

PROSPECTIVE TEACHERS' VIEWS OF MATHEMATICS TEACHING

Ildar S. Safuanov, Pedagogical Institute of Naberezhnye Chelny, Russia
E-mail: safuanov@yahoo.com

Introduction: theoretical and practical background

Theoretical background of this empirical research is constituted by theories of developing and genetic teaching, ascending to ideas of German educator Diesterweg, and also using theoretical ideas of Vygotsky, Bruner, Freudenthal, Lerner, Davydov, Wittmann.

In modern times, it is widely admitted that strict logical and deductive way is not always appropriate in teaching mathematics. The genetic way of teaching and learning, consisting in presenting subject matter as developing out of the principles that have determined its modern form, takes increasing role in mathematical education. Affective and emotional sides are also important in mathematics learning and teaching. However, these changes in mathematical classroom life have not yet found appropriate response in mathematics teacher training. In order to find out the problems in changing mathematics teacher preparation for modern requirements, in 1995 and 1998 we carried out the inquiry of pre-service (two groups of future secondary mathematics teachers and a group of future primary teachers, each group consisting of 30 students of Pedagogical Institute of Naberezhnye Chelny) and in-service mathematics teachers (also consisting of 30 participants from various schools of Naberezhnye Chelny).

Questionnaire

We used a questionnaire containing 29 questions.

In this questionnaire we offered the participants to rate their agreement with some didactical and methodical recommendations using a 5-step scale: 5 – corresponds to complete agreement, 4 – to agreement, 3 – neutral, 2 – disagreement and 1 – complete disagreement:

- 1) In a classroom, students should more write and speak rather than read and listen.
- 2) One should remember a proverb: "Slower go, farther will you be!" And with constant and not weakening persistence to stop on bases and all those sections of study that substantiate all further material.
- 3) One should co-ordinate new representations with old, already familiar and usual; renew from time to time old representations.
- 4) Teaching is not the purpose but means: principal is not just acquisition of knowledge as itself but the development.
- 5) One should delay mainly on study of basics.
- 6) When substantiating derivative it is necessary to often return to initial basic concepts and deduce derivative statements from them.
- 7) One should distribute a subject matter into small completed parts, with stoppings for reviewing and repetition.
- 8) One should distribute a subject matter into small steps so that at each step the student would be able to guess or foresee elements that will follow.
- 9) One should indicate at each step some elements of the consequent material and consider them in order to raise inquisitiveness of the student, not satisfying it, however, fully.
- 10) One should distribute and arrange a subject matter so that (whenever possible) studying new theme at the following step, students would repeat things previously learned.

- 11) One should pass from a subject to its sign rather the reverse (it is not necessary to begin from models, and the acquaintance with them should be a finishing moment).
- 12) Not an amount of knowledge, but the development of intellectual forces is more important.
- 13) One should teach a subject genetically, i.e. in the correspondence with ways and paths, along which science itself developed (subject represents a method). However, it is necessary to avoid all deviations and fallacies.
- 14) More important than to study all material included in the curriculum is to study less but in more detail and deepness.
- 15) The content of study should correspond to the level of modern science. The student, according to methodical recommendations and own forces, should be raised to the height of modern science.
- 16) One should make study interesting by means of variety.
- 17) It is possible to make study interesting with the help of liveliness (richness of spiritual life) of the teacher.
- 18) One should force the student to state a subject correctly orally (in her/his own words, in a coherent and sequential order).
- 19) One should induce the students sometimes to guess a result (answer of a task).
- 20) One should surprise the students by unexpected means, examples, and applications.
- 21) At mathematical lectures and in textbooks there should be a place to humour.
- 22) In a classroom there should be a strict discipline.
- 23) The instructor may offer on tests and examinations tasks not solved before in a classroom.
- 24) One should teach the students to perfectly solve standard tasks; if necessary the instructor must show exactly how to solve such tasks.
- 25) In teaching mathematics for future teachers, only strict reasonings are admissible.
- 26) One should conduct teaching at such level of accessibility that all students would be able to understand a subject matter.
- 27) One should teach on a high level of complexity, but take examinations rather liberally.
- 28) One should dictate statements, proofs and definitions so that students would have good lecture notes.
- 29) One should structure lectures; divide subject matter into chapters and sections so that lecture notes could serve as a good textbook.

Results

The students of both faculties (though there are some essential distinctions in the responses between two groups of mathematical faculty, see below) and teachers expressed greatest agreement in such items as 29 (one should structure lectures, divide subject matter into chapters and sections so that lecture notes could serve as a good text-book), 26 (one should conduct teaching at such level of accessibility that all students would be able to understand a subject matter), 28 (one should articulate statements, proofs and definitions so that students would have good lecture notes) and 16 (one should make study interesting by means of variety). Rather high agreement was reached also in item 24 (one should teach the students to perfectly solve standard tasks; if necessary the instructor must show exactly how to solve such tasks). In our view, such responses (to tell the truth, responses to item 16 require a separate interpretation) tell that among students and teachers the conviction in effectiveness of explanatory-illustrative and reproductive methods of teaching predominates. With the help of heuristic methods and cluster analysis, 5 "clusters" of questions reflecting some types of teaching were chosen: teaching on a high level of difficulty (13, 15, 23, 27); teaching for development (1, 4, 11, 12, 18); concentric teaching (2, 3, 5, 6, 7, 8, 9, 10, 14, 19); dogmatic

teaching (22, 24, 25, 26, 28); interesting, lively teaching (16, 17, 20, 21, 29). The average numbers for control (taught from 1995 to 1998 to mathematical disciplines by the traditional method) and experimental (taught from 1995 to 1998 to mathematical disciplines by the genetic method) groups were calculated on these clusters (note, that the lower numbers correspond to the greater agreement):

1995

Clusters	Average score for the control group	Average score for the experimental group	Statistical significance of distinctions (using Mann – Whitney U-test)
1) Teaching on a high level of difficulty	2,39	2,58	0,2992
2) Teaching for development	2,67	2,61	0,5475
3) Concentric teaching	1,92	1,87	0,4728
4) Dogmatic teaching	2,12	2,22	0,6207
5) Interesting teaching	1,56	1,76	0,1595

1998:

Clusters	Average score for the control group	Average score for the experimental group	Statistical significance of distinctions (using Mann – Whitney U-test)
1) Teaching on a high level of difficulty	2,24	1,78	0,0052
2) Teaching for development	2,66	2,28	0,0065
3) Concentric teaching	1,94	1,84	0,4878
4) Dogmatic teaching	2,02	2,33	0,0074
5) Interesting teaching	1,64	1,74	0,5836

The level of significance p is indicated in the last column. We see that in 1995 distinction in none of clusters were statistically significant. In 1998 in first, second and fourth clusters of distinctions were statistically significant on a significance level 0,01. In third and fifth clusters distinction were not statistically significant. Thus, the students from experimental group gave much greater preference than students of control group to the teaching on a high level of difficulty and teaching for development, and essentially smaller preference than students of control group to the dogmatic type of teaching.

Conclusions and discussion

The results of the questionnaire indicate that among students and teachers the conviction in effectiveness of explanatory-illustrative and reproductive methods of teaching still predominates. I. Lerner (See Skatkin, 1982, p. 197) wrote concerning these methods: "Both methods enrich pupils' knowledge and skills, form basic mental operation (analysis, synthesis, abstraction etc.) in their minds, but do not guarantee the development of creative abilities of pupils, do not allow systematically and purposefully form those abilities". And as the pedagogical activity in its nature carries a creative character, it is important, that the future teachers would change their beliefs, gain a wider view of the nature of the purposes and methods of mathematics teaching. And for this purpose, alongside with the appropriate construction of the curricula of didactical courses (e.g. by inclusion in them of all modern progressive theories and methods of teaching), it is necessary to train students of mathematical faculties of pedagogical institutes so that they would effectively acquire not only knowledge and ways of activity (i.e. ways of thinking and acquisition of new knowledge) in the field of mathematics, but also modern views of mathematical education.

Extremely important for this purpose is to try to apply new theories of mathematics teaching in standard mathematical courses at universities and pedagogical institutes. Note that many researchers argue that the methods of teaching mathematical disciplines in pedagogical universities should serve for the students - future teachers as a source of didactical ideas, helping them to acquire modern didactical beliefs and skills, and in some sense as a sample for building their future professional activity. This idea ascends to Diesterweg (1956): "The instructor of prospective teachers should not use any methods of teaching except those that can be applied in their (prospective teachers') future work at school".

Very promising seems the idea of intertwining didactical component with mathematical courses. This idea was suggested by several authors: E.C.Wittmann (1992), H.C.Reichal (1992) and earlier by G.Polya (1965). These authors indicate that such integration of didactical elements into courses in higher mathematics should be implicit rather than explicit.

Speaking about higher mathematics teaching, one should not forget that here mere correct, complete and organised presenting of the subject does not suffice. The importance of the style of conducting lectures and seminars for teaching at undergraduate level has been well understood and underlined by successful mathematics educators (see Safuanov (1995) and references there).

Our experience of teaching mathematics by genetic method (taking also into account affective and emotional aspects of teaching) has shown that pre-service teachers' views of mathematics teaching seriously changed and became more progressive and appropriate for modern teaching.

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