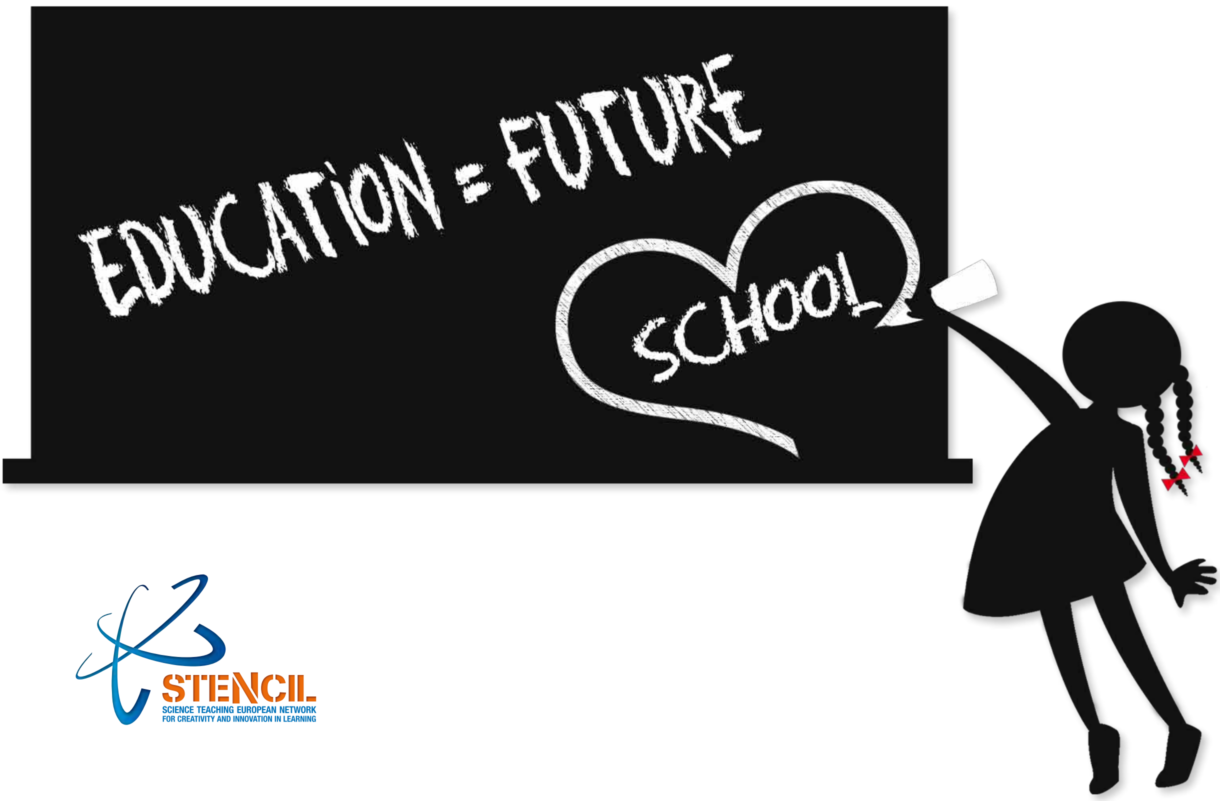
GUIDELINES FOR TEACHING AND LEARNING SCIENCE IN CREATIVE WAYS



STENCIL
SCIENCE TEACHING EUROPEAN NETWORK
FOR CREATIVITY AND INNOVATION IN LEARNING

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INDEX


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PREFACE

The Comenius Network STENCIL – *Science Teaching European Network for Creativity and Innovation in Learning* – has been funded in 2011 with support from the European Commission within the Lifelong Learning Programme and it is running since then. STENCIL involves members from 9 different European countries: Bulgaria, Germany, Greece, France, Italy, Malta, Portugal, Slovenia, Turkey, working together to contribute to the improvement of science teaching, by promoting innovative methodologies and creative solutions that make science studies more attractive for students. To involve organisations and schools from such a high number of countries represented a great benefit for the STENCIL project and a big challenge as well. This is true not only at a geographical level, but also considering that the STENCIL partners represent different points of view on science education, as they are: public and academic research institutes, private research organisations, science museums, educational authorities and schools. During the project lifespan the different cultural and geographical backgrounds of the STENCIL partners have been harmonized and a community of science education practitioners has been built, sharing science education experiences and methodologies at a national and European level.

During this 3 years period a lot of work has been done, also taking advantage of the positive results achieved by two former European projects: STELLA – *Science Teaching in a Lifelong Learning Approach* (2007-2009) and GRID – *Growing interest in the development of teaching science* (2004-2006). STENCIL members have worked together in order to identify innovative good practices in science education in their respective countries and at European level, as well as to exchange and reflect on how to innovate science teaching at school, through study visits, workshops and conferences.

Nowadays, STENCIL offers to science teachers, schools, school leaders, policy makers and all practitioners in science education from all over Europe, a platform – stencil-science.eu – to encourage joint reflection and European co-operation, and providing high visibility to schools and projects from all over Europe. On the STENCIL platform the main outcomes and results of the Network are made freely available, and in particular:

The *European Online Catalogue of Science Education Initiatives*, which offers to teachers and all persons interested in science education the possibility of publishing their science education projects and to be inspired from searching for initiatives within different subjects from other schools and countries. The STENCIL Catalogue is already featuring over 1200 initiatives, based on the activities by the former European projects STELLA and GRID.

The *Annual Reports on the State of Innovation in Science Education*, presenting the results of the joint reflection on science education themes and models carried out by STENCIL members as well as the detailed descriptions of the innovative practices identified at national and European level.

The *Guidelines for teaching and learning science in a creative way* focusing on the main issues for innovation on science education, and offering to stakeholders and decision makers recommendations for possible future initiatives.

STENCIL Network will not end with the funding period: its members are willing to do a step forward, to keep working and reflecting on science education. The Network is growing with the involvement of new associate members and new countries, and the present *Guidelines for teaching and learning science in a creative way* go in this direction by calling for actions and future projects.

INTRODUCTION

The STENCIL project is focused on teachers and aims to give them different tools and opportunities for sharing strategies to be implemented in the classroom according to the students interest, characteristics, skills and learning styles. The *Guidelines for teaching and learning science in creative ways* has been designed as final outcome of the STENCIL project with the aim to offer to educational authorities and policy makers from all over Europe an opportunity to reflect on strategies for innovating science education in their countries, taking into account the everyday teachers experiences and the inputs deriving from educational research in Europe.

The *Guidelines* represents the upshot of the STENCIL Network activities and in particular of the mainstreaming and multiplication actions, consisting in measures for transferring successful results and outcomes to educators and decision-makers from different countries, with the aim to achieve their maximum impact and to make connections between STENCIL and the wider community.

With this aim in mind, a wide range of contacts have been established with potential multipliers and stakeholders, such as: MST (Mathematics, Science, and Technology) teachers and school managers' associations, policy makers, science museums, coordinators of European funded projects, and all practitioners in science education from all over Europe. In order to foster the mutual exchange and to establish a lasting cooperation among the different stakeholders, the possibility to become an associated member of the Network was promoted. Associated members actively support and disseminate the STENCIL Network in their respective countries and fields of interest [1].

1 More information on how to become an associated member at http://www.stencil-science.eu/howtojoin.php; the list of the associated STENCIL members is available at http://www.stencil-science.eu/associated_partners.php

The STENCIL *Guidelines'* final aim is to provide all relevant actors in science education, at all school levels, a set of suggestions on how to achieve innovation and creativity in teaching, and to analyse the way science teaching and learning innovation is improved and perceived in the European schools.

In order to do so, the following tools and results deriving from the of STENCIL Network activity have been analysed:

a) The *European Catalogue of Science Education* Initiatives containing more than 1200 initiatives realised in schools all over Europe, directly uploaded online by teachers or educators who have planned or managed them;

b) the review of the innovative current thematics and good practices carried out by the STENCIL members and presented in the *STENCIL Annual Reports on the state of innovation in Science Education*;[2]

c) the answers of MST teachers and policy makers collected in the partner countries in the framework of the exploitation activities.

The STENCIL European Catalogue a) offers an overview on science education projects and initiatives carried out on different subjects by teachers and practictionnaire from schools, universities, foundations, associations, etc. of different European countries. The Catalogue includes also initiatives from the former European projects STELLA and GRID[3].

The *STENCIL Annual Reports* b) – which are titled *Enhancing Innovation and Creativity in Science Teaching* – include the results of the joint reflection on science education themes and models carried out by STENCIL members as well as the detailed descriptions of the innovative practices identified at national and European level, paying particular attentions to the following themes, coming from the most current researches and studies concerning the innovation of teaching in Europe:

Teachers of the future – Teacher training policies;

Science Education as a mean for key competences development;

2 STENCIL Annual Reports are available at http://www.stencil-science.eu/annual_reports.php

3 The STELLA project - http://www.stella-science.eu - has been funded with support from the European Commission within the Lifelong Learning Programme (2008 - 2009) with the aim to contribute to the improvement of science teaching in European schools and to stimulate young people to undertake science studies and careers. STELLA extended the results of the former European project GRID - http://www.grid-network.eu- by enriching and further developing the Online Catalogue of Science Education Initiatives already created in this framework. The GRID project (2004-2006) funded within the framework of the EU Socrates Programme, had the objective of creating a network for the exchange of good practice in the field of science teaching in Europe.

Collaborative approaches to science teaching;

Teaching in the ICT age;

Equality for Excellence (including gender issues);

Inquiry Based Learning;

Peer to peer;

Communities of practice;

Science education for diversity.

The *Annual Report n. 1* approached science education issues from the outlook of national policies, reporting different expert positions on teacher training, collaborative and new pedagogical approaches, development of key competence and gender/diversity themes. In the *STENCIL Annual Report n. 2* issues related to the themes "teacher of the future", "ICT and new technologies" and "equality for excellence" were analyzed. The *Report n. 3* is focused on current research issues in thematic areas which relate to everyday school practice and are of great interest to practitioners. These are presented in the form of expert positions and teacher reflections and feedbacks.

The stakeholder questionnaire c) was proposed in all the STENCIL Network countries[4] allowed to outline a comprehensible picture of what teachers and decision makers think about the suggested strategies at European level for innovating science education. The stakeholders interviewed were mainly MST teachers, school managers, teacher trainers, school authorities, policy makers, science museums operators, and all practitioners in science education from research institutions, universities, foundations, associations, etc.

By analysing results and information from the above mentioned tools and outcomes, critical issues in the implementation of good practices and in bridging the "gap" between expectations and everyday school practice have been identified. This gap is becoming an European discussion focus in the science education research communities. We caught an indication of that by comparing the stakeholders answers with the results of the analysis of the initiatives included in the *STENCIL European Catalogue*. The results of this analysis lead to a series of reccomandations for stakeholders and policy makers on future initiatives and actions.

4 STENCIL Networks countries are: Bulgaria, Germany, Greece, France, Italy, Malta, Portugal, Slovenia, Turkey.

The STENCIL *Guidelines* are organised into 3 Parts, as follows:

Part 1: *Science education in the European context* which outlines a picture of science education issues at EU level and from an historical point of view;

Part 2: *Analysis of the STENCIL catalogue and stakeholders questionnaires*, which presents a discussion of the data collected and analized within STENCIL, and identifies critical problems and gaps;

Part 3: *Conclusion and Recommendations* which presents the results of the reflection on the data analysed and offers recommendations to policy makers.

PART 1

SCIENCE EDUCATION IN THE EUROPEAN CONTEXT

1.1 A HISTORICAL OVERVIEW OF INNOVATION IN SCIENCE TEACHING IN THE SECOND HALF OF XX CENTURY

One of the first records devoted to the teaching of science dates back to the period of the Second Industrial Revolution, when in Europe the British Academy for the Advancement of Science (BAAS) published a Report[5] in which teaching of "pure science" and training of the "scientific habit of mind" were discussed and promoted. Nevertheless, until the '50s, the teaching of science remained characterized by the separation between pre-university and university studies, and a substantial inattention/liabilities towards students.

In the second half of the Twentieth century, in USA, the pioneering teamwork of the Committee for the Study of Science Physics (PSSC, MIT) and of the Project Physics Course (PPC, Caltech), led to a fundamental transformation of physics teaching methods[6].

In Europe, the Nuffield Science Teaching Project, promoted in UK from 1962, contributed to redraw science education methods for the innovation of teaching at all educational level[7].

All the innovation strategies adopted during this period highlighted the need to increase the students involvement and to bridge the gap between secondary school and university studies, by using suitable teaching material which should allow students to actually see in their everyday life the matter they are studying and check the learning progress through experiments and tests. Furthermore the role of the teacher was reconsidered, in the awareness that "The

5 Layton, D., *The schooling of science in England, 1854-1939*, in MacLeod, R.M.; Collins, P.D.B., *The parliament of science*, Northwood, England: Science Reviews, 1981, pp. 188-210. (//www.worldcat.org/oclc/8172024).

6 *Ibidem*.

7 American Association of Physics Teachers, http://www.compadre.org/portal/pssc/pssc.cfm?view=author from AAPT Celebrates PSSC's 50th Birthday); *The Project Physics Course*, preface to the Italian edition, Zanichelli, 1974; Gerald Holton, *The Project Physics Course: Then and Now*, Science & Education 12, 2003, pp. 779-786.

mediocre teacher tells, the good teacher explains, the superior teacher demonstrates, the great teacher inspires”[8].

The key element underlyining the proposal of science teaching innovation was the empirical approach (“hands-on”) believing that “that opportunities for students to engage in direct observations of phenomena describe the process of basic scientific research… is a plausible strategy for both attracting students to science as a career and countering popular views of science as isolated facts”.[9]

This trend, started during the ‘60s, provided also the stimulus for what would later become the *Research in Science Education*, the design of teaching strategies and the development of new curricula.[10] Thanks to the studies carried out from the ‘60s, science education has become an academic subject with a significant wealth of knowledge, and the role of scientists and science communicators have acquired greater relevance in the lifelong learning system.

1.2 European state of art of MST schooling

The beginning of the decline of key science studies and mathematics in young people’s interest, as highlighted in many studies and in the so called *Rocart Report*[11], can be traced back to the early ‘80s, when it occured for the first time in the USA. The phenomenon then spread throughout the ‘90s up to involve all the industrialized countries. The endurance of some areas (such as Life Sciences and Computer Science), and sometimes to the rapid growth of new areas (such as Biotechnology) was countered by the collapse of the so-called “hard sciences”: mathematics, physics and chemistry, responsible for the training of scientists and science teachers, and fundamental base knowledge for all other scientific disciplines or related to health care. Beyond the difficulty of these studies and the possibility of finding a job, it was understood that the passion for the “hard sciences” must be turned on until primary and secondary schools.

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8 http://www.nuffieldfoundation.org/nuffield-science-teaching-project William Arthur Ward (1921-1994).

9 *Taking Science to School: Learning and Teaching Science in Grades K-8*, Committee on Science Learning, Kindergarten through Eighth Grade, Board on Science Education, Center for Education, Division of Behavioral and Social Sciences and Education, The National Academies Press, Washington USA, 2007.

10 *Normann Herr, The Sourcebook for Teaching Science - Strategies, Activities, and Instructional Resources*, John Wiley/Jossey-Bass Publishers, 2007, (http://www.csun.edu/science/index.html)

11 Rocard *et al.*, High Level Group on Science Education, Directorate General for Research, Science, Economy and Science, European Commission, *Science Education Now: A Renewed Pedagogy for the Future of Europe*, 2007. http://ec.europa.eu/research/science-society/document_library/pdf_06/report-Rocard-on-science-education_en.pdf

Despite of the numerous projects and actions that are being implemented to reverse this trend, and the first positive signals, the improvement is far from satisfying in order to address the future societal challenges that EU will have to. Without more effective actions, indeed, Europe's longer term capacity to innovate and the quality of its research could also decline. Furthermore, among the population in general, the acquisition of skills that are becoming essential in all walks of life, in a society increasingly dependent on the use of knowledge and technology, is also under increasing threat.

The latest available data do not show sizeable improvements with respect to these critical issues. Statistics from the Report of Eurydice Network, *Key Data on Education in Europe 2012*,[12] demonstrated that in general (taking into account all fields of study), during the period 2000-2009, in the EU-27 on average, the student population in tertiary education increased by around 22% (2.7% annual growth rate), reaching almost 19.5 million individuals I n 2009. In the same document it is reported that in 2009, in the European Union, on average, 124 women are enrolled in tertiary education for every 100 men, as reported in Table 1.1 Since 2000, the women students increased by almost 10% with a constant annual rate.

Geo/%	people with tertiary education % of population - age 25-34		males with tertiary education % of male population - age 25-34		females with tertiary education % of female population - age 25-34	
	2003	*2012*	*2003*	*2012*	*2003*	*2012*
EU-27	25.6	35.3	23.6	30.7	27.7	40.0
FIN	37.9	39.7	30.0	30.8	46.2	49.2
E	37.1	39.3	33.5	34.2	40.8	44.5
IT	13.0	22.3	11.2	17.4	14.8	27.2
FR	38.0	42.9	36.4	38.3	41.4	47.3
UK	33.9	45.0	34.1	42.7	33.7	47.3
DE	21.8	29.0	22.7	26.8	20.9	31.3

Table 1.1 Trend of the tertiary education population, 2000-2009, in Europe and in specific Countries taken as specimens. Data from Eurostat3 (European Commision)

12 *Key Data on Education in Europe 2012*, published by the Education, Audiovisual and Culture Executive Agency (EACEA P9 Eurydice). This document is also available on http://eacea.ec.europa.eu/education/eurydice. February 2012. © Education, Audiovisual and Culture Executive Agency, 2012.

Regrettably, the trend appears very different when looking to Eurostat data[13] focused on MST graduates, as reported in Figure 1.1.

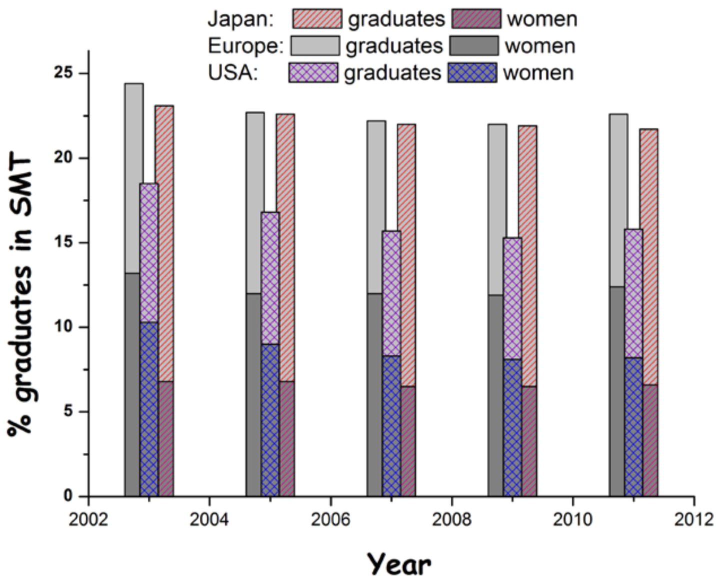

Figure 1.1 Graphic of the percentage of overall MST graduates and of women in the same disciplines, 2003-2011, in Europe (27 countries), USA and Japan.

Statistical data in Europe, USA and Japan remained unchanged in the time frame analyzed by Eurostat and indicates that the gender issue is still a topic to be urgently dealt with. The percentage of women graduated in MST has not changed significantly in the recent decades and remains significantly below that of men; women in general study at higher levels with respect to men, but a low percentage of girls undertake studies in MST.

Whatever is the reason that keeps women away from "hard science" subjects (cultural inheritance or fear to face professional careers dominated by men, for example), this represents a problem to be overcome along with that regarding ethnic minorities and immigrants.

The matter of enhancing young people interest in science and of encouraging girls to bridging the gap with the boys in this field is also relevant in extra-European countries. The OECD (the international Organisation for Economic Co-operation and Development), recently published the report *Education at a Glance 2012*[14] confirming that "science" have a low percentages of graduates in all OECD countries[15] and a big gap remains

13 http://epp.eurostat.ec.europa.eu/

14 *Education at a Glance 2012 OECD, Better Policies for Better Lives* http://www.oecd.org/education.

15 OECD countries: Australia, Austria, Belgium, Canada, Chile, Czech Republic,

between men and women graduating in scientific/technical faculties in the European and non-European countries, see Figure 1.2.

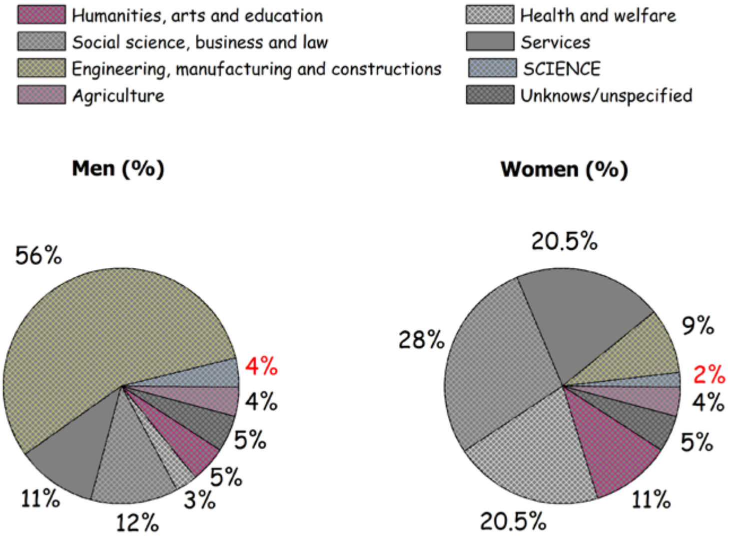

Figure 1.2 Distribution of graduates in upper secondary vocational programmes in OECD Countries, by field of education and gender (2010).
Source www.oecd.org/edu/eag2012.

1.3 EUROPEAN STRATEGIES FOR MST IMPROVEMENT

From 2000 to 2012 the need to innovate the way science is taught at school has been widely recognised at European and transnational level, and a large volume of strategies and projects have been developed to encourage teaching innovation for enhancing young people interest in MST.

In 2000, the *Lisbon strategy*[16] aimed at making Europe more dynamic and competitive, recognised the role played by education and training in the development of today's knowledge society and economy. The improvement of Maths, Science and Technology graduates by at least 15% and a better gender balance in this field was set as one of the five goals to be reached by 2010.

In 2002 the European Commission published the *Science and Society Action Plan*[17], supporting the strategic goal set by the European Union

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Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

16 European Commission 2000, Lisbon European Council 23 and 24 March 2000, Presidency Conclusions - http://www.europarl.europa.eu/summits/lis1_en.htm.

17 European Commission 2002,Science and Society Action Plan http://ec.europa.eu/research/science-society/pdf/ss_ap_en.pdf

in Lisbon and other important community debates and processes such as the creation of the European Research Area.

In 2006 the *Recommendation of the European Parliament and of the Council on Key Competences for lifelong learning* defined the "key competences" that all individuals need for personal fullfilment and development, inclusion and employment. One of the 8 key competences is indeed the "mathematical competence and basic competences in science and technology".[18]

On the same year, the European Commission appointed a group of experts chaired by the former French Prime minister Michel Rocard with the task to "examine a cross-section of on-going initiatives and to draw from them elements of know-how and good practice that could bring about a radical change in young people's interest in science studies – and to identify the necessary pre-conditions".[19] The teamwork carried out brought the famous Report issued on 2007 with the title *Science Education now: A Renewed Pedagogy for the Future of Europe* – the so called *Rocard Report*. The main novelty introduced by this report was the direct involvement of students in learning: the inquiry-based methods have to become a means to increase children's interest in science. Improvements in science education should be brought through new forms of pedagogy, the introduction of inquiry-based approaches in schools, actions for teachers training in IBSE (inquiry based science education), and the development of teachers' networks should be actively promoted and supported. Specific attention was given to gender issues encouraging the girls participation in key school science subjects and increasing their self-confidence in science. Were being solicited measures to promote the participation of cities and the local community in the renewal of science education in collaborative actions at the European level aimed at accelerating the pace of change through the sharing of know-how.

Following the main findings and recommendations of the Rocard Report, the European Commission decided to fund projects promoting innovative methods in science education. The Seventh Framework Programme[20] promoted the Science & Society Action to the 330 million euro committed in the period 2007- 2013.

In 2009 the *Strategic Framework for European Cooperation in Education and Training ("ET 2020")*[21] was launched by EU Member States and the European Commission as a follow-up to the previous Education

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18 *Recommendation of the European Parliament and of the Council on Key Competences for lifelong learning* - 2006; http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:en:PDF

19 Rocard et al. (2007) Science Education Now: A Renewed Pedagogy for the Future of Europe

20 http://cordis.europa.eu/pf7/home_en.html

21 http://ec.europa.eu/education/lifelong-learning-policy/policy-framework_en.htm

and Training 2010 work programme. The new framework addresses the following strategic objectives:

Making lifelong learning and mobility a reality;

Improving the quality and efficiency of education and training;

Promoting equity, social cohesion and active citizenship;

Enhancing creativity and innovation, including entrepreneurship, at all levels of education and training.

Among the new benchmarks set up for 2020 there is the reduction of the share of 15-years old with insufficient abilities in reading, mathematics and science to less than 15%. This target will be reached by developing existing cooperation to improve the take-up of maths and science at higher levels of education and training and strengthening science teaching. The assessment of future skill requirements and the matching of labour market needs should also be adequately taken on board in education and training planning processes, with reference to the Communication *New Skills for New Jobs*.[22]

A Report of the European Committee Education and Training Monitor[23], published in 2012, reaffirmed the topics expressed in the ET2020 adding the knowledge of a foreign language to the objectives that young people in Europe must be achieved by 2020. The document in addition states that much more effort is needed to increase the number of graduates MST fields, and this goal can be achieved only if science (and its "trades") is made fascinating in primary and secondary education.

Over the past years another crucial issue emerged for re-launching MST careers is the reassessment of the importance of the teachers role in the society. A UK governmental document published on 2004 and titled *Science & innovation investment framework 2004-2014*[24] has highlighted that the choice of undertaking a scientific career can strongly be influenced by the educators. If the teachers lack self-esteem, reputation, motivation to change, as well as resources and time,

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22 http://ec.europa.eu/social/main.jsp?catId=568&langId=en&eventsId=232&furtherEvents=yes

23 Education and Training 2012 Luxemburg: Publication Office of the European Union, 2012. ISBN 978-92-9201-350-9 - doi: 10.2797/51172. The 2012 Education and Training Monitor was prepared by the unit 'Analysis and Studies' with the help of thematic units within the Directorate-General of Education and Culture (DG EAC). DG EAC was assisted by the Eurydice unit from the Education and Culture Executive Agency (EACEA), the Centre for Research on Lifelong Learning (CRELL) and Eurostat. The members of the Standing Group on Indicators and Benchmarks (SGIB) were consulted during the drafting phase.

24 *Science & innovation investment framework 2004 - 2014* © Crown copyright 2004. Published with the permission of HM Treasury on behalf of the Controller of Her Majesty's Stationery Office. Printed by The Stationery Office 07/04 976938. www.hm-treasury.gov.uk

they are not often willing to experiment new pedagogical methods, to exchange ideas and materials, to networking with colleagues. This situation strongly influences performance and interest of the students and the relationship among teachers and society.

The *Learning Curve Report* published by the Pearson Institute and the Economist Intelligence Unit in November 2012, emphasizes the importance of the teacher as "one point of broad agreement in education is that teachers matter greatly. Students of certain teachers simply do better in a way that has a marked effect on social and economic outcomes and the single most important input variable in education is the quality of teaching". [25]

This report also provides useful suggestions to upgrade the educators quality activity: "Experts interviewed for this study repeatedly point to several of these other factors which are essential in promoting teacher quality:

- Attracting the best people to the profession: getting good teachers begins with recruiting talented individuals
- Providing the right training: the training of these new recruits has to be appropriate to the conditions in which they will work.
- Treating teachers like professionals: consistent with the need to promote the status of teaching is its treatment as a profession."[26]

Teachers will pay a key role in the future education policy and developments because it's already undeniable that : "There is no substitute for a good teacher"[27].

25 http://thelearningcurve.pearson.com/the-report

26 *Ibidem*.

27 *Ibidem*.

PART 2

ANALYSIS OF THE STENCIL CATALOGUE AND STAKEHOLDERS QUESTIONNAIRES

2.1 ANALYSIS OF THE STENCIL CATALOGUE: INTRODUCTION

The analysis aims to highlight the presence, in the *STENCIL European catalogue of science education initiatives*[28], of methodologies and critical issues which EU considers key factors for the innovation of science teaching and learning.

Information on the initiatives is primarily drawn from the forms filled out upon submission to the catalogue (a full copy of the form is included in Annex 1). When additional documentation or links are provided in English or Italian[29], these were examined too, to get a deeper insight into projects innovative contents.

Figure 2.1 Number of projects published in STENCIL catalogue by country.

28 http://www.stencil-science.eu/catalogue.php

29 The analysis was performed by the Italian STENCIL partner CNR - National Research Council - Bologna Research Area www.bo.cnr.it

Results of the analysis will be reported in section 2.2 Implications of these results and of those of the analysis of STENCIL questionnaires to stakeholders (which will be presented in section 2.3) will be discussed below**,** together with the recommendations emerging from the whole analysis and the final conclusions.

Data refers to a total amount of 201 projects published in the Catalogue from the beginning of STENCIL until June 20, 2013. Projects added after that date, were not taken into account.

Figure 2.1 shows the number of projects submitted to STENCIL catalogue by country. While some countries are well represented in the catalogue, others, especially northern and eastern EU countries, are not.

Figure 2.2 shows the distribution of projects according to the age range of pupils/students involved. All grade levels, from kindergarten to secondary school are fairly well represented in the catalogue.

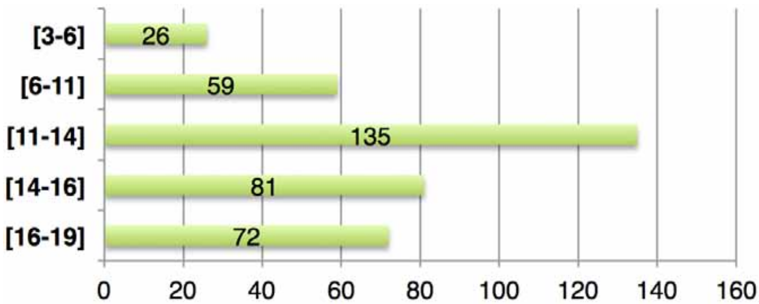

Figure 2.2 Projects distribution according to the age of pupils/students involved.

2.2 Analysis of the STENCIL catalogue: Results

Results presented here are far from being exhaustive. In fact, the number of initiatives considered is just a small fraction of all innovative science teaching projects carried out in EU. Moreover, as shown in Figure 2.1 some relevant countries are poorly represented in the catalogue. Nevertheless, as we will discuss in more details below, we believe that such results are still able to provide a significant, although rough, overview of the status of innovation in science education.

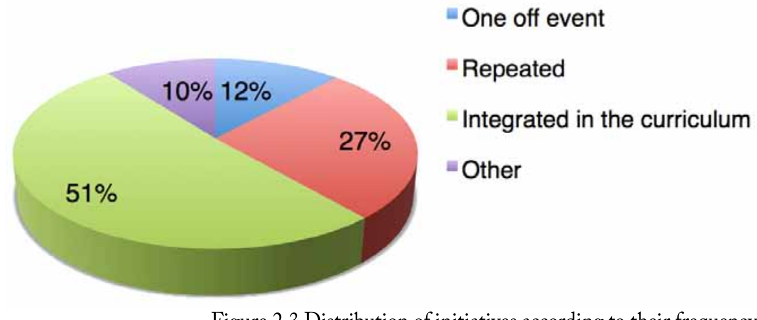

Figure 2.3 Distribution of initiatives according to their frequency.

Figure 2.3 reports the frequency of initiatives. Only a small fraction of them is one-off, the large majority of them is replicated and a half of them is part of the curriculum.

Figure 2.4 classifies the projects according to the number of people directly involved. Most initiatives are medium-large scale, only a small fraction involves less than 20 people.

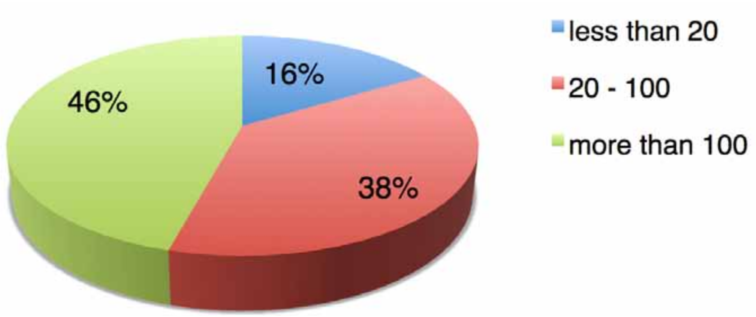

Figure 2.4 Distribution of initiatives according to the number of people directly involved.

Figure 2.5 shows the percentage of projects that contain the indicated innovative science teaching methodologies.

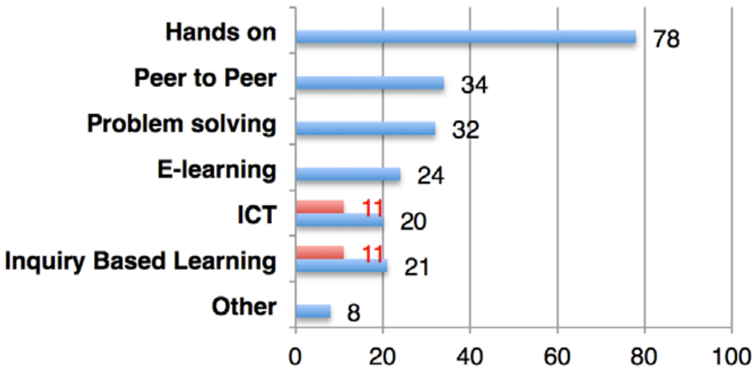

Figure 2.5 Occurrence of innovative teaching methodologies in projects (per cent). For ICT (Information and Communication Technologies) and Inquiry Based Learning items, red bars refer to the cases in which these methodologies were indicated in the empty field of the submission form. Blue bars refer to the previous cases, plus those in which the occurrence of these methodologies were identified by the curators after examining the project documentation

Not all methodologies reported in Figure 2.5 are items selectable in the submission form. We must consider that STENCIL Catalogue includes also initiatives published during former STELLA and GRID EU projects[30]. To compare evenly initiatives submitted in different periods, the submission form has been only slightly changed from 2004.

30 LLP STELLA project: www.stella-science.eu (2007-2009); Socrates GRID project (2004-2006).

The selectable entries do not therefore include methods and related acronyms, such as Inquiry Based Learning (IBL) and Information and Communication Technologies (ICT), which were refined and codified in subsequent years. IBL, for example, has become popular within education community mainly after the *Rocard Report*[31], published in 2007.

These two items have been in part mentioned by the compilers using the provided empty fields (red bars in Figure 2.5). In other cases their occurrence has been identified by the curators of the analysis through the examination of the documentation of the projects and by comparing them to projects where IBL or ICT was explicitly selected. It was found that the actual occurrence of both IBL and ICT was about twice of that declared explicitly. Ultimately, IBL and ICT are present in a substantial number of projects, however their incidence is significantly lower than that of other methodologies, in the first place the hands-on, which remains by far the most present.

Figure 2.6 reports the percentage of projects which mention at least one among the following issues that are considered critical to improve the impact of science in society: gender, school dropout, minorities, career, excellence.

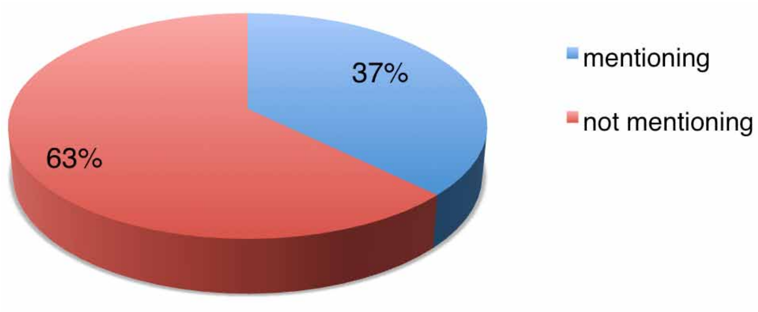

Figure 2.6 Fraction of projects mentioning one of the following critical issues: gender, school dropout, minorities, career, excellence.

These issues are mentioned only in a minority of projects. Figure 2.7 shows the occurrence of each single critical issue in projects.

It is known that Europe considers these issues, in particular the increase of women presence in science and technology, as political priorities for the innovation in science education and, more generally, for the socio-economic development[32]. The low percentage of initiatives addressing these issues do not therefore appear in line with these expectations.

31 Rocard et al. (2007) *Science Education Now: A Renewed Pedagogy for the Future of Europe*

32 See http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=1297

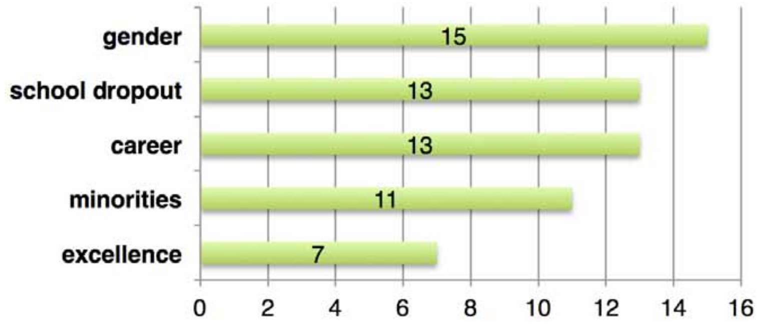

Figure 2.7 Occurrence of critical issues in projects (per cent)

2.3 Analysis of STENCIL questionnaires to stakeholders: Introduction

The STENCIL questionnaire to stakeholders was designed to investigate the opinion of people working in the field of education, on issues concerning innovation of science teaching. The aim was to collect information useful for:

- individuating guidelines and priorities for future projects and initiatives;
- comparing EU expectations/keywords with the point of view of people working in the field;
- helping policy makers to fill the gap between EU education policy and everyday classroom activity.

The questionnaire (a copy is included in Annex 2) is made of four panels, which address the following topics:

- Factors for innovating science education
- Competence of the teacher of the future
- Teachers training methodologies
- Teaching tools

Every panel provides several entries to which the respondents were asked to assign a degree of appreciation/importance. The suggested entries were chosen by the STENCIL team among those that EU is currently considering the most important to innovate science teaching. They are more articulated and partly different from those that we have seen in the analysis of the STENCIL catalogue (Figure 2.5). As noted previously, the latter are derived from a submission form that dates back to 2004, a period in which many of the items mentioned in our questionnaire were not yet the focus of the debate on science education.

All panels provide an empty field to allow compilers to suggest additional items not on the list.

Questionnaires were translated into national languages of STENCIL partners and distributed among people working in the school/education field, both teachers and non-teachers.

A total of 129 questionnaires were collected in 8 different countries. Figure 2.8 shows the number of collected questionnaires by country, divided by teachers and non-teachers.

In Part 2.3 the results of the analysis of questionnaires will be reported and briefly commented. The numbers that quantify the appreciation for the various factors were averaged over all compilers (teachers and non-teachers) of all countries. An analysis articulated country by country was not performed because only in a few cases we got a relatively high number of responses. As will be seen in Figure 2.8 and Tables 2.1-2.3, in some cases data show appreciable statistical dispersion, quantified by the standard deviations of the average values. This is due to the differences between responses of different individuals. The larger the dispersion, the lower is the agreement on the factor/issue under consideration. Results show that, in spite of this dispersion, it is still possible to identify some meaningful indications on what EU people involved in education as a whole think about innovation in science teaching. These indications appear to be quite independent of the country.

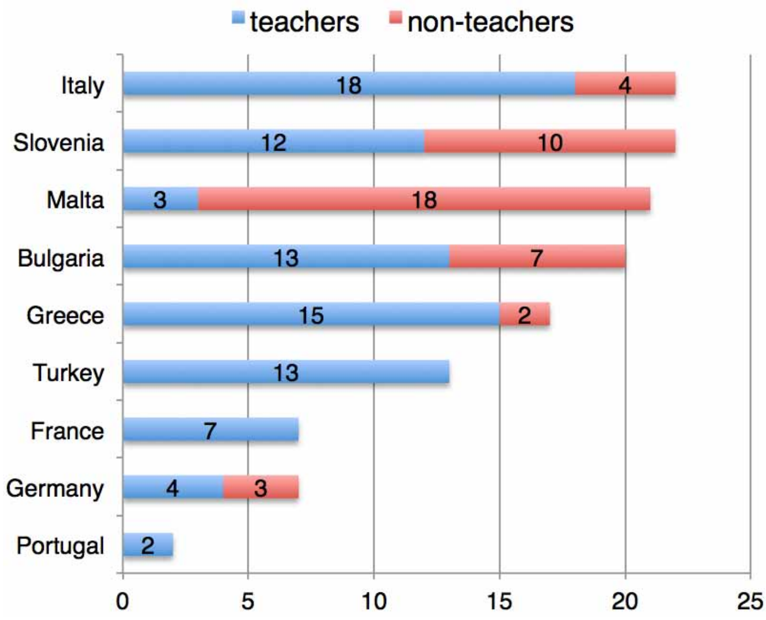

Figure 2.8 Number of collected questionnaires distributed by countries.

2.4 ANALYSIS OF STENCIL QUESTIONNAIRES TO STAKEHOLDERS: RESULTS

TOPIC 1. FACTORS FOR INNOVATING SCIENCE EDUCATION

For this topic, compilers were asked to assign a grade, from a minimum of 1 to a maximum of 5, to each of the methodologies/issues indicated in the questionnaire. Figure 2.9 reports average grades and associated standard deviations.

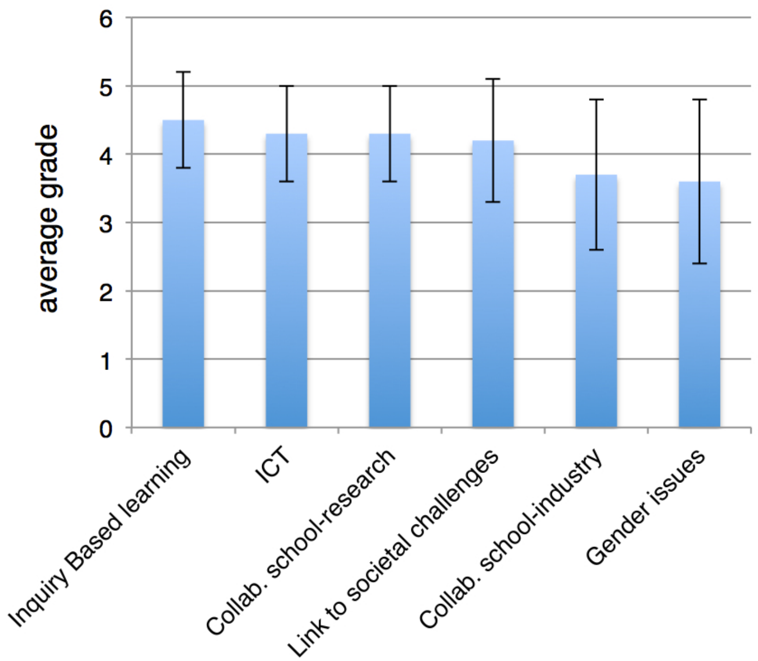

Figure 2.9 Average grades obtained by different methodologies/issues, calculated on data from both teachers and non-teachers of all countries. Black vertical bars show the standard deviations of the averages.

Among additional items suggested by compilers, the one most often cited was hands-on. We have already seen in part 2.2 that hands-on is by far the most present methodology in the initiatives of the STENCIL catalogue.

Comment. The degrees of appreciation of the proposed factors are rather leveled. We can distinguish basically two groups: the first comprising four factors: IBL, ICT, collaboration school-research, and link to societal challenges, which got similar high average grades, and the second, comprising two factors: collaboration school-industry and gender issues, which, on average, obtained a slightly lower grade, being at the same time characterized by a larger dispersion.

Topic 2. Competences of the teacher of the future

As for this and the other topics covered in the remainder of this Section, a different way of evaluation was proposed. Rather than to assign a grade, compilers were asked to arrange items in a ranking of importance.

Table 2.1 reports average ranks (and associated standard deviations) of items related to teacher competences.

type of competence	average rank	std. dev.
disciplinary	1.7	(±1.4)
science education and learning sciences	2.5	(±1.5)
ICT	3.0	(±1.4)
interdisciplinary	3.2	(±1.9)
progress in research	4.5	(±2.2)
public debate on science	4.9	(±2.2)
gender & minority issues	5.2	(±2.3)
epistemology	5.2	(±2.4)

Table 2.1 Average ranks obtained by each item indicated in the questionnaire, and associated standard deviations.

Additional competencies suggested by compilers were: IBL pedagogy, laboratory education, teamwork ability, soft skills.

Comment. Results show that, while assigning a grade tends to level out outcomes – as seen for Topic 1 –, putting issues in ranking leads to a greater differentiation. However, it must be considered that ranking gives results more relative than grade, not allowing in principle an assessment of absolute appreciation. At most, one can say that an issue is considered more important than another. From this point of view, in the results of Table 2.1 one can identify essentially three levels of importance. The disciplinary competence is considered most important above all, followed by a group comprising: competences in science education and learning sciences, competence in ICT and interdisciplinary competence. At the bottom of the list we find another group, comprising competences on advanced research, public debate on science, epistemology and gender issues. With regards to the additional items suggested by compilers, the mention of laboratory education can be easily put in relation with the reference to hands-on methodology, both emphasizing the centrality of the experimental laboratory in science teaching. Probably the recall to IBL pedagogy expresses the need of teachers to know more about how to apply this methodology in everyday school activity. On the other hand, teamwork ability and soft skills emphasize the ability of teachers to teamwork and collaboration, factors which seem very important in the work for innovation of science education.

Topic 3. Teacher training methods

Table 2.2 reports average ranks obtained by the three different teacher training methods indicated in the questionnaire.

teacher training method	average rank	std. dev.
face to face	1.6	(±0.7)
community of practice	1.7	(±0.7)
Online	2.8	(±0.7)

Table 2.2 Average ranks obtained by each item indicated in the questionnaire, and associated standard deviations.

Additional training methods suggested by compilers were: teaching abroad, teamwork, learning by doing, teaching in a real classroom under supervision.

Comment. Face to face and community of practice are clearly favored over online methods. Among the issues suggested by compilers, learning by doing can be put in relation with previously mentioned hands-on and laboratory education methodologies. The recall to teamwork emphasizes again the importance of collaboration between teachers involved in innovation of science teaching.

Topic 4. Teaching tools

Special emphasis on this topic was given to the new media and related technologies. Table 2.3 reports average ranks obtained by the proposed teaching tools.

tool	average rank	std. dev.
science lab	1.9	(±1.3)
computer & internet	1.9	(±1.0)
educational software	2.9	(±1.1)
digital whiteboard	3.2	(±1.3)
tablet	4.5	(±1.4)

Table 2.3 Average ranks obtained by each item indicated in the questionnaire, and associated standard deviations.

Additional tools suggested by compilers were: technical support, more hours per week in science, out of school activities, teamwork, high quality textbooks.

Comment. Here we can distinguish three different levels of importance. Above all we find traditional science laboratories and computer & internet, at the second level we find educational software and digital whiteboard, at the bottom we find the tablet. The highest importance attributed to traditional science labs, together with computer and internet, confirms the idea that laboratory practice is still considered by people working in the field as a key – if not *the* key – aspect for the innovation in science teaching. The mention of technical support by compilers probably means that teachers should be better empowered to make use of new media. Next to this more technical issue, it should be emphasized that the effective use of those media is strictly related to curriculum and teaching materials. In order to match the high potentialities offered by digital technologies, a deep and extensive work of curriculum and instruction design as well as a work of content reconstruction are needed.

PART 3

RECOMMENDATIONS AND CONCLUSIONS

3.1 Introduction

In this part, the results reported in part 2 and 3 are compared and discussed so as to point out the set of recommendations for possible future initiatives focused on science education.

As already stressed, the results are based on data that refer to samples which do not cover all the European countries and that coming from deeply different sources, respectively the STENCIL catalogue and the STENCIL questionnaire. The former is a database built on criteria that come from previous projects. The latter has been explicitly designed within STENCIL after that some foci of attention were selected as main factors of innovation, according to the most recent EU trends.

In order to guarantee the reliability of the discussion, the comparison of the results has *not* been carried out to discover new trends in the data *but* to bootstrap, from the data, sensible points to be evaluated against (triangulated with) other, comparable, studies.

3.2 Discussion of results and recommendations

The gap between Science Education research and school practice

As first macroscopic evidence, the comparison of the results seems to confirm the existence of the gap between the research expectations and school reality. The main indicator of the gap is the great importance attached to IBL or to ICT in the questionnaire *versus* their limited implementation.

As it is widely stressed in the *Rocard Report*[33], research in Science Education has produced plenty of examples of good practices focused on innovation aspects, but their impact on school teaching at large scale is still very problematic. The nature of the gap between research and school practice as well as the nature of the barriers which hinder transferability and dissemination of research results have been object

33 Rocard et al. (2007) *Science Education Now: A Renewed Pedagogy for the Future of Europe*

of important investigations (see, for example, the EU projects STTIS[34] and TRACES[35]). Nevertheless, the complexity and the relevance of the issue require further research effort. In particular, new methods and investigation tools effective to reach the core of the problem concerning the nature of the gap, are needed to be designed.

Recommendation #1:

> **EU and European Countries should encourage and support investigations explicitly aimed at analysing the nature of the gap between research and school practice as well as the nature of the barriers which hinder the transferability and dissemination of Science Education Research results. In particular, new methods and investigation tools should be designed for collecting comparable data across Europe and deeply investigating the nature of the gap in different contexts.**

Inquiry Based Learning (IBL)

As reported in part 2, the actual occurrence of IBL in the STENCIL catalogue is about twice of the explicitly declared one, whilst it is ranked as the most important methodology in the questionnaire.

The comparison of these results can be interpreted in two different ways:

- IBL is appreciated as an idea but teachers do not implement it;
- IBL is appreciated as an idea and many teachers use somehow this methodology without recognizing it as a codified one.

The first interpretation supports the hypothesis that teachers meet some difficulties in IBL implementation, as it is argued in the paper of Barajas and Trofonova[36].

The second interpretation highlights a limited diffusion of IBL and of its methodological specificity, even if many projects and a lot of good examples have been already produced (see, for example, the EU project PATHWAY[37] or the projects listed in the paper of Magrefi[38]).

Both evidences (difficulties in implementation and limited diffusion of IBL) seem to highlight a weak awareness about the scope of this

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34 R. Pintò, *Introducing curriculum innovations in Science: identifying teachers' transformations and the design of related teacher education*, Sci. Educ. 89, 1, 2005. L. Viennot, F. Chauvet, P. Colin, and G. Rebmann, *Designing strategies and tools for teacher taining: The role of critical details, examples in optics*, Sci. Educ. 89, 13, 2005.

35 http://www.traces-project.eu/

36 M. Barajas, A. Trifonova, *Teacher training in Science Education*, in Enhancing Innovation and Creativity in Science Education, STENCIL, Annual Report 1, p. 51

37 http://pathway.ea.gr/

38 F. Magrefi, *European Framework for Science Education*, in Enhancing Innovation and Creativity in Science Education, STENCIL, Annual Report 1, p. 9

innovative methodology that goes even beyond the scope of understanding scientific disciplines. IBL is an ambitious methodology that is supposed to be carrier of innovation in science education at many levels: it is supposed to foster understanding, but also to increase interest and engagement in science, foster creativity and critical thinking and, moreover, to provide key-competences that are fundamental not only for learning science but also for an aware and participative citizenship in Europe (Owen[39]). The width of IBL potential seems still far from school realities and teachers' perception.

Recommendation #2:

> **EU and European Countries should encourage and support the production of examples of good practices focused on IBL with the explicit goal to spread more explicitly the awareness about the wide scope of IBL. The examples, in particular, should show and discuss how and why the current science curricula should be changed or adapted in order to make most of the motivational, cultural and social potential offered by IBL.**

Information & Communication Technologies (ICT)

The analysis of the catalogue shows to what extent a specific reference to ICT is less present than other methodologies like, for example, hands-on.

From the questionnaire ICT, meant in a general sense, are said to be a competence of the teacher as important as the educational competences, but significantly less important than the disciplinary one. Science lab, moreover, is still ranked as the favourite tool.

The results show, like in the case of IBL, that the expectation about the educational potential of ICT is greater than its implementation.

This evidence can be interpreted in different ways, also because the data are not specific enough about what ICT are considered (e.g. online data collection in lab, internet, wiki, applet, virtual lab, digital whiteboard?). A surface consideration leads one to think that such a result is another confirm of the well-know fact that "ICT is widely promoted by central authorities as a tool for teaching and learning but large implementation gap remains"[40].

A more interpretative reflection can lead to think that a greater impact of ICT on school could be fostered if traditional curricula were revised so as to make the most of the educational potential offered by the ICT. As it is shown also in the STENCIL survey, science teachers attach

39 M. Owen, *Science Education as a Mean for Key Competences Development*, in Enhancing Innovation and Creativity in Science Education, STENCIL, Annual Report 1, p.81

40 Eurydice Report Key Data on Learning and Innovation through ICT at School in Europe 2011, http://eacea.ec.europa.eu/education/eurydice/documents/key_data_series/129EN.pdf

a great value to the disciplinary dimension. If contents and teaching materials are not deeply reconstructed to be adapted to, for example, digital whiteboard, the innovative potential of ICT is at risk to being not exploited.

Recommendation #3:

> **EU and European Countries should boost and support activities/projects that aim to revise traditional curricula so as to make the most of the educational potential offered by the ICT.**

Community of practice

The results of both the analysis reported in Part 2 seem to be consistent with the many research results which show to what extent: i) teachers need to strengthen teamwork abilities and soft skills, and; ii) communities of practice are fundamental for encouraging, supporting and sustaining long-term professional development (see, for example, the paper of Csermely and Réti[41]).

The EU FP7 project TRACES has deeply analysed such a theme and it got to point out, from the cross-analysis of case-studies, features, aims and exemplar activities that should characterize effective and sustainable communities of practice. In particular, TRACES argues the need to recognise, by policy-makers, principals and stakeholders, *"*cooperation and sharing as a structural part of teachers' practice and to provide [teachers with] appropriate resources in terms of time, spaces and training within schools*"*[42]. In order to build communities really based on *co-responsibility, ownership and relevance*, these are recommended to be designed with specific and shared educational aims. Such aims have to include and respect the local socio-cultural context of the school.

As far as the recommended topics and activities are concerned, TRACES stresses the need to *"*involve a commitment to outlining a reshaping of scientific knowledge in a pedagogical perspective [...] and to reconsidering disciplinary content taking its epistemological implications into account and developing insights about how scientific ideas form as suggested by their historical development.*"* Like many other studies, TRACES's case studies show to what extent *"*mutual observation and analysis of classroom activities emerged as effective tools for teacher training*"*.

41 P. Csermely, M. Réti, *Collaborative Approach to Science Teaching: School Partnerships*, in Enhancing Innovation and Creativity in Science Education, STENCIL, Annual Report 1, p. 66.

42 E. Balzano, F. Cuomo, C. Minichini, M. Serpico - Findings and Recommendations for Research-Based Practice in Science Education University of Napoli "Federico II" in the frame work of the FP7 project Traces - Transformative Research Activities: Cultural diversity and Education in Science. http://www.traces-project.eu/

Recommendation #4:

In order to promote, support and sustain innovation in schools, teachers, teacher trainers, researchers and stakeholders should design communities of practice which implement recommendations coming from the research in science education. The EU project TRACES is assumed to be an important reference for the features, aims and exemplar activities that should characterize effective and sustainable communities of practice.

Socio-scientific issues

Only a minority of the catalogue projects mentions at least one out of the 5 issues which are considered by EU critical to improve the impact of science in society (gender, school drop out, career, minority, excellence).

Moreover, in the questionnaire, the socio-scientific issues and, in particular, gender & minority are ranked as the less important topic both as factor of innovation, and within the competences of a teacher.

These results show how the social impact of science due to the gender & minority issue is not yet sufficiently acknowledged. It is moreover not yet sufficiently acknowledged to what extent the issue of cultural diversity can be carrier of deep epistemological innovation in science education, boosting approaches to science inclusive *for all*[43].

Recommendation #5:

EU and European Countries should encourage and support initiatives and actions aimed to spread the perception of how and why the gender and minority issue affects on the social impact of science and, vice versa, how science teaching, even implicitly, impacts on the social issue gender & minority.

Educational experiences that have proven effective in: i) stimulating the interest of girls in science and scientific careers, ii) fostering inclusiveness should be spread.

3.3 Conclusions: the teacher of the future

The results of the work undertaken in STENCIL show that the *Rocard* recommendations are still relevant and topical. In fact innovation in science teaching is generally hindered by many barriers, whose nature should be investigated in more depth. The main evidence that seems to emerge from STENCIL's analyses is teachers' difficulty to grasp, to

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43 Nasir, N.S., Rosebery, A.S., Warren, B., Lee, C.D., *Learning as a Cultural Process*, 2006.

accept or to implement the broad potential of methodologies (like IBSE, ICT) and socio-scientific issues recommended by EU as carriers of innovation. New materials and examples seem needed to show not only *how* to implement new methodologies but also *why* and *for what*. In particular, the disciplinary, epistemological and motivational change implied by a specific methodology should be more explicitly investigated and highlighted.

The width of the innovative potential of the recommended methodologies and issues shows again to what extent the complex process of science education innovation requires an extraordinary engagement and participation of the teachers.

The teachers are and, hence, must be acknowledged as the key enablers of innovation. "There is no substitute for a good teacher" is a statement from *The Learning Curve Report* by the Pearson Institute and the Economist Intelligence Unit, issued on November 2012[44]. This report shows that more effective educational systems are in those countries where the reputation of teachers is higher (Finland and South Korea). These countries are able to attract top talent to the school, to train them throughout their career and let them freedom in teaching.

The results of STENCIL, as well as the results of the plenty of EU projects in science education, should be exploited and capitalized with the aim to promote a positive image and social reputation of the teachers all over Europe, by highlighting their essential role in the society, and their daily efforts and contribution to the growing of the Europe.

The results of Learning Curve Report are enlightening: "Good teachers are essential to high-quality education. Finding and retaining them is not necessarily a question of high pay. Instead, teachers need to be treated as the valuable professionals they are, not as technicians in a huge, educational machine."[45].

Future projects should start from these considerations and move on from the spreading of good practices and methodologies in science education to a broader reflection on the role and the reputation of teachers into the society, fostering the discussion on how to attract talent to this profession and what skills and competence are needed to help teachers to cope with daily challenges and expectations.

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44 http://thelearningcurve.pearson.com/the-report

45 *Ibidem*.

ANNEX 1

STENCIL
Initiatives questionnaire

Fields marked with (*) are mandatory

1. General

Initiative title in the national language (*): ....

Acronym: ....

Initiative title in ENGLISH: ....

Where is it implemented? (Country) ....

In which context is it implemented? (school laboratory, classroom, school, school district, university laboratory, etc) ....

Who are the beneficiaries addressed by the initiative (*)? *At least one checked box*

o Pupils & school levels involved

- o Pre-primary school pupils (3-6 years of age)
- o Primary school pupils (6 to 11/12 years of age)
- o General secondary education (11/12 to end of compulsory education or even beyond)
- o Vocational or technical secondary schools
- o Further Education, Higher Education (post 16)

o Educational personnel

- o Teachers
- o Teacher trainers of science / technology
- o Schools heads
- o Lab technicians
- o Other: ....

o Other: ....

Frequency of the initiative (*) *One and only one checked box*

o One off event

o One off event repeated on an annual, semestrial, trimestrial basis

o Activity fully integrated in the academic term

o Other: ....

Number of people directly concerned by the initiative (*) *One and only one checked box*

o Less than 20 people

o Between 20 and 100 people

o More than 100 people

Summary in the national language (*) *At least 400 characters - max 2000 characters*

Please summarize the initiative including at least one sentence for each of the following:

- objectives
- activities concerned
- target group
- composition of the team
- organisational aspects
- Etc.

....

Summary in the national language (*) *At least 400 characters - max 2000 characters*

Please summarize the initiative including at least one sentence for each of the following:

- objectives
- activities concerned
- target group
- composition of the team
- organisational aspects
- Etc.

....

2. AUTHOR / CONTACT

1. ORGANISATION IN CHARGE

Name of the organization/institution(*): ....

Full Address(*): ....

Country (*): ....

Website: ....

2. NAME OF THE CONTACT PERSON

Full name (*): ....

Tel: ....

E-mail (*): ....

Nature of the organisation (*): *One and only one checked box*

o Formal education institution

o Research institute or research centre

o University

o Secondary school (11-18 years)

o Primary school (6-11 years)

o Pre-primary school (3-6 years of age)

o Network of schools

o Other: ………………………..

o Non institutional organisations linked to education activities

o Academy of sciences

o Foundation

o Science association (European, national, regional, local)

o Association of teachers (local, regional, national, European)

o Association of parents

o Museum of sciences

o Other: ………

o Industrial and services sector

o Industry

o Trade union

o Other: ………

o Educational and School authorities

o Ministry of Education

o Regional School Authority

o Local School Authority

o Other: ………

o Other: ………

Further communication:

o I would like to receive news from the STENCIL Network

o I agree to be contacted for additional information about the initiative

3. Thematic and Methodology

My initiative concerns the theme(s) of (*): *At least one checked box*

o Women and science

o Innovation in teaching and learning sciences at school

o Cooperation with the (local and regional) communities

o Cooperation with research laboratories of the universities, with schools of engineering, with companies

o Scientific culture

o Students counselling and career counselling

o School failure and drop out: primary school – secondary school – university

o Education and training of teachers and/or heads

o Education and training of specific groups (i.e. ethnic minorities, migrants, etc.)

o Other: ………

My initiative is about (*): At least one checked box

o Mathematics

o Physics

o Chemistry

o Natural sciences (biology, environmental sciences including agriculture, food-chain and medicine)

o Technology (mechanics, electricity, electronics, …)

o Cross-curricular approaches (environmental education, pollution, health education,…)

o Other: ………

My initiative adopts a methodology related to (*): *At least one checked box*

o Hands-on approach and activities

o Peer-to-peer education

o Learning objects

o E-learning

o Other: ………

4. ORGANISATION

Geographical coverage of the initiative: (*) *One and only one checked box*

o Isolated initiative o Local initiative o Regional o National initiative o European initiative

MANAGEMENT OF THE INITIATIVE:

Who has the management of the initiative? ....

Who is accountable for the initiative? ....

Who evaluates the initiative? ....

Inside the unit of implementation: there is collaboration between (*) *At least one checked box*

o Teacher(s)

o School head(s)

o Lab technician(s)

o Personnel of the school authorities (experts, pedagogical advisors, etc.)

o Other school personnel: ....

Investment in human resources: the initiative is carried out

o During the school hours

o As an extra curricular activity on a voluntary basis

o As an extra curricular activity on extra paid time

o Other: ....

EXTERNAL COOPERATION

Does the initiative involve people from external organisations? If yes, which kind(s)?

o Industry and services

o University

o Research institute

o Foundation

o Public utilities (water and energy providers, etc.)

o Media

o Science museums

o Other: ....

Which forms of cooperation are carried out?

- o placements of pupils
- o placement or exchange of teachers
- o project work of pupils
- o project work with teachers (preparation of experimentations, ….)
- o intervention of scientists / industry people in schools
- o visit or use of laboratories of research centres / industry by schools
- o Other: ……

FINANCIAL ISSUES (*) *At least one checked box*

How is the initiative financed/funded?

- o Self supported initiative
- o Regional support
- o National support
- o European support
- o Other: ……

5. RESULTS

What is (are) your initiative's major output(s)? (*): *At least one checked box*

o EDUCATIONAL MATERIALS

- o Handbooks, teaching materials
- o E-learning tools
- o Science simulations or experimentations
- o Publication / web site / cd rom
- o Other: ……

o TRAINING COURSES FOR TEACHERS

- o Subject related
- o Methodology related
- o Other: ……

o Special events, activities

- o In site workshops in science / industrial / scientific heritage museums
- o TV or Radio programme
- o Information campaign about science in general
- o Information campaign to promote sciences with girls
- o Other: ………

o Other: ………

Key Competences for lifelong learning addressed by the initiative:

- o Communication in the mother tongue
- o Communication in foreign languages
- o Mathematical competence and basic competences in science & technology
- o Digital competence
- o Learning to learn
- o Social and civic competences
- o Sense of initiative and entrepreneurship
- o Cultural awareness and expression

In your opinion, does your initiative constitute good practice for science teaching/learning?

o **Yes** o **No**

If yes, please elaborate

………

What do you consider as the most innovative aspect of your project and results achieved?

………

6. DOCUMENTATION

Accessibility of documentation and its outputs

o Website of the initiative:

....

o Other website/s showing information on the initiative:

....

Other documentation - Please attach additional material/s (PDF, PPT, DOC, Link/URL) about your initiative:

o Promotional materials (brochure, poster, flyer)

o Initiative description

o Methodology description

o Educational materials used in the initiative

o Educational materials produced by the initiative

o Other: .... *(please specify the document or link you are sending)*

7. MISCELLANEOUS

o **I give permission to use the information provided in this questionnaire within the STENCIL project as an example of initiative (*)** *This first box must be checked to submit the questionnaire. The two ones below are optional*

o including the file(s) attached

o including the contact details

ANNEX 2

STENCIL QUESTIONNAIRE FOR STAKEHOLDER'S FEEDBACK

NAME: ....

SURNAME: ....

INSTITUTION: ....

ROLE: *(e.g. teacher, school head, director of the school office, etc.)* ....

ADDRESS: ....

TOWN: ....

COUNTRY: ....

EMAIL: ....

PLEASE INDICATE IN YOUR OPINION HOW IMPORTANT ARE THE FOLLOWING FACTORS TO INNOVATE SCIENCE EDUCATION

1=don't know; 2= not important, 3=a little, 4=important, 5=very important

	INQUIRE BASED LEARNING
	INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT)
	SENSITIVITY TO GENDER AND MINORITY ISSUES - PROMOTING EQUALITY (EQUITY FOR EXCELLENCE)
	COLLABORATION BETWEEN SCHOOL AND OTHER EDUCATIONAL AND RESEARCH INSTITUTIONS
	COLLABORATION BETWEEN SCHOOL AND INDUSTRY
	LINK TO SOCIETAL CHALLENGES (ENVIRONMENT, HEALTH,..) AND TO PUBLIC CONCERN ABOUT SCIENCE
	OTHER, PLEASE SPECIFY

PLEASE INDICATE WHAT ARE IN YOUR OPINION THE MOST IMPORTANT COMPETENCES / CHARACTERISTICS FOR THE TEACHER OF THE FUTURE

(please list the competences below in order of importance, being 1=the most important, 9=the less important)

- [ ] **DISCIPLINARY COMPETENCE IN THE SPECIFIC SUBJECT MATTER**
- [ ] **INTERDISCIPLINARITY**
- [ ] **COMPETENCE IN ICT**
- [ ] **COMPETENCE IN SCIENCE EDUCATION AND IN THE LEARNING SCIENCES**
- [ ] **BEING UPDATED ON THE STATE OF THE ART PROGRESS IN RESEARCH**
- [ ] **COMPETENCE IN FOLLOWING THE PUBLIC DEBATE ON SCIENCE AND SCIENTIFIC CITIZENSHIP**
- [ ] **AWARENESS OF GENDER AND MINORITY ISSUES IN LEARNING**
- [ ] **EPISTEMOLOGICAL COMPETENCE ABOUT THE NATURE OF SCIENCE**
- [ ] **OTHER PLEASE SPECIFY**

WHAT ARE THE MOST EFFECTIVE TEACHERS TRAINING METHODOLOGIES?

(please list the items below in the order of importance, being 1= the most important, 4= the less)

- [ ] **FACE TO FACE**
- [ ] **ONLINE**
- [ ] **COMMUNITY OF PRACTICE**
- [ ] **OTHER, PLEASE SPECIFY**

WHAT ARE THE MOST USEFUL TOOLS FOR THE TEACHER OF THE FUTURE?

(please list the items below in the order of importance, being 1= the most important, 6= the less)

- [ ] **SCIENCE LABS**
- [ ] **ICT GENERAL TOOLS: COMPUTER AND INTERNET**
- [ ] **DIGITAL WHITEBOARD**
- [ ] **SPECIFIC EDUCATIONAL SOFTWARE**
- [ ] **TABLET**
- [ ] **OTHER, PLEASE SPECIFY**

STENCIL (**http://www.stencil-science.eu**) is a virtual community open to everyone for sharing ideas, news and events on science teaching in Europe and in your country. It gives you the chance to present your own projects to colleagues from all over Europe and the opportunity to get inspired and search for science education projects from all over Europe. It is a source of inspiration for those who are interested in discovering good practices, in learning more about science education practices, and in transferring them.

DO YOU THINK THAT STENCIL WEB PORTAL IS (OR MIGHT BE) USEFUL FOR YOUR ORGANIZAZION AND WORK?

o don't know

o not important

o a little

o important

o very important

WOULD YOU LIKE TO BECOME AN ASSOCIATED PARTNER OF STENCIL?

o yes

o no

o I have not enough elements to decide now

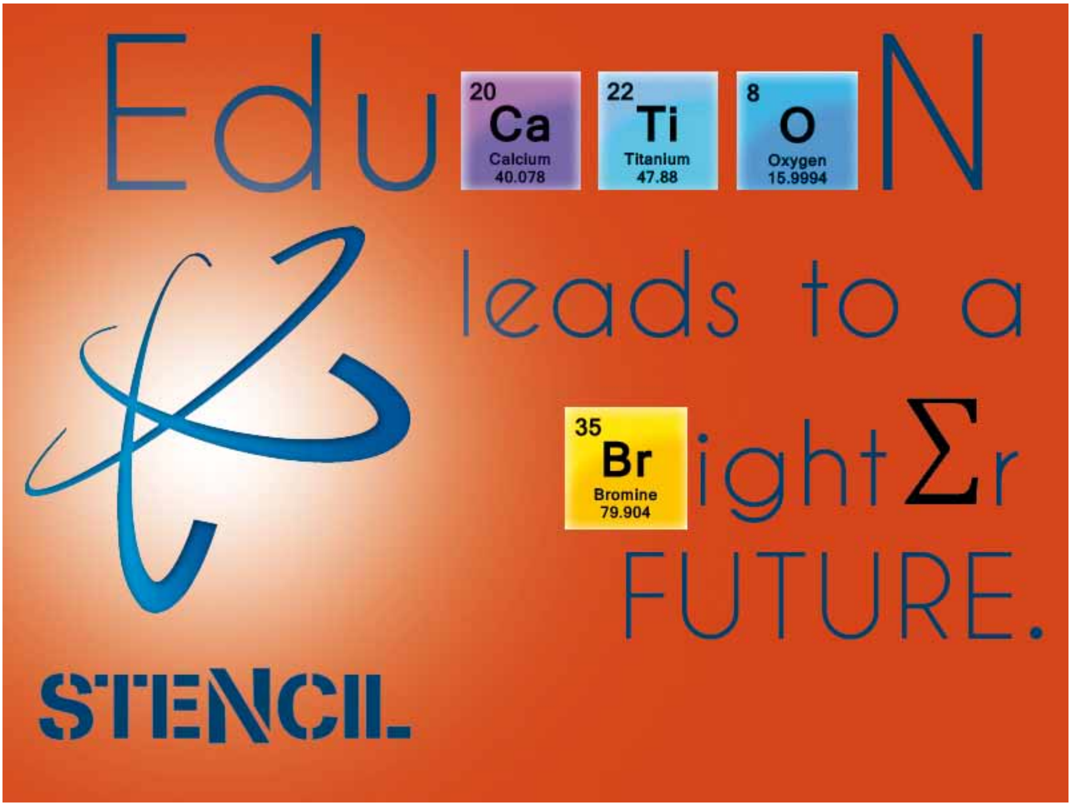
DO YOU KNOW OF OTHER ORGANIZATIONS, NETWORKS, INDIVIDUALS ETC. THAT MAY BE INTERESTED IN STENCIL?

Please supply information useful to contact potentially interested subjects

....

IS THERE ANY ADDITIONAL INFORMATION YOU WOULD LIKE TO RECEIVE FROM OUR WEB SITE OR PROVIDE US YOU?

....



Edu
20
Ca
Calcium
40.078
22
Ti
Titanium
47.88
8
O
Oxygen
15.9994
N
leads to a
35
Br
Bromine
79.904
ightΣr
FUTURE.
STENCIL