BACK

CONTENT OF TECHNOLOGY-SUPPORTED EXAMS

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Abstract
Refocusing what we teach and how we teach, as required through the use of technology in teaching and learning of mathematics, also includes the necessity to reconsider all aspects of assessment, i.e. both the organization/administration and the content. In this paper the content of exams in technology-supported mathematics teaching and learning environments is discussed.

1. Examinations ...

... and exam questions, are an indispensable part of mathematics teaching. They are a key for both the teacher and the student for getting feedback about their efficiency during the learning process.

Exams have to be organized in a way so that the feedback indicates the teaching/learning efficiency with respect to the intended teaching goals.

To be in accordance with the main goals of mathematics teaching, i.e.

- the development of understanding the *theoretical meaning* of mathematical concepts and
- the development of abilities and competencies in *applying* mathematical knowledge,

it is important to obtain, through appropriate questions, feedback about these two components.

The demand for changing the exams in the light of using technology concerns both the organization and the contents.

2. The use of technology (CAS, DGS) in mathematics teaching ...

... inevitably influences the teaching and learning of mathematics.

The new tool itself requires changes of the *teaching methods*. For most teachers this is the first step in changing their teaching styles when using technology. The use of technology dictates a change from frontal, teacher-centered, and mostly individual work towards student-centered group work. In most cases this change also requires a change of the technicalities of teaching at school. But we need to change not only the methods of introducing concepts – e.g. how we deal with (new) topics – also the methods of assessment need to be changed. Both are part of the development of concepts.

There exists a concrete proposal for organizing exams so that they provide *feedback about basic skills* (students' knowledge that is independent of the use of technology) as well as *feedback about abilities in the appropriate use of mathematical concepts* (students' competencies in situations where the use of tools such as scientific/graphic calculators, CAS, or DGS can offer essential support) – see the "two-tier exams" described in [Kutzler 2000].

Not only the methods, but also the *focus of teaching* becomes different when using technology. This concerns the topics we teach and the assessment (examination) as one of the key parts of the teaching process. Most traditional mathematics lessons are very much centered on the craftsmanship of learning and executing algorithms (i.e. the learning and practicing of the ability to *perform mathematical operations*). Since CAS performs most of these algorithms (mathematical operations) much faster than we can do them in a paper and pencil environment, we ought to shift the focus of traditional mathematics lessons from *performing* mathematical operations to *using* mathematical operations. This is closely related to *understanding the meaning* of mathematical concepts.

Shifting the emphasis of teaching more towards applications inevitably influences the assessment – in particular the content of exam questions.

3. Looking at an example

Typical questions when testing calculus knowledge in traditional teaching are, for example,

1) Solve the following system of equations:

$$6x + 3y = 639$$
$$8x + 11y = 1293$$

2) Calculate:

$$\int_{\pi/2}^{2\pi} \frac{\cos x}{(1 - \sin x)^2} dx =$$

Such questions are characterized by the fact that in a paper and pencil environment the students need (sometimes a very specialized) knowledge about calculation procedures, which in some cases are irrelevant to the underlying mathematical concept. Such questions exclusively test the capability of performing specific operations or algorithms, i.e. calculation skills. They serve a very narrow purpose only, namely the development of the craftsmanship of learning and executing algorithms (without even touching its usefulness or applicability), which is a purely mechanical goal and, actually, should not be a major goal of mathematics teaching. Questions like these lose their purpose in a CAS environment, because CAS reveals the insignificance of these questions' traditional purpose. When using CAS, all that remains with such questions is the testing of the technical ability to use the CAS. They are worthless for obtaining feedback on students' mathematical abilities or competencies.

To get feedback about students' mathematical knowledge or their competencies in applying it (according to the teaching goals, listed above), we have to radically change the wording of such questions, for example into:

1′) Find the intersection of two lines p_1 and p_2 given by the equations $p_1 : 6x + 3y = 639$ and $p_2 : 8x + 11y = 1293$.

1′′) Ann and Tom have a party. Tom bought 6 chocolate muffins and 3 pieces of fruit tart and paid 639 SIT while Ann bought, in the same store, 8 chocolate muffins and 11 pieces of fruit tart and paid 1293 SIT. How much does one chocolate muffin cost and how much one piece of fruit tart?

2′) Calculate the area between the x-axis and the curve given by the function $f(x)$ for $f(x) = \frac{\cos x}{(1 - \sin x)^2}$.

With such changes, questions get reoriented towards the initial goal.

4. A summary

Regarding the content of exam questions in technology supported mathematics teaching, the two major issues we have to look at are:

- students' knowledge of the *theoretical meaning* of mathematical concepts and
- students' competencies in *applying* mathematical knowledge (*use of mathematical conceptual knowledge* inside and outside of mathematics).

References

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