SLOVENE FINAL EXTERNAL EXAMINATION – MATURA IN THE VIEW OF COMPUTER ALGEBRA SYSTEMS

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Abstract
In Slovenia students have to pass an external examination (called the Matura – "the maturity Exam") at the end of high school as a prerequisite for studying at University. At the moment the usage of graphic calculators is forbidden during the examination. In the view of emerging usage of CAS, we will take a look at one of the last exams. We classify the questions according to three schemes, which measure the usefulness and the impact of CAS on exam questions.

About Matura

In Slovenia we have various types of secondary education programmes. The Gymnasium (4 years duration) prepares students (15 years +) for higher education and ends with the Matura examination. Students must pass the Matura examination at the end of the final year as a prerequisite for studying at university. The Matura consists of five subjects, three of which are compulsory (the mother tongue, mathematics and a foreign language), the other two are chosen by the student. Questions are prepared externally and are the same for all grammar schools. Mathematics and foreign languages are offered at two levels of difficulty: standard and higher. The higher level has additional content and more depth. The candidates who take the subject at the higher level are awarded extra points in the overall grading for the Matura ([Budin, Gaberscek 1999]).

At the moment the usage of graphic calculators as well as those with symbolic algebra capabilities is forbidden during the examination.

Examination and CAS

Computer algebra systems (CAS) inevitably influence teaching and learning of mathematics. One of the most debated questions that arise from this fact is the influence on assessment. This question is especially important where examinations are public and external. Various approaches are present nowadays, ranging from the one present in Slovenia (CAS and graphical calculators are forbidden) to those requiring the possession of a graphical calculator. Some tests merely allow the use of such technological tools (they tend to produce graphic calculator neutral examinations), in the other ones students are expected to have a graphics calculator (graphic calculator active examinations), yet another type of examinations expects or allows the usage of CAS in one part and forbids the use of any tool in the other part of the exam. When deciding which approach to use, one possible and reasonably obvious stepping stone is to start with the existing exams and see what difference having access to a CAS might make.

In the paper we will take a look at the last standard level test exam, used as a preparation for the students passing the examination (Matura) at the end of the 1999/2000 school year. We will classify the questions according to two schemes proposed in [Kokol 2000] and using the categorisation scheme of [Jones 1995; Jones, McCrae 1996].

Of course, as with all descriptive schemes, these three schemes have several possible shortcomings as well. The precise meaning of, for example, detailed knowledge depends on the evaluator (an example of this fact is clearly described in [Jones, McCrae, 1996]). All three schemes are often much too rough and a detailed explanation of the classification of the particular question is necessary to clarify the situation.

The test

We will take a look at the exam, used as a preparation for the students passing examination at the end of the 1999/2000 school year. The test is aimed at the standard level. It has 12 questions. For each one we state:

- The exercise, as it appeared in the test;
- Its intention: we try to describe the purpose of the exercise. Our description, which is based on the proposed marking scheme, can vary from the exact intention of those who prepared the test;
- Solution with *DERIVE*;
- Categorization according to all three schemes;
- Value of the exercise with symbolic helper: according to the intention described as well as to the categorization we tried to value the exercise in its present form and
- Proposed change if symbolic computation is allowed. Some brief remarks how to (if necessary) change the exercise to stay as much as possible within "the spirit and intention" of the question. Each exercise is considered separately from the others and this is a serious drawback, as the test should be considered in its entirety.

Due to restrictions in length of the paper, just the first question is presented. The rest of exercises as well as description of the schemes can be found in [Lokar, Lokar, 2000].

Exercise: *Calculate the exact value of the expression* $\left(-\frac{2}{3}\right)^{-2} + 0.25^{-\frac{1}{2}}\left(2^{-3} - 1\right)$.

Intention: To calculate the expressions with rational exponents.

Solution with DERIVE: Entering the expression suffices. We must know how to use exponents (Z). Unfortunately we get the right result even if we forget the parentheses around (-1/2) in the exponent. So there is no need to even know the structure of the expression.

Categorization**:** *KOde* (should be *KObe* but due to the mistake of the person who prepared the question is not), *KUpr* (the deficiency of this scheme is that there is no category for questions which are trivialized with CAS usage), *JOtr*.

Value of the exercise with symbolic helper: Almost none.

Proposed change if symbolic computation is allowed: We should at very least use an expression where possible mistakes in the order of the operations should not lead to the right answer. The expression could be more complicated; also the root sign should sometimes be used. With symbolic computation the main task left is the priority of operations and the structure and the equivalence of expressions.

Conclusion

The main benefit of such an analysis is mainly in emphasizing the fact that we must consider what we really want to test with each exercise. For example if we want to test the knowledge of the procedure of solving a linear equation, we must state explicitly that all steps must be clearly written down.

References

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