

QUADRATIC FUNCTION - EXAM QUESTIONS WITH USE OF COMPUTER ALGEBRA SYSTEMS

A. CVETKOVIČ, D. IVANEC,
B. K. STARIN, T. ŠPEGEL - RAZBORNİK
Gimnazija Jožeta Plečnika, Ljubljana

Abstract

The quadratic function was chosen for our study in which we wanted to analyze some of the existing (traditional) exam questions according to the skills and abilities they test and according to the use of CAS. We prepared two separate test papers that would complete each other with the aim to test skills and abilities students should master within this topic. We wanted to check whether the operational goals could be achieved to a higher or to a lesser degree by using CAS. Finally we reconsidered the advantages and disadvantages of using CAS in exam questions,

1. TEACHING WITH CAS IS FUN ... BUT IS IT POSSIBLE TO USE IT FOR TESTS?

In traditional mathematical lessons a lot of time is dedicated to learning and executing the algorithms instead of learning underlying mathematical concepts. There is not much focus on the use of mathematics, which is aimed at solving problems. Students are bad in applying mathematical knowledge in other sciences like physics or chemistry because there is a lack of correlation between mathematical lessons and other. Many teachers feel frustrated to teach »recipes« instead of developing students' sense of logic and creativity. Students' approach towards learning mathematics could be simply described in two ways. The majority are quite keen on practicing algorithms without asking questions about the use of it. They feel safe because they know from their experience that strenuous work will be awarded with a medium or even with a good mark without a necessary understanding of mathematical concepts. Lesser number of students (often more intelligent but idle) want to know in what cases particular algorithm is used, which could be in certain cases a sign of protest about sometimes a sign of real interest. If a teacher refuses to give the answer these students

often use motivation to work. Teacher is faced with a sad paradox that talented and creative students might be unsuccessful in mathematics because they do not practice enough to master techniques, but on the other hand, those who are excellent in performing algorithms could not use them because they do not see the point. With the use of CAS the focus of a mathematical lesson(topic) could and should be shifted from performing mathematical operations to using them and above all to understanding of mathematical concepts. The change of teaching methods will inevitably effect the ways of testing mathematical skills and abilities and thus exam questions.

2. EXAM QUESTIONS

Dr. Kokol divides classical exam questions into various categories according to their usefulness in CAS environment (with respect to their significance of testing abilities and skills) such as :

- a) *CAS-insensitive questions*
- b) *CAS-devaluated questions*
- c) Questions changing with technology, where CAS is just the tool to do quickly and reliably the routine(technical) part but does not impoverish mathematical concept We call these *CAS - applicable questions*

We wanted to prepare two test papers that would in combination cover the skills, abilities and theory knowledge of our topic. The first paper has to be done without the use of calculator. These are CAS insensitive and CAS devaluated questions. All these questions test basic skills and techniques, knowledge of basic formulas, understanding of link between graph and equation and understanding of some general concepts. The working is technically undemanding and little time-consuming.** In the second paper

** Paper 1 and 2 are available in unabridged version.

CAS is used to reduce the time needed to perform some operations, time-consuming calculations and graphing. The emphasis is on understanding the problem, analyzing it, splitting it in steps towards solution and commenting on the results. These are so called CAS applicable questions

3. ACHIEVEMENT OF OPERATIONAL GOALS AND GENERAL EDUCATIONAL GOALS WITH THE USE OF CAS

Our national mathematical curriculum determines operational goals as goals of higher taxonomy degree such as:

- formation of basic mathematical notions and structures
- development of different ways of thinking and processes of thinking
- development of creative potential
- possessing formal knowledge and abilities
- learning about practical use of mathematics

It can be observed that with CAS most of these goals could be achieved to same or even to larger extent than by classical math teaching and assessment. Also didactical advice recommends problem approach: real world problems, with emphasis on the presentation of problem in mathematical form, on the interpretation of solution. With general use of CAS many classes which have been spent for learning and practicing algorithms, techniques and methods could be dedicated to application of mathematics in order to solve problems. From this point of view, all seems to be in favour of mass implementation of CAS in mathematical or natural science education. Nevertheless, we see some problems on the horizon.

4. WHAT SHOULD BE TAKEN INTO CONSIDERATION OR SCRUPLES OF A CONSERVATIVE TEACHER

As the first we would expose a statement also taken from the curriculum. Calculator should be a tool after student has mastered basic mathematical skills. We can agree on that. The same goes for basic formulas, algorithms

and techniques.. Teachers know how many exercises have to be done before certain knowledge is sound and how many difficult problems solved before we are sure to solve simple ones. We fear that the general level of basic mathematical knowledge could decrease on the account of greater insight into applicability of mathematics. And there is another, wider problem – *demand of university studies*. Nearly half of students' population want to continue their studies on university. It's rather likely that practical, application oriented approach would satisfy the needs of future lawyers, linguists or sociologists but would it also satisfy needs of future engineers, physics or mathematics?

That means that every change of technology and methods that leads to the change of curriculum or educational standards requires a thorough consideration and above all compatibility and adjustment of all educational levels. Finally, we don't agree with the extreme trend towards usefulness that seems to be taking over in our society with the slogan: *I DISCARD WHAT I CAN NOT USE* (or understand). I am afraid that the beauty of mathematics as a logical construction, a perfect system, as philosophy will be considered by majority as "not for use" and as such unnecessary. If we compare traditional mathematics taught at school nowadays to a book with recipes of exotic dishes nobody wants to taste, we certainly don't want it to be replaced by some "User's guide". At the moment we see CAS as a strong medicine that should be taken by drops to have its revitalizing effect whereas overdose could be fatal.

References:

- Vlasta Kokol-Voljč, 1999: Exam questions when using CAS for school mathematics teaching. Int. Journal of Computer Algebra in Mathematics Education, vol. 7, no. 1, pp. 63-76.