Current Reform of the School Leaving Examination in the Czech Republic

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Abstract: In view with the main theme of CIEAEM, the paper addresses one challenge for mathematics education brought about by the changes in the Czech society during the last 15 years, that is the reform of the School Leaving Examinations. Its roots are described as well as its main stages. General ideas are illustrated by several model problems which show the level of difficulty of the examinations. The influence of both professionals and public on the examinations are discussed.

1. School Leaving Examinations in CZ – Reform

After November 1989, the political situation in the former Czechoslovakia changed which affected the educational system, too. This manifested itself, among others, in the establishment of private secondary schools which often had a liberal approach to the school leaving examinations (or SLE). Their difficulty varied from one school to another, there was no state control and many students did not meet the requirements of universities. The situation was exacerbated by the decentralisation of the management of the educational system in that districts were given the control of schools. Moreover, in the new democratic society, general public started to take notice of education more than ever before and wanted to influence it.

In view with the development in other countries, the influences of mathematics on students' personal development have been stressed at the expense of mastering procedures of calculation, skills and formulas at all levels of schooling[1]. Document [1] gives 5 target competencies (Mastering mathematical concepts and skills, Mathematical modelling, Problem posing and problem solving, Communication, Using aids), however, it also stresses that "the target competencies are not the only ones which the teaching of mathematics should aim at. The affective goals ... are very important, too. They concern the development of interests, attitudes and values of students." Moreover, apart from professional knowledge and skills "the teaching of mathematics influences the student's personality, too: it develops his/her abstract thinking, teaches him/her logical reasoning and precise language" [1].

Educationalists and the state felt that it was the task of the state to control the quality of education. Thus, the preparation of a new conception of SLE started. "An attempt to conciliate the two approaches, that is to give regions and school some freedom when determining ways of the completion of secondary education and at the same time to reach an adequately united level of education after the secondary school, led to a certain split of the organisation of school leaving examination into its common and school part" (Sykora, Zhouf, 2002).[2]

A common part of SLE should be a written test prepared by the state. Its evaluation would also be controlled by the state. *A school part of SLE* would remain the responsibility of schools and should observe their specific aspects. The Ministry of Education published a *Catalogue of requirements for the common part of SLE* [1] describing the new conception in detail (target competencies, topics, specific goals, model problems). The common part of SLE was to be prepared on two levels, *basic* and *higher*, whose choice would depend on the student. While the basic level was to ensure the level of a general secondary education, the higher was to make entering the university easier and in the future, replace the entrance examinations.

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[1] At least in theory; it is well documented that practical changes are slow to appear as the world of schools has a strong resistance, e.g. Cooney (2001).

[2] It should be stressed that unlike in some other countries such as USA and UK (see e.g. Van den Heuvel-Panhuizen, Becker, 2003) in which students have to sit for many standardised tests during their schooling, in CZ there is no such nation-wide testing.

2. Past of the Reform

Before the reform, the SLE consisted solely of open problems. Smaller mistakes in the solution were tolerated if the solving strategy was correct. (The tests were corrected by mathematics teachers of the school.) Due to the influence of school systems of some countries (mainly western), multiple-choice problems entered the scene and especially at the beginning, were very popular among people preparing SLE in other subjects. The opinion of the mathematical community was (and still is) reserved. It is felt that multiple-choice problems cannot diagnose whether the problem was solved with understanding or whether a chance played a role. Moreover, the form of multiple-choice problems is unfamiliar to Czech students and teachers. We share an opinion of Van den Heuvel-Panhuizen and Becker (2003) that multiple-choice questions "are limited in both their mathematics and the opportunities they provide to classroom teachers to access students' understanding".

Finally, it was decided that the common part of SLE would include *closed problems*, that is "problems in which several options are offered to the solver and he/she has to choose one. The assignment usually consists of a relatively easy monothematic problem whose solution requires 3–5 minutes" (Zhouf, Sykora, 2002b). On the other hand, there would also be *open problems* where a description of the solving strategy should be written, too. "These are usually complex, more time-consuming problems, integrating knowledge and skills from different parts of mathematics" (Zhouf, Sykora, 2002b). Similarly to multiple-choice problems, open problems usually have one correct answer, however, there might exist several different solving strategies to solve them and "the assessment approach is interested in both the procedure *and* the answer" (Van den Heuvel-Panhuizen, Becker, 2003).

The above considerations will be illustrated by problems from a book of model problems (Zhouf et al., 2002). The book includes problems of both types (multiple-choice and open) for both levels (higher and basic). The problems were prepared by a team of professionals and reflected opinions of most mathematics teachers of the level of difficulty of SLE. As will be seen later, these were not shared by students and general public.

a) Multiple-choice problem, higher level

In the formula $p_1V_1^{\kappa} = p_2V_2^{\kappa}$, V_1 and V_2 are volumes of gas, p_1 and p_2 corresponding pressures of the gas and κ a characteristic constant of the gas. If we express κ from the formula, we will get

A. $\kappa = \ln\frac{p_2}{p_1} - \ln\frac{V_1}{V_2}$ B. $\kappa = \frac{p_2}{p_1} - \ln\frac{V_2}{V_1}$ C. $\kappa = \frac{\ln(p_2V_2)}{\ln(p_1V_1)}$

D. $\kappa = \frac{\ln\frac{p_2}{p_1}}{\ln\frac{V_1}{V_2}}$ E. $\kappa = \ln\frac{p_2}{p_1}\cdot\ln\frac{V_2}{V_1}$

b) Open problem, higher level

Given points $A[-1,0]$, $B[1,0]$ and $C[0,p]$, $p>0$. Let *M* be a set of all points $X[x,y]$ for which $|AX|^2 + |BX|^2 = |CX|^2$.

i) Find *M* for $p=1$. ii) Prove that if $p>1$, *M* is a circle. Find its centre and radius.

iii) Prove that if $0<p<1$, *M* is empty.

c) Multiple-choice problem, basic level

Straight line *p* comes through point $P[5,2]$ and its equation is $x + y = m$. Number *m* is an element of the interval

A. $(-\infty,1)$ B. $\langle 1,3)$ C. $\langle 3,7)$ D. $\langle 7,20)$ E. $\langle 20,\infty)$

d) Open problem, basic level

Charles got 5 marks from mathematics in the first quarter of the school year. Their average is 2.4. Charles knows that he will get another 4 marks in the second quarter. What does the average of marks from the second quarter have to be if he wants to reach at worst the average of 2?

3. Present of the Reform

The above problems were model problems of the common part of SLE and were to be first used in 2004. However, their publication provoked an immediate negative response from both professionals (such as the Union of Czech Mathematicians and Physicists that objected to the use of closed problems) and public that considered problems (especially from the higher level) too difficult. Thus, the common part of SLE started to be discussed in more detail. A rather surprising (and disappointing) result of the discussion was that there would only be one level of the common part of SLE whose level of difficulty is even lower than the basic level of SLE as suggested originally.[3] This change is reflected by the new title – *Test of Mathematical Literacy*. Moreover, mathematics is no longer a compulsory subject in SLE.

Problems in the new SLE were also influenced by the surveys TIMMS and PISA (OECD, 2000). Two problems will be used as an illustration.

A square garden has an area of 1 hectare. It should be fenced with wire netting which is attached to posts. The distance between two adjacent posts cannot be bigger than 3 m. What is the smallest number of posts necessary for the fence of the garden?

A. 134 B. 136 C. 138 D. 140

John is a great optimist. Before the school leaving examination, he boasts to Alice:
1. No question from mathematics can take me by surprise.
2. I will dazzle the examining board with my articulacy or wit.
3. I will be accepted at, at least, two universities.
Alice is a prudent girl and sums up her chances by opposite statements. Write down what the negation of all three statements is, that is what Alice says about herself.

The above type of SLE is being tested now. In 2004, a so-called "Draft SLE" was organised in secondary schools. The Test of Mathematical Literacy consisted of both 'real-life' problems whose solution only required primary mathematics and several traditional school problems. The average success at secondary grammar schools was 65%, at other types of schools 44%. The biggest surprise for teachers was that even though traditional problems were more difficult in terms of mathematics involved, students were more successful in solving them than in solving easier 'real-life' problems. This revealed one of the problems of the Czech mathematics education at school where high emphasis is still placed on drilling standard mathematical procedures. Only after the results of the international studies such as TIMMS and PISA became known, the situation started to be changed. This change will probably (and hopefully) be seen in the results of students later.

[3] In the school part, the difficulty can be bigger to allow for the study at university and the head teacher can order the test from the state agencies.

As the success rate for the 'Draft SLE' was not big enough and as it was not possible to draw any definite conclusions in terms of the complexity of SLE after one trial, another trial was organised in 2005. Its results have not been published yet. Similar trials will be carried out in 2006 and 2007.

4. Conclusion – Future

A new school law has been approved which determines that the new type of SLE will first be used in 2008. Schools and other institutions have been preparing for it, among others, by calling for model problems that they could use with students prior to SLE. Thus a well documented phenomenon of 'teaching for tests', that is the influence of tests on teaching, manifested itself (see e.g. Van den Heuvel-Panhuizen, Becker, 2003; Tirosh, Graeber, 2003).

On the other hand, some professionals and organisations such as the Union above still try to increase the level of SLE which they feel is very low. They question the value of such examinations that, in their opinion, only assess the basic levels of mathematical content knowledge (a similar claim was made by Van den Heuvel-Panhuizen and Becker, 2003, who emphasise that standardised tests "rarely include items which assess complex levels of students' understanding") despite the proclamations of the value of mathematics as a formative subject in official documents.

It may well be that the last word has not been said yet. However, we can observe an important trend in the present society (confirmed by the situation in the reform of primary and secondary school teaching): while public seems to be convinced that mathematics taught at school (and examined in SLE) is far too difficult and "ordinary people do not have any use of it", mathematicians, mathematics educators and teachers face a difficult task of convincing students, parents and politicians of the value of mathematics. In this respect, we are part of the European trends as enumerated in the main themes of CIEAEM.

5. References

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