for TIE-CLIL.
- Prodromou, L.: 1991, 'The Good English Teacher', in: *English Teaching Forum*, April 1991.
- Rogers, A.: 1996, Teaching Adults, Open University Press.
- Simon, M. A.: 1995, 'Reconstructing Mathematics Pedagogy from a Constructivist Perspective', *Journal for Research in Mathematics Education* 25, 1, pp. 50-85.

Wajnryb, R.: 1992, Classroom Observation Tasks, Cambridge University Press.

Acknowledgment: The training activity was supported by the Socrates Comenius 2.1 project LOSSTT-IN-MATH – LOwer Secondary School Teacher Training IN MATHematics. Project reference: 112318-CP-1-2003-1-IT-COMENIUS-C21.

#### ATTACHMENT



Using the newly adapted text means working in more detail with components of the language system, e.g. grammar issues (e.g. examples of interference), lexical issues (specialized terminology, e.g. "Explain what an equation is.")

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#### **Question No.1**

Is this a pattern from our set?



#### **Question No.2**

If our catalogue contained all the other patterns, what would the pattern no.16 be like? (Blacken the appropriate squares!)

80	81	82	83	84
			<u> </u>	

#### **Question No.3**

What is the number of this pattern? (If there are more possibilities, write ALL of them!)

?	?	?	?	

#### **Question No. 4**

Choose a pattern from the set and write the appropriate number.

Using the newly adapted text offers the opportunity to look at the mathematical situation from different perspectives and change algorithms to problem solving towards a more creative approach.