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Book of Abstracts

M. Marjanović, Đ. Kadijević
S. Jokić & J. Vučo (Eds.)

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ISDTF 2011

Improving specific subject didactics at the teacher training faculties

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Edited by

Milosav M. Marjanović
Serbian Academy of Sciences and Arts

Đorđe M. Kadijević
Mathematical Institute of the Serbian Academy of Sciences and Arts

Stevan Jokić
Vinča Institute of Nuclear Sciences

Julijana Vučo
Faculty of Philology, University of Belgrade

SASA, Belgrade, 2011

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Preface

The ISDTF 2011 Conference – Improving Specific Subject Didactics at the Teacher Training Faculties, takes place in Belgrade, Serbia, on 20 and 21 October 2011, organized by the Committee for Education of the Presidency of the Serbian Academy of Sciences and Arts.

This conference has for its main focus the improvement of specific subject didactics, through the presentation and exchange of research experience of respected scholars.

This booklet contains the abstracts of talks to be given at the Conference, which have passed a detailed reviewing, done by the members of the Programme Board. We thank both the authors and the reviewers for their contribution.

We express our gratitude to the Serbian Academy of Sciences and Arts for hosting the Conference and for publishing this booklet of abstracts. It is also our pleasure to express our gratitude to members of the Organizing Board and our sponsors for their contribution.

The Editors

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Abstracts of *Invited talks*

PISA AND THE SOCIOLOGY OF EDUCATION

Roger Establet
Université de Provence I, France
roger.establet@gmail.com

I summarize my talk to the conference in five points:

1. The chief theories of sociology of education (human capital theory and heredity of cultural capital) were developed in the 1960's based on national data (France, England, USA).

   The progress of international data (UNESCO levels of education; enquiry of OCDE about 65 countries about the level of the fifteenth years old: PISA 2000, 2003, 2006 and 2009) allow us to submit the founders' theories to a rich field of data.

2. What measure the PISA test? The ability of a country to teach the fundamentals and the aptitude of the individuals to learn the fundamentals.

   I put emphasis on the strong correlations between results in maths, science and reading. And it's an occasion to show the position of Serbia in these three fields.

3. Human capital and scholastic performance: If we observe the relation between national wealth and PISA results in the 65 countries, we get strong and significant correlations. But at the same time, at each level of GDP per cap, we notice different levels of scholastic performance.

   Among the countries with a GDP per cap of 10,000$, Serbian children have got the best results in maths, reading and science. There is an action margin for school politics.

4. Social heredity and PISA results: Firstly, always and everywhere, from Azerbaijan to Korea, pupils from unprivileged social backgrounds have weaker results in reading, mathematics and science than privileged ones.

   Secondly, always and everywhere, from Tunisia to Finland, the proportion of pupils with very weak results is greater among boys than among girls.

   Thirdly, always and everywhere, for science and reading, the proportion of excellent results is greater among girls than among boys. With a light male domination, there is almost a draw, in mathematics.

   Fourthly If we have a look on the centre of the distribution of scores, we notice more girls with averages score in mathematics and excellent in reading and more boys with excellent scores in mathematics and average score in reading.

   So we seemed to be led to a pessimistic conclusion: "It's always and everywhere the same thing."

   But Leibniz used to say "It's always and everywhere the same thing, give the varying degree of perfection." Always and everywhere, their social problems for school are the same, but there are very strong degrees in the solution of this problem. Let's now have a look – an optimistic look – at these degrees of variation.

5. Mass and elite: fighting against school failure is a good solution to get a good basic level and at the same time a greater share of excellent pupils.

   The correlation between excellent results and the worst ones is negative, strong and significant in PISA 2003, 2006 and 2009.

   So when in countries like France or Serbia where we count a great % of low performers in maths, reading, and science, PISA show us the chore of the target: to avoid, if possible, any school failure. In such a way, we'll get also a more numerous elite, as is shown by the results in Canada, Finland and Korea.

MATHEMATICS TEACHER EDUCATION: RETROSPECTIVE AND PERSPECTIVE FROM A MATHEMATICIAN'S POINT OF VIEW

Bernard R. Hodgson
Département de mathématiques et de statistique, Université Laval, Québec, Canada
Bernard.Hodgson@mat.ulaval.ca

In this talk, I wish to reflect on the mathematical education of primary and secondary school teachers, using the vantage point of a mathematician involved in teacher education within a department of mathematics. In most universities, the education of pre-university teachers constitutes, among the various tasks of the mathematics department, an important one, at least in terms of the number of students involved. While this has been the case for a long time for secondary school teachers, one can now witness a growing involvement, although possibly still somewhat modest, of mathematicians in primary school teacher education.

I will first offer some comments on the role of mathematicians in teacher education, based both on my personal experience and on the history and actions of the International Commission on Mathematical Instruction (ICMI). As discussed in Hodgson [1], the history of ICMI can be seen as a rich source of inspiration with regard to the contribution of mathematicians to educational issues in general, and to the preparation of teachers in particular. I will highlight the role played by two former ICMI presidents, Felix Klein (1849–1925) and Hans Freudenthal (1905– 1990), as well as by Djuro Kurepa (1907–1993), vice-president of ICMI from 1952 to 1962.

I will also discuss some general issues related to the preparation and development of mathematics teachers, based in part on the outcomes from the 15th ICMI Study on *The Professional Education and Development of Teachers of Mathematics*, whose volume has recently appeared, see Even & Loewenberg Ball [2].

In the next part of my talk, I will present the context for the preparation of school teachers in Canada, and more specifically in the province of Québec (education being of provincial jurisdiction in Canada). Comments will be offered about the two main models for teacher education in Canada: the so-called *consecutive* model, where the pedagogical content is addressed after a first university degree, and the *concurrent* model, where the choice of a teacher education programme is made upon entering university.

I will then examine some of the themes around which the mathematics preparation of school teachers at my university is articulated, in particular in the context of courses specifically designed for teachers. A brief presentation will be made of two compulsory mathematics courses for primary school teachers and of the 'philosophy' behind these courses. A special emphasis will be placed on two mathematics courses specific to secondary school teachers where mathematical themes of particular significance to the secondary curriculum are covered, that otherwise are not or rather superficially addressed in the education of mathematics majors. Typical instances of such topics include the study of conic sections from different vantage points, polynomials or infinity. I will stress how some of the mathematical topics then encountered, although somewhat elementary, are rich and can lead to gratifying and stimulating mathematical moments. Examples will be given, pertaining to the mathematical preparation of both primary and secondary school teachers and connected to central topics of the school curriculum, see Hodgson [3], [4].

Finally, the specific role played by the history of mathematics in teacher preparation will be discussed, and examples will be presented of mathematical topics covered in a course on the history of mathematics specific to prospective secondary school teachers.

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DOES SUBJECT MATTER?

Peter Menck
University of Siegen, Germany
menck@erz-wiss.uni-siegen.de

In educational research much trouble has been taken to find out the best method of teaching, to develop effective rationales of lesson-planning, and even to theoretically model the teaching-learning process in an adequate way. Usually this is done

– within the narrow limitations of a specific subject – mostly a math topic, as these are fairly easy to handle – , or
– regarding subject matter as a controlled variable, i. e. as a variable which is kept constant in order to find out relevant methodological or organizational variables which determine the learning outcome of the students.

My paper is meant as a contribution to a general *framework for a detailed didactical analysis of all school contents*. So I confine myself to the second one. For that I allude to some interesting findings:

The epoch-making *The Language of the Classroom* of Arno A. Bellack and his colleagues was designed to find out general traits of classroom communication. They identified an overall pattern of the language game played in the classrooms. What they did not expect: All of the 15 classrooms dealt with an *identical* topic within the field of international economics but the result was 15 *different* economics, as it were.

Erhard Wiersing, a former colleague of mine, attempted to follow them and persuaded 12 German teachers of German to work on one and the same text from Montesquieu's *L'esprit des Lois*. The same happened: The documents confirm the findings of Bellack *et al – and* they present a variety of 12 quite *different* Montesquieus, so to say.

In 1988 Susan S. Stodolski published a research report with the title The Subject Matters. She studied classroom activity as dependent from the subject taught. The result of her study: Subject matters – with regard to teaching method.

Though I have adopted the title of her book my point is another one: *Subject does matter* – with regard to *humans' humanity*. To put this thesis slightly modified and in terms of German philosophy of education: The students' *Bildung* depends on the subjects taught as well as or even rather than on patterns of instruction and classroom management, and so on, in short: as well as teaching methods.

The method-impact we find in didactical theory and research as well as in teacher training obviously results from the large diversity of school subjects and, even more, from the immense variety within even one of the subjects. So I'm going to ask: Have we to resign and to confine ourselves to the study of content-free methods? Or is there anything the manifold of matter may have in common? And if this were the case: Can we outline a more comprehensive model of teaching-learning-processes than those method-orientated ones we have at hand? And finally: Can we improve classroom work on the basis of a more complex insight in the complexity of its determinants?

I shall begin with a reference to Plato's Socrates. He was asked whether or not it would make sense for youngsters to learn how to fight in full armor. His answer: Before all we have to deliberate what that skill may be good for? This is the crucial question of curriculum theory and development up to our days. With that dialog – *Laches* – in mind I'd like to make two points:

– Before talking about subjects, topics, themes, before talking about subject matter we should look for an answer to the question: What is it *good for*? And, after all, what could 'good for' mean? Obviously this is a political issue, too: ancient vs. modern languages; or within history: WW I vs. Napoleon's wars. I won't go into this. In my paper I'm going to discuss the educational aspect with respect of the field of teacher's work.
– There is no end. There is no answer once and for all, moreover, the *discussion*, today and tomorrow and the day after tomorrow, – *is* the answer.

  In this point curriculum theory differs from curriculum practice. The latter has to come to an end time after time. But curriculum practice is not my question here, either.

In my paper I'm going to outline and to fill in the field opened up by Plato's Laches. I'll begin with my view of classroom work – *Unterricht*: a social situation in which the participants work on topics or *themes*. The themes worked on lead to human *culture*. Culture – in opposition to nature – can be considered to go back to *specific needs* of humankind and to meet these needs. That leads me to the concept of humans' *Bildung* which is without doubt one of the aims of – *Unterricht*: It's content as well as curriculum content is intended as *a means that enables the younger generation to make humanity its own.*

For curriculum practicians a theoretical discourse ad kalendas graecas is unsatisfactory, and after all this is true with curriculum theory, too. I shall conclude with an outlook to consequences for teacher education and illustrate my argument with examples from language teaching and from history.

SCIENCE AND MATHEMATICS AS AN INTEGRAL PART OF EUROPEAN CULTURAL HERITAGE: "HANDS ON" AS A CRUCIAL ELEMENT OF EDUCATION FOR THE FUTURE

Dusan Sidjanski
University of Genèva
dusan.sidjanski@unige.ch

Hands on aims to stimulate the interest of children in science and to introduce scientific reasoning through an experimental method. In our age of science and technology, also characterized by the importance of fundamental values and democratic principles, we have to build a new knowledge base in Europe. By disseminating *Hands on*, we are introducing observation and discussion based on proof. In fact, the children formulate hypotheses, carry out experiments and engage in discussion using scientific reasoning. They also learn to respect each other and to practise team work. *Hands on* is also the best introduction to the practice of democracy. It contributes towards the training of the young generation for new jobs.

Developed in the United States and France by Leon Lederman and Georges Charpak, *Hands on* was applied at the European level by the *Pollen* project, followed by the *Fibonacci* programme as a result of the first meeting between Georges Charpak and President José Manuel Barroso in 2004.

Fibonacci, a well-known medieval scientist from Pisa, brought up in the fertile atmosphere at the eve of the Renaissance, is an example of the role of culture in our society. As in Pisa at that time, culture today includes religion and philosophy, the arts and architecture, as well as science, mathematics and technology. The development of the society of knowledge takes place in Europe in a democratic setting. This is the principle asset of the European Union for our future.

Abstracts of presentations in section *Mathematics*

Edited by M. Marjanović

KARAMATA'S INEQUALITY AND SOME APPLICATIONS

Zoran Kadelburg
Faculty of Mathematics, University of Belgrade, Serbia
kadelbur@matf.bg.ac.rs

It is well known that Jensen's inequality is the basic one characterizing convex functions. In this short communication we will discuss another inequality also connected with convex functions with one real variable, sometimes called Karamata's inequality. It can be formulated using the following notion of majorization of finite sequences.

Definition: Let $a=(a_1,\ldots,a_n)$ and $b=(b_1,\ldots,b_n)$ be two finite sequences of real numbers. It is said that sequence *a majorizes* sequence *b*, which is denoted by $a \succ b$, if after a possible renumeration, the terms of these sequences satisfy the following three conditions:

1. $a_1 \geq a_2 \geq \cdots \geq a_n$ and $b_1 \geq b_2 \geq \cdots \geq b_n$,
2. $a_1 + a_2 + \cdots + a_k \geq b_1 + b_2 + \cdots + b_k$ for each *k*, $1 \leq k \leq n-1$, and
3. $a_1 + a_2 + \cdots + a_n = b_1 + b_2 + \cdots + b_n$.

Theorem: Let $a \succ b$ be two sequences from the interval $(\alpha, \beta) \subset \mathrm{R}$ and $f : (\alpha, \beta) \to \mathrm{R}$ a convex function. Then $\sum_{i=1}^{n} f(a_i) \geq \sum_{i=1}^{n} f(b_i)$.
.

We will prove this inequality and also its weighted form and discuss their connection with Jensen's inequality.

As application, we will show how these inequalities can be used in solving several olympiad-type problems. Some of the examples are the following (for more problems see [1]):

1) $\frac{1}{a+b} + \frac{1}{b+c} + \frac{1}{c+a} \leq \frac{1}{2a} + \frac{1}{2b} + \frac{1}{2c}$ for positive numbers *a*, *b*, *c*;

2) $\sqrt{a+b-c} + \sqrt{b+c-a} + \sqrt{c+a-b} \leq \sqrt{a} + \sqrt{b} + \sqrt{c}$ if *a*, *b*, *c* are the length of sides of a triangle;

3) $\cos(2x_1 - x_2) + \cos(2x_2 - x_3) + \cdots + \cos(2x_n - x_1) \leq \cos x_1 + \cdots + \cos x_n$ for arbitrary $x_1, x_2, \ldots, x_n \in [-\pi/6, \pi/6]$.

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INQUIRY BASED MATHEMATICS EDUCATION IN BULGARIA AND THE EUROPEAN PROJECTS FIBONACCI AND INNOMATHED

Petar S. Kenderov
Institute of Mathematics and Informatics, Sofia, Bulgaria
kenderovp@cc.bas.bg

The words *Inquiry Based Education* (IBE) are used to describe a process of education where, under the guidance of a teacher (or a supervisor), the students are “creating” or “discovering” the knowledge themselves by conducting experiments, by asking relevant questions, by searching for answers in the existing information resources, by formulating and investigating conjectures, by discussing with peers. The teacher does not provide the knowledge in “ready for use” form. He/she helps the students understand the major ideas, develop the necessary skills (analytical thinking, formulation of conjectures, experimental check of conjectures, documentation of findings, etc.) and guides the overall process of study. This approach to education based on experiments and inquiry is widely used in sciences like Physics, Chemistry and Biology because the majority of humans learn by their own experience. In Mathematics Education (ME) experimenting has never had the place it deserves. This is so because, over the centuries, there was no widely available proper equipment for doing mathematical experiments. Only professional mathematicians were capable of performing complicated arithmetical calculations, not to mention experimenting in geometry where one was able to draw and explore only static configurations of relatively simple geometrical objects. With the advent of powerful modern computers and specially designed educational software for mathematical experiments (like GEOGEBRA, GEONExT and many others) it became possible to use IBE successfully in Mathematics as well. Since then, in many countries, didactical concepts and strategies were developed for the use of Information and Communication Technologies (ICT) in Mathematics Education not only for visualization but also as a tool to develop deeper understanding of the studied material. Examples of Educational Environments which illustrate this approach to mathematics education will be given.

Recent developments in Bulgaria in the field of IBE are closely related to the European Projects *InnoMathEd* (Innovations in Mathematics Education on European Level; www.math.uni-augsburg.de/prof/dida/innomath/) and *Fibonacci* (Disseminating inquiry-based science and mathematics education in Europe; www.fibonacci-project.eu/). The essence, the structure and the realization of these two projects will be presented and discussed.

SOME IMPROVEMENTS IN THE DIDACTICS OF MATHEMATICS AT PRESCHOOL TEACHER TRAINING COLLEGES

Aleksandra Mandić
Preschool Teacher Training College inVrsac, Serbia
edusoft@open.telekom.rs

Requirements to overcome the weaknesses that resulted from teaching separate subjects arose in the mid 19th century. The terms found in pedagogical literature, as are “concentration of teaching”, “complex systems”, “correlation of subjects”, etc. indicate this tendency to enforce integration of knowledge. Of course, such a disintegration of knowledge does not exist at the level of preschool education, but courses of didactics of mathematics for pre-service teachers should combine the subject matter with the basics of pedagogy and cognitive and developmental psychology. On such a basis these teachers should be acquainted with the genesis of elementary mathematical concepts as resulting from the spontaneous concepts of a preschool child. In describing our approach we rely on the generally accepted ideas found in current literature as well as on our own teaching experience gathered through work with students at the institution where we are employed.

We continue with a critical observation that concerns some possible programmes of teaching mathematics in the kindergartens (age 4–6), when they offer contents that are usually scheduled for the first class of primary school. When, in addition, this is accompanied with the insistence on calculation skills then it may be nothing more than a premature formalism. In order to explain our idea of preschool mathematics as activities through which the intuitive roots of elementary concepts are formed, we use the scheme according to which a concept is seen as the tripartite entity that consists of corresponding examples, mental image and name (symbol). Classification of examples and “discovering” of their inherent mathematical pattern result in the formation of the corresponding mental image. The activity of classification gets the form of games of equating examples with their standard representative (the example having the least possible amount of noise).

We illustrate this process using a variety of examples from arithmetic and geometry. This is also an instance where the Bruner’s iconic representation has to be appreciated as an inevitable means of shaping the acts of thinking of a preschool child. As one of our contributions we include representation of “numbers as visible shapes” (R. Arnheim), analyzing the requirements that the number images have to obey. At the end, we also add that we have implemented a number of advantages that modern information technology brings.

INNOVATING THE DIDACTICS OF MATHEMATICS COURSES

Milosav M. Marjanović
Serbian Academy of Sciences and Arts, Serbia
milomar@beotel.rs

The appreciation of the didactics of mathematics course is a very variable idea. The reason is that objectives and contents of such courses vary very much from a teacher training institution to another (and from one country to another). Moreover, teachers of teachers have often an inclination towards theorizing matters that ensure a more academic feature to such courses. Thus, the main purpose of such a course to help a school teacher to form a deeper understanding of the teaching matter and its proper didactical transformation, as well as to consider critically good and bad points of teaching materials, may easily be missed.

For this author an inspiration and a permanent source of ideas have been Freudenthal's well-known books on education. Freudenthal's claim that "a science of teaching must start with a science of teaching something" should be taken as an important didactical dictum and his concept of didactical analysis, which is so clearly exemplified in his books, deserves to be in focus for further elaboration

Towards an integrated course of didactics. A thorough analysis of teaching themes and their proper didactical transformation requires a wide knowledge which includes not only the subject matter but also some related facts from the history of mathematics, educational heritage, and particularly psychology. Here, we confine our attention only to the case of psychology.

Psychology is defined as the study of the mind and of human behavior. Thus, the goals of a psychology course are usually set independently of the interest of students specializing in a particular branch of science. Thereby, a course on specific subject didactics must include some particularly relevant psychological topics. We form a list of them in the case of mathematics at primary and middle levels and the arguments for their relevance will be given in a more extended version of this paper. Our list comprises the following topics: Function of the eye; Comprehension of perception; Principles of perception; Cues for seeing depth; Concepts as tripartite entities – corresponding class of examples, mental image and name (or labeling symbol); Hierarchy of concepts according to the degree of abstractness; Definitions as sentences which determine a concept via another one of higher degree plus *differentia specifica*; Bruner's modes of enactive, iconic and symbolic representation; Pictograms and ideograms; Ontogenetic development of speech – egocentric speech of the child and inner speech (Vigotsky); Structures, cognitive schemes and systems of concepts; Spontaneous and scientific concepts.

Main teaching themes. Here we select just three of the main themes of primary and middle school mathematics, sketching in a suggestive way what their didactical analysis should be.

- *Number blocks and number systems***.** Let us note that an often stated dilemma – counting or matching, seems to be completely false. Neither simple matching suffice to develop a general idea of natural number nor counting, taken as an *a priori* activity, have much sense beyond the naming of the first ten numbers. No matter which approach is taken in the actual school practice, the initial natural numbers are always and inevitably treated as the individual concepts. Such a way of treating arithmetic brings back the idea of number blocks (1–10, 1–20, 1–100, 1–1000) which make gradual steps in building natural number system. Our concern here will be packages of didactical tasks attached to these blocks.

  This is a lengthy theme which extends to the building and structuring of further systems of numbers (whole, rational and irrational), comprising similar packages of didactical tasks.
- *The concept of set***.** Being more general than all other concepts of classical mathematics, the concept of set played an important role in its logical foundation. A similar idea of the role of this concept was largely exploited during the "new math" period. Elements of set theory that existed on school curricula lacked a proper didactical transformation and as such, these new contents have been much reduced in or completely banished from the school programs. Having such an extent of meaning, the concept of set has its corresponding examples at all levels of abstraction. For the purposes of school mathematics, these levels have to be fixed dependently on corresponding concrete contents – sets at the sensory level, sets having for their elements conventional symbols, sets given by predication of the characteristic property of their elements, etc.
- *Variable – the key idea of algebra***.** Vieta's *logistica speciosa* had a great influence on the further development of 16^{th}–18^{th} century mathe-matics. In the course of the 19^{th} century, symbolic algebra was formed as a branch of mathematics having its own logical foundation and the variable as its key idea became also a topic of highest interest in the didactics of mathematics. Attempts to start developing this idea at the right time, supported by the concrete content of arithmetic, led to the constitution of the so-called early algebra which is a didactical matter equally significant for both primary and middle mathematical education.

Summarizing, we find that an integrated course of didactics is a necessary framework for performing didactical analysis of the main themes of school mathematics. Analysis of these themes should be the core content of each course of didactics if its objective is the profound knowledge of the teaching matter. Without such an analysis, a course of didactics may easily stray into superficial theorizing.

A CONTRIBUTION TO THE DEVELOPMENT OF FUNCTIONAL THINKING RELATED TO CONVEXITY AND ONE-DIMENSIONAL MOTION

Miodrag Mateljević & Marek Svetlik
Faculty of Mathematics, University of Belgrade, Serbia
miodrag@matf.bg.ac.rs

Mathematical concepts are defined precisely, using the language of the branch of mathematics to which they belong. But their meaning can be enriched through different interpretations and those of them belonging to real world situations, we call "vivid" mathematics, which especially improves the understanding of students. In contacts with Professor M. Marjanović, we investigated a case of "vivid" mathematics ([1] and [2]) and continue to do it in this paper.

Suppose that a liquid (water) flow has a constant inflow rate v_0 and that a vessel has the form of a surface of revolution, and suppose that this process begins at moment $t = 0$ and ends at moment $t = T$. We study the dependence of the height $h = h(t)$ of the liquid level at the time *t*, which will be called the *height filling function* of the liquid level at the time t. The height filling function is convex or concave depending on the way the level of the liquid changes. When the level changes accelerating or slowing down, the function is convex or concave, respectively. This vivid interpretation holds in general, namely we prove that given a strictly increasing convex (concave) continuous function on $[0,T]$ with $h(0) = 0$, $h'_+(t) > 0$ and $h'_-(T) < +\infty$, then there exists a vessel such that its height filling function is equal to the given function. This is a fact that seems to be new and we continue paying attention to it.

In this way, we hope that we are providing a matter that can serve as the motivation and the illustration for a deeper understanding of basic concepts and ideas of the differential and integral calculus, as well as it can serve for a further development of functional thinking in teaching mathematics.

We also consider more general concept of one-dimensional motion, including changes in direction of motion and the difference between velocity and acceleration defined by the position and the path as being the functions of time. We indicate how one can apply this for studying the height filling function of a liquid flow, which can be considered now as the one-dimensional motion of a liquid along the axis of rotation of the vessel.

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A VIEW ON THE LEVEL OF COMPUTER USAGE IN MATHEMATICAL TEACHING IN SERBIA

Branislav Z. Popović, Slađana Dimitrijević & Marija P. Stanić
Faculty of Science, University of Kragujevac, Serbia
bpopovic@kg.ac.rs

Usage of digital technologies, computer based applications, hardware and communication devices have become ubiquitous in modern society. Contemporary generations, who have been growing up on the wave of technological revolution (which started several decades ago, and reached every person in almost all life segments now) should not be taught only by means of paper-pencil or blackboard-chalk techniques. For these students, constant interaction with computers and contemporary technologies is definitely natural and that is why it should be used for the improvement of the quality of teaching. Therefore, it is natural to expect that teachers, in particular young ones (who have graduated in the last ten years) use digital devices in their school practice. Are those expectations real in the case of school practice in Serbia?

During the last two years we participated in the State Commission for Teacher Licensing. The examination includes preparing and giving one mathematical lesson in a school in which the applicant is not employed. We evaluated 123 such lessons. That experience gave us the possibility to perceive the situation about computer usage when the teachers who are the beginners are considered.

As our statistical analysis of collected data shows, the situation is not satisfactory. We found that the faculty from which a teacher has graduated, the region where he/she works, and the type of school where he/she teaches, are not decisive for the quality of computer usage in the teaching process. But, it is interesting to point out that the average of marks that a teacher has obtained during his/her studies has a significant impact on the quality of using computers in teaching. Those conclusions have additionally convinced us that teacher education is a strategically critical period, during which improvements have to be made. We see a possible solution in providing a wider range of topics directly related to the school practice in the didactics courses at the teaching faculties, which would help future teachers to deal with multiple problems that they may face in their practice. Also we suggest restructuring already existing courses in such a way that they encourage the use of digital technologies which improve the quality of teaching process.

ON MAJOR GOALS AND PROBLEMS IN MATHEMATICS TEACHER EDUCATION AND SOME SUGGESTIONS

Bernd Zimmermann
Faculty of Mathematics and Computer Science, Friedrich-Schiller-University of Jena, Germany
bernd.zimmermann@uni-jena.de

Ways to improve traditional teaching, which were very often neglected until now, should, according to [1], be:

- promoting the human face of mathematics;
- relating procedural and conceptual mathematical knowledge (cf. also [2]);
- utilizing mathematical modeling in humanistic, technologically-supported way; and
- promoting technology-based learning through applications and modeling, multimedia design, and on-line collaboration.

Taking these important approaches as a starting point, *goals* as follows are important to be achieved by student teachers:

1. profound knowledge of and interest in the subject of mathematics, including not only relevant content, its history and methods, but also comprehensive own experience and competence in mathematical problem solving and modeling,
2. profound knowledge of modern learning theories,
3. sensitivity for pupils and their needs,
4. profound knowledge of and competence to apply different teaching methods,
5. profound knowledge of ITC and competence in using it in a reasonable way in mathematics instruction,
6. sound knowledge about mathematical learning and the problem solving processes (including the history of problem solving) and ability to recognize and analyze students' mathematical thought processes,
7. ability to reflect their own picture of mathematics (mathematical belief), sound knowledge about different views on mathematics in its history (cf. [3]) and at present (cf. [4]),
8. sound knowledge about methods of evaluating students' mathematical learning progress and problem solving ability and the competence to apply this knowledge.

I will discuss some of these goals in more detail as well as some *critical issues* as follows:

a) problems in implementing modern approaches into mathematics instruction,
b) teachers' beliefs and problems to change them (cf. e.g. [5]),
c) the image of mathematics and mathematics teachers in society,
d) difficulties in gaining appropriate student teachers.

Finally I will present *some ideas how one might improve* mathematics teacher education:

I. Entrance-examination for mathematics student-teachers.
II. Closer coordination of mathematics and mathematics education courses and rethinking the proportion of allocated time.
III. Special courses in school mathematics.
IV. Special courses in mathematical problem solving and modeling (including the use of IT).
V. Courses in mathematics education should be organized in a similar way as good mathematics instruction is organized at school (more students' activities and fewer lectures).
VI. Pre-service courses for student-teachers at school, which should be accompanied by lesson-preparation and final discussion and evaluation of the outcomes of a lesson with the support of mathematics educators at the university.

The discussion of all such points will follow scientific literature and present some examples from my own experience at school (including the writing of mathematical textbooks for secondary schools [6]), which refers to Germany (west and east) mainly, but also to Finland and to the US.

It is quite clear that such considerations are dependent on such cultural-specific experience and it has to be discussed to what extent the suggestions presented above might fit to the cultural boundary conditions of Serbia and to what extent they are to or can be modified.

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WHAT DOES DATA PROCESSING CONTRIBUTE TO THE TEACHING OF MATHEMATICS?

Amalija Žakelj
National Education Institute of Slovenia, Slovenia
Amalija.Zakelj@zrss.si

Financial/economic sections in newspapers, advertisements, political argumentations and other media usually contain tables, graphs, and comparisons between averages. Sound data literacy not only requires the understanding of such messages, but also asks for their critical examination.

Individuals have at their disposal today a wide range of digital tools for data presentation and analysis, such as MS Excel, OpenStat, NumberGo and SPSS. The 2008 Slovenian curricula for all subjects calls for digital competences, encouraging activities for their development towards critical usages of digital tools.

What can technology-supported data presentation and analysis contribute to the teaching of mathematics?

First, it is necessary to know the techniques of data presentation with different diagrams. By using them we describe or convey data and results to others in a clear way. Quite often an adequately selected display gives holistic insight into the collected data, which can then make it easier to search for regularities in the data and compare different sets of data.

This kind of data elaboration is a very natural link between the instruction of mathematics and other school subjects and out of school experiences, which would promote functional literacy and quantitative understanding in the context of solving realistic problems. With computer tables and charts, efficient data processing is enabled. Automatic ordering, sorting, computing and displaying facilitate the processing of large volumes of data and real data. Thus, the focus can move onto the interpretation and explanation of phenomena specified by processed data.

Second, work with data can serve also as a first experience with probability. Example of such activity is the introduction of empirical probability through empirical investigation, where the use of knowledge about the data processing is necessary.

With the introduction of nine-year primary school, the Mathematics 1998 Curriculum included the content of data and probability for the first time. This content, as a new one, was supported by teacher seminars funded by the Ministry of Education of Slovenia. I will examine this support, which has contributed to a positive trend in the Slovenian TIMSS Grade 8 Data Content results: from 494 points in 2003 to 511 points in 2007. Note that this curriculum recommended the use of ICT, but this was not particularly emphasized. It was done in the updated Mathematics 2008 Curriculum.

ON ALGEBRIZATION OF GEOMETRY AND GEOMETRIZATION OF ALGEBRA

Rade Živaljević
Mathematical Institute of the Serbian Academy of Sciences and Arts, Serbia
rade@mi.sanu.ac.rs

Mathematics is often described as the science of discovering patterns (see e.g. Keith Devlin, Mathematics: The Science of Patterns: The Search for Order in Life, Mind and the Universe, W. H. Freeman's Scientific American Library, 1994). Patterns arising from the study of space and shape are the subject of Geometry and Topology while the patterns of more linguistic nature, arising from the study of the language and formal manipulation of symbols, are traditionally associated to Algebra.

A vigorous exchange and interplay of ideas between Geometry and Algebra has been for centuries one of the major driving forces of all Mathematics, as was insightfully summarized by Hermann Weyl in his famous sentence, *„In these days the angel of topology and the devil of abstract algebra fight for the soul of each individual mathematical domain"* (Wikipedia).

Inevitably this geometry-algebra dualism, arising from studying patterns of seemingly different nature, is present also in the way mathematics is taught in schools where the method of coordinates and the calculus of vectors serve as standard examples of algebraization of geometric notions.

In our lecture we offer some new ways of illustrating the rich and fruitful interplay of topological phenomena (patterns of shape) and their algebraic counterparts, in the form perfectly suitable for general audience and, in particular, for didactic purposes.

We start with an outline of geometry and topology of Borromean (Brunnian) rings supplemented with illuminating, high quality computer animations providing immediate insight into the properties of these objects. A translation into the world of algebra is offered, providing both a new insight and enabling the student and teacher to design new links and predict their actual behavior. Boy's surface, the famous immersion of the projective plane into the 3-space, is analyzed in a similar manner, with a computer animation and associated diagrams (planar graphs) providing convenient algebraization. Finally we show how the study of seemingly innocent and simple patterns arising from configurations of points in the plane, notably the configurations of Tverberg type, is quite complex , often requiring deep topological tools for their thorough analysis and full understanding. These and similar examples are intended to stimulate students' imagination and excite their minds for learning mathematics.

Abstracts of presentations in section *Informatics*

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TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE: A FOCUS ON TEACHING SPREADSHEETS

Charoula Angeli
Department of Education, University of Cyprus, Cyprus
cangeli@ucy.ac.cy

Spreadsheets are computerized systems that have automated the record-keeping process. Learning about them in school is thus important and useful. Traditionally, the teaching of spreadsheets has had a technocentric and decontextualized focus, and aimed at mainly demonstrating the technical features of the computer application in relation to storing, calculating, and presenting information. However, spreadsheets are an example of a cognitive technology, a mindtool, which amplifies and reorganizes mental functioning and can therefore engage learners in higher-order thinking and reasoning [1].

What is the required knowledge for teaching spreadsheets as mindtools?

I will answer this question by using technological pedagogical content knowledge (TPCK), which is a framework that can help us understand the complexity of the required knowledge for teaching spreadsheets.

TPCK is an extension of Shulman's pedagogical content knowledge and represents the body of knowledge that teachers need to have in order to teach adequately with technology. It is defined as the ways knowledge about tools and their affordances, pedagogy, content, learners, and context are synthesized into an understanding of how particular topics that are difficult to be understood by learners or difficult to be taught by teachers can be transformed and taught more effectively with ICT, in ways that signify the added value of technology [2]. Thus, TPCK is a highly contextualized body of knowledge, situation-specific, personal, schematic, transformative, and contingent upon learner's ecology (i.e., understandings, preconceptions, misconceptions, and or alternative conceptions that learners may have about a content domain). Therefore, the development of TPCK should be conceptualized by considering the interdependencies among technology, learners, content, and pedagogy.

Teachers who teach informatics constitute a special group, because they are technology experts by training, and technology is what they teach. However, their expertise, often times, is limited to the mere technical use of the tools themselves and does not entail the necessary pedagogical skills that will allow them to present the material to students at appropriate levels [3]. The framework of TPCK can delineate the knowledge that teachers need in order to teach spreadsheets in optimal ways. In particular, teachers need to (a) develop an educational rationale about why spreadsheets are important to teach, (b) understand the educational affordances of spreadsheets and learn to differentiate between technical capabilities and affordances, (c) know what to teach, (d) be aware of students' learning difficulties with spreadsheets, and (e) teach spreadsheets in pedagogical sound and powerful ways to meet learners' needs and educational objectives.

Succinctly, developing an educational rationale about teaching with or a particular technology is important, because it sets the stage about how the technology will be used. For teachers who believe that spreadsheets are tools for performing complex calculations, the focus will be on entering numbers and formulae into the cells, whereas for teachers who view spreadsheets as tools to reason with, the focus will not be on the tool per se, but in engaging students in authentic meaningful tasks to reason with the tool (e.g., making decisions by comparing the outcomes of different scenarios). This, of course, has implications about the instructional design decisions that teachers will have to make about what content to teach and how to teach it. Additionally, teachers often lack the knowledge to differentiate between tool affordances and the mere technical capabilities of the tool. Affordances are about what the tools enable us to do. It is the meta-knowledge that a teacher has about the transformative power that the technical capabilities of tools have in teaching and learning a particular content domain. Moreover, teachers need to also be knowledgeable of students' difficulties with spreadsheets so they can adapt their instructional plans and strategies accordingly. Research showed that students face difficulties with both the technical use of spreadsheets (i.e., with absolute cell referencing and functions) and with translating problems into mathematical representations during the phase of spreadsheet development (see [4]).

Implications for teacher professional development are: (1) spreadsheet teaching should be carried out in contextualized and interdisciplinary ways so that knowledge about content, pedagogy, and technology can be used concurrently; (2) detailed analysis of the affordances of spreadsheets should be made explicit to teachers so that they can make connections with real life tasks that students can find meaningful and useful to complete; (3) considering the difficulties students have with spreadsheets, adding design, testing, and debugging components to spreadsheet education as well as information about the impact and causes of spreadsheet errors may help increase accuracy during spreadsheet development.

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PERSONALIZED LEARNING ABOUT DATABASES: DOUBLE STRUCTURING IN PLACE

Peter K. Antonitsch
Department of Informatics Systems/Informatics Didactics
Alpen-Adria University Klagenfurt, Austria
Peter.Antonitsch@uni-klu.ac.at

Personalization and standardization are more than catchphrases of modern pedagogy. Shifting the focus from teaching to learning, these concepts call for rethinking educational practice, especially with topics that are taught using established instructional patterns.

Besides programming, databases can be considered to be the second classical topic of the subject-matter Informatics in secondary education. When it comes to teaching databases, two different instructional patterns are common practice, though: The "traditional" pattern focuses on database concepts like conceptual data modeling and logical database design, while a more recent pattern concentrates on how to use database management software. These patterns address different aspects of the structure within databases.

In many cases, database courses seem to provide answers to questions starting with "how to" rather than "why" or "what if", In doing so, they give procedural knowledge prominence over conceptual knowledge.

Having in mind, that learning, among other things, aims at adopting and being able to contribute to the structures and thought of the society the learner lives in, this impression raises a few questions:

- Can we find a way that learners not only accept that the structure of a database is "composed of connected tables" and learn how to apply ready-to-use rules within that structure (e.g., how to create a simple database-query), but also create understanding of the structure (e.g., why "connections" between tables should be modeled in different ways) and thus become able to reflect upon the structure (e.g. argue, whether the database is a valid representation of "reality")?
- Is there an interface between the two patterns sketched above, so that they can be combined into a single pattern containing the essence of both? and
- What structure should learning-aids provide to support the learners in understanding database structure?
- How can we turn learners from passive consumers of knowledge into active creators of competence in the field of (database) structures?

A few years ago a learning pattern influenced by constructivist learning theory was proposed, which seems to answer some of these questions [1]. This pattern relies on a database-microworld that provides visual representations of a ready-to-use database of considerable size and carefully simplified structure, and describes a universe of discourse the learners are familiar with, for example, some aspect of school life.

First experiences indicate, that these “structural aids” are important, if learners are supposed to comprehend database structures by exploring the provided microworld mainly by themselves, while the teacher coaches the learning processes. The learners explore the semantics of visual representations and thereby learn about the basic structure of database models. The learners explore the structure of the database to collect the information needed for database queries. Furthermore, the learners explore the results of the queries to decide whether the provided database is a valid model for the described part of the real world.

On the other hand it has become clear that further steps are necessary to add “true” personalization to this learner-centered approach to databases: It is still the coaching teacher who directs the learning processes. But, per definition, personalization of learning processes means that learners plan their own learning process and strive for common compulsory learning goals by following their own individual learning path. With personalized learning, the learners have to deal with the structures of the current topic and to structure their learning process as well. Consequently, to implement personalized learning, the learning pattern at least has to be enriched by a competence matrix informing the learners about the learning goals in advance, and by checklists of learning tasks they can choose from [2].

Suitable environments for personalized learning of databases can be developed by using common software tools such as *OpenOffice*/*LibreOffice Base* or *Microsoft Access* as done in [1]. Further development might also include intelligent tutoring systems like *ActiveMath*, which has been successfully applied in the teaching/learning of mathematics [3].

Implications for teacher professional development can briefly be summarized in the following way: Although deep understanding of subject matter knowledge has to be considered an essential prerequisite of teaching, it has to be augmented by the teacher’s ability to transform subject matter knowledge into learnable knowledge. This not only includes (a) the ability to create learning environments that stimulate active exploration of structures and construction of knowledge on the side of the learners (in the sense of mindtools [4], for example), but also (b) the ability to coach the learners at structuring their learning processes.

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A VIEW ON TEACHING INFORMATICS BASED ON PROGRAMMING AND PROGRAMMING-LIKE ACTIVITIES

Boyko Bantchev
Institute of Mathematics and Informatics, Sofia, Bulgaria
bantchev@math.bas.bg

A programming-based introduction to informatics in some countries is gradually being displaced by instruction in using application software because the majority of students and many of their teachers are viewing programming as both too difficult and boring. Convinced that such a perception stems to a great extent from the unsuitability of the programming languages currently used for teaching, I propose replacing them with more appropriate ones, as well as exploiting other tools whose use is akin to programming.

Popular languages, such as *Basic*, *Pascal*, *C/C++*, and similar are heavily used for educational programming, but are verbose, 'bureaucratic', and hinder direct expression of data and algorithmic structures. Teaching informatics using such languages mostly degenerates into struggling with their syntactic intricacies and imparting the 'incantations' needed for running simple programs. Little room is left for conceptual modeling, building abstractions, thinking over alternatives, and generalization.

Concentrating on exploring fundamental algorithmic and data structures, which I believe is the essence of the introductory teaching in informatics, is much more workable if a dynamic language, e.g. *Ruby*, *Python*, *Lua*, or *Icon* is used. These languages facilitate educational and exploratory programming by featuring rich data structures, well designed algorithm-building blocks, an unobtrusive and readable syntax, and interactive environments for executing and verifying a program code in pieces before assembling it as needed. Significantly more substantial and thematically varied programming can then be experienced, resulting in a straightforward and succinct code.

Functional languages, such as *ML* and *Haskell*, are also worth considering as tools for educational programming. Besides being expressive and concise, they are characterized by higher-level, declarative semantics, treatment of functions as first-class program objects, and rich, polymorphic, yet automatically deducible datatypes. All of these are of great conceptual and practical value, fostering a clear and concise style of expression.

A notable example of a small language combining a functional style with picture composition facilities, intended as a tool for teaching fundamentals of computing to young pupils, is *GeomLab*.

Using programming languages is not the only option for teaching organization and algorithmic processing of information. Carrying out problem-specific computations, such as planning how to build a textual, geometric, purely symbolic or other structure, using scriptable application or tool programs, can be an activity no less meaningful and inspiring than 'true' programming. Even a capable text editor, used knowledgeably in solving text processing problems, can lead to rewarding intellectual and practical accomplishments.

Regular expressions (regexes) are a good example of an algorithmic tool for text manipulation. Their use spans not only programming languages but also many utility programs, including most modern text editors. Constructing a regex to match a specific text structure – a number, a file name, an e-mail address, a sentence in a natural language – is a kind of small-scale, but potentially demanding programming task.

There are many other utilities widely used for extraction, splitting, rearranging, merging, etc. of textual information. Combining several of them to solve specific problems provides a range of creative and engaging programming activities that can be used as a teaching resource.

Furthermore, the realm of text processing integrates well with other kinds of utilities or application-specific languages, such as those for diagram generation, notably *dot* for abstract graph drawing and *gnuplot* for scientific visualization. These and other programs accept declarative text input describing an image of the respective type, and therefore their use can be automated by piping other programs to them. This also presents a good opportunity to explore links with mathematics and other disciplines.

Dynamic geometry systems (DGS) are widely used for exploration and education in mathematics. Some of them are equipped with a built-in language, allowing geometric models to be constructed programmatically, and thus turning a DGS into an excellent tool for teaching informatics as well. Geometry's clear logical and algorithmic substance becomes explicitly available as a domain of programming activity. A good example is *GeoGebra* with its language, featuring geometric construction capabilities along with high-level general programming semantics.

There is indeed a great variety of problem domains to investigate, and means and tools to employ in teaching informatics, each of them making it possible to discover different forms of organizing and processing information. These options currently remain mostly unused. My belief – based on extensive studying of, and practice with, tens of programming languages and many programmable or programming-like tools – is that a number of these languages and tools can be put to successful use in teaching informatics. This is confirmed by my experience in teaching to university, high-school, and younger students.

Teachers should not limit themselves to a specific programming language, and should avoid those that are syntactically or otherwise complicated in favour of ones fostering straightforward expression of ideas, as well as other environments enabling algorithmic activities. Combined use of tools is possible. The described approach may be challenging to the teachers, as it requires continuously educating themselves, but the results should be worth the effort.

VISUAL PROGRAMMING OR VISUALIZATION OF PROGRAMMING?

Mordechai (Moti) Ben-Ari
Department of Science Teaching, Weizmann Institute of Science, Rehovot, Israel
moti.ben-ari@weizmann.ac.il

In an effort to improve the didactics of informatics in general and of programming in particular, educators have developed many pedagogical software tools. Professional software development environment (such as *Eclipse*) are far too complex and confusing for novices, so one approach is to create environments like *BlueJ* (www.bluej.org) that are friendly to novices. Another approach is to use visual software tools that facilitate learning by using graphics in place of or in addition to textual programming languages. This talk will compare two visual tools that we have investigated for use in teaching programming to novices.

Scratch (http://scratch.mit.edu/) is a visual programming environment. Students write programs by dragging-and-dropping blocks labeled with commands and operations; this totally prevents difficult syntax errors. Scratch programs control the animation of sprites, thus providing a context that motivates students. The MIT website holds millions of projects, many written by young students.

In our research [1], we found that while Scratch fulfils what it promises, it can cause students to develop bad habits that may be difficult to overcome: (a) Extreme bottom-up programming, where students dragged blocks for many commands and then tried to construct a program. (b) Extremely fine-grained programming, where students used dozens of small program fragments instead of combining them logically. For example, instead of using a single `if-then-else` statement to handle two cases, students would use separate `if`-statements for each case. Sometimes, the two statements would even be in separate scripts, further reducing the coherence of the program. We attribute these bad habits to the superficial ease of programming, which can discourage good programming practices, in particular, the all-important phase of program *design*.

The *Jeliot* program animation system (http://cs.joensuu.fi/jeliot/) *automatically* generates detailed animations of textual programs written in the Java programming language. Extensive research [2] has shown that *Jeliot* significantly facilitates learning because it provides a graphic display of the *dynamic* aspects of program execution that are hidden within the computer. In this, *Jeliot* is superior to *Scratch*, because *Scratch* does not support visualization of the execution of the statements of a program, only of the visible outcome of the execution in terms of animation of the sprites. However, when using a program visualization system like *Jeliot*, there are several pedagogical obstacles that must be overcome: First, the use of *Java* requires that students learn a professional-grade programming language that is difficult to master; especially, at secondary level, there are those who would argue that visual languages like Scratch are more appropriate and that professional programming languages can be left to university students. Second, *Jeliot* is a challenge to teachers who need to understand the details of the animated execution and then to integrate it into their classroom practice.

The conclusions that we draw from our research should not be surprising: pedagogical software tools and creative activities by students cannot "replace" teachers, as one might infer from the doctrine of *constructionism* [3]. In the case of *Scratch*, only teachers can teach good programming habits and the principles of program design. In the case of *Java* and *Jeliot*, only teachers can decide how to use the tool in order to achieve better learning of a complex programming language. The main implication for the professional development of teachers is that they need to have a deep understanding of the subject matter of informatics in addition to pedagogical methods. Without professional knowledge of the subject they will lack the confidence necessary to optimally use pedagogical software tools.

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PEDAGOGICAL BELIEFS AND ATTITUDES OF COMPUTER SCIENCE TEACHERS IN GREECE

Georgios Fesakis[1] & Tsampika Karakiza[2]
[1]Learning Technology and Educational Engineering Laboratory
University of the Aegean, Rhodes, Greece
[2]Education department, University of the Aegean, Rhodes, Greece
gfesakis@rhodes.aegean.gr

The information and Communication Technology/Computer Science (ICT/CS) curriculum in Greece was introduced in 1992 (grades 7–9 in Gymnasium), updated in 1998 (grades 10–12 in Lyceum) [1] and is currently being updated with extension to the kindergarten and primary school (grades 1–6). New Greek ICT/CS curriculum is consistent with the international standards of ACM and ISTE and aims to bridge the ICT and CS directions by both integrating learning goals to other subject curricula and providing a separate course for developing ICT competences [2] and CS concepts [3].

The successful implementation of any curriculum requires well prepared teachers. Today's educational studies of future teachers and professional development programs for in-service teachers are usually based upon constructivist pedagogy. As teachers' beliefs and attitudes determine the ways they learn and teach in general, these studies also shape teachers' pedagogical beliefs and attitudes in a constructivist direction [4, 5]. The majority of Greek ICT/CS teachers are well qualified with content knowledge since they study the subject for 4 or 5 years at the university. However, only a small percentage of them have attended educational courses since it is not a prerequisite for secondary teachers to receive any pedagogical training prior to entering the school service. As a result, many professional development programs in Greece have been implemented to elaborate ICT/CS teachers' pedagogical knowledge.

What are the pedagogical beliefs and attitudes of Greek ICT/CS teachers after these efforts? This study presents an investigation of pedagogical beliefs and attitudes of ICT/CS teachers in Greece, using instruments designed by Becker [6]. The analysis is based on four axes: curriculum, teaching approach, students' work and assessment.

The sample of the research was 100 ICT/CS in-service teachers, who had been informed about the purpose of the research through e-mails. The procedure involved the completion of an anonymous on-line questionnaire. The research data reveal that Greek ICT/CS teachers usually have personal learning theories and develop both traditional and constructivist attitudes. For example, the same teacher might state that her/his role is *"mainly as a facilitator who tries to provide opportunities and resources for students to discover or construct concepts for themselves"* and – at the same time – to prefer *"short-answer and multiple-choice tests"*. In addition, teachers' pedagogical beliefs and attitudes change with the years of service. Teachers seem to have strong beliefs in the beginning of their career (either traditional or constructivist ones). These beliefs become less strict after some years of teaching as, in about quarter of cases, teachers cannot decide which of the two sets of beliefs should apply to certain educational situations. Then teachers formulate again new personal solid theories (in the traditional, a constructivist, or a mixed spirit). Although, in some cases, statistically significant relations to the educational level of service or to the total teaching service are detected, teachers' beliefs and attitudes seem to be generally unrelated to their prior studies in education and/or participation in professional development programs. This is quite surprising, setting questions for the efficiency of the teachers' training programs.

The results of the study set out suggestions concerning the preparation of teachers, the design of pedagogical training programs and the type of support teachers need during their service. More specifically, in order for teachers to develop modern pedagogical theories and to adopt consistent teaching practices, their training requires a practical as well as a theoretical form.

Furthermore, teachers' pedagogical education needs the creation of continuous supportive structures in the form of professional communities of learning and practice, where teachers are given the chance to exchange and reflect on experiences, to experiment with teaching methods, ultimately aiming at an ever-evolving, efficient teacher. Finally, the study reveals systemic and administrative factors (e.g., school culture, assessment laws considering the number and kind of questions, time administration in schools) that shape teachers beliefs making modern pedagogy appear impractical (e.g., preferring short teacher-centered discussions because of short class sessions per week), especially for ICT/CS, and undermining any teaching reform effort and curriculum principles implementation.

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USING SOLO TAXONOMY IN EXPLAINING DIFFICULTIES IN INFORMATICS LEARNING

Đorđe M. Kadijević
Mathematical Institute of the Serbian Academy of Sciences and Arts, Serbia
djkadij@mi.sanu.ac.rs

The quality of learning outcomes can be described in terms of the so-called SOLO taxonomy [1]. It specifies that learner's accomplishment in a learning task progresses from a single aspect (called uni-structural response) to several disjointed aspects (multi-structural response) to several integrated aspects (relational response). Clearly, it is much easier to examine task elements separately than to deal with these elements integrated in a coherent whole.

The SOLO framework has been used in educational research, especially in statistics education. In informatics (computer science) education the use of this framework has, to the author's knowledge, been limited to the learning of programming (e.g. [2]). As regards this important area, it can be said that, in general, there are different program structures in each program as well as different instructions within each structure, and, in SOLO terms, difficulties were not generated by individual parts but primarily by wholes containing them. Consider, for example, loop structures, They are usually hard for most students of introductory programming because there are different elements (a loop control variable; initializing, checking and updating the value of that variable; a block of code to be executed repeatedly) that must be properly combined.

The SOLO framework can, for example, be successfully applied in explaining difficulties in spreadsheet development. Consider, for example, the development of a simple deterministic and non-optimization spreadsheet that examines the profitability of some business situation. This business situation may be car washing service or annual school celebration. As examining things in a coherent whole is hard, many developers may prefer to examine different types of services (e.g., cleaning cars and washing cars) and their profitability separately than to consider them jointly and find the overall profitability. Also, despite the fact that the number of guests is used as an input variable, the costs for food and drinks for annual school celebration may be examined as fixed costs, not as variable ones depending on that number. (See [3].)

Because it essentially deals with structuring content and relating its parts – learning requirements present in many computer science topics – the SOLO model can be used to explain and understand reasons for difficulties in learning these topics and design conceptually-framed activities that would reduce them. It is thus important to enrich teacher professional development by describing and using the SOLO model and other suitable conceptual frameworks to better plan and implement learning activities and assess their outcomes.

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NOTES ON THE APPLICATION OF STANDARDS FOR COMPUTER SCIENCE EDUCATION FOR SECONDARY SCHOOL IN GERMANY

Carsten Schulte
Computer Science Education Research, Free University, Berlin, Germany
schulte@inf.fu-berlin.de

In 2008 the German Gesellschaft für Informatik presented Standards for Computer Science Education in secondary schools, covering grades 5–10. They describe 5 content, and 5 process standards, with several sub-items for each standard, plus an additional differentiation for grades 5–7, and 8–10.

Content standards	**Process standards**
1. Information and data	A. Model and implement
2. Algorithms	B. Reason and evaluate
3. Languages and automata	C. Structure and interrelate
4. Informatics systems	D. Communicate and cooperate
5. Informatics, man and society	E. Represent and interpret

The standards are supplemented by a framework explaining the general approach to the subject and some sections with suggestions for application in the different grades. The overall goal is informatics education that:

a) enables students to cope with the widespread use of digital artifacts and information technology (IT) in everyday life, and
b) provides a foundation for learning computer science at more advanced levels (upper secondary; vocational training or university education).

The aims of the standards are discussed in terms of *identity formation* (e.g. developing an individual perspective on chances and risks of IT use), *everyday life* (e.g. knowing and being able to respect legal issues and norms like copyright), and *vocational training* (e.g. developing programming-related competencies). (See [1].)

The standards are useful tool for thinking about the goals of CS education and therefore raised enormous interest among CS teachers and educators at universities to develop teaching units or teaching models that embed CS education in everyday life, so called context-based teaching. For example, consider the unit *E-Mail for you (only?)* for grades 8-10. In this unit students would learn: 1) how E-Mail is transferred from sender to receiver; 2) what risks are included in this technique; and 3) how one is able to achieve privacy and authenticity in E-Mail communication. The unit aims at two content standards (Informatics systems; Informatics, man and society) and one process standards (Reason and Evaluate).

In the similar way, the standards are impacting teacher education, too. In a project of my working group, we're working with prospective teacher students to develop such units, thereby deepening their knowledge of the standards and their application in everyday teaching. One such unit deals with location based data produced by mobile phones. Firstly, students are uncovering structure and function of the cellular network. They learn that location data are needed, and how these emerge. Secondly, students visualize location data, using a framework implemented by teacher students at the university. This framework allows inserting a graphical representation (e.g. a dot) on an on-line map with geographical coordinates such as *openstreetmap*. School students can then change this visualization, by adding a counter for each position or filtering the represented positions for some time slots (e.g. a fixed position during some night time slot may reveal the residence of cell phone owner). Producing different visualizations of the same data should promote a sense for information needed, putting into practice content standard Information and data. Finally, such different possible interpretations should trigger ideas for additional and future features of mobile phones, implementing two other content standards (Informatics systems, Informatics, man and society).

The application of the standards reveals two important issues. First, they contain some repetitions or overlaps. For example, the teaching unit outlined above could also be seen as covering algorithms (because changing the visualization includes changing some source code). Second, as the standards are relatively abstract, the teacher may think he/she has applied them without really adopting the intentions. It is easy to argue, for example, that the unit above also includes all process standards (i.e. students model, evaluate, structure, communicate, and interpret), but does this apply?

Experience shows that authors of teaching units are likely to be generous about all the standards included – in future the standards and our way to use them should be sharpened so that it becomes clear to what extent a teaching unit is a substantial contribution to a standard.

Apart from constructing teaching units and teaching models showing their application at schools, these standards have influenced thinking about teacher education. For example, we are trying to reduce the gap between theory (e.g. the Standards) and practice (the actual teaching) by including teacher students into the process of developing, testing and refining teaching units that implement the standards [2]. Note that the standards had generated similar efforts for grades 11 and 12 in Germany and for grades 5–10 in Austria.

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Abstracts of presentations in section *Science*

Edited by S. Jokić

EXPERIENCES ABOUT PREPARATION OF PRE-SERVICE PRIMARY SCHOOL TEACHER FOR REALIZATION OF SCIENCE CONTENTS

Marija Bošnjak, Nataša Branković & Olja Maričić
Faculty of Education in Sombor, University of Novi Sad, Serbia
96marija.bosnjak@gmail.com

The aim of this study was to confirm the importance and to check the quality of the prior curriculum reforms of pre-service teacher science education, but also to receive guidelines for further improvement of science teaching in general, and the didactics of science teaching at the Faculty of Education in Sombor. Also we were interested in pre-service teacher experiences in science teaching at the previous levels of education (primary and secondary education). The sample group consisted of students at undergraduate, graduate and master level. The results showed that the inadequate implementation of science teaching methods in the previous levels of education lead to a decrease in interest in science contents and to the formation of incomplete or wrong notions about the essence and importance of natural processes and phenomena. Research also confirmed the need and significance of science subjects in the curriculum of teacher 's education and its impact on the quality of didactics of science teaching and students practice. The implementation of the experiment in the science teaching and didactics of science teaching contributed to higher quality of the didactical transformation of the science contents and more up-to-date methods of implementation of programs through students' practice in elementary school.

LIQUID CRYSTALS IN EDUCATION

Mojca Čepič
Faculty of Education, University of Ljubljana, Slovenia
mojca.cepic@pef.uni-lj.si

Liquid crystals are met every day in laptops, mobile phones and in many other devices. Also many forms of nature consist of liquid crystals. They are found in cells and silk worm threads are formed by them. In addition, they are not completely understood by researchers as well. The ongoing scientific research is vivid and few 1,000 of researchers actively contribute to new knowledge in liquid crystals every day [1]. Liquid crystals also offer several possibilities for hands-on and rather simple laboratory experiments [2]. As such, they are an ideal modern topic for school. The topic is interdisciplinary as it can connect the three science disciplines (chemistry, physics and biology), it has context related to everyday life and still today there exist unsolved scientific questions. In contrast, physics topics usually taught are

rather abstract, detached from daily life and discovered almost centuries ago, which is not interesting for students. In this contribution the liquid crystals will be shortly presented. In the continuation, concepts that are important for understanding of liquid crystals and concepts that could be taught by liquid crystals will be discussed. The set of simple experiments which allow students to study properties of liquid crystals will be shown. Finally, the project: *Introduction of a modern topic into teaching – liquid crystals*, which was recently accepted by Slovenian Agency for Science and Development, will be briefly described.

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THE IMPLEMENTATION AND DISSEMINATION OF THE IBSE METHOD IN TEACHING SCIENCE AND NATURE

Irena Golubović-Ilić & Olivera Cekić-Jovanović

Faculty of Education in Jagodina, University of Kragujevac, Serbia

irenagolubovic74@yahoo.com

Students in Serbia learn about natural and social life and their surrounding through the school subjects *Science and nature* and *World around us*. These two subjects are obligatory in the first four grades at primary school and these courses take 2 classes per week and 72 classes per year. The contents that are taught are taken originally from natural and social sciences and these contents are the result of the didactic and methodological transformation of historical contents, geographical contents, contents that deal with production, sociology, ecology, technique, technology, traffic, culture, education, art and everyday life. These contents represent the foundation for further study of the natural and social sciences in the next educational levels of primary and secondary schools. Although these contents are very interesting, authentic and interdisciplinary and provide active, individual and creative students' participation in all phases of the teaching process, students mostly dislike *Science and nature* as a school subject and their knowledge is way below the needed level. We believe that the cause of this situation is the inadequate presentation of the curriculum – the traditional way of teaching in which students sit in their places, listen and remember the information presented by the teacher, who is not, in our opinion, motivated enough to move students to make some intellectual effort or to apply modern methods and strategies in their teaching.

There are numerous seminars and other ways of educating primary school teachers that teach Science and nature in our schools, but we need modern and adequate education of the primary school teachers, education that is intense, modern, innovative, and effective. At the Faculty of Education in Jagodina during the last five years, students (future primary school teachers) learn through the academic subject *Methodology of Teaching Science and Nature* how to apply IBSE method and some research methods in the teaching of subjects *World around us* and *Science and nature*.

In this paper we will present the concrete activities that we have applied with our students in order to implement and disseminate the mentioned way of working in schools.

REFORMING SCIENCE EDUCATION – FOCUSING ON TEACHERS' ROLE

Ana Gostinčar Blagotinšek
Faculty of Education, University of Ljubljana, Slovenia
ana.gostincar@pef.uni-lj.si

Science education is considered to be one of the most important causes for the declining interest for science and technology studies among pupils. The way science is being taught at school is one of the reasons for this situation. Experts agree that the current state of science education is to blame, but with appropriate changes science education can also provide solutions. The majority of the experts agree that new pedagogy is needed [1].

The European Commission assigned a group of distinguished experts to assess the situation and form guidelines for action. An appropriate approach should be based on inquiry-based science education (IBSE) and provide: continuous personal development and education for teachers; materials for classroom use; adequate didactic materials to support teachers with their daily work; local initiatives for innovation, sustainability and evaluation. These are so called pillars, on which successful initiative can be built. The approach has already been tested and the results of evaluation showed an improvement of pupils and teachers' attitudes to science learning and teaching (http://fibonacci-project.eu/, http://pollen-europa.net/).

Changes in education should be gradual and take time. The success of the reform depends on many factors, but the role of the teachers is central. New pedagogy cannot be implemented without educational authorities' support, or without local community and parents' consent. But providing adequate support for the teachers and helping them with their daily routine is essential.

Teachers, who are expected to change their approach to teaching, need education to be able to do it [2]. As learning is attractive, effective and engaging when pupils are active, experimental equipment has to be provided. And because new ways of teaching requires new ways of assessing, teachers should receive didactic support for developing it.

Having teachers' needs as a priority, activities within The Pollen and The Fibonacci projects in Slovenia built a system of support for the teachers, including experimental equipment centers, didactic materials and peer to peer support, providing hundreds of teachers and thousands of pupils with innovative and stimulating encounters with science.

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LEARNING PHYSICS FROM ELEMENTS OF HISTORY OF SCIENCE

Cécile de Hosson
Laboratoire de didactique, Université Paris Diderot-Paris 7, France
cecile.dehosson@univ-paris-diderot.fr

If the interest for the history of science seems to be accepted by most educational communities in the World, its implementation in the science classroom still remains difficult. Considered as a deepening cultural tool, history of science mostly appears as a complement to the traditional physics course and still fails to establish itself as an alternative way to learn physics.

In this talk, I will face this challenge and see how history of science can become a tool for physics learning.

Indeed, a lot of researches in science education show that an historical perspective can allow students to reach a more appropriate view of the nature of science. Beyond this cultural aspect, I think that history of science should also be incorporated as an element of fostering a deeper understanding of laws and concepts involved in science courses. From this perspective, the efficiency of the incorporation of historical elements largely depends on the constraints that shape the physics classroom (students' difficulties, pedagogical requirements, number of students, material available...).

I will present three educational reconstructions designed from the corresponding historical reconstructions. These educational reconstructions concern the following areas of physics: kinematics, astronomy, and geometrical optics; they take into account various educational limitations specific to the physics classroom that will be explicated.

THINKING ABOUT "INSIDES" IN PLANTS

Dušan Krnel
Faculty of Education, University of Ljubljana, Slovenia
Dusan.Krnel@guest.arnes.si

This lecture presents one of the ways in which the ideas of inquiry based learning, seen as a complex of active learning, problem solving, using history of science, probing students ideas and other approaches, can be implemented to bring about meaningful learning. Exposed is also the link between old and new knowledge and a multidisciplinary approach. The example is taken from the plant chemistry and is suitable for the lower secondary level.

In this lecture I wanted to show how, from a seemingly simple question **“**What’s inside a sweet pepper fruit**”** one can develop a complex teaching situation that leads to the realisation of teaching goals in a unique way. It shows merely one approach as an example of how to connect content, i.e., declarative knowledge; practical skills, and understanding of scientific processes, i.e., process-based knowledge; as well as the understanding of their own thought processes, i.e., metacognitive knowledge.

If the wish is to preserve the credibility of science and present science as a a real, rational and objective activity to pupils, and at the same time expand knowledge of modern research methods, I propose to expand school work with a real trip to a modern analytical laboratory. The chemical analysis of the gases in the sweet pepper fruit done in a “real” laboratory, showed that there was an increased concentration of carbon dioxide which is around 200 times greater than in the air and this is perhaps a good starting point for new problem-based teaching.

PRACTICAL IMPLEMENTATION OF IBSME METHOD THROUGH THE EU "GREENWAVE 2011 SIGN OF SPRING" PROJECT

Dragana Miličić
Faculty of Biology, University of Belgrade, Serbia
draganam@bio. bg. ac.rs

The Greenwave project is the part of European scientific project FIBO-NACCI (www.fibonacci-project.eu) whose objective is to contribute dissemination and practical implementation of IBSME (Inquiry Based Science and Mathematics Education) in classrooms. As a part of this large EU Project, the Greenwave is designed to allow an exciting demonstration of how spring moves across the continent. During 2011, for the first time schools from Serbia could participate, in company with 21 countries across Europe.

About 180 teachers of different fields (biologists, physicist, IT specialists, chemists, teachers in primary schools, as well as the pre-school teachers) from 44 schools throughout Serbia were involved. Between February and June 2011 schools recorded sightings of two animal species: swallow (*Hirundo rustica*) and the common European frog (*Rana temporaria*) frog-spawn, as well as two vegetal species: the ash (*Fraxinus excelsior*) and horse chestnut (*Aesculus hippocastanum*). The total number of records submitted from Serbia was 724 (72 Official Records and 652 Observations, according to criteria that were defined by the Project). Also, schools measured air temperature on a daily basis and sent data from hand made rain gauges and anemometers.

During their work on the project, pupils successfully applied processes of observation, experimentation and construction of the measuring instruments. They tried using digital cameras and processing images onto the web site Gallery (www.greenwave-europe.eu). In addition, they were uploading their sightings and observations on an interactive map on the web site. The significant value of the Greenwave project is its multi-disciplinary approach and the fact that schools were able to communicate using the website, which makes their information accessible to all European participants. The results of project Greenwave Serbia 2011 is also available through the web site www.rukautestu.rs

BASIC UNDERSTANDING OF CRITICAL THINKING AMONG TEACHERS AND STUDENTS

B. Mitrevski & O. Zajkov
Faculty of Natural Sciences and Mathematics, University „Sts. Cyril and Methodius“, Macedonia
boce@pmf.ukim.mk

Teachers are important agents of change in education. They always play a key role in education reform. The way teachers are trained and prepared can significantly affect how they teach in the classroom [1].

Critical thinking skills are often known as higher order cognitive skills (HOCS) to differentiate them from simpler, i.e. lower order cognitive skills (LOCS). HOCS are relatively complex, require judgment, analysis, synthesis and evaluation. The effective teacher is someone who can select, combine and validate different methods, choosing proper strategies [2].

The purpose of this study was to investigate students' and teachers' basic understanding of the term "critical thinking". Using a survey questionnaire (teacher and student questionnaire) we analyze one item presented in the form of statement, the same in both teacher and student questionnaires. The sample included 178 math and science teachers and 712 high school students (178 students in each grade, from grade 9 to grade 12). Respondents rated items on a 4 point Likert-type scale, ranging from "strongly agree" to "strongly disagree". Statistical analysis was performed using the Chi-square test and the 0.01 level of significance was used.

Results indicate that basic understanding of critical thinking is likely to be more related to curriculum and subjects than students' maturity or grade level. The prevalence of uncertain responses rather than certain responses among students and teachers reveals a lack of basic understanding or poor understanding of the term "critical thinking".

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THEMATIC APPROACH IN TEACHING PHYSICS AND CHEMISTRY

D. Ž. Obadović, M. Segedinac*, I. Rančić, M. Pavkov-Hrvojević & M. Stojanović
Faculty of Sciences (Depart. of Physics, *Depart. of Chemistry), University of Novi Sad, Serbia
dusanka.obadovic@df.uns.ac.rs

Contemporary school education is a unique educational process which includes both the teacher and the student as active participants in the realization of stated educational tasks. For the dynamic educational process it is necessary to achieve a symbiosis of theory and practice, clearly structured experiments, well-defined research tasks that require student's creativity… In a thematic approach in teaching of physics and chemistry, "Hands on" experiments are of multiple significances. They allow young pupils to discover and understand the world around them through observing causal relationship between natural phenomena [1].

Because of that, the Faculty of Sciences of Novi Sad organized a number of regional seminars dealing with a thematic approach in teaching physics and chemistry in elementary and secondary education. The seminar enables teachers to expand their scientific and professional knowledge, which is necessary for the realization of the teaching of natural sciences at different levels of education. The emphasis of the program of seminars was on the implementation of "Hands on" experiments, demonstrations and new methods, evaluations, and self-evaluations, with the goal of the acceptance of the curriculum of science in the simplest way. Special attention was dedicated to integrated themes and forming new subjects in correlation with them.

The paper presents results of research into teachers' opinions about the impact of implementing "Hands on" experiments on efficiency of the teaching process. A group of teachers formed within a number of Primary schools in Novi Sad, the capital of the northern Serbian province of Vojvodina, answered a questionnaire within this research. It included a group of questions that dealt with the implementation of "Hands on" experiments in the teaching process, and about the pupils' activities. The obtained results have been treated statistically.

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ONTOLOGICAL REPRESENTATIONS IN REVIEWING EDUCATIONAL CONTENT IN CHEMISTRY EDUCATION

M. Segedinac[1], J. Adamov[1], S. Cvjetičanin[1] & T. Hrin[2]
[1]Faculty of Sciences, [2]Faculty of Pedagogy in Sombor, University of Novi Sad, Serbia
mirjana.segedinac@dh.uns.ac.rs

This paper gives a survey of ontologies used for the representation of chemical knowledge, especially in reviewing educational content. Numerous examples are shown and their efficiency further explained.

One of the main goals of learning and training in chemistry education is the development of effective methods and strategies used to create a system of scientific chemical knowledge. Relying on the principles established by Novak, Fahmy and Lagowski, development of interest in the field of chemical sciences, progress in the understanding of chemical facts, and increasing success in acquiring new and unknown chemical entities by students can be achieved by using concept maps, which are developed into simpler or more complex systemics. The highest levels of abstraction, involving the most complex cognitive processes, are accomplished through visual representations that gradually and vertically develop quality chemical knowledge, which, according to Bloom's taxonomy, go through three categories: knowledge, comprehension and application.

Systematic arrangement of these concepts and conclusions in a system in which the connections between concepts and conclusions are strongly pronounced, allows the realization of such quality of knowledge. This approach to knowledge representation uses real maps of knowledge in the form of modified graphs that reflect the structure of certain scientific and educational content. Their great advantage is clearer and more efficient structuring of learning material, and planning of the teaching process. This inter-connection between the concepts provides a strong natural connection, which improves the quality and quantity of students' knowledge, facilitates teachers' time articulation of classes and successful transfer of knowledge to students.

Abstracts of presentations in section *the Humanities*

Edited by J. Vučo

LANGUAGE EDUCATION POLICIES AND FOREIGN LANGUAGE TEACHER EDUCATION: AGENCIES, PRACTICES AND PERSPECTIVES

Jelena Filipović
Faculty of Philology, University of Belgrade, Serbia
jelenafilipovic@fil.bg.ac.rs

"Foreign language education, in line with current innovation trends all over Europe, may be viewed within the framework of an interparadigmatic change which is characterised by the generally accepted feeling that language is the most significant social activity human beings are able to perform" [1]. However, even though issues regarding foreign language teaching methods and practices have been addressed and investigated in great detail from many perspectives throughout the 20th century and are still actively researched at the beginning of the 21st century, the relationship between language education policies and foreign language teaching process has not received the attention it deserves until very recently.

The Council of Europe and the European Union have, through various institutions at European level, made comprehensive attempts to affect national and international language education policies which would help define curriculum frameworks and provide institutional support for foreign language teaching and learning based on ideas of plurilingualism, pluriculturalism and intercultural competence as gateways to European mobility and enhanced international communication. Nevertheless, very little attention has been paid to raising teachers' awareness and critical attitude toward foreign language education policies and national agencies which create them, which would enable them to take an active and productive role in the formation of those policies and implementation of teaching/learning practices. Consequently, a more detailed research regarding macro social and political relationships among foreign language teachers, students, local communities and national agencies of language education planning is needed in order to understand how national foreign language curriculum operates at the level of educational practices; what communication styles are enacted; and what identities are being promoted, enforced, etc within a foreign language classroom throughout the foreign language teaching/learning process.

Language education policies always "interact with contested and contesting ideologies" [2] regarding the status and the position of different foreign languages within the society at large on diachronic and synchronic axes (popular language attitudes), and are based (among other things) on economical, political and other orientations of local communities and individual students and their parents (affective and other attitudes toward foreign languages, their speakers and cultures as well as the perception of languages as economic and other resources).In order to be able to better address all the above raised issues, in order to be able to contest, fight and eliminate negative stereotypes, cultural, ethnic, racial and other types of intolerance and ignorance, foreign language teachers need to recognize their own agentive role and its impact on foreign language policy creation which must take into consideration not only pedagogical and methodological but also historical, cultural, and other aspects of speech communities and polities they live in, on one hand, and cultures and polities of the foreign languages they teach on the other hand [3]. Furthermore, they need to be able to prepare their students for the lifelong learning that lies ahead of them, which opens up new perspectives for acquiring and using a number of foreign languages in a broad range of communicative contexts, open to creating and accepting their own new identities through recognition and understanding of identities of others. In other words, foreign language teachers as foreign language education policy makers and classroom practitioners engage in critical foreign language teaching "in a foreign language classroom which becomes a 'third' space, a place where the source and the target cultures meet, to create an atmosphere of interculturality leading to heightened degrees of intercultural and plurilingual competence and awareness" [4].

In this paper, the above outlined multilateral and multidimensional approach to foreign language education policy is presented, which should help all interested parties (students, parents, local communities, as well as teachers and policy makers) make informed decisions about the choice of languages which should appear in the formal educational system, and which should support the best possible methodological options that improve students' cognitive and learning strategies and help them become autonomous and successful learners and language users.

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THE NATIONAL EDUCATIONAL STANDARDS FOR WRITING – HOW TO MEET THEM?

Jasmina Moskovljević Popović
Faculty of Philology, University of Belgrade, Serbia
jasmina.moskovljevic@fil.bg.ac.rs

The project of introducing national academic standards into the Serbian education system started in 2005, and after four years of talking over, writing, circulating, researching, piloting, recirculating and rewriting, the National Educational Council adopted the National standards for the end of elementary school education in 2009 [1], and the National standards for the end of the first cycle of elementary school education in 2011 [2]. Teams of elementary and secondary school teachers and university professors had been working together to develop and formulate content standards for ten school subjects, Serbian language being one of them. Standards are formulated at three different achievement levels (basic, intermediate, and advanced), and, in the case of the Serbian language, they subsume four strands: Reading, Writing, Grammar, and Literature. Like the other sets of standards, writing learning standards indicate what students should know and should be able to do at the end of grade 4 and grade 8. Besides incorporating traditional curriculum requirements (e.g.: *students demonstrate a command of standard written Serbian*), both sets of writing standards (grade 4 and grade 8) introduce some relatively new elements and requirements (e. g.: *students are able to write for different audiences in different formats and different genres*, or: *students write ... expository and argumentative texts which are clear and coherent...*). As the new standards which set the goals of schooling have been established, the question arises: how can teachers implement these standards in their classrooms? So the major aim of my presentation would be to review and to discuss major aspects of writing standards implementation problem.

For writing standards to be achieved, every student and every teacher should know, in the first place, what the standards are, what counts as an adequate performance in fulfilling a given standard, and what both teacher and student have to do in order to meet the standard. This has to do with the culture of the classroom: of course that even in the most traditional classrooms good teachers have always had standards for their students, but the problem was that very often students were not aware of what those standards had been, or whether they had been applied differently to different groups of children or even to different individuals within a class. Getting the benchmarks known, and making expectations clear is important, especially for average– to lower–achieving students who may not always take the initiative regarding their work or know how to aim for those goals without guidance.

The second major point of teaching to standards has to do with teacher training programmes. Unfortunately, standards haven't yet penetrated much into teacher training curricula. It seems that schools of education still have to realize that their graduates would likely have to learn to teach to standards wherever they get their jobs.

The third aspect of teaching to standards problem involves Serbian language curricula in general, and writing curricula in particular, as well as textbooks which are now available on the market. Without major changes in writing curricula, it's difficult to see how writing standards might be met. Instead of the traditional approach to teaching of writing, which emphasizes the teaching of grammar, the paragraph or sentence structure, a purpose–oriented approach, which considers the reasons for writing, and the audience for whom to write has to be adopted. The same stands for textbooks. The latest analysis of elementary school textbooks [3] revealed that writing prompts offered to students include narrative and descriptive topics almost exclusively, with no expository, persuasive, or argumentative ones.

Further problem (and not a small one) in writing standards implementation presents the assessment of students' work. It would be very difficult, if not impossible, to align present norm-referenced system of marking with writing standards. Norm-referenced marking system allows the teacher to compare students to each other, but standard-based marking system presupposes that students' progress has to be compared to the given standard, not to how well or poorly other students do. To fully implement the new system, not only that performance (instead of content) writing standards would have to be developed, but in-service training for teachers would have to be organized, so that they can successfully apply the new marking system.

Taken all this into account, it seems that a lot of changes and adjustments in our education system would be necessary before we can at least hope to meet the writing (and all the other) standards established in the national educational standards documents.

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FROM THEORY INTO PRACTICE: OPPORTUNITIES AND CHALLENGES TO REFORM SUBJECT TEACHER EDUCATION

Vera Rajović & Lidija Radulović
Faculty of Philosophy, University of Belgrade, Serbia
vrajovic@f.bg.ac.rs

This paper will introduce the methodology of and experiences with developing a modern and flexible interdisciplinary master-level programme for subject teachers in second cycle of primary education and secondary schools in Serbia, compliant with Bologna requirements and with recently enacted Serbian Law on the Fundamentals of Education and Pedagogy (Tempus project MASTS 511170). The main goal of the project is to develop a Master level teacher initial education program that would fit to the societal needs, as well as to provide a sustainable solution that would make such a program systemic part of higher education offered by all state universities. The program should provide all potential future subject teachers with the possibility to gain 36 ECTS as required by law, together with a Master degree. Also, the program should contribute to substantially redesigning initial teacher education so as to modernize it based on three main pillars:1) teacher competences framework, 2) reflective practice, and 3) professional development as the process of LLL, with the initial education as a first stage [1, 2].

The first step to building such a program is getting an overall picture about current state of the art in teacher education. Although there is a number of research studies done and some of the information can be found on websites [3, 4], we all know that reform is a live process with continuous changes based on experiences (introducing new programs, changing current programs and syllabi...). Together with the authors' stance that all changes in practice should be research-based, this continuously changing context was the reason that we did research at all five state universities and their member-faculties about the current state of teacher education programs and their perspective on future developments. The main body of data consists of survey results, but preceded by an expert group action research and followed by few focus group workshops aimed to deduct the meaning of survey results for new program planning.

Research has been performed at 1) university level and 2) individual faculty – university member- level. Some of the results relevant for new program development are:

- There are no unified TE programs accessible to all students at any university. There still exists a division among faculties being classified as "teacher-faculties" and "non-teacher faculties", with the first being faculties of basic scientific disciplines taught mostly in compulsory and general education. Vocational schools, apart from the general part of education, are under the biggest risk for not having any trained teachers, except for the subjects they teach.

- As to the model of TE at those faculties where there is any, predominant model is “leaking”, i.e. simultaneous realization of teacher preparatory courses together with subject discipline courses during undergraduate and master studies. Both universities and individual faculties expressed the need for strengthening the pedagogical part of teacher education as priority, together with well organized teaching practice. But, when asked about where they would like new master program to be installed, the majority (including “non-teacher faculties) answered that they’d prefer it to be at their faculty, with some of the “teacher-faculties” answering that the optimum solution would be a teacher education center at university level that could serve all students future teachers.
- Competences and research based teacher education are still new concepts that should be understood together with their implications for teacher education system

These and other implications are analyzed and the ways to integrate them in to quality assurance mechanisms for all five programs at all universities involved are further discussed in the paper.

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THE SCHOOL LIBRARY AS A FACTOR OF TEACHING IMPROVEMENT

Aleksandra Vraneš
Faculty of Philology, University of Belgrade, Serbia
aleksandra.vranes@fil.bg.ac.rs

Although they are of exceptional importance for the education and upbringing of our youth, school libraries in this country have remained stuck between the formal legal proclamations of the state organs dealing with education and the lack of funds and understanding on the part of schools [1]. Established around the middle of the 19th century, owing to the joint activities of state ministries, municipal councils, the educational authorities and institutions, as well as independent cultural organisations such as “The St Sava Society” in the 19th century or the Cultural League in the 20th century, school libraries directly contributed to the teaching-educational process in schools, increase in the knowledge of certain teaching areas and the development of the practice of systematic use of reference works, scientific literature and *belles lettres* works.

The contemporary school and its library, providing support to the educational-teaching process, should ensure accessibility, evaluation, interpretation of information and knowledge, communication with new and fresh ideas, affirm and develop critical thinking, and be open to all pupils and teachers, irrespective of their intellectual and emotional level. They should be able to recognise and offer to their users professional media programmes and conferences, have relevant and topical materials at their disposal, and activate the individual potential of every child [2]. The school library should be an information/communication centre possessing various types of library materials, processed from a number of different aspects, and skillfully, knowledgeably and inspirationally presented to the reading public through stimulating programmes aimed at increasing the level of reading.

The school library of today stimulates: investigative learning, as the most creative form of learning, focusing on curriculum contents, learning through games and extracurricular activities, and establishing connections between different subjects [3]. Focusing on the school-age population is a constant and basic determinant of the school library, guided by the wish to develop knowledge, skills and principles that enable it to access the local, regional, national and global sources and possibilities. It is our duty to develop a new strategy and methodology of teaching and cooperation between librarians and teachers with the aim of improving learning results.

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CURRENT ISSUES OF FOREIGN LANGUAGE TEACHER EDUCATION – FROM THEORY TO REALITY

Julijana Vučo
Faculty of Philology, University of Belgrade, Serbia
julijana.vuco@fil.bg.ac.rs

The education of foreign language teachers means a completely inclusive process during which the following should be given: the knowledge about theory and its application in foreign language teaching; the theory of teaching foreign languages; psychology; the conditions of teaching; and the methodological knowledge. At the same time, multiple external factors influence the preparation of foreign language teachers, for example, the pressure of globalization processes and the needs for language as a way of international communication, specific language politics, national and supranational strategies about foreign language learning, establishing centralized control over learning and teaching of foreign languages (CEF), as well as relevant learning standards, education of teachers [1] and their competences [2].

The education of teachers is one of the most important tasks of educational systems in the modern world. Among multiple attitudes towards these questions, most experts consider that the education of foreign language teachers should include several main issues: excellent practical knowledge of the foreign language, through knowledge of foreign language theory and related disciplines, and knowledge of conditions and contexts in which the teacher works. The importance of high-grade foreign language teachers in Europe confirms a great number of projects, which had been carried by the European Council by the end of XX century (SIGMA - www.sigmaweb.org TNTEE - http://tntee.umu.se/index.html) with the aim to support and offer the most appropriate model of a teacher education. Documents that originate from that kind of effort in which problems and mistakes from previous systems are recognized are well known [1]. From these documents it is clear that the main support for new viewpoints require an academic level for the teachers' profession.

There are multiple sources that point us to types of teacher education. Most of them mean that the teachers' profession supposes mastery of knowledge which is scientifically founded, solid formal education, a sense of social benefit, high standards for professional behaviour and skills for competently performing challenging and useful tasks [3].

In this paper, relations between modern theoretical attitudes, models of teachers education, legal obligations according to the current laws in Serbia are established, and the *de facto* situation at the Faculty of Philology, University of Belgrade – an institution that educates to a great extent of foreign language teachers in our environment.

A lot of theoretical critical views and experienced and possible solutions in practice are offered for the determination of certain pedagogical – psychological – methodical teaching, as well as implementation of required methodological practices.

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