Scientific Creativity: The Missing Ingredient in Slovenian Science Education

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Creativity is regarded as one of the cornerstones for economic and social progress in every society. There are two possible ways to get creative people to work for an enterprise or community. The first is by attracting creative employees by good working conditions – a solution for those who can afford such an approach. For communities that are not so rich, the only solution is to foster creativity by education and by helping small and medium enterprises to create products based on creative ideas and innovations. In Slovenia, proposals for nourishing creativity and innovations emerge from the government thus forgetting that creativity does not start at University or on the first day of employment. To increase creativity, immediate action should be taken throughout the educational system, recognizing that society needs not only creative artists but scientists, economists and engineers as well. Through the analysis of the legislation, syllabi and textbooks, it can be recognized that they do not promote or even allow creativity in science education; even more, they can be regarded as creativity killers. In such a way key documents and teaching resources are placing creative science teachers in the position of guerrillas in a battle against prevailing teaching methods influenced by high-stakes external exams or measurable outcomes. To improve science creativity, the legislation should be changed to give creativity appropriate value, and teachers must be educated to use methods that increase creativity in students, with the aim of producing open minds that will be able to work in a creative way.

Key words: creativity, education, elementary education, secondary education, innovation, strategies

Introduction

Creativity is regarded as one of the cornerstones of economic and social progress (e.g., Economy of Culture, 2006; Creative Economy Report, 2008; Creativity and Innovation European Year, 2009), and creative people, regardless of whether they are conforming adapters or rule-breaking innovators (Kirton, 1976), are valuable resources in limited supply. Communities, organisations and enterprises which do not recognize creativity as one of the key elements of progress are condemned to stagnation or even regression. There are two possible ways to get creative people to work in a country or organisation. One is by attracting them, as described by Florida (2004, p.1):

> "It is not the country's generous endowment of natural resources, the size of its market, or some indigenous Yankee ingenuity that powered its global competiveness for more than a century. America's growth miracle turns on one key factor: its openness to new ideas, which has allowed it to mobilize and harness the creative energies of its people."

What is left to less prosperous or even poor countries, with limited resources to buy or attract the brightest minds from abroad with superior working conditions? Countries performing poorly in national economic competitiveness rankings can improve their standing significantly by focusing reform efforts on raising the quality of education and on expanding access to education and training (Sabadie & Johansen, 2010). However simply adding a class or two here or there or opening a new school based on

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existing teaching practices can only slow down regression. Progress can occur only through the enhancing and nurturing of creativity locally through their educational systems (Villalba, 2010) and through building effective, small-network, innovative communities (Chen & Guan, 2010). In such a way there is the potential to nourish creative capital (McWilliam & Dawson, 2008) and to produce a surplus of creative people – if creativity is something that can be taught, or to raise those with in-born creativity to higher creative levels if creativity is inherited (Simonton, 1999a, b). Such a surplus of well-educated innovators, in both quantity and quality, correlates with progress, at the best, and can prevent a country or region from becoming an underdeveloped colony as a result of “brain drain” (Stark, Helmenstein & Prskawetz, 1997; Beine, Docquier & Rapoport, 2008), at the worst. Additionally, besides giving students opportunities to be creative, the goal of educational systems should be the development of a culture of innovation and creativity (Dobrowolska, 2010), on that is lacking in many countries, among them Slovenia (Zenko, Mulej & Marn, 2004; Mulej, Likar & Potocan, 2005). It would be unfair to say that the importance of education is not recognized in Slovenia, but one anticipated problem is that simply increasing the frequency and intensity of conventional educational activities is hardly going to transform schools into creative communities with students working at the upper end of their cognitive and creative limits. A similar failure has been already observed in the case of narrowing the gap in achievement between students coming from different social environments (Whitty, 2010).

It remains open question whether different kinds of creativity are recognized by all stake holders in education and what kind of creativity should be nurtured to a greater extent in schools. Based on outcomes, we can recognize different kinds of creativity (Creative Economy Report, 2008), as follows:

- cultural (artistic) creativity involves imagination and a capacity to generate original ideas and novel ways of interpreting the world, expressed in text, sound and image;
- scientific creativity involves curiosity and a willingness to experiment and make new connections in problem solving;
- economic creativity is a dynamic process leading towards innovation in technology, business practices, marketing, etc., and is closely linked to gaining competitive advantages in the economy.

All of the above involve technological creativity to a greater or lesser extent and are interrelated, as shown in Figure 1 (Creative Economy Report, 2008, Economy of Culture in Europe, 2006).

Additionally, one should recognize the difference between big 'C' creativity as a complex set of behaviours and ideas exhibited by an individual and small 'c' creativity located in the processes and products of collaborative and purposeful activity (McWilliam & Dawson, 2008). If we accept that creative thinking assumes, among other things, the ability to generate a variety of original ideas, to see different viewpoints and elaborate on ideas (Meintjes & Grosser, 2010), then small ‘c’ creativity is what can be nurtured systematically in formal education without the need for dramatic change in the educational system but through changes in teaching and learning methods and strategies. Even better news is that many of the methods and strategies to enhance small ‘c’ creativity, like problem-based teaching, are not unknown, but the problem is that they are rarely used in teaching (Šorgo et. al, 2011).

In 2010, the Ministry of Higher Education, Science and Technology of the Republic of Slovenia (now Ministry of Education, Science, Culture and Sport) produced two documents and launched a general public debate via its website. One of the papers was a National Higher Education Programme for the period 2011–2020, with the cover title ‘*Daring Slovenia: A knowledge-based society’*, and the second paper was entitled *‘Research and Innovation Strategy of the Republic of Slovenia’* In both papers, the words *innovation* and *creativity* are mentioned on several occasions, in such sentences as these:

- create an environment conducive to inventiveness, innovation, entrepreneurship and knowledge transfer in products and services with high added value (Research and Innovation Strategy, p. 1);
- The University environment will be creative and innovative and will offer a good place to solve current challenges. Additionally universities will take particular care to instill the generic skills, especially creativity, innovation, critical thinking, independence, team work and ability to work in the international arena (Daring Slovenia, p.33).

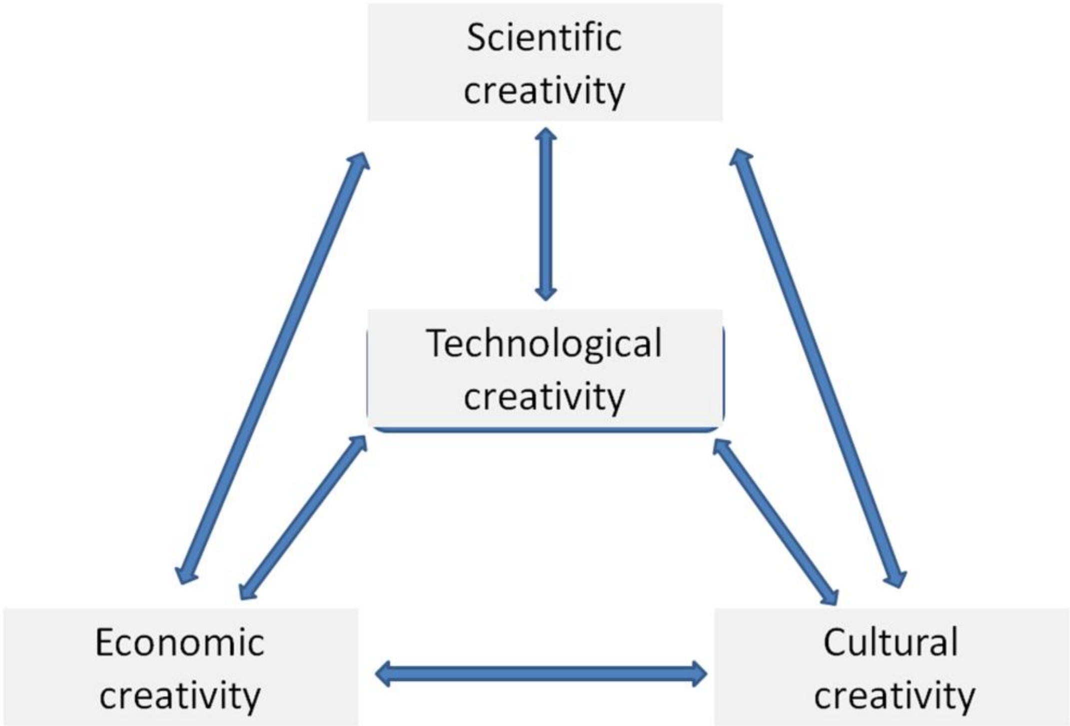

Figure 1. Relations between Creativities (source: Economy of Culture in Europe, 2006, 2006, 42)

There is no choice but to applaud to such sentences, as always, however, problems are hidden in the details. One of the most important is the lack of recognition that innovation and creativity cannot be initiated at the universities and research institutes. You cannot increase creativity simply by providing resources and imaging that someone is going to became creative the next day after entering University or on the first day of employment. If one thinks seriously about an innovative society, such a society should start nurturing imagination, a sense of innovation and creativity on the very first day of kinder-garten to produce open-minded students on entry to higher education or the world of work. This argues for policies, schools and pedagogies that promote creativity and the human capacity for innovation, not the relentless pursuit of externally imposed, measurable standards (Sahlberg & Oldroyd, 2010), and teachers who can recognize and nurture creativity (Newton & Newton, 2010). The third paper, produced in 2011, is a White paper on Education (Bela knjiga, 2011), covering pre-university education. But contrary to previous two documents, one can conclude that creativity and innovation were not on the minds of the committee.

Creativity in schools is traditionally connected with subjects such as art or literature but rarely with science subjects or mathematics (Newton & Newton, 2010) and even more rarely with technology and economics. On the other hand, successful societies cannot prosper only on creative artists or writers. Society also needs creative scientists, economists and engineers who will be able to find solutions to local and global problems such as improving the efficiency of usage of energy and material sources, finding new methods of health care, improving yield, managing waste, activating of local resources and human potential, to mention only few. Even if one is not going to use creativity as an employee, creativity can help in solving home or personal problems or simply add methods and instruments for better understanding the world and surrounding phenomena.

It cannot be expected that a shift toward creativity and innovation will be welcomed in schools. The main reason is that inventors need to think differently in order to break existing paradigms (Chen & Guan, 2010), a fact that is not in line with conservative teaching practices and established cultures of assessment in schools. Sahlberg & Oldroyd (2010) recognize that the bureaucratic 'industrial', standards-driven model of schooling currently fails to release the talents of students for either the competitiveness or the collaboration that will be crucial in facing the demands of the decades ahead. Yet, it would be unfair to say that creativity does not already have its place in schools. One can easily identify many activities which can be regarded as creative at every school, ranging from art and theatre groups to young researchers or work with gifted children. The problem is that such activities are mostly performed as extracurricular activities or projects, and not all students take part. The intention should be that teaching in all subjects, not only in those regarded as creative, should have at least some components that will lead students toward innovation and creativity. In science education such strategies are most often connected with inquiry and problem-solving strategies used to solve real world problems and occasionally with imagination.

Teachers may be regarded as key role players in the introduction or obstruction of innovation and creativity in schools. On the student- teacher-level, four marginal situations can be recognized. The most favourable is when creative students are taught by a creative teacher. In this case all that is needed is autonomy within the school curriculum which allows creativity and some free resources that can be used on demand, because one cannot plan the outcomes of the creative process in advance. The second case is when uncreative students encounter creative teacher. In this case students can only gain by learning strategies of creative work if conditions allow such work. The third case is when creative students have an uncreative teacher. Such a situation is common in schools, and students can have conflicts with such teachers and end by considering lessons boring and unattractive. Additionally some student absenteeism can be attributed to this kind of work, because students seek out-of-school activities that can fulfil their creativity potential. In the last case, uncreative students are taught by an uncreative teacher. Even if the outcome of such teaching is cook-book results, this are tolerated or even preferred in schools because this situation does not produce creative conflicts, and outcomes can be easily measured.

Science teaching in Slovenia at the pre-university level

The Slovenian school system can be considered as good in many ways, and in terms of international studies (PISA 2006, PISA2009), Slovenian students fall in the upper part of the scale in science achievement. Additionally, around 98 % of students enter upper secondary education after finishing compulsory education. Less positive news is that our students are excellent in repeating of memorized facts and problem solving in familiar situations, but their knowledge is flawed in solving problems in novel ways (Strgar, 2010; Glažar & Devetak, 2010). These findings call for action, not to change the school system or the number of lessons dedicated to science subjects, but in didactic renovation of teaching strategies nurturing inquiry and problem-based strategies, creativity and evidence-based critical thinking. It should be mentioned that there exists in Slovenia a well established system of student competitions based on presentation and defence of research work and a network of summer schools. The problem is that the system is based on voluntary work and only a small fraction of teachers and students participate.

The Slovenian school system is mostly public and the percentage of private schools is less than 1%. The majority of schools follow one educational doctrine, and only a couple of private schools are based on Waldorf pedagogy. Elementary nine-year (3 three-year cycles) education is compulsory, with students aged from 6 to 15. Primary and lower secondary education are unified, and most students continue education in upper secondary schools. Upper secondary education includes vocational and technical schools and general secondary schools (gimnazija) with different streams (general, classical, art, technical, economic or sport). Gimnazija lasts four years and prepares students for further study. Upper secondary educations ends with external examinations called the Matura examination (vocational Matura, general Matura), and high school teaching is greatly influenced by these (Ivanuš Grmek & Javornik Krečič, 2004, Pšunder & Harl, 2008).

Science is taught as an integrated subject in the first seven years of compulsory schooling. After that, it is divided into Biology, Chemistry, and Physics and taught as separate subjects in the last two years of compulsory schooling. The same division is prolonged into the gimnazija programme. Biology, Chemistry, and Physics are compulsory subjects in the first three years of gimnazija and elective in the fourth year. Every student in general gimnazija must take 210 lesson hours in Biology, Chemistry and Physics (total 630) and can elect one or two of these (140 additional lesson hours for each science subject) as optional subjects to sit at the Matura examination. There are differences in the number of lessons for science subjects in different streams, but ultimately the number of optional lessons in every stream in each science subjects allows students to finish school with a Matura result in a chosen science subject. In vocational schools subject diversity is much higher (Aberšek, 2004).

Curricula for the whole school system are approved by the governmental bodies, a situation which allows only limited autonomy to individual schools and teachers in choosing elective content and subjects, but which leaves teachers free to choose teaching methods. There exist more than one textbook for all major subjects, and there is strong concurrence between publishers for a share of the relatively small market. Teachers can choose the textbook to be used in a classroom, but differences between textbooks lie more in the number of photos, quality of graphics and text style than in content. The reason is that textbooks must follow prescribed syllabi for the subject, "covering" all the goals that are controlled and approved by governmental bodies.

Research Methodology

Teaching, especially in regulated and controlled systems, is greatly influenced by regulation, and the syllabi for a subject are key documents in preparing teachers' work (Šorgo & Šteblaj, 2007; Šorgo & Špernjak, 2012). Syllabi for the science subjects in the primary and secondary schools and matura catalogues were checked by using the *find* option and by searching for these key-words: innovation, creativity, and roots of these words (e.g. creativ*). Additionally some of the key acts were checked in similar fashion.

By Slovenian rules, textbooks must be approved by governmental bodies, and they have to be prepared in such a way that all objectives and goals are covered. They must be constructed in a way that does not call for students to fill in blanks in order to answer questions or solve tasks directly in the text-book. Teachers can choose textbooks published by one of several publishing companies. Textbooks are accompanied by teaching materials, work-books, and recently with web-pages, but teachers can use these or not, at their own discretion. The Science textbooks were checked in a search for the cognitive levels of activities and tasks as part of student research work completed for graduating theses at the Department of Biology at the Faculty of Natural Sciences and Mathematics of the University of Maribor and supervised by the author.

Results

Mention of creativity and innovation in the key acts

Five key acts regulating primary, secondary and higher education in Slovenia were checked for the key words creativity and innovation. The documents checked were as follows:

- Elementary School Act
- Gimnazije Act
- Matura Examination Act
- Vocational Education Act
- Higher Education Act

In all five documents the words *innovation* and *creativity* were found only once: in a sentence in the Elementary School Act. In paragraph 2 about the goals of Elementary school, one of the listed goals is,'development of entrepreneurship as a personal stance in the effective action, innovation and creativity of students'.

From the analysis of the key acts regulating the entire educational system of Slovenia, it can be easily recognized that innovation and creativity (with the exception of one line in the Elementary School Act) are not issues worthy of being be mentioned. It should be suggested to Parliament that they add to every act where the goals of education are listed a sentence indicating that one of the main goals of the whole educational system, and every institution inside it is to nurture creativity and innovation. Creativity and innovation should not be regarded only from the standpoint of development of entrepreneurship (as in the Elementary school Act), but as an added value of education by itself.

Mention of creativity and innovation in the science subject syllabi for elementary school

The syllabi checked (available online) were as follows:

- Environmental Education (1st cycle)
- Science and Technology (4th and 5th grades)
- Science (6th and 7th grades)
- Biology (8th and 9th grades)
- Chemistry (8th and 9th grades)
- Physics (8th and 9th grades)

Creativity in the context of experimentation is mentioned only once among the general goals of the subject Environmental Education in the first three-years cycle of Elementary school (Table 1):

> "Overall goals of instruction in the first trimester are: social (communication, relationships between students and teacher) motivation (curiosity), development of work habits (to learn), moral and ethical objectives (norms of behaviour, resolving ethical conflicts), creativity (experimentation), physical (manual dexterity, safety at work) and emotional (self, relationship with nature)" (Environmental Education, p. 6).

Table 1. Science subjects, lesson hours and mention of the words *creativity* and *innovation* in the relevant syllabi

Subject / Grade	Grades	Sum of lessons	Innovat*	Creativ*
Environmental Education	1, 2, 3	315	0	1*
Science and Technology	4, 5	210	0	0
Science	6, 7	175	0	0
Biology	8, 9	116,5	0	0
Chemistry	8, 9	134	0	0
Physics	8, 9	134	0	0

Study of documents (Table 1) clearly shows that creativity and innovation were not on the minds of reformers from the late 1990s and later revisions of the syllabi. Inquiry and problem-solving strategies can help in developing creativity, especially if problems are ill defined or generated by students, and students are encouraged to generate ideas. The syllabi of all science subjects were checked not only for the keywords *problem* and *inquiry* but to recognition of such work from context. It was possible to recognize that inquiry and problem-solving strategies are not mentioned or recommended in the syllabi of Environmental Education (1st cycle) and Science and Technology (4th and 5th grade). They first appear in the syllabi of general Science in the 6th and 7th grades. Such methods are not, however, directly mentioned in the general goals of the subject or didactic recommendations about methods to be used in the classroom. One can first recognize the problem-based approach in the paragraph 'Acquisition and processing of data and problem solving' as part of the chapter, 'General goals of assessment and grading', where one can read that students should,

- solve problems by integrating knowledge from different scientific topics and other subjects (Science, p.8);
- apply knowledge in new situations, to critically analyze and raise new problems; to give reasons for and against (Science, p. 8).

From the wording of the whole chapter, it appears that the writers of the syllabi do not have in mind ill defined problems that are to be solved in a creative manner, but instead as a problem-based approach is recognized as the solving of simple, well-defined problems, with the solution to be applied to a family of similar problems. Similar reasoning is implicit in the syllabi of Biology, Physics and Chemistry. Teachers should lead students to solutions that are allready known.

Mention of creativity and innovation in the science subject syllabi of general secondary school (gimnazija)

The syllabi (available online) checked were as follows:

- Biology – general programme
- Chemistry – general programme
- Physics – general programme

In the Biology syllabus (Biology) the word *innovation* is not mentioned, and the word *creativity* is mentioned only once in a list of general goals for biology teaching,

- to encourage creative thinking about complex biological systems and problems, thereby building the capacity for a conceptual leap between the various levels and addressing the problem of different angles by moving through the network of knowledge either in a vertical or in a horizontal direction (The capacity for complex thinking) (Biology, p.5).

In the Chemistry syllabus (Chemistry) the word *innovation* is not mentioned, and the word *creativity* is used three times: twice in the section General Goals/ Competences, where it is written, as follows: High school chemistry, as a general educational subject, is based on a problem-oriented teaching and research approach. Students in high school should upgrade skills they have acquired in chemistry in elementary school and develop as a priority,

- cognitive processes (complex thinking), critical thinking and creativity (Chemistry, p.6);
- initiative and entrepreneurship (creativity, initiative, planning, organizing, leading, risk assessment, decision making (Chemistry, p.7).

The wording of the syllabus continues thus (Chemistry, p. 45):

- Interdisciplinary integration in terms of interdisciplinary work is one of the key concepts of modern education policy development, since young people are now expected to have lateral thinking ability and skills in various fields, creativity and flexibility. In doing so, the interdisciplinary integration of networking and the transferability of knowledge and skills are invaluable.

In the Physics syllabus (Physics) the word *innovation* is not used while the word *creativity* appears as a part of an explanation of competences based on the definition of the key competences defined by the European Parliament and later in the sections 'Procedural knowledge and skills' and Cross curricular connections:

- In addition, the major physics issue is developing core competences: critical thinking, problem solving ability, creative ability and the capacity for initiative, decision making, and risk assessment ((Physics, p. 6).
- The major physics major issues for developing core competences are the following: critical thinking, problem solving ability, creative ability and capacity for initiative, decision making and risk assessment (Physics, p. 6).
- Sense of initiative and entrepreneurship: Developing creativity, initiative, risk assessment and decision-making (Physics, p. 7).

- The capacity for complex thinking: This implies, in particular in physics, systematic observation, inference, generalization, interpreting and evaluation, modeling, solving problems and the like. Important skills developed by students in physics include the acquisition of critical thinking, creative thinking, the ability to take the initiative and decision making (Physics, p. 36).
- The purpose of increased cross-disciplinary and interdisciplinary transferability of skills, thus creating conditions for better understanding, to enhance the usefulness of knowledge and thus greater creativity in all subject areas. (Physics, p. 40)

The word *problem* is mentioned on several occasions and in different contexts in all three syllabi. The first context involves using the word *problem* in frameworks such as ‘environmental problems, health problems, the problem of alcohol abuse, etc.’ The second context is in general aims and goals, where on several occasions it is mentioned that students should be competent to recognize problems. From the context, it can be recognized, that through school work, they should be able to recognize issues such as environmental problems, health problems, energy saving and similar and make personal decisions based on evidence at some point in the future or in an out-of-school context. From an analytical reading, it can be concluded that problem solving is understood merely as an intellectual strategy for solving tasks, a conclusion derived from the operational goals, as follows:

- (Students should be) able to analyze and solve problems in cases that require the use and integration of concepts from different areas of science (Biology);
- (Students should) develop complex reasoning by solving simple real (authentic) problems associated with mass and energy changes in chemical reactions (Chemistry);
- Students solve more complex problems (as in elementary school), in which the resultant forces on the body equal zero, and the body is stationary or moving with constant speed in a straight line (Physics).

Mention of creativity and innovation in the Matura documents

The matura documents checked were as follows:

- Biology matura catalogue
- Chemistry matura catalogue
- Physics matura catalogue

The Catalogues for Biology, Chemistry and Physics to be used as guidelines for the Matura examinations in the year 2012 were checked. In the three documents, the word *creativity* was found only in the Chemistry catalogue in two sentences.

The first sentence was listed among the goals and objectives of the Matura examinations and stated that the Matura should nurture ‘cognitive processes (integrated thinking), critical thinking and creativity’ (Chemistry matura catalogue, p 6), and that,

> ‘In particular candidates, through experimental work in chemistry and the general Matura exam exercise many other key elements of the generic capacity for lifelong learning, such as: initiative and entrepreneurship (creativity, initiative and planning)’ (Chemistry matura catalogue, p. 7).

Creativity and innovation in textbooks tasks and questions
Questions and tasks at the ends of chapters in the commercially available textbooks for Science in the 6th grade of Elementary school (Table 2) and Biology (Table 3) in the 9th grade were ranked according to Blooms' revised taxonomy (Krathwohl, 2002).

Table 2: Cognitive levels of questions according to Blooms' revised taxonomy (Krahtwohl, 2002) used in textbooks for thesubject Science in the 6th grade of Elementary school

Cognitive levels	Textbook 1	Textbook 2	Textbook 3	Textbook 4
Remembering	45 (48.4 %)	108 (73.6 %)	88 (83.0 %)	17 (100 %)
Understanding	36 (38.6 %)	23 (15.6 %)	13 (12.3 %)	0
Applying	2 (2.2%)	9 (6.1%)	1 (0.9%)	0
Analyzing	10 (10.8 %)	5 (3. 4 %)	4 (3.7 %)	0
Evaluating	0	0	0	0
Creating	0	2 (1.3 %)	0	0

Table 3: Cognitive levels of questions according to Blooms' revised taxonomy (Krahtwohl, 2002) used in textbooks for the subject Biology in the 9th grade of Elementary school

Cognitive levels	Textbook 1	Textbook 2	Textbook 3
Remembering	47 (43.5%)	89 (72.3%)	35 (40.7%)
Understanding	45 (41.7%)	25 (20.3%)	42 (48.8%)
Applying	1 (0.9%)	5 (4%)	8 (11%)
Analyzing	13 (12%)	4 (3.2%)	0
Evaluating	1 (0.9%)	0	1 (0.9%)
Creating	1 (0.9%)	0	0

Because all goals and objectives, prescribed by the syllabi, should be covered, which is a prerequisite for a textbook to be approved for use in the classroom there is little difference between the textbooks in content; differences appear only in writing style, use of examples and figures and diagrams. Textbooks are written mostly as a source of information, with added questions mostly intended to assess recall and understanding of the information presented. It can be easily seen from the Table 2 and Table 3 that creating something or solving problems in an innovative or creative way is not regarded as an important goal by the textbook authors, their reviewers or the approving governmental bodies. The situation in the other subjects and at other levels of education is almost analogous to that in the subjects Science and Biology.

Discussion

From the results of the analysis of legislation, syllabi and science and biology textbooks, it can be concluded that creativity and innovation were not a preoccupation of creators or writers of these documents, even if it is mentioned on several occasions that students should be able to solve problems. One cannot begin blaming students and teachers if science teaching in Slovenian schools is dominantly traditional and teacher-centred (Šorgo et al., 2011). Students are students, and they are going to do what is asked of them to conform to at least minimal standards of success as set by them or by their surroundings in most cases, and so rarely drop out of the school system. When 1046 upper secondary-school students were asked what they would change in biology teaching in most cases they would like to change the way they are taught in favour of interesting themes and active methods such as laboratory- and field-work (Šorgo & Špernjak, 2007). So, if intention of the school system is to help students by increasing creativity, several steps should be taken, and there is no one solution. Two approaches should be taken simultaneously. In a top-down approach, the first question to be answered is whether school regulation and available resources promote innovation and creativity. Based on the evidence the answer is clearly "No". Changing regulations can be regarded from a top-down approach as the easiest part of the work. If the political climate and political will in the society can foster change in favour of creativity and innovations by adding a couple of paragraphs to existing acts this cannot be regarded as mission impossible. The inclusion of creativity and innovation in legislation cannot by itself bring about change but is necessary to give creativity and innovation appropriate status among the goals and objectives of education and to protect creative teachers and students in an environment that in most cases only tolerates and does not warmly support activities that depart from school tradition. In the second step the syllabi and Matura guidelines should be prepared in such a way as to free space for innovative teaching and to promote inquiry and problem-solving strategies, leading students to achieve and show knowledge at the higher cognitive levels (DeHaan, 2009). Creativity should be embedded in all parts of the syllabi not, only in preambles and proposed didactic strategies that promote active methods and critical thinking, but as a number of well defined goals. Such goals must be operational and based on solving ill-defined problems. There is no necessity to completely rewrite the syllabi, because several creative solutions can greatly help in improving teaching. One such simple and far-reaching assertion could be that each teacher must prepare some academic lessons together with students to solve real world problems, covering more than one discipline using imagination and 'out-of-box' thinking. A choice of socioscientific issues, such as genetic engineering, biotechnology, bionics, environmental problems, energy saving, etc. are at hand as real world problems. On the other hand, problem-based laboratory and experimental work should be promoted instead of the cook-book experiments that dominate contemporary school practice (Šorgo, Vrčkovnik & Kocijančič, 2007).

For the second step, textbooks must be rewritten, and if a strategy of questioning is used to raise creativity, several standard questions should be asked concerning each activity or topic: "Is it possible to do something in an alternative way? Is it possible to use a process or product for something not mentioned in the textbook? Is it possible to connect new knowledge with knowledge from some other subject, or something not learned in school? Find an alternative way to solve the problem", and similar. "Cook book" laboratory manuals should be changed into inquiry- and problem-based labs and the word *discovery* should be the leading idea of textbooks and laboratory manuals, teaching students, even uncreative ones, to use strategies and algorithms leading to novel solutions.

From the bottom-up perspective immediate work with teachers is necessary. Because public schools cannot choose students by their creativity potential, what must be changed is the teaching. Creative teachers need autonomy and the resources to work in a creative way, goals that can be achieved by opening up the curricula and allowing freedom to create their own teaching materials. A much greater problem involves uncreative teachers. Because they are not going to produce out-of-box solutions, they must receive bullet-proof materials or be forced to use methods that will enhance creativity in students even in the absence of teacher creativity. In such case, both creative and uncreative students can gain. The first will gain by nurturing their creativity, and the second by learning algorithms that can result in producing creative solutions for problems. Strategies that promote cognitive flexibility, such as inquiry- and problem-based methods, can be implemented, to allow students to imagine creative solutions, viewpoints and possibilities (DeHaan, 2009), and work with scientists from research institutes can help in building research skills and in narrowing the gap between educators and scientists (Taylor, Jones, Broadwell & Oppewal, 2008) and helping to build a creative school climate (Dobrowolska, 2010) by the exchange of ideas. Teachers should cease to think of creativity as something that cannot be learned. Thus they must be educated in the use of strategies and appropriate methods (Jang, 2009). Additionally, teacher will need support to build sufficient self esteem to be aware that not knowing something is not a shame but a starting point for inquiry (Šorgo, 2010).

As a conclusion of this study, it can be said that the legislation, syllabi of the science subjects and textbooks prepared accordingly together with the intended outcomes of the external Matura examinations contribute potential creativity-killers in Slovenian science education. These findings from Slovenia are in line with conclusions by Villalba (2010) that the educational systems were designed for a different type of economy that valued a different set of skills. They were not designed for the so-called knowledge-based society that requires highly creative individuals, ready to be lifelong learners and to apply their knowledge and skills in a variety of settings and forms, even though it should be taken for granted that only creativity and innovation can show the way out of recession or stagnation at best. All kinds of creativity should be nurtured because the best results are achieved by a combination of creative and innovative "both-brain teams" (Rigby, Gruver & Allen, 2009). Honestly speaking, altering documents is only a prerequisite but not something that will change the school climate without redirecting well-established teaching practices in science toward creativity and innovation. This must be the challenge of all science teacher educators in in-service and pre-service courses. Finally, creativity should not be nurtured predominantly as an extracurricular activity, running parallel to mainstream teaching or as something restricted to cherry-picked gifted students, but as part of the normal everyday process of school work.

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Appendix: List of checked documents (Available online on 12, May, 2012) Acts

Elementary School Act. Online: http://zakonodaja.gov.si/rpsi/r08/predpis_ZAKO4918.html)
Gimnazije Act. Online: (http://zakonodaja.gov.si/rpsi/r00/predpis_ZAKO450.html)
Matura Examination Act. Online: (http://zakonodaja.gov.si/rpsi/r04/predpis_ZAKO2064.html)
Vocational Education Act. Online: (http://zakonodaja.gov.si/rpsi/r02/predpis_ZAKO982.html)
Higher Education Act. Online: (http://zakonodaja.gov.si/rpsi/r02/predpis_ZAKO172.html)

Elementary school syllabi

Environmental Education (1st cycle) . Online: http://www.mizks.gov.si/fileadmin/mizks.gov.si/pageuploads/podrocje/os/devetletka/predmeti_obvezni/Spoznavanje_okolja_obvezni.pdf
Science and Technology (4th and 5th grades) . Online: http://www.mizks.gov.si/fileadmin/mizks.gov.si/pageuploads/podrocje/os/devetletka/predmeti_obvezni/Naravoslovje_in_tehnika_obvezni.pdf
Science (6th and 7th grades) . Online: http://www.mizks.gov.si/fileadmin/mizks.gov.si/pageuploads/podrocje/os/devetletka/predmeti_obvezni/Naravoslovje_6_obvezni.pdf
Biology (8th and 9th grades) . Online: http://www.mizks.gov.si/fileadmin/mizks.gov.si/pageuploads/podrocje/os/devetletka/predmeti_obvezni/Biologija_obvezni.pdf

Chemistry (8th and 9th grades) . Online: http://www.mizks.gov.si/fileadmin/mizks.gov.si/pageuploads/podrocje/os/devetletka/predmeti_obvezni/Kemija_obvezni.pdf
Physics (8th and 9th grades) . Online: http://www.mizks.gov.si/fileadmin/mizks.gov.si/pageuploads/podrocje/os/devetletka/predmeti_obvezni/Fizika_obvezni.pdf

General upper secondary school (Gimnazija) syllabi

Biology for General Gimnazija Programme. Online: http://portal.mss.edus.si/msswww/programi2009/programi/media/pdf/ucni_nacrti/UN_BIOLOGIJA_gimn.pdf
Chemistry for General Gimnazija Programme. Online: http://portal.mss.edus.si/msswww/programi2009/programi/media/pdf/un_gimnazija/un_kemija_gimn.pdf
Physics for General Gimnazija Programme. Online: http://portal.mss.edus.si/msswww/programi2009/programi/media/pdf/un_gimnazija/un_fizika_gimn.pdf

General Matura Catalogues

Biology matura catalogue. Online: http://www.ric.si/splosna_matura/predmeti/biologija/
Chemistry matura catalogue. Online: http://www.ric.si/splosna_matura/predmeti/kemija/
Physics matura catalogue. Online: http://www.ric.si/splosna_matura/predmeti/fizika/