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Science as an Integrated Approach - A Démarche Focused on Promoting the Competencies for Life

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Abstract

Our world is not a world made of disciplined puzzle pieces, but one where issues, situations, realities must be addressed in full uniform, gathering knowledge, skills, abilities, patterns, acquired interdisciplinary mental schemes and actions, but also *beyond disciplines*. Unfortunately, the knowledge is transferred often to pupils/students in limited contexts, circumscribed different subjects, and the attempts for *breaking this pattern* are quite shy, at least in Romanian schools.

Considering that the learning objects subsumed under Science area are the first enabled to be envisaged in an integrated approach, with the help of a conducted Delphi study organized in the FP7 European Research Project *PROFILES - Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science* (code: SiS-2010-5.2.2.1-2.2.1-266,589), it was proposed to identify the perception of the academic trainers in relation to the content to be taught to lower and upper secondary school-children, Science teaching skills, as well as learning contexts to be organized.

The paper illustrates some results of this investigative approach that shows a gap between the effectively implemented curriculum in school and the real training needs (objectified in content and specific skills) identified by questioned trainers. Most opinions stipulate that a Science integrated approach allows the students' experience to be clearly involved in the process, offering more substance and relevance of learning. Topics such as *Renewable Energy Sources, The Environment - Do We Love It or Destroy It?, Nutrition and Health: What Is Good to Eat?,* have a great potential to become more accessible and interesting for students if they are considered beyond the *narrow lens* of disciplines, isolated from each other, and treated inter-, many-(multi-) and/or trans-disciplinary.

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1. Introduction

The major changes that accompany the path of the postmodern society force us to reconsider the educational theories and practices and to employ other axiological retrospections. At the same time, it determines profound transformations which are produced, first of all, inside our beings, in our mentality.

"Through the unprecedented growth of knowledge in our epoch, the problem of adapting the mentality to that knowledge gains legitimacy", asserted Basarab Nicolescu in 1999. For an optimum reporting and adaptation to the world we live in, it is necessary *to break the disciplines' patterns* (and the actual curriculum is centered on disciplines), *to create bridges between them*, trying to see also what is *beyond disciplines*.

The reviving of the Romanian school depends not only upon the educational policy decisions which were taken lately, but especially upon the measure in which the teachers can effectively achieve the profound and so necessary curricular reform. That implies a pragmatic orientation of the curriculum, a connection to the problems of the contemporary society, an educational paradigm change and a flexible pedagogical conception, dissociated from the canons of the traditional, conservatory and out-dated pedagogy. In this context, the curriculum integrated approach, the alignment with the competences represent - both for the conceivers of educational policy, of scholar curriculum etc., and for the education practitioners - the reference that can *move* the school out of its old patterns / routine.

2. The skills - a desirable result of the educational process

On the18th of December 2006, the European Parliament and the European Council adopted *the recommendation regarding the key skills for the lifelong learning* - a document that constitutes the *European reference frame* in the related field. *The European reference frame of the key skills for lifelong learning* defines 8 key-skills, already integrated in the educational policy documents. As such, in Romania, in the *National Education Law*, the 68th article stipulates:

"(1) The national curriculum for primary and secondary school is axing on 8 domains of key skills that determine the pupil's training profile:

a) communication skills in Romanian and mother tongue (in the case of the national minorities);
b) communication skills in foreign languages;
c) basic skills of mathematics, sciences and technology;
d) digital skills of using the information technology as a learning and knowledge instrument;
e) social and civic skills;
f) contractor skills;
g) cultural sensitiveness and expression skills;
h) skills of learning how to learn."

The defining and description of the key-skills constitute an actual preoccupation not only for the EU organisms, but also for other institutions, national and international institutions and organizations. The project *Partnership for 21st century skills*, which started in 2002, involving the USA Department of Education, but also other organizations interested in the educational field, aimed also to define the key-skills for the XXI century, starting from the premise that every child needs certain specific knowledge and skills in order to become an efficient citizen, worker or leader, in order to efficiently integrate in the society he leaves in.

The observation that served as a benchmark in the projection of those skills - an observation which is valid also for the Romanian space - is that there is a profound disparity between the knowledge and competences delivered to the pupils in school and the knowledge and skills they need in the communities of the 21st century and at their future job.

In order to help the education practitioners for integrating the necessary competences in the basic academic disciplines, it was elaborated *the learning framework in the XXI century* (*P21 Framework Definition Document*), which offers an unitary vision upon the learning process. This framework generally describes the abilities, knowledge, skills and expertise that pupils must master / detain in order to have success at work and in life. Three

types of skills are identified: *learning and innovation skills*, *information*, *media and technology skills* and *life and career skills*.

In the Romanian school, we begin to see the huge effort of involving in an oriented démarche toward producing - in general - the necessary skills for social development - and especially, for the personal development - taking into account specific needs analysis (Gorghiu et al., 2012) but also the conditions of identification and maximal valorization of pupils' individual abilities.

The achieving of such démarche requires the pupil's placement in the center of the educational process, thus ensuring the satisfaction of his / her expectations, interests and needs. In this sense, we should be preoccupied with the organization of a motivational educational environment that stimulates the pupils' participation at their own training process, allowing so the formation and practicing of the cognitive, instrumental-applicative, attitudinal, meta-cognitive etc. skills and facilitating / ensuring the necessary conditions for their placement in specific situations of scholar success.

3. The Science integrated approach and the formation of life skills

In Romania, the *Science skills* were defined in a special report produced by the *Romanian Academic Society* (*SAR*), in March 2010, as the ability to use a methodological and knowledge body, implicated in the actual world explaining, in order to identify questions and to draw conclusions based on empiric evidences. For *Science and Technology*, the *essential knowledge* includes: basic principles of the natural world, the fundamental scientific concepts, technology, technological products and processes, the understanding of the Science and Technology impact upon the natural world. Those skills must help individuals to a better understanding of the progress, limitations and risks of the scientific theories, of the applications of technology in the society (in relation with the decisional process, the moral and cultural aspects and values).

The abilities include the capacity to use: instruments and devices; scientific data to achieve an objective or to reach a conclusion / to make a decision based on empiric evidences. Persons should be able to recognize the essential features of the scientific investigation and to have the ability to communicate the conclusions and the reasoning through which they were achieved (*School's exit from mediocrity. How do we define key skills and the risks of scholar curriculum modification*, SAR Report, 2010).

Benefiting of a clear description of the knowledge and abilities circumscribed to the Science skills, we wonder *in what measure are our pupils in their possession* and *in what measure does Science represent for them a field attractive enough to study it thoroughly at a superior level, through university studies*? We identify the answer to those questions in a document issued by the European Union Council. Thus, in *the conclusions of the Council regarding the improvement of the basic skills level in the context of the European cooperation for the schools in the XXI century* (2010), the following statements are specified:

- innovative pedagogic methods and well trained teachers can improve the pupils' attitude towards *MST* (*Mathematics*, *Science*, *Technology*) and the accomplishments in this field; at the same time, this might lead to the situation in which more pupils will continue at superior levels the studies in those fields and, eventually, to a growing of the number of graduates in the *MST* field;

- following the Commission Report from 2007 (*Science education now: a renewed pedagogy for the future of Europe*), it is recommended a more extended usage of the education based on research in Science, the elimination of the Science teachers' own action by creation of specific networks, paying a special attention to the girls' attitude towards Mathematics, Science and Technology, and the school opening toward a larger community;

- achieving of basic skills - the foundation of the key-skills development for lifelong learning - will have an essential role in the improvement of the professional insertion capacity, of the social inclusion and personal fulfillment. Consequently, measures must be taken in order to stop the low learning results and the social exclusion;

- good level of reading skills and arithmetic knowledge, next to a solid understanding of the basic principles of the natural world and fundamental scientific concepts, ensure the basis of achieving of the fundamental skills for lifelong learning and thus they must be approached from an early age;

- when approaching the complex problematic related to the improvement of the *MST* reading skills and knowledge, it must be paid attention to the following aspects:

a) *conceiving of scholar curriculum*;

b) *motivation for reading skills and MST knowledge*;

c) *impact of the new technologies on the basic skills and their usage in order to support those who study to gain autonomy and to remain motivated*.

In conclusion, especially in Science teaching, it is necessary to renounce to the pedagogical practices centred on the formalized presentation, excessively abstracted of the specific contents, and to promote an integrated approach (multi-/inter-/trans-disciplinary) involving teaching-learning methods axed on action, experimentation, investigation and problems solving.

The formation of pupils' scientific spirit, of their learning abilities during the entire life, implies "… a changing of the type of intellectual activity, of the method used by the one who learns; and, of course, a problem of teaching, and exercising in an activity of learning specific scientific issues, which to offer the possibility to make a kind of "Science indenture" or of "discovery indenture", to behave like a "pupil-researcher", able to regard reality with the researcher eyes, that is to ask questions (raise problems), to issue hypothesis, to imagine strategies; to engage in an activity of search, exploration, attempts, investigation, rediscovery of what he / she *should know*" (Cerghit, 2002).

The teaching practices activated by teachers should then be *thought over*, selected and used according to their capacity to start an authentic learning, based on understanding, on the logic thought mechanisms. The expert-teacher builds his / her didactic démarche respecting the principles of the pedagogic constructivism and constantly reporting to the age and individual psychological particularities of his / her pupils. The teacher creates a learning environment in which pupils can valorize their own knowledge, even if they are acquired in non-formal or informal contexts, they can verify their validity, they can confront them with other colleagues knowledge, they can share them with others; an experiential learning environment, based on action, scientific investigation, experiencing, on the discovery of new truths that will be the generating source for restructuration in the previous build cognitive structures.

4. Results and discussion

The formation of the skills that are usable in a variety of actual situations is - according to the EU documents - the mission of the contemporary school. In this respect, in a specific Delphi study organized in the FP7 European Research Project *PROFILES - Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science* (Bolte et al., 2011; Bolte, & Schulte, 2011), it was identified the perception of the academic trainers in relation to the content to be taught to lower and upper secondary school-children, Science teaching skills, as well as learning contexts to be organized.

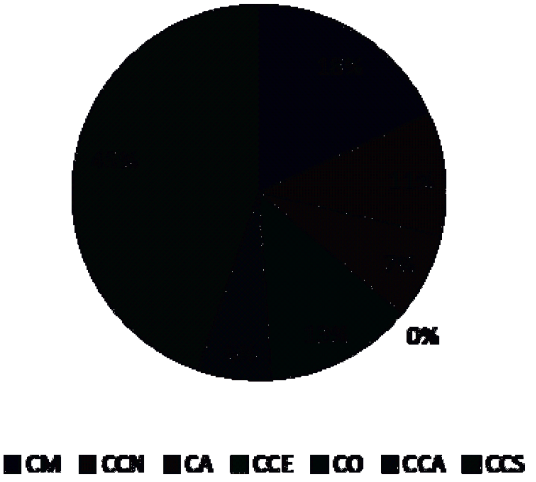

Figure 1. Chemistry situations and contexts appreciated as useful to be introduced in the lessons in order to stimulate and further the Science-related educational processes (CM - Environmental Chemistry; CCN - Unconventional combustibles; CA - Food Chemistry; CCE - Experimental Chemistry; CO - Organic Chemistry; CCA - Inorganic Chemistry; CCS - Chemistry as Science)

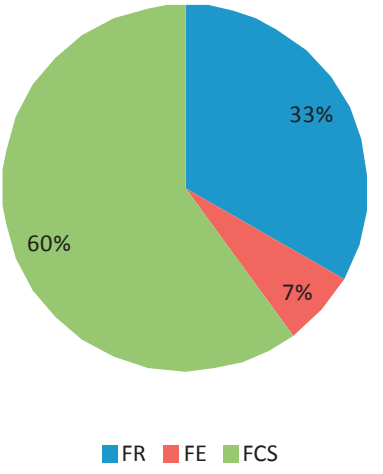

Figure 2. Physics situations and contexts appreciated as useful to be introduced in the lessons in order to stimulate and further the Science-related educational processes (FR - Physics of radiations; FE - Electricity; FCS - Physics as Science)

The Romanian Delphi study respondents were various stakeholders, starting from students (pupils) - 16-18 years old to Science teachers, educators, researchers, education spokespersons for education policy, and finalizing with people who are not directly involved with Sciences (Gorghiu et al., 2012).

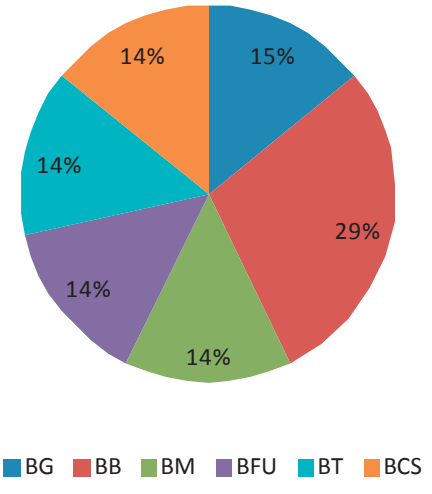

Figure 3. Biology situations and contexts appreciated as useful to be introduced in the lessons in order to stimulate and further the Science-related educational processes (BG - Genetics; BB - Biosystems; BM - Microbiology; BFU - Human Physiology; BT - Biotechnologies; BCS - Biology as Science)

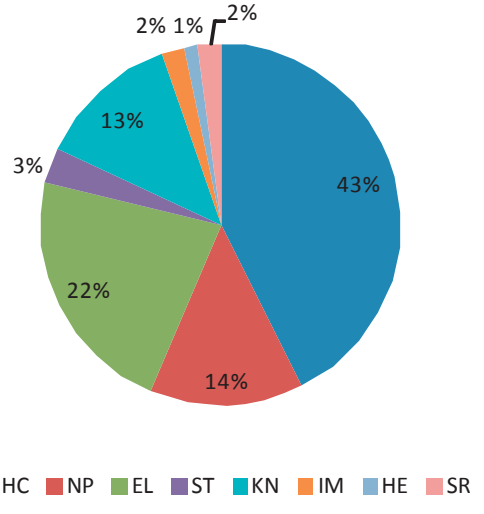

Figure 4. Interdisciplinary situations and contexts appreciated as necessary to be introduced in the lessons in order to stimulate and further the Science-related educational processes (HC - Health care; NP - Nature preservation; EL - Everyday life; ST - Free time observation; KN - General knowledge; IM - Technological development; HE - Home environment; SR - Scientific research)

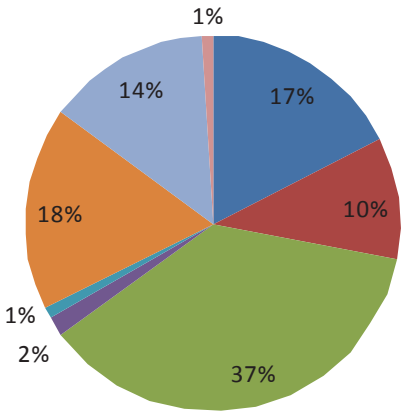

Figure 5. Skills / competencies / attitudes that should be developed and enhanced to support students in becoming scientifically educated (MI - Motivation and interest; SNE - Sensitivity related to nature and environment; ARR - Acting reflectively and responsibly; SC - Social competences / ability to work in a team; CS - Communication skills; CU - Contextual understanding; ICT - Interdisciplinary and complex thinking; FSQ - Formulating scientific questions / hypotheses)

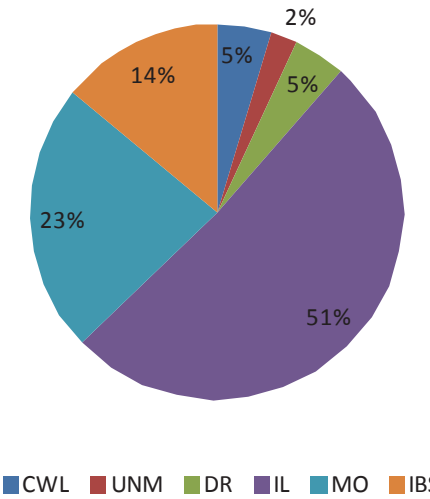

Figure 6. Didactic methods that should be used to support students in becoming scientifically educated (CWL - Cooperative learning; UNM - Using new technologies; DR - Experimenting; IL - Interdisciplinary learning; MO - Modeling; IBS - Inquiry-Based Science Learning)

For the teaching practices, the most interesting feed-back was offered by the *Science teachers* and *Science trainee teacher educators* who formulated specific statements related to *Science situations, contexts and motives* that can be taken as a basis in order to stimulate and further science-related educational processes, but also to evidence *skills, competencies and attitudes* that should be developed and enhanced to support students in becoming scientifically educated. In this respect, figures 1, 2 and 3 illustrate the Chemistry / Physics / Biology situations and contexts appreciated as useful to be introduced in the lessons, in order to stimulate and further the Science-related educational processes. It is evident that Chemistry / Physics / Biology as Sciences, as natural and life sciences need more detailed information, attention and time to be considered more in the actual teaching / learning process than usual. On the other hand, as figures 4 and 5 present, interdisciplinary studies (as *health care* of *everyday life* contexts) are appreciated as very necessary and important for promoting the students' competencies for life, and specific skills / competencies / attitudes (as *acting reflectively and responsibly* or *contextual understanding*) should be developed and enhanced for supporting students in becoming scientifically educated.

Finally, as figure 6 illustrates, it is important to mention that more than half of the interviewed *Science teachers* and *Science trainee teacher educators* express that *interdisciplinary learning* represents the main channel that should be used for supporting the students in becoming scientifically educated persons. At the same time, *process and phenomena modeling* and *inquiry-based Science education* should be taken into consideration as specific didactic methods focused on student's constructed learning.

5. Conclusions

We consider that the themes afferent to the Sciences field can be approached in an integrated manner, the scholar curriculum being susceptible of being multi-/inter-/trans-disciplinary projected, thus facilitating the understanding of the physical, chemical and biological processes and phenomena which are vital for the conservation of a healthy natural environment. Acting in this manner, we will accomplish a quality education *for* and *through Science*, centered on skills, promoting an integrated curriculum which subsumed the basic scientific contents and the related abilities, the practical habits and the attitudes specific for Science. Covering such an educational path, the future

graduates will possess the instruments that will allow them to have continuous access at complex scientific knowledge and to extend learning at their entire life scale (*life-long learning*).

We nourish the firm conviction that "the scholar success is given by the pupil's capacity *to excel* in the various disciplinary structures and context, when success in personal, professional and social life is given by the capacity to get out of the *disciplinary box*, by the ability to make fast connections and transfers, which lead to the efficient solving of the actual problems with which he / she confronts" (Ciolan, 2003).

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