

# **SIGNIFICANCE OF USE OF TECHNOLOGY IN MATHEMATICS IN VOCATIONAL EDUCATION AND SOME PRACTICAL ILLUSTRATIONS**

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## **Abstract:**

The role of mathematics in the field of vocational education is quite different from other levels of education. Students in vocational education are to a greater extent practically oriented therefore concrete objects are closer to their understanding. Classical mathematics very often does not make much sense to them, so they find it useless and hard to accept. Mathematics in vocational schools should be adjusted to the needs and possibilities of the students. It is very important to connect teaching of mathematics with student's vocation and their practical knowledge.

Due to a different role of mathematics also the use of technology in mathematic lessons of vocational education has a different role compared to other programs. In my presentation I will try to enlighten the above mentioned specialties of vocational education. Through a demonstration of a concrete case I will tackle the issue of choice of ICT and the proper way of using it in mathematics lessons in vocational schools.

## **Actual situation**

Actual way of teaching mathematics on the level of vocational education in Slovenia showed not to be effective enough any longer. Due to the changes in society the population attending vocational schools has changed. At the same time needs of different vocations are quite different then those from the past. So "classical" mathematics and educational methods don't meet all needs nowadays.

In the year 2002 National Education Institute founded a working group for mathematics in vocational and technical education. In this group we invited also a mathematical professor from university and some teachers from vocational and technical schools. We conducted some activities to analyze the situation in mathematical classrooms and then carried out some developmental projects and prepared a new syllabus for new vocational programs.

Our first activity was preparing a questionnaire about problems in the teaching of mathematics in vocational and technical schools. Teachers filled in a questionnaire and above all they stressed weak pupil's habits of work, their weak ability, poor basic mathematical knowledge and weak motivation. Teachers also disagreed with the syllabus and some standards in educational system.

The analysis of these results gave a clearer picture of the situation. Students in these programs are to a greater extent practically oriented. For many of them the "classical" mathematics is too abstract and hard to understand. For this reason they find it uninteresting or useless and they don't have proper motivation for learning. That is one of the reasons for their poor knowledge. Also their ability is not that much in abstract world but they need more

concrete objects to work with. So the introduction of mathematical concepts should be built on life experiences or vocational situations.

We agreed that many of these changes are allowed by our previous syllabus but not stressed clearly enough. So the possibility for syllabus changes was well-timed.

## **New concept of vocational education and mathematics**

A new philosophy of vocational education was set up about two and a half years ago. Changes of our previous education system on this level were pretty vast. The most significant innovation are the integration of different branches and the concept of competences. Due to integration, the educational programs should not be subject oriented. And the goal of education should become competences of students.

How to change mathematics to satisfy these demands?

We tried to think different than it was usually thought in mathematics. A student should be the center of the educational process. There was important to think about his needs of mathematical knowledge when he finishes the vocational school, his possibilities to educate on higher level and his personal development in view of life long learning.

We defined ten mathematical competencies that the students should develop in vocational school:

- understanding and ability for using of basic mathematical concepts;
- ability for collecting, organizing and analyzing of data;
- ability for using mathematical tools in communication;
- ability for use of technology in mathematical procedures;
- ability for interpretation and critical estimation in using mathematics in vocational situations;
- ability for problem solving in mathematics;
- ability for planning and organizing working procedures;
- ability for cooperation and team work;
- accepting and experiencing mathematics as a cultural worth;
- trusting in ones own mathematical capacity and development of positive self-esteem.

To reach these goals effectively, three important fields were exposed and three projects realized:

1. differentiation of the goals,
2. connection of the knowledge from mathematics and other fields,
3. use of technology.

### Differentiation of the goals

Vocational education is three years long education. Students in these programs are more practical oriented. Many of them have difficulties of understanding abstract mathematics and for this reason they take mathematics as uninteresting or useless. It is necessarily to make mathematics more acceptable and more accessible for students. But another important fact is a possibility to continue education for two more years on the technical school that finish with the state examination for technical schools. It means that students in vocational schools have to develop enough systematical mathematical knowledge for successful continuation of their education.

The solution of this problem was found in differentiation of the goals. In one hand there are two groups of mathematical chapters. One group is obligatory for all vocational schools and from another group particular school selects those chapters that are more needed for their particular programs.

In another hand knowledge that students need for working in the vocational school and in their vocation is defined as "basic knowledge". Knowledge that they need for progressing in the vocation or for further education in technical school is defined as "continuing knowledge". Continuing knowledge includes more abstract concepts, more symbolism, more complexity and more demanding problem solving.

In the lessons this means much more individualization and also possibility for students to choose. They should have the chance to develop as much knowledge as they wish and can.

### Connection of the knowledge from mathematics and other fields

There are many different possibilities of connections between mathematics and other fields. There were also wishes that students just learn to use some mathematical procedures in their vocation. It could seem reasonable but it means that students learn only some procedures and have almost no basic mathematical knowledge for further education. There is also the mathematical way of thinking which makes student's knowledge more complete and enables student to understand some processes in his or her personal, social and vocational life.

There are other connections that can be most welcome. Deductive way of teaching in the context of well known vocational or everyday situations makes mathematics for student acceptable. It should not be a teaching of how to use mathematics in vocation but the method of how to understand and develop mathematical concepts. Through these methods also the vocational situations can be understood better.

The basic idea here is that mathematical concepts are thought on concrete well known situations and not together with some facts in vocation. But some parts of mathematics can be learned together with learning in other fields, like data handling for example.

## Use of technology

Significance of the use of technology in vocational schools is various.

1. In every vocation is necessary to use technology. Mathematical problems in vocational and everyday life are mostly solved by it. So for efficient work in vocational environment students have to be competent in using contemporary technology.
2. Introduction of mathematical concepts can be much more efficient with the proper use of technology. It is necessary to consider the specifics of particular vocation and choose the technology which is also used by students in their profession.
3. Through use of technology there is possible to treat more complex and realistic situations and students can learn also pretentious mathematical strategies.
4. With technology also students with low mathematical skills or specific learning difficulties have bigger chance to proceed in their learning.

In view of this in mathematics lessons students should learn to use and should use numerical and graphical calculators and different computer programs. Technology used should be connected with corresponding vocation. There should be used spreadsheets, programs for dynamical geometry or programs for geometrical drawing that student use in their vocation, programs for three dimensional modeling and maybe some special programs for different mathematical themes.

## **Holistic approach and new role of a teacher**

Through defined mathematical competences we wish to attain better balance between cognitive, operative, affective and social goals. By cognitive goals students should become fully confident with numbers, they should have a chance to adopt also pretentious mathematical concepts and become critical in use of mathematical tools.

By operative goals we think on other important skills as work with information and data, planning of the work and competent use of needed technology. For students there is also important to develop trust in their own abilities, positive relation to mathematics and to accept mathematics also like a cultural wealth. With proper activities and methods in the lessons students should now cooperate and work in the team better and be able to speak of mathematical ideas.

Role of technology is not mentioned only as a good possibility in mathematics lesson or a helpful tool but is exposed as an equivalent area of important goals in mathematics.

All these goals demand many changes from the teacher. He can not teach mathematics separate from other fields of knowledge any more however he has to plan his lessons in team with other teachers. Teaching methods should be quite different, that they allow

students to develop so diversified knowledge. Teacher of mathematics has to be connected to the vocation and has to know the "hidden" mathematics in vocational activities. We suggest that he goes regularly in the workshops and accompanies his students in their activities. That is also important in building mutual confidence and understanding. Teacher of mathematics should become part of student's vocational "world".

## Practical illustrations of technology use

### Example 1

In the Syllabus there is a goal: Student solves a linear equation.

This goal is developed on two levels:

basic knowledge	continuing knowledge
A student solves the equation with help of any method (mentally, with a table, with the graph, with diagrams). He tests the solution, interprets the method of solving the equation and the meaning of the solution. A student solves more demanding linear equation with the use of graphical calculator.	Student solves the equation with the transformations to equivalent equations.

Due to such differentiation of the goal a student can have a free choice how to manage the linear equation. He is also free to use technology and avoid harder symbolical manipulations if they make him too much troubles and to little meaning. But it must be exposed, that for best grades student should achieve as basic as continuing knowledge.

### Example 2

Measurements and conversions of units are also part of mathematics. Students should get the feeling of different sizes.

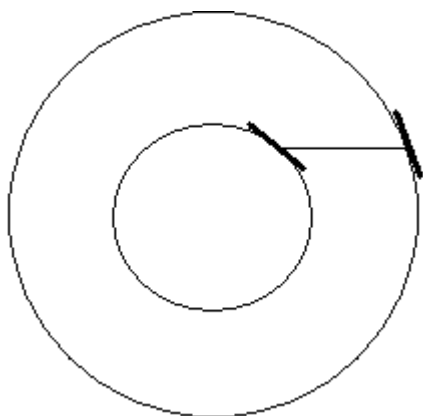
There are specialties of different vocations what quantities are used and what units. Students can use technology for measurements. They can do it during mathematics or they just use the results from activities in other technical subjects. It is advisable that teacher of technical subject and teacher of mathematics prepare these sequences in such a way that they complete each other.

### Example 3

How can two wheels that are connected on the same axle make a turn?

Teacher can use a model made by program for dynamical geometry for example to show the movement of the wheels. Students can explore then the situation. In one hand it is the

situation that helps to understand geometrical concepts and in another hand it helps to understand the practical vocational situation.



## Conclusion

The biggest acquisition in our new program for mathematics can be observed in more holistic approach clearly exposed in the syllabus. Defined competences orient in one way methods of teaching and in the other way methods of assessing. They explicitly demand more active role of students in the lessons and more complex role of a teacher. Use of technology is an equal part to other goals of mathematics. The whole syllabus follows the question: why to learn this? And that makes it more meaningful.

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