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[1] 1 PU = Public

PP = Restricted to other programme participants (including the EC services);

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CO = Confidential, only for members of the Consortium (including the EC services).

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Executive summary

This European Synthesis report summarises the main research results relevant for the design and implementation of STEM-related school-industry initiatives aiming to promote STEM careers. The mentioned results come from the study performed under inGenious WP2-"Observatory of Practice and Needs Analysis: Monitoring Research Developments"-, and include the results gathered from different studies and reports published at international level and from the field research carried out by WP2 all along the InGenious project. Specifically, WP2 has carried out a research study addressed to explore both the current situation of and the main existing challenges in school-industry partnerships in Europe with the aim of understanding, (i) which elements influence young people in their process of career choice towards STEM; (ii) which kind of STEM school-industry partnerships are being promoted in Europe and which their potential contribution upon STEM career choices is; and (iii) which obstacles exist for their establishment and maintenance.

The ultimate goal of this research is to provide recommendations which can help to improve both the impact of school-industry collaborations in increasing young people's interest in STEM careers and the establishment and maintenance of successful collaborations. Thus, the present document is addressed to the different stakeholders involved in this kind of partnerships, such as policy makers in STEM education, STEM researchers, teacher trainers and teachers and industrial representatives.

The document is structured in five sections. First of all, an Introduction presenting the InGenious project and its interest in promoting School-Industry partnership in order to foster STEM careers interest among young people. Secondly, the factors influencing young people's interest in STEM careers and the potential usefulness of STEM-related school-industry partnerships is discussed in section 2. Afterwards, the study performed in the frame of the inGenious project with the objective of understanding current attempts to promote young people's interest in STEM careers through school-Industry partnerships is presented in section 3. In the same line, InGenious results regarding the difficulties identified within the development and implementation of school-industry partnerships are summarized in section 4. The last section provides a set of recommendations arisen from the whole research process undertaken within the InGenious-WP2. These recommendations are briefly summarized below:

a) Recommendations for improving the effectiveness of initiatives involving school-industry partnerships

- To incite **real engagement of students**. This can be achieved through problem solving and inquiry activities such as (i) working around questions/problems (asking questions and encouraging students to participate actively in the discussion); (ii) proposing problems as open-ended questions; (iii) proposing activities which require the application of knowledge from one context to another, in order to promote the ability to abstract and generalise; and (iv) proposing exercises for making connections between different ideas.

- To promote the **initiatives addressed to primary school level** students. The majority of young children have positive attitudes to science at age 10, but this interest then declines sharply and by age 14 their attitude and interest in the study of science has been largely formed.
- To provide **information about a wide range of STEM jobs** to make students aware about careers that match their personality, by allowing interaction with STEM professionals (role models) and by engaging students in activities in diverse roles. This will also help to break gender and other cultural stereotypes.
- To propose scientific activities and/or technological problems through which **students can realize their good capabilities** to deal with them.
- To **show the social relevance, ethics or social responsibility** of the work in the industry (students will only be willing to pursue STEM careers if they have a positive view of them)
- To design interventions which take place for a **long time**. Educational choices are not static and–"one-off" events do not have long-term impact on the process of career choice
- To include **comprehensive evaluation** in the design of S-I partnership activities in order to confirm their effectiveness

b) Recommendations for facilitating the establishment and maintenance of sustainable S-I partnerships

- Operational recommendations: Disseminate and share the know-how of existing initiatives
- Tactical recommendations: Contribute to the alignment of expectations of stakeholders and search for common goals
- Strategical recommendations: Support sustainable school-industry relationships from different Ministries, i.e. Education, Science, Industry, Employment, etc

CONTENT

INTRODUCTION

In its objective of becoming "the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth, with more and better jobs and greater social cohesion" (EC, 2000) Europe has been concerned in the last years by the quality and quantity of European STEM[2] professionals. While it has been pointed out that Europe needs more technology-driven highly skilled people to drive innovation forward, last study results confirm that the number of science enrolments and graduates in Europe has been slowing down over the last decade, from 24.3% in 2002 to 22.6% in 2011 (Eurostat). Looking to the future European citizens, trends are not encouraging: more than half the EU 27 countries have below average PISA scores in maths and science (OECD, 2009) and, according to some global surveys 13-15 year olds in developed nations do not place a high value on science and technology (they do not think these are important for their career) (OECD, 2009; Sjøberg & Schreiner, 2010)

In this context, the inGenious project was conceived as a three-year European strategy (2011-2014) aimed to strengthen links between compulsory education and STEM careers as a way of promoting STEM vocations and to expand them across Europe. Within this project, the tasks performed in Workpackage 2 –WP2, entitled "Observatory of Practice and Needs Analysis: Monitoring Research Developments"–, are addressed to explore both the current situation of and the main existing challenges in school-industry partnerships in Europe.

The present document is a cross-country synthesis report which includes fundamental research results that contribute to the knowledge necessary for the design or adaptation of STEM-related education initiatives within a school-industry partnership aiming at increasing young students' interest and knowledge of STEM careers in Europe. It intends to summarise main research results from both the work developed within inGenious (mainly under WP2) as well as from other studies and reports that have been published at international level.

[2] The acronym, standing for Science, Technology, Engineering and Mathematics, is used along the document.

ECB project

1. Review 'milestones' and 'degree or level of achievements'

As a synthesis of all the tasks carried out under WP2, this deliverable accomplishes most of the milestones linked to this Work package, being a final update of most relevant WP2 deliverables. Hence, milestones related to the 'observatory of practices', 'needs analysis' and 'STEM education research update' (MS2, MS3 and MS4) are accomplished by delivering the present document.

Being WP2 tasks expected to be carried out until the end of the project, and since the project extension has been extended from 36 to 45 months, this final WP2 report is in time according to the DoW.

2. Review 'Risk Analysis'

In line with ECB-InGenious objectives, this deliverable is an important output of the whole project, meaning main knowledge baseline generated by the project in the field of school-industry partnerships. In this sense, it has been sought to maintain the degree of quality of this deliverable in line with the expected outcomes of the project.

3. Ethical Issues & IPR issues

This synthesis report combines results from both the research carried out within the project and results from diverse research studies and projects. In this sense, all third sources have been appropriately cited all along the document.

1 ECB-INGENIOUS PROJECT: FOSTERING SCHOOL-INDUSTRY RELATIONSHIPS

1.1 School-Industry relationships – What for?

During the last years there has been an increasing concern in developed countries about the fact that current and future shortages of qualified STEM professionals might represent a disadvantage for the progress of their economies. Europe, in particular, faces major structural challenges including globalization, climate change and an ageing population. The economic downturn has made these issues even more pressing. On March 2010, the European Commission launched the Europe 2020 Strategy with the purpose of going out of the crisis and preparing the EU economy for the next decade challenges (EC, 2010), aiming to stimulate growth and to create more and better jobs, while making the economy greener and more innovative. In this regard, it has been pointed out that Europe needs more technology-driven highly skilled people to drive innovation forward, and it is not only the quantity but also the quality of the STEM workforce which poses a challenge for European economies. In fact, the future labour market will be characterized by quantitative and qualitative mismatch, the former implying that there will be fewer workers than jobs in the future and the latter implying that the skills of the workers do not match the required skills of the job (Berkhout et al., 2012, EU Skills Panorama, 2012). In any case, while the current economic crisis illustrated the complexity in predicting future labour market requirements for STEM, there should be no doubt about the importance of basic STEM competences being absolutely necessary for the entire workforce in the future (OECD, 2013).

In this context, education on STEM disciplines is a key element for future innovation and economic growth, and it has been argued that a closer cooperation with STEM-related business could help equipping students with the right skills for the jobs of today and tomorrow (ERT, 2009; Hardisty & Cunningham, 2013). Actually, evidence exist suggesting that employer's involvement with education has positive impacts on students in terms of preparedness for work, developing job and work skills, improving work-based competencies, attitudes and behaviours, enhanced employability and higher initial wage rates (NCSR, 2008; Mann & Oldknow, 2012). In fact, S-I relationships have long been a mechanism to bring the world of work closer to education (see Wright (1990) for a good description on the origins of these relationships) and different studies have suggested that this cooperation could help raising awareness of STEM careers, thus representing a good mechanism to promote STEM vocations among young people. For instance, Henderson & St. John (1997) evidenced that this cooperation enabled a more 'real world' and problem-solving approach to mathematics education, and Miller (1999) showed that cooperation between employers and students can have a significant impact on students' motivation to succeed at school.

1.2 School-Industry relationships – a European study

Being aware of the interest of fostering school-industry partnerships, the inGenious project was addressed to strengthen links between compulsory education and STEM industries as a way of promoting STEM vocations and to expand them across Europe. Several tasks have been undertaken within the project, encompassing research on school-industry partnerships (WP2), school-industry activities pilot in several schools across Europe (WP3) and evaluation of the impact on pupils and teachers of these pilot activities (WP6).

As a synthesis of the research tasks undertaken under WP2 -entitled "Observatory of Practice and Needs Analysis: Monitoring Research Developments"-, the present document offers a European synthesis report in the field of school-industry partnership. Addressed to explore both the current situation of and the main existing challenges in school-industry partnerships in Europe, WP2 has carried out a research study with the aim of understanding (i) which elements influence young people in their process of career choice towards STEM; (ii) which kind of STEM school-industry partnerships are being promoted in Europe and what is their potential contribution upon STEM career choices is; and (iii) which obstacles exist for their establishment and maintenance. The ultimate goal of this research is to provide recommendations which can help to improve both the impact of school-industry collaborations in increasing young people's interest in STEM careers and the establishment and maintenance of successful collaborations. The details concerning the methodology used along the study have been presented in the ESERA 2013 conference (two oral contributions[3]) and in several project meetings, and are also available in reports and papers[4] (e.g.: Deliverable D2.1). Figure 1 outlines the research stages and the contribution of WP2 to this final synthesis, as well as the complementary information arisen from WP3 (school pilots of S-I practices) and WP6 (internal evaluation of the school pilots).

[3] Ríos,R., Artigas,A. & Pintó,R. *Exploring the challenges in school-industry partnerships.* Oral contribution at ESERA 2013, Cyprus; and Artigas, A., Ríos, R. & Pintó, R., *Analysis of European School-Industry partnerships aimed to foster young people into STEM careers.* Oral contribution at ESERA 2013, Cyprus.

[4] Two papers are forthcoming (currently in review process) for the Needs Analysis and for the Factors influencing students' STEM career choice.

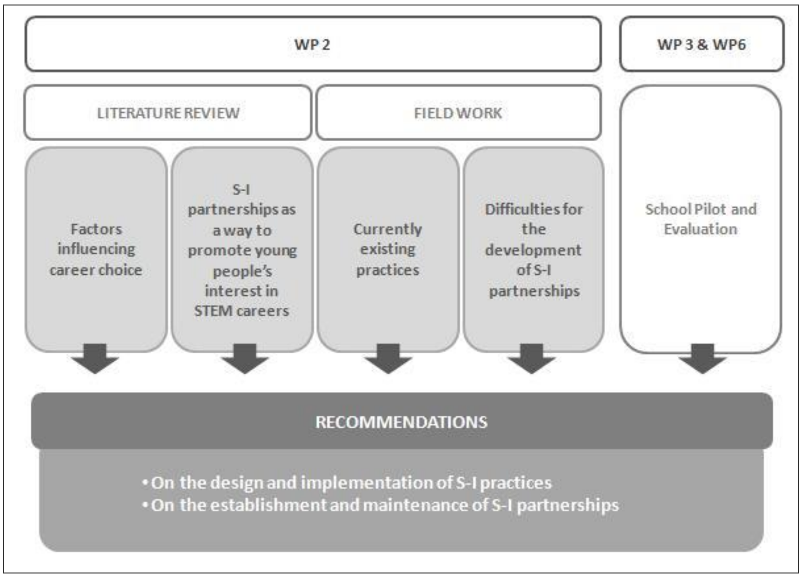

***Figure 1**. EU synthesis report sources*

2 RESEARCH EVIDENCE ON HOW TO PROMOTE YOUNG PEOPLE'S INTEREST IN STEM CAREERS THROUGH SCHOOL-INDUSTRY COLLABORATION

Several actions (e.g. school visits to industrial facilities, talks from STEM professionals at schools, fairs involving several businesses, etc.) have been promoted from diverse companies and public administrations in order to increase students' interest in STEM disciplines and, particularly, in STEM careers. However, we have to be cautious since not all of the school-business collaborations might be as effective as intended in promoting STEM vocations; in fact, many of these initiatives are designed following intuition instead of well-founded knowledge, and the outcomes of such collaborations are hardly ever evaluated, which makes it difficult to check if the intended goals have been properly achieved[5]. Therefore, it is essential to analyse how these partnerships should be focused and designed if the aim is that they are able to positively influence students in terms of developing work skills, improving STEM competences providing information about the world of STEM careers. This information is necessary not only for designing new partnership activities, but also for defining the evaluation strategies for assessing their real impact.[6]

[5] See Deliverable D2.2 written by the authors

[6] InGenious WP6 has been in charge of the evaluation of some pilot activities. The evaluation criteria and the resulting analysis has been based on WP2 proposals.

2.1 Elements influencing the process of career choice towards STEM

The attractiveness of STEM subjects in the school does not mean that students decide to work in this area and to orient their career in this field. Evidence from a UK survey of over 9,000 pupils aged 10/11 shows that even though the vast majority of children at this age enjoy science at school, very few (17%) aspire to a career in science (Archer, 2013). The results of InGenious do also confirm that making science lessons interesting or informing pupils about social significance of STEM is not enough to sway young people towards STEM careers (Kudenko & Gras-Velázquez, 2013). If we try to influence in the career decision, we have to take into account how the process of choosing career is developed.

The social and the economic needs of having more STEM educated citizens and graduates working in the industries may not correspond to the adolescents needs. They are more interested in *who they will be* rather than *what they will do*. Following Fouad (2007), Gago (2004), Lent, R. W., Brown, S. D., & Hackett (1994), Singh & Greenhaus (2004), Becker (2010), the study by ERT (2009) or the study by UPC (2008) among many others, we can analyse the students' reasons for not opting to STEM careers. The perspective is that only by identifying potentially valid reasons for the lack of interest in STEM will it be possible to change not just some "misguided" perceptions among the younger generation, but to make viable recommendations for necessary changes in society. Normally, it is assumed that young people shy away from "tough majors" or make irrational choices, based on an absence of information but (Becker, 2009) insists on the idea that young people do not shun engineering careers just due to laziness or ignorance.

Sociologists and psychologists have intervened in the debate about factors influencing the choice of academic pathways, the former focused on the effects of social environment, and the latter being more interested in the conditions that influence individual reasoning, beliefs, attitudes and actions. On the other hand, research on STEM education can give clues about how to stimulate STEM choices through teaching and learning approaches.

Taking into account the literature on the fields mentioned above, and the experiences of career counsellors, we can pick out and formulate the factors influencing students' career choice in the following four categories or spheres of influence (Figure 3):

A. Level of students' engagement and competence in the study of STEM disciplines (School Factor):

As stated above, a necessary, but not sufficient, condition for someone to choose a STEM career is that he or she is engaged with the related disciplines at school, and this is closely related to the competence on STEM: a deep knowledge of specific STEM topics is essential to make one enjoy the study of such disciplines. Actually, negative experiences of STEM in school seem to deter students from decisions to pursue STEM further, and act as a barrier to STEM career aspirations. Aschbacher, Li, & Roth (2010) found through longitudinal interviews and surveys that students often perceived science at school as hard and discouraging, and Cleaves (2005) confirmed previous studies about negative attitudes towards science in secondary school students and disenchantment with the school science curriculum. Therefore, unattractive curriculum or teaching can make young people decline interest in STEM subjects, in the same way that teaching methods presenting STEM disciplines as particularly difficult can frustrate students in their willingness to succeed in class and dispel them from STEM careers (Becker, 2010).

Several strategies can be considered when trying to address this factor. For instance, the importance of providing support for teachers to collaborate with colleagues in the science education research community so as to understand, develop and teach in ways that are consistent with contemporary professional standards was highlighted by Hofstein & Lunetta (2003). It is important, thus, to establish frameworks and methodologies which can help improving the quality of science education at school, and actually some reports and reviews have been published worldwide with this aim. One example is the new Framework for K-12 science education in the US (built on the fusion of expert science knowledge and leading research in the teaching and learning of science) that is the foundation for the upcoming Next Generation Science Standards (NGSS) (Schmidt, Burroughs, & Cogan, 2013). Another report published in the US which provides an overview of K-12 (primary and secondary) STEM education (Hanover Research, 2011) states that good STEM education should include careful research, a long planning process, and a detailed blueprint of the STEM program, and that a coherent and rigorous curriculum that focuses on depth rather than breadth is essential for any successful STEM school initiative (better to focus on teaching few but fundamental ideas instead of teaching collections of fragmented concepts and series of disconnected facts). At European level, several reports have also been published providing recommendations and presenting national strategies for promoting science education ((Rocard, 2007), Osborne & Dillon (2008), Kearney et al. (2011)). Some highlighting remarks arise from the previous references, such as the need to give incentives to schools and colleges to provide an enriched and enhanced STEM curriculum, including links with employers, quality practical experiences, and research in schools in order to maximise positive impacts on pupil achievement.

On the other hand, it has to be stressed the research results that have demonstrated that the majority of young children have positive attitudes to science at age 10. Unfortunately, this interest then declines sharply and by age 14, their attitude and interest in the study of science has been largely formed (Louise Archer et al., 2010). In this sense, some authors (Osborne & Dillon, 2008) highlight that the emphasis in science education before 14 should be on engaging students with science and scientific phenomena and that evidence suggests this is best achieved through opportunities for extended investigative work and “hands-on” experimentation and not through a stress on the acquisition of canonical concepts. Following these authors and Brandford, Brown, & Cocking (2000) , there is the need to incite real engagement of students through problem solving and inquiry activities such as (i) working around questions/problems (asking questions and encouraging students to participate actively in the discussion); (ii) proposing problems as open-ended questions; (iii) proposing activities which require the application of knowledge from one context to another, in order to promote the ability to abstract and generalise; and (iv) proposing exercises for making connections between different ideas.

B. Availability of information about STEM careers (Career Information Factor):

Students' knowledge about the variety of careers is crucial to understand their final decision regarding their future profession. For this reason, access to understandable information about the types of STEM jobs is essential and well-organised career information, guidance and counselling services are important to education systems and to the future of the labour market, as well as the interface between them (OECD, 2002). Nevertheless, according to Archer (2013), evidence indicates that careers education in school is currently "too little, too late", and although this statement applies to a particular study performed in the UK, it is possible that a similar situation exists in the rest of European countries. This is a concerning fact, especially given that international evidence from the OECD shows that young people benefit from receiving high quality, appropriate advice and guidance to build their aspirations. In this regard, the need to improve career orientation about STEM studies in secondary school was also identified as one of the main challenges to increase STEM vocations, according to the authors of a study carried out in Spain (Everis, 2012).

With this regard, it is worth mentioning that in the UK a three-year programme was carried out aimed at exploring the potential to embed STEM careers awareness in the early stages of secondary education (STEM Careers Awareness Timeline Project)[7], and some interesting key findings were highlighted in the final report (Finegold, 2011). For instance, it is highlighted that successful STEM education should commit adequate resources and establish a STEM coordinator role in schools -with appropriate status- or that better STEM careers activity arises where subject teachers see the preparation of young people for work as an integral part of their professional role and where they have the professional skills and confidence to act on this. The same report evidences that STEM enhancement and enrichment activities are often seen as a mechanism for generating interest in the subjects, but tend not to be valued for careers learning potential, situation that should be reversed.

C. Awareness of whether the personal traits fit with those required for STEM careers (Psychological Factor):

One of the questions that students face when choosing their professional career is: Is this career appropriate for me? The answer to this question is related to the matching of individual traits with the career characteristics, which has to do with how well the individual's skills, abilities and values

[7] http://www2.warwick.ac.uk/fac/soc/cei/stemeducation/casestudy/

correspond to activities, tasks, and responsibilities associated to the jobs in the field. Therefore, before making a career choice one should learn about their own values, interests, personality and skills, being particularly important the perceived ability to pursue particular tasks (Bandura et al., 2001). That is, within the process of career decision-making, emphasis is placed on the accuracy of self-knowledge since it has been long suggested that the closer the match of personality to job requirements, the greater the satisfaction (Holland (1997) among others). It is essential to have in mind, however, that individual factors such as vocational interests seem to be less fixed than it has been assumed in theories of vocational personalities (Savickas et al., 2009) and that life experiences are able to progressively change them. According to the results of a study which explored the impact of role models schemes in inspiring young people about science, engineering and technology (OPM, 2004), the perception of own ability is the most popular factor contributing to enter STEM fields. In line with this, and based on the results of a study exploring factors influencing students' decision making, it has been suggested that an important challenge to increase STEM vocations is the need to work on breaking the "Pygmalion effect" (i.e. the self-perceived capability as a limiting factor to study STEM) and reinforce the circle "I like it; I'm good at it; I feel capable" (Everis, 2012).

Beyond that, children's career aspirations are shaped by parents' perceptions of their child's potential and by teachers' assessment of pupils'. This sense influences children's academic development and level of aspirations and expectations (Bandura et al., 2001). And this perception has to do with what some authors have recently called "science capital", which is referred to science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (e.g. knowing someone who works in a science-related job)(Archer, 2013b). Thus, activities addressed to this factor may aim at giving to parents and teachers a better understanding of the role and work of STEM professionals compared with the capabilities of their child and students.

D. Social perception of the work related with STEM careers (Social Factor):

The opinion that society has about STEM careers appears to be essential for the process of career decision-making towards STEM. However, in western countries there is no general awareness of the social relevance and responsibility of business, nor a good image of the environmental impact of industries (Becker, 2010), which damages the image of STEM related business.

Additionally, there is also a perception of barriers related to STEM careers such as a low expectative of growing, job instability, salary, social status and particularly regarding the gender issue (Sjøberg & Schreiner, 2010). Women still have assigned different career expectations and their perception of barriers is higher (Fouad, 2007). Actually, although the perception that some jobs should be performed only by one gender decreases over time for females, they continue to want to pursue female-appropriate jobs. As shown in Figure 2, the number of female students enrolled in STEM fields in Europe (at ISCED levels 5-6) has been, along the last ten years, significantly lower than the number of male students. Furthermore, stereotypes of scientists as being mostly white, male and middle-class (Scantlebury, Tal, & Rahm, 2007) make post-compulsory science and science careers particularly unattractive for women, working-class and some minority ethnic groups (for both, the children and their families) (Archer, 2013b). In this regard, Sinnes & Løken (2012) highlight that fundamental changes are required to the practices and priorities within STEM subjects and fields in order to attract and keep people with diverse interests and priorities than those considered mainstream within STEM fields.

Some researchers state that girls' relationships with mothers are important in influencing self-efficacy for non-traditional careers (O'Brien (1996), cited by Fouad (2007)) and that girls' perception of their parents' and their boyfriends' preferences for them affects their career orientation (Vincent et al. (1998), cited by Fouad (2007)). In this context, it has been suggested that masculine stereotypes of STEM careers should be changed and that the visibility of female role models and referents in these fields need to be increased (Everis, 2012). Actually, in the last years it has become frequent to promote initiatives specifically addressed to encourage the interest of girls towards STEM and STEM careers, particularly in countries such as Germany and the Netherlands (Booy et al., 2012; Quaiser-Pohl et al., 2012) In this respect, a number of steps have been suggested to address gender inequalities and to encourage girls and young women in science (OECD, 2008), including the adaptation of the learning context and approach to make them more attractive to girls, the provision to female students and those from minority backgrounds with opportunities to identify with STEM professionals and also to develop self-confidence as regards to STEM studies and the improvement of the perception that STEM careers are difficult to balance with personal/family life

However, these recommendations have to be followed with caution. Some authors have argued that ideally, a uniform STEM educational system should be applied for all students, and that even though female students should benefit from priority measures, this should preferably not be achieved via programmes that are targeted at "girls only" as such labelling often lowers their credibility for various stakeholders. In a paper which explored a research project in Norway aiming to contribute to improving recruitment, retention and gender equity patterns in STEM education and careers, Sinnes & Løken (2012) argue that adjusting science subjects to match perceived typical girls' and boys' interests risks being ineffective, as it contributes to the imposition of stereotyped gender identity formation thereby also imposing the gender differences that these adjustments were intended to overcome.

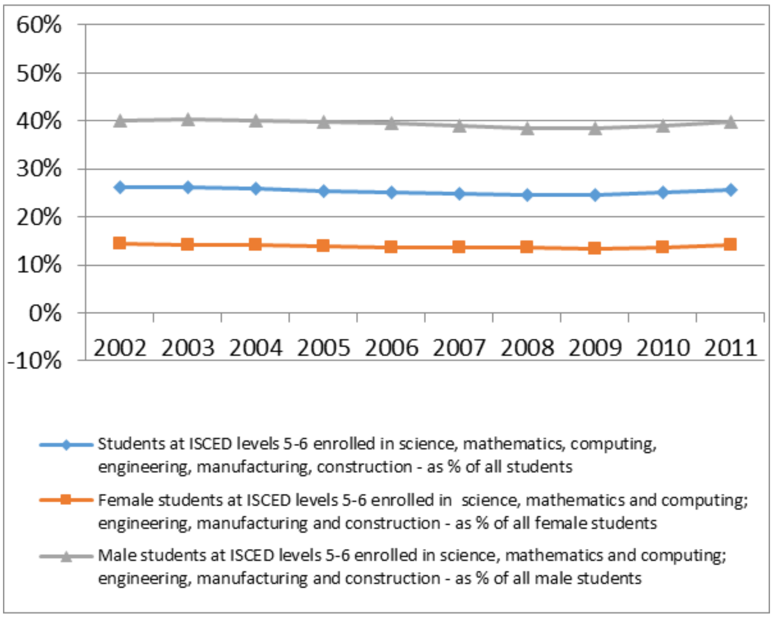

Figure 2: *Tertiary education graduates in Maths, Science and Technology as % of all fields (EU-27 countries). Source: Eurostat Statistics (Population and social conditions/Education and training/Database/Education indicators – non-finance/Tertiary Education Graduates (educ-itertc). Last update 11.06.13 / Extracted on 26/06/13.*

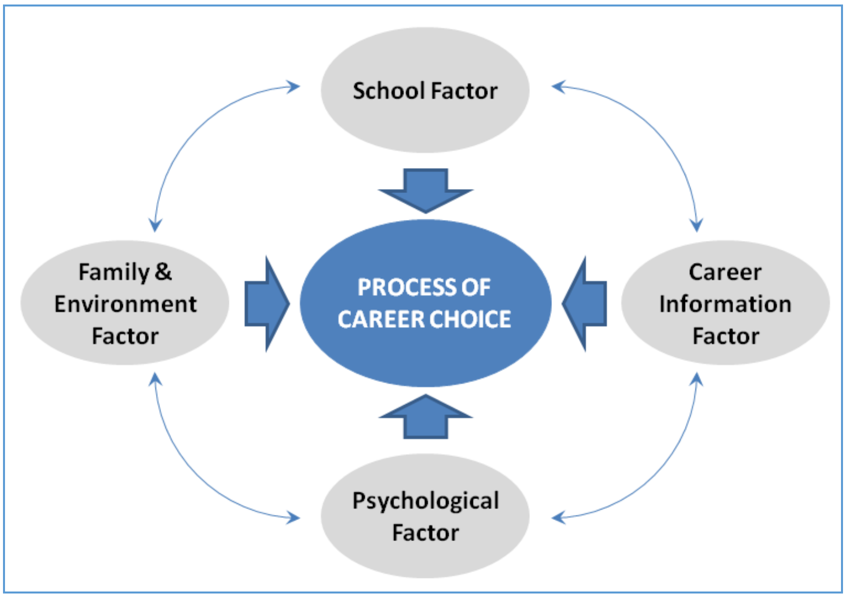

Figure 3: *Factors involved in the process of career choice.*

Summarizing, the process of career choice is very complex and several aspects are involved in it (see Figure 3). One way to address the influent factors is through proper collaboration between school and business. Actually, the involvement of the STEM-related business sector in education could help to increase the interest and competence in the study of STEM disciplines, by linking the subjects studied at school to the real life and by contributing to provide information about career opportunities as well as about the skills and abilities needed in the labour market.

However, we might wonder if any initiative of school-industry collaboration is able to effectively contribute to increase students' interest on STEM careers. For instance, when we think on visits of engineers and scientists to schools to give talks, or on school visits to manufacturing facilities, we need to know how these activities (which are usually focused on promoting STEM disciplines or giving career information) are performed in order to understand if the resources are effectively invested.

2.2 School-industry partnership: what the research tells us

The expressions “school-industry partnerships”, “school-industry collaboration”, “school-industry links”, “STEM policies” and “STEM practices” have been extensively used throughout the inGenious project, although some ambiguity exists regarding their meaning (CRECIM, 2011, 2013). Moreover, references in the literature are frequently found (especially in the UK) which use expressions such as “employer engagement” or “employer involvement” associated to schools or education. These types of engagement, which can be considered as particular kinds of school-industry collaborations, usually include: (i) work experience, school/workplace visits, apprenticeships/training and mentoring; (ii) employers/businesses support to the leadership and governance of schools (e.g. sitting on the board of governors of a school or providing professional development for teachers) and financial support to schools; (iii) employers support to the curriculum (e.g. advising on and developing relevant curricula as well as developing curriculum-related and lessons resources); and (iv) direct work of employers with students to develop skills and awareness (Burge, Wilson, & Smith-Crallan, 2012).

With this in mind, it is important to establish and agree on some definitions in order to clarify and make the work presented through the document understandable. According to Kisner, Mazza, & Liggett (1997), a partnership is “a continued cooperative effort or agreement to collaborate to generate ideas or to pool resources for a mutually acceptable set of purposes”. This broad definition can be applied to the relationship between industry and education, although it is still too unspecific.

Iredale (1999) uses the term “work-related education” to encompass “a wide variety of approaches to and aspects of education, which are linked to business and industry”. She points out that “work-related aspects of education could conceivably include such things as: careers education and guidance, economic and industrial understanding, enterprise education and community education, or they might simply be called education-industry links set up for the purpose of enhancing the curriculum or teaching about the world of work.” With this in mind, school-industry partnerships may be considered to be a mechanism to contribute to work-related education, since many of the initiatives developed in collaboration between industry and education are addressed to one or more of the previously mentioned purposes. Moreover, Iredale also highlights that "work-related education may be interpreted as that which educates pupils for work, or indeed it may be a term used by some teachers to describe *good* education (in the sense that the curriculum is enhanced by work links)." According to this, we could argue that school-industry partnerships are a mechanism to provide work-related education placing the emphasis of the educational purpose either on career orientation (i.e. by enhancing careers education and guidance) or on the curriculum (i.e. by enhancing it through links with the world of industry).

Furthermore, such relationships can have a positive impact on students' vocational/employability skills, knowledge and understanding, academic and learning outcomes, health and well-being and enjoyment and engagement (Burge et al., 2012); they can also positively contribute to the leadership of schools and to the development of teachers' expertise in particular curriculum areas (Mann et al., 2010); and employers can benefit from staff development, staff engagement and improved reputation and stronger links with the communities in which they operate (Mann & Oldknow, 2012). Moreover, cooperation with STEM professionals and their workplaces -such as industries- can provide teachers with real-life frameworks which contribute to enrich the STEM curriculum, highlighting the applicability of these disciplines and improving their content knowledge (Houseal et al., 2014).

However, it should be taken into consideration that educational choices are not static (Savickas et al., 2009) and that –"one-off" events do not have long-term impact on the process of career choice (Louise Archer, Osborne, & DeWitt, 2012). Therefore there is the need to provide students continuous links with industrial world (e.g. integrating school-industry collaborations as a normal part of the teaching and learning activities). Thus, it is recommended to design interventions that take place for a longer time, either by involving students and industrialists in cooperative projects, by stressing on teachers who are able to embed STEM careers awareness to the daily STEM lessons or by giving students several opportunities to participate in S-I partnership activities.

The research undertaken by InGenious-WP2 has been addressed to identify what is currently done across Europe in the field of S-I partnerships and which are the barriers that potentially hinder effective and sustainable S-I partnerships. The results of such research are presented below.

3 CURRENT ATTEMPTS TO PROMOTE YOUNG PEOPLE'S INTEREST IN STEM CAREERS THROUGH SCHOOL-INDUSTRY PARTNERSHIPS

The objective of this section is to give an overview of existing initiatives involving S-I partnership in Europe which aim at promoting STEM careers. This will be done by combining main findings of the study performed under WP2 (via the Observatory of Practices and the Needs Analysis) and bibliographic references. The section is structured at two levels:

- Design and implementation of S-I partnerships (Partnerships "for" learning): based on the results of the observatory of practices and the compilation of country reports on research literature
- Establishment and maintenance of S-I partnerships (Partnerships "towards" learning): based on the needs analysis and the compilation of country reports on research literature

In order to better understand the results commented below, a brief summary of the observatory and the need analysis is presented.

- Observatory of practices:

In the framework of the InGenious-WP2, data about the existing school-industry collaborations in Europe was gathered through a survey that was launched and addressed to industries and networks of industries from 17 European countries. A total of 152 different descriptions of actions were gathered. The answers to the survey, containing closed and open questions, allowed making a qualitative study about the objectives that are persecuted when designing school-industry practices and how they are related to the factors involved in the process of careers' choice. As well as a quantitative study about some concrete practicalities: target group, duration and existence of an evaluation process.

- Needs Analysis:

Based on the information collected through a set of reports which summarised the results of 15 national workshops organised within the framework of the InGenious-WP2, an analysis of main obstacles for establishing and maintaining S-I partnerships was carried out. These European workshops brought together representatives from the worlds of industry and education as well as political authorities involved in school-industry partnerships, and were addressed to discuss the current situation of STEM-related school-industry partnership ,and particularly about the existing obstacles.

3.1 Design and implementation of S-I practices

The aim of this section is to highlight the main characteristics of currently existing S-I practices (in terms of their design and implementation) that can contribute to foster young people's interest in STEM careers. Based on the results of the study performed within the Observatory of Practices carried out under WP2 (see Deliverable D2.2. for the details of the implementation and results of the Observatory) and on the country reports on research developments (Deliverable 2.5) which include also international results beyond Europe, current STEM-related S-I practices addressing the promotion of STEM vocations.

In general terms, from the analysis performed in the project, it has been confirmed that there is a broad range of initiatives which can positively contribute to the factors influencing career choices previously mentioned. It is very usual that STEM professionals go to schools to give lectures and that students visit industrial facilities to bring the industrial reality closer to the students. These activities do not necessarily have to be linked to the school curriculum, especially if their main aim is to give career information but not to give support to STEM teaching. Another kind of initiative that is promoted from the private sector consist on particular projects where students actively collaborate with the STEM workers, by means of having to solve simple industrial problems or having to overcome proposed technological challenges in the frame of an interschool contest. Many activities exist focused on girls, since a patent concern exists regarding the low interest of girls in STEM careers.

It is worth mentioning the long tradition of school-industry partnerships in other Anglo-Saxon countries (see Wright (1990) for a good review on the topic) such as the United States where the bigger businesses in the country actively collaborate with education (STEMconnector, 2013). There seems to be a broad agreement about the importance of promoting problem-solving, critical thinking and teamwork skills since they are seen as essential in any work environment. From the point of view of the businesses in the mentioned report, the promotion of the mentioned skills should be done through inquiry based learning, via group lab exercises and science projects. Examples of their collaboration with education include offering the support of an expert to create new didactical content aligned to industry standards, and partnering with higher education and designing new internship models that better equip students with essential skills. It is also common to participate in mentoring programs that are able to give students a connection to someone in the field that can help with career-related questions, which is considered to be very effective to encourage underrepresented groups (i.e. women) towards the world of STEM.

After having collected more than 150 examples of S-I practices across Europe, an analysis[8] was performed. A comparative analysis among the actions was performed finding common ground between the collected initiatives which allowed categorizing them into 11 different kinds of initiatives:

[8] See deliverable D2.1, D2.2 and D2.3 for details on the methodology used in the study

- **Use of support materials for the implementation of STEM educational programmes:** industry designs and elaborates some teaching and learning materials (e.g. multi-media resources, booklets, experimentation kits, serious games, etc.) to be used as a support for learning STEM topics, either with or without the guidance of the teachers. The purpose is usually to transmit information, although favouring STEM skills can be also intended.

- **Use of materials for giving career information:** apart from designing materials aimed at increasing students' competence in STEM disciplines, industry can also develop web portals, serious games, exhibitions, etc. intended to give awareness of STEM careers and addressed to students as well as to career counsellors and teachers.

- **Promotion of STEM education through science ambassadors:** industry gives economic support to fund science ambassadors who act as promoters of science and science education by proposing activities (such as hands-on experiments) addressed to make science relevant to students.

- **Promotion of STEM education through a STEM Centre:** industry gives economic support to a centre specialized either on STEM education, or on the dissemination of STEM.

- Support teachers' continuous professional development focused **on STEM-related industrial topics:** in general, there is a lack of awareness among primary and secondary school teachers regarding the world of STEM professionals, and industry can develop actions addressed to update their knowledge about STEM topics linking the curriculum and the world of work, as well as about professional opportunities within STEM.

- **Talks given by STEM professionals:** employers/employees from industry can establish a dialogue with students in order to either provide them information about jobs, academic and professional backgrounds, or to give talks, lectures or longer courses about STEM topics linking curricular contents with real industrial applications. These talks can take place at school, on-line or out-of-school, although if they are carried out in the facilities of a certain company students will have the opportunity to have a closer knowledge of the industrial world.

- **Debates with students around STEM-related subjects:** STEM professionals moderate a debate where students discuss about contemporary STEM topics, presenting and defending their points of view by using the arguments they consider most appropriate. The fact that the debate is performed with the involvement of a STEM professional makes it easier for them to link their scientific knowledge to social issues and industrial solutions.

- **School visits to company premises:** students' visits to company facilities allow them getting a closer view of the work and environment in industry. However, apart from a simple guide through the premises, students might be also proposed to participate in other activities within the company which might enrich their educational programmes by linking the school curriculum with the normal working of the company.

- **Students' participation in a technological challenge proposed by industry:** students participate in a contest addressed to solve a technological challenge (i.e. building a robot, designing a specific device, etc.), usually working in groups and with the help of their teachers and/or families.

- **Students' participation in research projects or studies proposed by companies:** students are proposed to explore in depth a certain STEM topic related to the industrial context, which might have been planned by STEM professionals or by STEM professionals together with educational experts (e.g. teacher, science education researcher, etc.). With the help of teachers and STEM professionals, students are expected to tackle and solve the challenge.

- **Internships in a company:** students are allowed to spend some time in a STEM company with the aim of experiencing what it is to work in such an environment.

Being focused on the target to which these initiatives where addressed and the factor (see section 2.1) that they could be potentially tackling (based on the description of the initiatives), a global picture of current European S-I partnerships for fostering STEM careers could be done. Specifically, InGenious research has evidenced that most of the initiatives are addressed to the first factor (school factor) while little attention is paid to other factors such as the self-efficacy of students (psychological factor). Furthermore, despite most of the practices declare to address more than one target group the results of the analysis highlight that the audience from secondary school is the most demanded. Another important result is the fact that most of the actions are not actually evaluated. Usually the impact is simply considered according the number of pupils involved in the action and it is, therefore, almost impossible to assess the real impact and if the desired goals are effectively achieved after its implementation. Finally, the analysis highlight that most of the described practices take hours or some days to be performed. There are few actions longer than a month, which would allow students to work deeply and jointly with STEM professionals around some specific topic. All these results are more deeply analysed when presenting the identified gaps on existing S-I partnerships.

Finally, the study performed under WP2 has allowed classifying S-I partnerships from a specific perspective. Depending on the degree of interaction between students and STEM professionals, it is possible to identify three main ways in which S-I collaboration can represent appropriate mechanisms to help promoting young people's interest in STEM careers (see Figure 4):

- **Helping to contextualise and enrich teaching and learning of STEM subjects:** the contribution of the industrial world to education can be very valuable in terms of contextualising STEM teaching, which has the associated benefit of stimulating pupils' interest in science. Moreover, by proposing real industrial problems to students (adapted to their age level) it is possible to promote important skills like finding plausible solutions to problems and deciding on an informed basis what the best solution is.
- **Making achievable Role Models and show the industrial reality to students, thus contributing to make STEM careers "thinkable" for them:** the students benefit from the contact with the world of work in terms of realizing the big diversity of existing jobs and breaking stereotypes related to STEM professionals. Actually, bringing STEM professions closer to students can make these more understandable and a real option for their future.
- **Promote awareness of students' own capabilities (and self-efficacy) by playing the role of STEM professionals:** S-I partnerships that allow students to perform tasks related to STEM professions are appropriate mechanisms to make them aware of their own capabilities and combat the common idea that STEM is "too difficult for me". In fact, self-perceived capability is a key factor in the choice of STEM studies, and it is important to break limiting perceptions that can discourage students. Moreover, role playing activities can help students to see if their own personality (interests, skills, values, etc.) matches with the tasks related to certain STEM jobs.

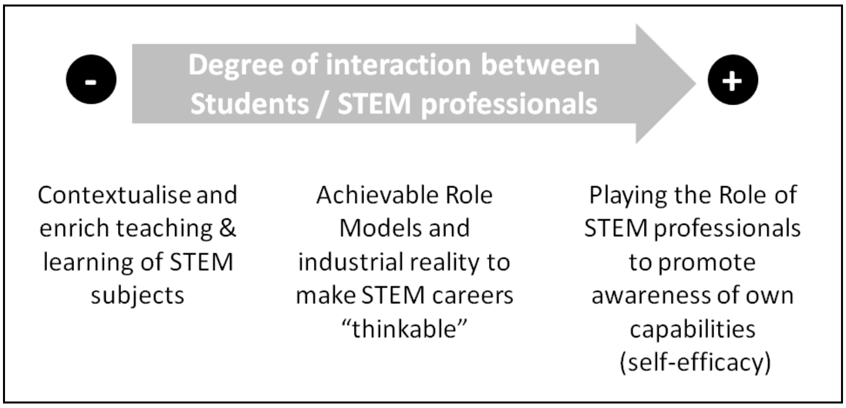

Figure 4: *Possible ways of contributing to promote young people's interest in STEM careers through S-I partnerships, according to the analysis of initiatives collected within inGenious.*

3.2 Establishment and maintenance of S-I partnerships

Several policies and schemes have been implemented worldwide to increase students' interest in STEM studies, and apart from the action plans already mentioned, other countries such as Japan or Korea have launched similar initiatives to promote young people in STEM, as detailed in chapter 3 of the report Encouraging Students Interest in Science and Technology Studies from the OECD (2008). However, although many countries have developed programmes, projects and initiatives to encourage the setting up of school partnerships in the field of science, those involving collaboration between schools and the private sector are not the most frequent ones. Actually, according to a comparative study of national policies, practices and research in science education in Europe (Eurydice, 2011), these partnerships with schools mostly involve stakeholders from either publicly-funded bodies or non-profit-making organisations, and only three examples are mentioned in the report in which the main partner collaborating with schools is from the private sector, i.e. industry and business: Jet-Net (the Youth and Technology Network in the Netherlands, which was established in November 2002 as a partnership between Dutch industry, the government, and the education sector); STEMNET (the STEM network in the United Kingdom funded by the Department for Business, Innovation and Skills and Department for Education); and the "Business and Industry" programme (developed in Norway by the Confederation of Norwegian Enterprise, NHO) (Eurydice, 2011, pg. 36-38).

In this sense, one of the objectives of the study performed in the frame of the inGenious project was to have a general view on the existing national policies or strategies in Europe addressed to reinforce the links between school and industry to promote STEM careers. A great diversity of strategies were identified (see deliverable D2.4 for details on the methodology used), which can be summarised as shown in Table 5.

The existence of **private strategies** to promote school-industry collaboration is totally dependent on the willingness of certain companies, networks of companies or employers' organisations to establish links with the educational system. It is worth mentioning that within the inGenious project, a great number of educational programmes developed by companies (such as Volvo, Nokia, Shell, Philips or BASF) and networks of companies (such as Teknikföretagen, Wissenfabrik and Jet-Net) have been identified. However, it should be kept in mind that, despite the existing benefits that school-industry partnership can bring to both parts, the collaboration between the two worlds is not an end in itself, and companies and employers/employees might have difficulties to promote these strategies on their own. In fact, as highlighted in a research study carried out by the National Foundation for Education Research (NFER) and commissioned by STEMNET, "business face a range of challenges in engaging with education including: time, capacity and financial constraints; low awareness and understanding of schemes and how to link with education; difficulties in engaging schools; health and safety constraints and bureaucracy; low awareness of the benefits of engagement; and difficulties in appropriately pitching activities and relating them to the curriculum" (Harland, Straw, Stevens, & Dawson, 2012).

Hence, it is important that some support from the political sector is also provided to facilitate the establishment and maintenance of partnerships through **public-private strategies** promoted both by industry and political authorities at different levels (nationally, regionally or locally).

Table 5: General scheme summarising the kinds of strategies identified to promote the interest of students in STEM careers through S-I partnerships.

<table>
<tr><td>Private strategies</td><td colspan="2">Programmes and action plans developed by employers' organisations, companies or networks of companies.</td></tr>
<tr><td>Public-private strategies</td><td colspan="2">National / regional programmes and agreements between government and private sector.
Local projects and agreements between municipal authorities, schools and industry.</td></tr>
<tr><td rowspan="2">National public strategies</td><td>Promoted by Ministries of Education</td><td>Reforms / regulations in:
STEM curriculum
Career guidance
Vocational Education and Training (VET)</td></tr>
<tr><td>Promoted by several Ministries (Education, Science, Industry, Employment, etc.)</td><td>Integral strategies focused on the links between different kinds of education and between education and the labour market.</td></tr>
</table>

For instance, the Universum Programme in The Netherlands, the STEM Ambassadors programme in the UK or the program Engineering made in Portugal (see below) are some worth mentioning examples of national programmes and agreements between political authorities and the private sector. A different approach is the case of the Danish Science Municipalities, which involve public-private partnerships at local level (i.e. they are based on local projects and agreements between municipal authorities, schools and industry).

- The **Universum Programme**, developed by the Dutch Platform Bèta Techniek, aims at helping science & technology oriented schools (secondary education) to pursue their own technical aspirations and educational ambitions. The Universum Programme works closely with Jet-Net, a joint venture of larger

Dutch companies and pre-college schools in the Netherlands that helps schools to improve the appeal of their science curriculum and to allow people to gain a better understanding of their future career prospects in industry and technology (Kaashoek, Bilderbeek, & Hamer, 2010, pg.5).

- The **STEM Ambassadors Programme**, carried out by STEMNET in the UK, enables young people, teachers and schools to interact with thousands of people working in any area of STEM. http://www.stemnet.org.uk/ambassadors/
- In Portugal, a protocol was signed in January 2013 between the Ministry of Education and Science (MEC), the Ministry of Economy and Employment (MEE) and Siemens to increase national development. The aim of the agreement "**Engineering made in Portugal**" is to promote the study of engineering, stimulating elementary and secondary students to pursue an academic career in this area and facilitating the integration of engineers in the labour market.
- The **Science Municipalities project**, which has been introduced in 25 out of 98 Danish Municipalities, is conducted by the Danish Science Factory and is based on coordination and continued development of local school initiatives within a municipal framework involving stakeholders such as local enterprises and political authorities. http://danishsciencefactory.dk/science-kommuner

On the other hand, Ministries of Education can promote **educational policies at national level** which allow reinforcing the links between education and industry, although these policies can be addressed to different educational levels. In the case of Vocational Education and Training (VET), policies regulating the relationship between school and industry have long existed in most countries. Moreover, in some cases this relationship can be coordinated by organisms linked to the private sector (such as private foundations promoted or supported by political authorities, and networks of companies. It is worth mentioning that some countries count on a dual system, in which VET is combined with apprenticeships in a company (a set of schematic diagrams showing the mainstream educational programmes considered to be the most representative in each country can be found in Eurydice, 2013). However, according to Akkerman & Bakker (2012), although apprenticeships have been identified as valuable learning and working trajectories for successful transitions and relations between school and work, they have been mostly located as activities taking place solely in the workplace with hardly any attention for what students do and learn during release days at school. Regarding compulsory education, countries such as Denmark, Finland and Portugal are promoting reforms in the curriculum in order to give a more application-oriented focus on STEM disciplines, particularly considering a close cooperation between school and industry (according to information provided by inGenious partners). Furthermore, curriculum reforms can also be translated into changes on pre-service and in-service teacher training involving Universities, employers' associations and other organisations (such as in the case of the Swedish MATENA teacher training program[9] promoted by Teknikföretagen).

An important point to bear in mind is that encouraging interest in STEM involves dealing with an enormous range of parameters and it has been argued that ideally, interventions to improve human resources in STEM should take account of the educational system as a whole (OECD, 2008). This would not mean central planning of the entire process with little regard for lower level initiatives and concerns, but rather a constant awareness of how actions on one aspect are influenced by, and influence in their turn, other parts of the system.

[9] http://www.matena.se/

In this respect, it is worth mentioning that two examples of broad **national public strategies** have been identified which involve several Ministries (such as the one from Education, Science, Economy and Industry). In The Netherlands the research and innovation Deltaplan Science and Technology was formulated in 2004, and for the strategy to be followed, a national Platform (Platform Bèta Techniek) was set up, commissioned by the government, education and business sectors to ensure sufficient availability of people who have a background in scientific or technical education. More recently (January 2012), the Flemish government in Belgium set forward the Actieplan STEM (Action Plan for the Promotion of Careers in Mathematics, Exact Sciences and Technology). This national/regional joint initiative, which involves the Ministries of Education and Training, Work and Social Economy, and Economy, Science and Innovation, is intended to address the shortages of STEM graduates in Flanders and to enhance cooperation with industry.

These so called integral strategies are oriented to reinforce the whole national economic, education and labour system, based on an integral approach for STEM and targeting all levels of education as well as the labour market in order to contribute to improving the competitiveness of the country. A common element shared by the two action plans previously mentioned is the creation of STEM platforms which allow implementing the plans and make them concrete. In particular, the Dutch Science and Technology Platform (Platform Bèta Techniek) was launched in 2004 by the Dutch Ministry of Economic Affairs, the Ministry of Social Affairs and Employment and the Ministry of Education, Culture and Science to increase the number of new science and technology graduates in 2010 by 15% compared to 2000 and to ensure that scientists and technologists are more effectively retained and used (OECD, 2008). The Platform's approach consists on anchoring STEM studies institutionally, from primary schooling to the labour market, although nothing is imposed and schools have the autonomy to use the range of methods developed by the Platform (which are addressed to improve science curricula and teaching, participation by girls and development of partnerships, among others). The working definition of a National Platform is "*A structure on national level coordinating and implementing European and national STEM agendas in dialogue with national STEM stakeholders and in collaboration with national STEM operators targeting the STEM education system*" [10]

The existence of these National Platforms, which count on the involvement of several ministers and are guided by clear national goals and agenda, allows more sustainable and effective S-I partnerships by:

- Avoiding stand-alone activities
- Creating synergies
- Having clear common goals
- Exchanging good practises

In this context, it is worth mentioning that the great potential of these national STEM platforms in developing effective S-I partnerships has led to the creation of a Task Force within the inGenious project aimed at providing start-up support to Member States wishing to create their own National STEM Platform adapted to local conditions but adhering to key principles. Giving the relevance of this initiative within the InGenious project, a specific focus is made in the

[10] This definition is made by the task force at the Madrid Meeting 2013

methodology and results of this NPTF which may inspire other countries and organizations to undertake such task.

3.2.1 The National Platforms Task Force

To support the spreading of good practices through strategic national adaptations of experiences from other member states as well as implementation of European STEM agendas, a National Platforms Task Force (NPTF) was created within the InGenious project. (more details on the NPTF, its members, methodology and results, can be found in Annex I)

The hypothesis of the NPTF was that member states are different and that good ideas, experience and policies therefore must be adapted to national and from there to regional and local agendas. Also, the NPTF assumed that such "translations" could be helped by the formation of national public-private partnerships to promote STEM education – the National Platforms (NP).

To carry out this task, the NPTF set up an experimental methodology to communicate these experiences to two other member states – Estonia and Portugal. The methodology was based on a value proposition, stating that if the member state were able to organize a national round table meeting with key public and private stakeholders, the NPTF would come and present the Dutch and Danish experiences as well as facilitate a discussion. In order to consolidate the exchange of experiences among the involved countries, the NPTF made a study trip to the Netherlands for further discussions and on-site experiences of the Dutch national platform for STEM education.

The NPTF found great enthusiasm for the applied methodology in both Estonia and Portugal in Sep-Oct 2013 and was able to have interesting and enlightening round table discussions with relevant stakeholders in each country. The need for more coordination on a national level was very clear in both countries.

From the experience of the NPTF, a successful national stakeholder meeting is characterized by the following do's and don'ts for the European organizer of a National Platforms stakeholder meeting:

1. The initial contact must be made with government officials with a clear decision mandate to prepare the stakeholder meeting
2. There must be a very clear value proposition to make sure that expectations are clear before the meeting
3. Make sure that both Ministries of Education as well as Ministries of Financial Affairs are involved in the meeting
4. Work with the national hosts to invite a broad range of public and private stakeholders with decision mandates
5. Make sure to present very concrete experiences
6. Make sure to present both successes and failures
7. Avoid to present a "one size fits all" model for a National Platform, but respect the national agendas
8. Make sure to facilitate ample time for discussions – preferably in the national language
9. Try to make action-based decisions on next steps with a clear understanding of who's responsible (preferably a Ministry)

10. Follow-up and take care to create contacts between countries who are working to create National STEM Platforms.

The results of the two national visits, turned out to be very different. Estonia was at the time of the visit in the process of making a national STEM and innovation agenda, whereas Portugal struggled with organizational changes in the administration, which made strategic decisions very hard at the time. However, Portugal is still optimistic about the possibility of a national platform in the future as can be seen in the official letter to the NPTF from the Portuguese Ministry of Education (See Annex 1)

For Estonia, the visit in February 2014 to the Netherlands was particularly helpful, as it has lead to a number of national meetings and seminars and Estonia is now using this input in the establishment of a strong national platform., as can seen from an official letter from the Estonian Research Council to the NPTF September 2014 (for full text, see Annex I):

> "Today the Estonian Research Council has strong mandate to move forward with National STEM Platform and Estonian Technology Pact. There is an agreement to plan financial support for boosting the process from the next European Social Fund funding period. The activities of the period (2014-2020) will be planned in details by the end of this year. Already on September 16 Estonian Research Council will hire a person whose main job will be to launch both processes, lead it to the results and keep it running."

The conclusion of the work of the NPTF highlights the relevance that an initiative such as the InGenious project as a European Coordination Body may have in the effort for enhancing students' interest in science education and careers. Specifically, the results of this NPTF suggest that:

- Given the differences of the member states, any European coordinating body like InGenious can benefit tremendously from having national partners to "translate" best practice into a national context
- There is a big wish from public and private stakeholders to discuss national strategic collaborations in STEM
- It is important to secure high-level political support from both public and private leaders in order to establish a national platform
- Public-private stakeholder meetings is a cost-efficient way to promote national STEM collaborations
- There is a need for a European meeting-place for national platforms, a "platform of platforms"
- There is a great potential for developing and qualifying more national strategies for STEM through the establishment of National platforms and a European "Platform of platforms".

4 DIFFICULTIES IDENTIFIED WITHIN THE DEVELOPMENT AND IMPLEMENTATION OF SCHOOL-INDUSTRY PARTNERSHIPS

As previously discussed, although S-I partnerships can bring multiple benefits (Price, 1991; National Centre for Social Research, 2008; Mann, Lopez, & Stanley, 2010; Mann & Oldknow, 2012), the collaboration between the worlds of industry and education can be sometimes difficult to be initiated and maintained in a sustainable manner due to several challenges that the involved parts might have to face. In this respect, identifying the main obstacles that partners can encounter in their collaboration is a crucial step to be tackled in order to allow making effective decisions which can help bringing more partnerships to fruition. On the other hand, it is also challenging to design S-I practices which are effective in promoting STEM careers, and as previously mentioned, this will be more likely to occur when certain criteria for “good practices” are fulfilled.

In this section we will discuss the main gaps and obstacles that have been identified based on the findings of the study performed within the inGenious project and which would need to be paid attention to in order to improve both the establishment and maintenance of S-I partnerships as well as their effectiveness upon the promotion of STEM vocations.

4.1 Gaps for an effective impact of school-industry practices

As presented in previous sections, the analysis of 150 practices of S-I collaboration at European level has allowed characterizing them in terms of the target and the objectives addressed, as well as their duration and the level of evaluation that they carry out. Analysing these features in the light of the factors influencing students’ interest in STEM careers may help understand which are the gaps that may hinder more effective school-industry partnerships. Specifically, the InGenious-WP2 analysis has revealed that:

- **Most practices of S-I collaboration try to increase young people’s motivation by promoting actions which are mainly addressed to make STEM more attractive** (presenting the friendly face of STEM by proposing fun activities). However, and as already mentioned, **liking science is not enough** (L. Archer, Osborne, & DeWitt, 2012) and according to the results of a study which explored the impact of role model schemes in inspiring young people about science, engineering and technology (Office for Public Management, 2004), the perception of own ability is the most popular factor contributing to enter STEM fields.

- **Secondary school students are the main target group for most S-I collaborations**. However, it should be considered that children’s science attitudes start to decline after the age of 10/11 (notably from ages 10-14)(L. Archer & Tomei, 2013), thus targeting the activities to primary school level should be also an objective.

- **Most practices of S-I collaboration take place at school and for few hours**. We should have in mind, thought, that educational choices are not static (Savickas et al., 2009), and that "one-off" events do not have long-term impact on the process of career choice (L. Archer et al., 2012). For this reason, it would be necessary to envisage continuous and long-term relationships.

- **Few actions evaluate if the expected outcomes for students are effectively achieved**, and evaluation is usually performed in terms of:
  - Number of participants
  - Fitting between the contents of the practice and the school curriculum
  - Students' / Teachers' satisfaction

  Nevertheless, the fact that an initiative fits the curriculum and that their participants are numerous and feel satisfied after having taken part in it, does not guarantee that it will have an efficient impact on promoting STEM careers. Evaluation plans bearing in mind the pursued objectives and the elements influencing their achievement must be conceived.

4.2 Obstacles for the establishment and sustainable maintenance of school-industry partnerships

Despite the multiple benefits that can arise from school-industry partnerships (Price, 1991; National Centre for Social Research, 2008; Mann & Stanley, 2010; Mann & Oldknow, 2012), the collaboration between these two worlds is not an end in itself, and the parties involved in these activities might have to face shared difficulties (Eurydice, 2011). As highlighted by Sagar, Pendrill, & Wallin (2012), although collaboration with the surrounding world (including industry) in the teaching practice is one of the components which may be included in entrepreneurial learning, teachers perceive requirements and barriers for integrating collaborations. In this respect, the identification of the main obstacles that partners can encounter in their collaboration is a crucial step to be tackled in order to help bringing more partnerships to fruition. Obstacles might exist both for school teachers who try to cooperate with a company, as well as for industrialists who are keen to design education practices. Moreover, policy makers can also contribute to this kind of relationship through particular policies that offer suitable conditions for the stakeholders involved. It is important, thus, to identify the existing barriers in current school-industry collaboration, since being aware of them is crucial to allow making effective decisions addressed to reinforce the establishment and maintenance of fruitful partnerships.

In this sense, Ingenious-WP2 has been also addressed to explore which kinds of obstacles are currently impeding STEM-related S-I partnerships according to the main stakeholders (i.e. representatives from industries and from schools), a Needs Analysis process was performed within the frame of the inGenious project. To do so, be based on the information collected through a set of reports which summarised the results of 15 national workshops organised in the partner countries (Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Israel, Italy, Netherlands, Portugal, Slovakia, Spain, Sweden and United Kingdom). The aim of these workshops was to bring together representatives from the worlds of industry and education as well as political authorities involved in S-I partnerships so that a fluent dialogue could be established and the different stakeholders could share their perspectives about the current situation of STEM-related S-I partnerships (and particularly about the existing obstacles) in order to come out with recommendations.

The information gathered through the 15 National Needs Analysis reports was qualitatively analysed in order to identify the kind of obstacles that both industry and school find to collaborate. The types of barriers that were identified as hindering the establishment and maintenance of S-I collaborations are shown in Table 6, together with the frequency in which they appear in the reports and the four main families of obstacles in which they were classified:

- **Structural obstacles:** those which have to do with partners' limited availability of resources, support and infrastructures (lack of resources –funding to cover costs of materials, equipment or travel expenses, appropriate staff, time investment, know-how and methodologies, etc.–; lack of support –from school administration, peers and institutions–; geographical closeness between schools and companies).

- **Motivational obstacles:** those related to the interests and motivations of the parts involved (goals of the collaboration –unclear matching of expectations of both partners, questions regarding the value/usefulness/benefits of the collaboration–; lack of partners interested in school-industry collaboration; lack of continuity and commitment between partners).

- **Procedural obstacles:** those related to the way school-industry links are managed (communication between partners –finding the right contact person to establish the collaboration, keeping contact between partners despite changes of personnel–; existing regulations –outdated and inflexible legislation at schools).

- **Cultural obstacles:** those related to the tradition and different ways of working in school and industry worlds (different realities of the worlds of industry and education –lack of mutual awareness between both sectors, lack of tradition in school-industry collaboration at primary and secondary level–; matching of schedules –end of year for companies and periods of exams for schools–; negative stereotypes of industry in schools).

Table 6: Classification of the types of obstacles hindering the establishment and maintenance of S-I collaborations (according to stakeholders involved in the national workshops) and percentages over total obstacles referred in the reports.

Category		**Family of Obstacles**	
Lack of resources (economic/human/time)	23%	STRUCTURAL	35%
Lack of support	10%		
Geographical closeness between schools and companies / lack of companies in low industrialized regions	2%		
Goals of the collaboration	18%	MOTIVATIONAL	33%
Lack of partners interested in collaborating	9%		
Lack of continuity/commitment between partners	6%		
Communication between partners	13%	PROCEDURAL	17%
Existing regulations	4%		
Different realities of the worlds of industry and education	13%	CULTURAL	16%
Matching of schedules	2%		
Negative stereotypes of industry in school	1%		

The information obtained from the research performed by InGenious-WP2 can be complemented with the information identified from the country reports on research. For instance, according to Harland et al. (2012), much of the S-I partnerships have involved large companies, and the engagement of SMEs has been seen as a major challenge, since their small size leaves little flexibility to find time or staff to engage with education. In fact, the authors of the mentioned study aimed at exploring the engagement of STEM SMEs with education found that there is a relationship between size of business and the extent of engagement (smaller businesses are less likely to engage, and to engage on more *ad-hoc* basis and with a narrower range of activities, often due to the lack of dedicated human resources staff). Furthermore, it is also important to consider that the presence of STEM employers in the community local to the school can shape how the school builds its STEM career-related learning activities, as highlighted in a research conducted by the International Centre for Guidance Study at the University of Derby (UK) (Hutchinson, 2013). That is, schools that are part of a local economic community which is built on STEM-related industries are better placed to take advantage of links with STEM employers than those in economic areas dominated by non-STEM industries. However, the authors of the mentioned research state that schools without an obvious STEM employer presence in their locality could still become engaged with STEM industry in other ways, although the commitment of the school senior leadership and the extent to which they prioritise STEM career-related learning seems to be essential.

5 RECOMMENDATIONS

In order to contribute to the research in the field of school-industry partnerships and willing to help those stakeholders interested in such kind of cooperation, several recommendations could be derived from what has been introduced in previous sections.

5.1 How to improve the effectiveness of initiatives involving S-I partnership?

Bearing in mind the research evidence on how to promote young people's interest in STEM careers and current European panorama in terms of S-I partnerships, several recommendations could be elaborated in order to improve the effectiveness of initiatives involving S-I partnership.

RECOMMENDATIONS

S-I partnerships should contribute **to make students competent in STEM related disciplines and make them aware of their ability to perform tasks related to STEM jobs**. Bearing in mind the influencing factors introduced in section 2.1, the following **recommendations** should be taken into account when designing school-industry initiatives:

- To incite **real engagement of students**. This can be achieved through problem solving and inquiry activities such as (i) working around questions/problems (asking questions and encouraging students to participate actively in the discussion); (ii) proposing problems as open-ended questions; (iii) proposing activities which require the application of knowledge from one context to another, in order to promote the ability to abstract and generalise; and (iv) proposing exercises for making connections between different ideas.
- To promote the **initiatives addressed to primary school level** students. The majority of young children have positive attitudes to science at age 10, but this interest then declines sharply and by age 14 their attitude and interest in the study of science has been largely formed.
- To provide **information about a wide range of STEM jobs** to make students aware about careers that match their personality, by allowing interaction with STEM professionals (role models) and by engaging students in activities in diverse roles. This will also help to break gender and other cultural stereotypes.
- To propose scientific activities and/or technological problems through which **students can realize their good capabilities** to deal with them.
- To **show the social relevance, ethics or social responsibility** of the work in the industry (students will only be willing to pursue STEM careers if they have a positive view of them)
- To design interventions which take place for a **long time**. Educational choices are not static and–"one-off" events do not have long-term impact on the process of career choice
- To include **comprehensive evaluation** in the design of S-I partnership activities in order to confirm their effectiveness

Following these recommendations, in order to design or to assess initiatives involving S-I collaboration that can positively contribute to the factors influencing career choice mentioned in section 2 a set of *criteria for good practices* was developed in the frame of the inGenious project within WP2 (see Deliverable D2.1 and D2.2). These criteria were categorized in three groups according to the three questions previously stated: (i) general criteria for a quality educational practice; (ii) criteria for STEM education; and (iii) criteria for STEM careers education:

- General Criteria for a quality educational practice:
  - Have clear expected outcomes for students able to be achieved.
  - Fulfil the students' STEM curriculum.
  - Integrate the evaluation as part of the design of the practice.
- Criteria for STEM education:
  - Propose activities focused on the attainment of:
    - Content knowledge.
    - Skills: scientific, mathematical, technological and social.
    - Attitudes towards science.
  - Promote skills well appreciated in STEM jobs (capability for teamwork, communicating in different forms of languages, etc.).
  - Design initiatives with previous understanding of the knowledge, skills and beliefs of the target audience.
  - Promote pedagogical approaches allowing free role of the students: work around questions or debates in teams, proposing open-ended questions, inquiry activities and modelling of main scientific ideas[11].
- Criteria for STEM Careers Education
  - Make known the academic profile and the professional path of STEM professionals.
  - Provide opportunities to gather and process information about the work performed by professionals in a wide range of STEM jobs making this work understandable by the students, through role-model and role-playing exercises.
  - Propose scientific activities and/or technological problems through which students can realize their good capabilities to deal with them and not think they exceed their coping capabilities.

[11] If a focus wants to be made following this perspective, it is worthwhile to highlight the list of criteria that a STEM education practice should meet, according to a compendium of best practice promoted by Bayer Corporation (Bayer Corporation, 2010)

- Foster girls into STEM careers and jobs by showing them that STEM is not a man's world and through role-model exercises.
- Show the social relevance, ethics or social responsibility of the work in the industry.

Finally, it is worthwhile to highlight that the InGenious project has been also addressed to transfer already existing practices across Europe. In this sense, when thinking on the adaptability of existing S-I initiatives, it is worth considering some important remarks arisen from research in science education. First of all, transferring an innovation to a different context requires that the innovation is perceived by the adopters as usable in the new context. Actually, in order to facilitate the implementation of an innovation in a new context, Ely, (1999) mentions the environmental or human-related conditions that can facilitate it. These are: dissatisfaction with the status quo which would drive the will to implement an innovation, adequate resources to implement the innovation, rewards and incentives that result from using this innovation, knowledge and skills needed to implement it, adequate time to adapt and become familiar with it, participation of the necessary stakeholders, institutional commitment and leadership that motivates the users of the innovation.

Moreover, according to Pintó, Hernández, & Constantinou, (2013), transferring an initiative linked to the educational curriculum to another setting without previous adaptation is not feasible. They state that, in order to adapt an initiative to a new context, a previous effort should be done to abstract the core elements and to decode the underlying pedagogical orientations embedded in the original material in order not to lose its essence (for example, the success of a particular initiative could rely on the original use of a certain ICT tool and a good adaptation of the initiative should replicate that). Ideally, this would be done through mutual interaction between the institution that designed the original initiative and the one trying to adapt it.

5.2 How to facilitate the establishment and maintenance of sustainable S-I partnerships?

On the other hand, in order for these partnerships to be effectively established and maintained, there is also a need to provide certain conditions and resources. Specifically, and in order to overcome the obstacles mentioned in the previous section, a broad range of measures involving different levels of complexity should be put in place. Moreover, we should keep in mind that many of these obstacles are strongly interrelated (for instance, certain structural barriers might be the cause for some procedural obstacles, and similarly, cultural barriers are closely linked to motivational ones). In this sense, it is not our purpose to give recommendations specifically addressed to particular obstacles, but to make suggestions that can be useful for all of them in a transversal way. To do so we will focus on recommendations at three different levels.

First of all, some **operational recommendations** can be addressed to the main actors involved in the implementation of practices of school-industry partnership, i.e. representatives from industry, on the one hand, and teachers and other professionals from the world of education, on the other. Having in mind that these are usually the main actors involved in the design and implementation of school-industry partnerships, it is important that they take into account practical advice and suggestions, which will usually help to achieve short-term objectives, with the aim of improving and facilitating the proper development and effectiveness of these practices.

On the other hand, **strategic recommendations**, usually focused on the achievement of long-term objectives, should also be established. In this respect, it is important to address policy makers at national and European level and establish action plans and promote broad approaches that can offer a proper environment to reach the goal of increasing the number of STEM qualified people.

In between of these two levels of measures, it is also necessary to establish **tactical recommendations**, which will usually be focused on short and medium-term objectives. These are mainly addressed to policy makers at national, regional, and local levels, as well as to facilitators or organisations which can coordinate school-industry partnerships (e.g. National STEM platforms, employers' organisations, universities, research centres, etc.). The importance of particularly acting at regional and local levels is crucial to effectively reach the main stakeholders involved in school-industry partnerships (i.e. school and companies) and to align the national strategic objectives with the (mainly local) operational actions.

The following recommendations were discussed in a workshop that took place in Brussels the 18th November 2013 and that joint important stakeholders at European level (policy makers, representatives from multinational businesses, experts in STEM education ...).

OPERATIONAL RECOMMENDATIONS

Disseminate and share the know-how of existing initiatives

By e.g.:

- Making available guideline documents, evaluation tools, databases with practices, policies and role models.

TACTICAL RECOMMENDATIONS

Contribute to the alignment of expectations of stakeholders and search for common goals

By e.g.:

- Establishing frameworks that stimulate teachers' involvement in school-industry collaborations.
- Promoting multi-stakeholder networks.
- Improving coordination within local, regional and national initiatives.

STRATEGICAL RECOMMENDATIONS

Support sustainable school-industry relationships from different Ministries, i.e. Education, Science, Industry, Employment, etc.

By e.g.:

- Promoting integral comprehensive strategies implemented through National STEM Platforms.
- Supporting public-private strategies at regional and local level.

5.2.1 Recommendations arisen from the National Platform Task Force

In order to face the challenges related to S-I partnerships at different levels that have been mentioned along this document, certain organizations have been established in some countries which contribute to promote stronger links between the worlds of STEM education and business. Some examples of such organizations are JetNet and Platform BètaTechniek in The Netherlands; Teknikföretagen in Sweden; The House of Natural Sciences and Danish Science Factory in Denmark; Wissensfabrik in Germany; and STEMNet in United Kingdom. The existence of these organisations is seen as positive to contribute to overcome several difficulties or needs faced by the stakeholders involved in S-I collaborations and they might also have the potential to influence at the political level and to place the STEM challenge on the political agenda. With these benefits in mind, in the frame of the inGenious project, a task force aimed at the promotion of this kind of organisations, known as National STEM Platforms, has been created. Main conclusions of this National Platform Task force give room to next steps in the promotion of School-Industry partnerships at a European Level, but bearing in mind the local needs:

- Given the differences of the member states, any European coordinating body like InGenious can benefit tremendously from having national partners to “translate” best practice into a national context
- There is a big wish from public and private stakeholders to discuss national strategic collaborations in STEM
- It is important to secure high-level political support from both public and private leaders in order to establish a national platform
- Public-private stakeholder meetings is a cost-efficient way to promote national STEM collaborations
- There is a need for a European meeting-place for national platforms, a “platform of platforms”
- There is a great potential for developing and qualifying more national strategies for STEM through the establishment of National platforms and a European “Platform of platforms”.

A final worth mentioning remark that should be considered at all levels (from the operational to strategic one) is the need to fix clear and **achievable objectives and evaluate actions** accordingly. In this sense, and although several benchmarks have been set at European level[12], few countries have established indicators at national level and perform evaluations at different levels to monitor its achievement. Taking note of the S-I partnerships potentialities –what can they contribute to?- and the recommendations –how to establish effective and sustainable S-I partnerships?- summarized in this document, may serve as a basis for working on these evaluation actions.

[12] For instance, and according to the strategic framework for European cooperation in education and training (2009), by 2020 the share of low-achieving 15-years olds in reading, mathematics and science should be less than 15%

http://europa.eu/legislation_summaries/education_training_youth/general_framework/ef0016_en.htm

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7 ANNEX I

The National Platforms Task Force (By Mikkel Bohm)

1.1. Summary

The overall purpose of the InGenious project is ”to reinforce young European's interest in science education and careers and thus address anticipated future skills gaps within the European Union.”

Working with a number of communication methods (website, conferences, teacher academies, summer schools etc.) InGenious has worked to spread best practice of particularly school-industry collaborations.

To support the spreading of good practices through strategic national adaptations of experiences from other member states as well as implementation of European STEM agendas, a National Platforms Task Force (NPTF) was created within the InGenious project.

The hypothesis of the NPTF was that member states are different and that good ideas, experience and policies therefore must be adapted to national and from there to regional and local agendas. Also, the NPTF assumed that such “translations” could be helped by the formation of national public-private partnerships to promote STEM education – the National Platforms (NP).

The working definition of a national platform is thus:

“A structure on national level coordinating and implementing European and national STEM agendas in dialogue with national STEM stakeholders and in collaboration with national STEM operators targeting the STEM education system”

Inspired by successful NP experiences from the Netherlands and the subsequent good practice transfer of the Dutch Jet-Net programme to Denmark, the NPTF set up an experimental methodology to communicate these experiences to two other member states – Estonia and Portugal.

The methodology was based on a value proposition, stating that if the member state were able to organize a national round table meeting with key public and private stakeholders, the NPTF would come and present the Dutch and Danish experiences as well as facilitate a discussion. In order to consolidate the exchange of experiences among the involved countries, the NPTF made a study trip to the Netherlands for further discussions and on-site experiences of the Dutch national platform for STEM education.

The NPTF found great enthusiasm for the applied methodology in both Estonia and Portugal in Sep-Oct 2013 and was able to have interesting and enlightening round table discussions with relevant stakeholders in each country. The need for more coordination on a national level was very clear in both countries.

The results of the two national visits, however, turned out to be very different. Estonia was at the time of the visit in the process of making a national STEM and innovation agenda, whereas Portugal struggled with organizational changes in the administration, which made strategic decisions very hard at the time.

For Estonia, the visit in February 2014 to the Netherlands was indeed very helpful, it has lead to a number of national meetings and seminars and Estonia is now using this input in the establishment of a strong national platform. Portugal is working somewhat slower but are still optimistic about the possibility of a national platform in the future (see official statements from the two countries in section 3 and 4)

The conclusion of the work of the NPTF is, that

- Given the differences of the member states, any European coordinating body like InGenious can benefit tremendously from having national partners to “translate” best practice into a national context
- There is a big wish from public and private stakeholders to discuss national strategic collaborations in STEM
- It is important to secure high-level political support from both public and private leaders in order to establish a national platform
- Public-private stakeholder meetings is a cost-efficient way to promote national STEM collaborations
- There is a need for a European meeting-place for national platforms, a “platform of platforms”
- There is a great potential for developing and qualifying more national strategies for STEM through the establishment of National platforms and a European “Platform of platforms”.

1.2. Background

The idea of working closer with national strategies and national platforms for STEM education in general and school-industry collaborations in particular grew out of the National Needs Analysis (NNA) done by the UAB in the beginning of the InGenious project.

Many of the NNA country reports stated, that one of the major obstacles in promoting STEM careers was the lack of an overall national strategy for STEM as well as a nationwide organisation of STEM initiatives. Without such overall strategies, a lot of efforts were made on local, regional and national level, but without best practise sharing or coordination:

> **Germany: ”**Concerning a long term perspective it would be beneficial if the different networks in Germany would work together, teaching with a common goal, improving the conditions of STEM education and using synergies.”
>
> **Spain: ”**Increasing awareness among all the agents (governments, schools, companies, families and the society in general) about the importance of an education that promotes STEM.”
>
> **UK**: “One place - a portal website that showcases and lists ways that schools can engage with industry. This site should guide schools into what the first step to take is (where do you go to start the journey / relationship).”
>
> **Finland: “**The need of co-operation between different stakeholders was seen clearly and a few concrete steps forward were established.”
>
> **Austria**: ”A national STEM information platform on the internet is needed with “best practice “examples and contacts on regional basis.”

Looking to the Netherlands, it was clear that the Platform Beta Techniek, the Jet-Net initiative and latest, the Technology Pact, all made to happen through a massive coordinated public-private partnership between industry and a number of ministries (education, economic affairs, social and labour etc.), was a both impressive and successful solution to the coordination challenges for STEM initiatives.

Just at the same time as InGenious was started, a version of the Jet-Net initiative was established in Denmark, proving that it is indeed possible to take best practise from one country to another –

not as a 1:1 copy but in a way that respects the individual countries' particular culture and socio-economic structure.

So the question was – could this happen in other member states, too? Would it be possible to inspire others to learn from the recent experiences in the Netherlands as well as Denmark to establish national platforms for STEM education? And if yes, how to go about the job?

Based on this challenge, a Nation Platforms Task Force (NPTF) was founded within the InGenious project, the task being to test a methodology to transfer best practise between member states.

1.3. Task Force members

The NPTF was formed with the following initial members:

- Mikkel Bohm, Danish Science Communication, DK (chair)
- Kimberly Lansford, European Round Table, BE
- Sebastiaan Smit, Jet-Net, NL
- Nanna Seidelin, House of Natural Sciences, DK
- Franziska Hutzler, Wissensfabrik, DE
- Anna Artiguas and Raquel Rios, UAB, ES
- Stephanie Parsons, FutureLab, UK
- Neil McLean, FutureLab, UK
- Hans Colind Hansen, Danish Science Factory, DK

The members of the NPTF shifted somewhat during the next year as can be seen in the appendix of meeting attendees.

1.4. Activities

The NPTF produced the following activities

<u>Meetings</u>

1. Meeting Madrid, March 8 2013
2. Meeting Copenhagen, June 12 2013
3. Meeting Brussels, September 11 2013
4. Meeting Brussels, November 18 2013

<u>Travel missions</u>

1. Estonia, September 15-17 2013
2. Portugal, October 24-25 2013
3. Netherlands, February 16-17 2014

These activities will be explained in detail below

2. Definitions and methodology

2.1. Definition of a National Platform

At the two first NPTF meetings in Madrid and Copenhagen, the group worked to define what characterises a National Platform and what functions it should have. A definition was formulated:

"A NP is a structure on national level coordinating and implementing European and national STEM agendas in dialogue with national STEM stakeholders and in collaboration with national STEM operators targeting the STEM education system"

The Task Force also found:

- That the NP cannot just focus on school-industry collaboration about STEM-education but should also deal with the *overall promotion* and performance of STEM-education from "kindergarden to upper secondary school or even PhD". The Dutch Platform Beta Techniek with Jet-net.nl as an integrated activity offers an example of that.
- That the work of present NP's of inGenious and the National Needs Analysis workshops has shown *differences in the national systems of STEM-education*, that have to be taking into consideration, when a European STEM-agenda is implemented to influence and impact the performance of the respective national STEM-education-systems,
- That the member states have different levels of aspirations, experiences and resources in national efforts developing the practice and performance of their STEM education system,
- That successful NP's are the result of *political and industry commitment in a participatory dialogue* with the existing STEM stakeholders and a collaboration with competent public and private operators,
- That due to national differences and cultures the NP's will have to *act differently at national and regional/local levels*.
- That the source of financing the NP and its activities is not of importance – it can be public as well as private sources or a mix of these.
- That exchange of experiences between the NP's at European level will inspire, align and enhance the work of the NP's in relation to an European STEM-agenda
- That important factors influencing the KPI are:
  - quality of existing STEM teachers
  - quantity of educated STEM teachers
  - appliance of school/industry collaboration as tool to raise the motivation for STEM education
  - ongoing focus and dialogue on increasing the quality of the STEM education/didactics and the image of STEM related jobs.

All these discussions pointed towards a model for national platforms that will vary according to national differences but will have clear goals and have many players involved from both public and private sector. Also a NP should be able to build bridges between European, national and regional/local levels as shown below:

Level	Public bodies	Industry	Education & research	Operator	ACTIVITY
European	EC	ERT etc.		A "Platform of platforms"	Survey, analyse, disseminate, inspire, finance
National	Ministries responsible for e.g. education, research, economy and labour market	Association/cluster of companies	Universities, Evaluation institutes Didactical research Education of teachers	National STEM Platform (NP)	Initiate, finance and coordinate national programmes, inspire. Monitor key performance indicators and evaluate
Regional/local	Relevant authority	Clusters or individual companies	Schools at primary and secondary level. vocational and profession schools	Public-private partnerships involving science communicators as centres and festivals	Implement activities, competitions and networks. Media contact

2.2. Methodology for travel missions

Having established agreement on the basic formats of NP's, the task force then turned towards developing a methodology for inspiring member states to create NP's to support STEM.

The following ideas came up:

- share examples of good practices and tools, e.g. a annual working plan and budget, case-stories from establishing NP's in NL, D and DK, templates for agreements, catalogues of activities, monitoring and evaluation tools, manual for school/industry collaboration (Astrid book).
- offer consultations sharing experiences and good practices from existing NP's, analysing the STEM education chain from "kindergarten to PhD" and existing STEM promoting initiatives and stakeholders,
- offer and facilitate a one day workshop with the stakeholders of a NP
- offer study visits,
- offer access to EU/private seed-money conditioned by a defined level of progress

The TF discussed that a pilot-case to establish a NP would be useful in order to develop a concept and a toolbox for the further work of the TF. Estonia and Portugal were proposed to get a wide sample of national, cultural, socio-economical and geographical differences, and the group set to work to create contacts in the two countries following this time schedule:

Summer 2013	Contact EE/PT
September 2013	NPTF mission EE
October 2013	NPTF mission PT
Spring 2014	Joint EE/PT visit Netherlands

The group found that the right way to approach the two countries would be through their MoE, making a value proposition that could benefit both the InGenious project and the involved country:

Value Proposition	
Contribution from inGenious TF	*Contribution from Estonia/Portugal*
Visit by the NPTF Team	Key STEM-stakeholders representing ministries, industry and NGO's
Examples of the historic development of a NP	Landscape of STEM operators
Authentic experiences – good and bad	Decision power or mandate
Tools to develop NP's	Basic data on STEM – e.g. from National Needs Analysis workshop
European STEM overview	
Process and meeting structure	

It turned out that it was surprisingly easy to organise these two trips, as both countries were really interested in getting inspiration from abroad. Also the two national hosts did a very dedicated effort to get the right people around the table for the two meetings as can be seen in the detailed descriptions in section xx and yy.

A travelling team was appointed for both visits consisting of:

- Mikkel Bohm, Danish Science Communication (chair),
- Kim Lansford, ERT,
- Sebastiaan Smit, Jet-Net,
- Nanna Seidelin, NV-HUS,

- Hans Colind Hansen, Danish Science Communication

Also a basic agenda for the two meetings was defined:

1. Welcome by the host
2. Introduction to the NP concept
3. Industry’s point of view
4. Description of the Dutch experiences
5. Description of the transfer of Jet-Net to Denmark

After these presentations, groups of national stakeholders were invited to discuss their reactions to the presentations and finally a round table debate ended the meeting.

3. Estonia

The first travel mission went to Estonia on Sep 15-17 2013.

3.1. Agenda and participants

The meeting was held at the Meriton Grand Conference & Spa Hotel, Tallinn, with the below agenda:

Moderator of the day – Taivo Raud, Deputy head of Research Policy Department, Estonian Ministry of Education and Research

9.30	Welcome coffee
10.00	Setting the Scene. Taivo Raud
10.10	Experiences with creation of national STEM education platforms in the Netherlands and Denmark • Background for the visit and thoughts on national platforms. Mikkel Bohm, director, Danish Science Factory • Experiences from the Netherlands. Sebastiaan Smit, project manager, Dutch Jet-Net • Experiences from Denmark. Nanna Seidelin, director, House of Natural Sciences and Danish Jet-Net • Industry's viewpoints. Kim Lansford, senior policy advisor, European Round Table of Industrialists
11.40	Coffee break
12.00	Overview of the Estonian case
12.00	Activites and experiences from the first year of the cooperation network of companies „Unistused ellu!“ (Make Dreams Come True)/ Maarja Loorents, Communications Manager, Estonian Chamber of Commerce and Industry
12.15	Practical excample on school and industry collaboration in ICT sektor. Jüri Jõema, Doris Põld, Infotehnoloogia Liit
12.30	Summary of Estonian InGenious report Signe Rosin-Ambre., project coordinator in Estonia, Information Technology Foundation for Education
12.45–13.45	Roundtable discussion on further cooperation between enterprises and schools in Estonia in the STEM field and planning the following actions

The participants were a good mix of public and private stakeholders as can be seen below:

First name	Surname	Organisation
Alvo	Aabloo	NGO Robootika
Mikkel	Bohm	Danish Science Factory
Hans	Colind Hansen	Danish Science Factory
Imbi	Henno	Estonian Ministry of Education and Research
Andres	Juur	Ahhaa Science Centre
Jüri	Jõema	Estonian Association of Information Technology and Telecommunications
Tiina	Kalju	Enterprise Estonia
Eike	Kingsepp	Bayer AG
Kristi	Kivilo	Looking@World Foundation
Kim	Lansford	European Round Table of Industrialists
Ave	Lauringson	Ministry of Economic Affairs and Communications
Margit	Lehis	Estonian Research Council
Madli	Leikop	Educational Portal „Koolielu“
Tõnu	Lelumees	Estonian Federation of Engineering Industry
Mirjam	Lindpere	Eesti Energia
Maarja	Loorents	Estonian Chamber of Commerce and Industry
Karin	Lukk	Tartu Kivilinna Gymnasium
Margit	Meiesaar	Estonian Research Council
Hallar	Meybaum	Federation of Estonian Chemical Industries
Piret	Potisepp	Ministry of Economic Affairs and Communications
Doris	Põld	Estonian Association of Information Technology and Telecommunications
Taivo	Raud	Estonian Ministry of Education and Research

Priit	Reiska	Tallinn University
Signe	Rosin-Ambre	Information Technology Foundation for Education
Tiia	Rüütmann	Tallinn University of Technology
Kertu	Saks	Energy Discovery Centre
Nanna	Seidelin	House of Natural Sciences and Danish Jet-Net project
Peeter	Sipelgas	Viimsi Secondary School
Sebastiaan	Smit	Dutch Beta-Platform Techniek and Jet-Net project
Merle	Tiigisoon	Estonian Chamber of Commerce and Industry
Terje	Tuisk	Estonian Research Council
Kadi	Vellner	Estonian Chamber of Commerce and Industry
Epp	Vodja	Junior Achievement

3.2. Conclusions, current situation and future possibilities

The meeting was held in positive spirits with good discussions by the participants. There was a general agreement that the idea of a NP is important and good. However, there was a need to find out who could take lead on such a process. The Ministry of Education volunteered.

After the meeting, the NPTF members held a meeting with the Estonian hosts, who agreed to visit the Netherlands in spring 2014 as well as organise national meetings on STEM education.

Estonia has made impressive progress following the stakeholder meeting and the subsequent high-level delegation to the Netherlands in February 2014, as can be seen in the official progress report from the Estonian Research Council.

Eesti Teadusagentuur
Estonian Research Council

Development of Estonian National STEM platform

Summary Report to the Mission Study

The implementation of Estonian National STEM platform, supported by InGenious project, Danish Science Factory, Jet-Net Netherlands, Jet-Net Denmark and European Roundtable of Industrialists (ERT) has gone through several stages since the beginning of cooperation in August 2013.

The Past

On September 16, 2013 a benchmarking meeting „Cooperation between industry and schools in STEM education" was organized by Estonian Research Council. Together with InGenious Task Force (Mikkel Bohm, director of Danish Science Factory, Sebastiaan Smit, project manager, Dutch Jet-Net, Nanna Seidelin, director, House of Natural Sciences and Danish Jet-Net, Kim Lansford, senior policy advisor, European Round Table of Industrialists) 30 people attended the meeting. There were representatives from Ministry of Education and Research (Taivo Raud), Ministry of Economic Affairs (Department of State Information Systems and Economic Development Department), Enterprise Estonia (Entrepreneurship and Innovation Centre), Junior Achievement program, Federation of Estonian Chemical Industries, Estonian Association of Information Technology and Telecommunications, universities - University of Tartu, Tallinn University of Technology, Tallinn University, Eesti Energia Group (energy company), schools, Estonian Research Council, Science Centers (AHHAA, Energy discovery center) and Estonian Chamber of Commerce and Industry. Besides the background information given by Task Force several Estonian existing cooperation cases between industry and schools were introduced. Meeting ended with roundtable discussion on further cooperation between enterprises and schools in Estonia in the STEM field and planning the following actions. Common understanding was that National STEM Platform in some format is needed to enhance the cooperation and to give it more formal framework. The day was moderated by Taivo Raud, Head of Research Policy Department, Estonian Ministry of Education and Research and the strong support from the ministry gave to Estonian Research Council mandate to move forward with developments.

The meeting was followed by a cooperation workshop organized in cooperation with Estonian Chamber of Commerce and Industry on October 10, 2013 in Tallinn: "Maintaining the Entrepreneurial Spirit: Cooperation Possibilities for Schools and Industry". Workshop gathered 60 educators and people from industry. Existing cases and follow-up steps were discussed.

To get more background information Terje Tuisk and Margit Lehis from Estonian Research Council participated at a EUN meeting "Towards 2020: Priorities for STEM education and careers in Europe, in the European and Economic Social Committee on November 18 and on the Symposium „Jumping the Skills Gap" hosted by the European Round Table of Industrialists (ERT), in cooperation with CSR Europe, JA-YE, European Schoolnet and BusinessEurope on November 19, 2013 in Brussels.

On February 16-18, 2014 the National Platform Study Mission was organized by Task Force to Haag, The Netherlands

Participants from Estonia:

Eesti Teadusagentuur
Estonian Research Council

- Mr. Ando Leppiman, Vice Minister of the Estonian Ministry of Economic Affairs and Communications
- Ms Ave Lauringson, Estonian Ministry of Economic Affairs and Communications
- Mrs. Irene Käosaar, Head of General Education Department and head adviser of the Estonian Ministry of Education and Research
- Terje Tuisk, Head of the Science Communication Unit, Estonia Research Council
- Ms. Signe Ambre, Information Technology Foundation for Education

During the Study visit practical examples of Jet-Net partnerships between schools and enterprises on several cases were visited and discussed. Also the motivation and possibilities for this kind of cooperation from the viewpoint of SME was addressed as most of the potential cooperation partners in Estonia are SMEs and not big Industry players. In addition the process of Dutch Technology Pact was introduced.

After the Study Visit vice Minister Ando Leppiman summoned a meeting between his Ministry, Ministry of Education and Research, Estonian Association of Engineers and Estonian Research Council stressing his commitment on the issue and the importance of initiating the process of Estonian Technology Pact. Before the Summer vacations 3 meetings were held (on March 31, May 26 and June 26) and plans were made to bring together 2 ministers (Minister of Economic Affairs and Communications and Minister of Education and Research) in order to convince them to initiate this process together. Unfortunately during the same period Estonian Government changed including both ministers involved and the process was stopped for Summer.

In May 22, 2014 second public workshop was organized in cooperation with Estonian Chamber of Commerce and Industry on the topic: "How to bring STEM at school closer to real life". Day was moderated by Urmas Vaino, a famous TV host from Estonian National Broadcasting. Terje Tuisk made a presentation with overview of our activities towards STEM platform, Estonian Technology Pact and lessons learned from Study visit to Netherlands. Workshop gathered around 90 educators and entrepreneurs.

The current situation and the nearest future

Today Estonian Research Council has strong mandate to move forward with National STEM Platform and Estonian Technology Pact. There is an agreement to plan financial support for boosting the process from the next European Social Fund funding period. The activities of the period (2014-2020) will be planned in details by the end of this year. Already on September 16 Estonian Research Council will hire a person whose main job will be to launch both processes, lead it to the results and keep it running.

We hope to keep up the cooperation on STEM Education on European level with InGenious Task Force and beyond.

Tartu, September 8, 2014

Terje Tuisk
Head of Science Communication Department
Estonian Research Council

4. Portugal

The second travel mission went to Portugal on Oct 24-25 2013.

4.1. Agenda and participants

PROVISIONAL AGENDA

Thursday, October 24th

20:00	**Evening meeting with organisers and Task Force members (includes dinner).**

Friday, October 25th

9:00	**Reception**	
9:30 – 9:45	Welcome	Pedro Cunha, Sub director General, Sub directorate-General for Education
9:45 – 10:15	National STEM Platforms: background, motivation, vision Q&A	Mikkel Bohm, Director, Danish Science Factory Kimberley Lansford, ERT Senior Policy Adviser
10:15 – 10:45	The case study of The Netherlands - Q&A	Sebastiaan Smit, Project Manager, Jet-Net
10:45 – 11:15	The transfer of Jet-Net to Denmark – Q&A	Nanna Seidelin, Director, Danish House of Natural Sciences
11:15 – 11:45	Coffee break	
11:45 – 13:00	Roundtable stakeholder dialogue (Everyone should feel free to speak Portuguese)	Moderators: Kim Lansford, José Moura Carvalho
13:00 – 14:00	**Lunch**	
14:00 – 15:30	Wrap up and Next Steps	Organizing team with Task Force members

The meeting was held in the Ministry of Education, Lisbon, with the below agenda.

Name	**Institution**
Cláudia Azevedo	ANPME
Sara Cardeira	IBM
Cristina Semião	IBM
Marta Brígido	IBM
Pedro Sá	SONAE
Sofia Altman	SONAE
Ana Ribeiro	Siemens
José Alberto Silva	Agrupamento de Escolas do Forte da Casa
Isabel Araújo	Escola Secundária Dom Manuel Martins (Setúbal)
António Carvalho	Agrupamento de Escolas Cidade de Castelo Branco
João correia de Freitas	Universidade Nova de Lisboa
Vitor Duarte Teodoro	Universidade Nova de Lisboa
António Manuel Dias Domingos	Universidade Nova de Lisboa
Isabel Hormigo	Ministério da Educação e Ciência
	Ministério da Economia
Gonçalo Xufre Silva	ANQEP
João Fernandes	Academia das Ciências de Lisboa
Rosário Oliveira	Ciência Viva
Rita Siborro	Confederação do Comércio e Serviços de Portugal
Helena Caiado	Associação Industrial Portuguesa
Rui Vieira	AIA – CTS
Kim Lansford	ERT (Senior Policy Advisor)
Mikkel Bohm (Task Force Leader)	Danish Science Factory (Director)
Hans Colind Hansen	Danish Science Factory (Consultant)

Sebastian Smit	Jet-Net (Project Manager)
Nanna Seidelin	Danish House of Natural Sciences (Director)
José Moura Carvalho	ERTE
Fernando Franco	ERTE
Orlando Figueiredo	ERTE
Fernando Campos	ERTE
Carlos Cachado	Teachers' coordinator
***Ana* Noronha**	Ciência Viva
Carlos Cunha	Escola Secondaria Dom Manuel Martins
Grasiela Costa	
Vera Vieira	ERTE

4.2. Conclusions, current situation and future possibilities

Even though there was a fruitful discussion at the meeting, the starting point for establishing a Portuguese STEM NP is weak and the area was described as "disruptive". Furthermore the Portuguese industry may yet not have realized the anticipated shortage of STEM-workers.

Nevertheless the participants of the meeting expressed their commitment to support actively the further process. The MoE was asked to take the leadership of the work.

In the months after the meeting several efforts were made to form a contact between the Ministry of Education and the Ministry of Financial Affairs.

inGenious/ECB

National STEM Platform

Summary Report to the Mission Study

The implementation of a National STEM platform in Portugal, supported by the inGenious/ECB project, STEM platforms from the Netherlands and Denmark and the European Roundtable of Industrialists (ERT) has implied several actions that have been taken since September 2013 by the Directorate-General for Education.

On October 25th a benchmarking meeting was carried out at DGE facilities. The Task Force promoting the meeting was constituted by Mikkel Bohm, Director at the Danish Science Factory; Kimberley Lansford, ERT Senior Policy Adviser; Sebastiaan Smit, Project Manager at Jet-Net and Nanna Seidelin, Director of the Danish House of Natural Sciences. In the meeting were present several representatives of schools, industry, universities, science-related associations and a representative from the Portuguese Ministry of Economy.

DGE has been represented by Orlando Figueiredo at the following meetings: (1) Towards 2020: Priorities for STEM education and careers in Europe, in the European and Economic Social Committee (Jacques Delors building), Brussels, 18 November 2013, and (2) Symposium Jumping the Skills in Gap Thon Hotel EU, Brussels 19 November 2013, organized by ERT.

In December 2013 information was sent to the Director-General of Education presenting a project on the implementation of a National STEM Platform and its aims and goals. It contained conceptual arguments to support the implementation of such a STEM Platform in Portugal, as well as descriptions of the ones in the Netherlands and Denmark. Three possible implementation scenarios were presented. Each scenario involves the Ministry of Education and Science in different degrees, and contains a five-year agenda with an annual budget. The document was discussed with the Director-General for Education, our Department and Unity

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Heads (José Vitor Pedroso and José Moura Carvalho) and two experts (including the Head of Department) on curriculum from the DGE Department of Curriculum Development of DGE.

Following this meeting, two main changes were introduced to the proposal and the modified document was sent to the Secretary of State of Primary and Secondary Education. The two main changes made to the original document were: (1) – although the three initial scenarios were maintained, a preferred scenario was selected and recommended; and (2) a recommendation to create an inter-ministerial team including members from the Ministry of Education and Science and the Ministry of Economy. The remit of this team would be to bring forth the project in collaboration with partners from industry and professional associations. It was expected that the members of this team would be able to participate in the meeting of the Study Mission that took place in Hague last February. However, that was not possible.

A reply from the Secretary of State is still pending. We hope to have a positive answer soon. As soon as this happens, we will inform you and keep all the team updated of the project developments in Portugal.

Lisbon, July 7th, 2014

José Moura Carvalho

José Moura Carvalho

Head of Unit

Apoiado pelo Programa FP7 da Comissão Europeia

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5. Study mission to the Netherlands

Following the successful stakeholder meetings in Estonia and Portugal, the NPTF in collaboration with Platform Beta Techniek in the Netherlands arranged a study mission for representatives from Estonia and Portugal.

The primary purpose of this mission was to meet Dutch companies, government representatives and organisers to learn directly from their experiences. The secondary purpose was to promote networking between key stakeholders in the Netherlands, Portugal and Estonia.

Estonia sent a very strong delegation, including Mr. Ando Leppiman, Vice Minister of the Estonian Ministry of Economic Affairs and Communications. Because of unexpected impediments, the Portuguese government was not able to be present at the meeting. Mr. Joao Bras from the Sonae Retail School in Portugal was, however, present in the study mission.

In addition to Estonia and Portugal, a delegation from Denmark and Belgium was also present in the study mission.

For a full participant's list, please see below

5.1. Agenda and participants

The agenda was tailored to meet a broad range of examples of good practise in school-industry collaborations (large as well as small companies were presented) as well as meeting government representatives for presentations of the strategic level of a national platform.

Please see the next pages for further details on agenda and participants.

Study Mission to the Netherlands, February 16-18

Contact: Sebastiaan Smit +31 (0)6 10 68 07 30

Sunday 16th:

- Arrival and check in at Corona Hotel – Buitenhof 39 in The Hague
- 19.00 Meet in lobby Corona Hotel
- 19.30 Dinner – Restaurant Pastis: Oude Molstraat 57 in The Hague

Monday 17th:

Morning Session:

- 08.15 Meet in lobby of Corona Hotel
- 08.30 Taxis to Shell Headquarters, ***Carel van Bylandtlaan 16, The Hague***
- 09.00 Reception at Shell – ***please bring your passport***
- 09.20 Welcome – Jules Croonen, Vice President HR Benelux/France, Chairman Jet-Net
- 09.30 Introduction & expectations
- 10.00 Jet-Net teachers – Aloysius College
- 11.00 Shell and Jet-Net – Jules Croonen & André van Aperen – the role of a company
- 12.00 Wrap up and **lunch at Shell**

13.00 Walk to CAOP, Lange Voorhout 13, The Hague (20 min. walk)

12.30 Lunch for people who just arrived and join the afternoon session at CAOP, Lange Voorhout 13 in The Hague. Meeting room: Harry Borghoutszaal

Afternoon Session:

- 13.00 Reception with coffee and tea
- 13.30 Welcome & Introduction – Mikkel Bohm & Sebastiaan Smit
- 14.00 Technology Pact – Pieter Waasdorp, Director Entrepreneurship at Ministry of Economic Affairs
- 15.00 Platform Bèta Techniek – Joanne Kuipers – Senior Project Manager
- 15.45 Jet-Net Netherlands – Hein van der Zeeuw – Managing Director Jet-Net
- 16.30 Jet-Net Denmark – Nanna Seidelin – Managing Director Jet-Net Denmark
- 17.15 Wrap up & conclusions
- 18.00 Drinks & Dinner – Millers, Plein 10a, The Hague (10 min. walk)

Tuesday 18th:

Morning Session:

- 08.00 Bus leaves from Corona Hotel, Buitenhof 39 in The Hague
- 08.45 Arrival in Arminius Church, Museumpark 3 in Rotterdam
- 09.00 Welcome – Taco Bresser – Managing Director Bresser
- 10.00 Bus leaves for Libanon Lyceum, Mecklenburglaan in Rotterdam
- 10.15 Arrival Libanon Lyceum
- 10.30 Welcome & introduction Libanon Lyceum
- 11.00 City walk – projects & Jet-Net activities Bresser and Libanon Lyceum
- 11.45 Discussion and wrap up
- 12.15 Bus leaves to The Hague, CAOP, Lange Voorhout 13 in The Hague

Afternoon Session:

- 13.00 Lunch at CAOP, Lange Voorhout 13 in The Hague – meeting room: Hans Pont
- 14.00 Reflections and next steps
- 15.30 Finish

Name	Organisation	Monday 17th morning	Monday 17th afternoon	Monday 17th evening	Tuesday 18th morning	Tuesday 18th afternoon
Adress		Shell, Carel van Bylandtlaan 16 The Hague	CAOP, Lange Voorhout 13 The Hague	Millers, Plein 10a The Hague	Rotterdam by bus	CAOP, Lange Voorhout 13 The Hague
Total		21	29	26	15	13
Estonia						
Ando Leppiman	Deputy Secretary General for Energy, Estonian Ministry of Economic Affairs and Communications	0	1	1	1	1
Ave Lauringson	Department of State Information Systems, Estonian Ministry of Economic Affairs and Communications	0	1	1	1	1
Irene Käosaar	Head of General Education Department, Estonian Ministry of Education and Research	1	1	1	1	1
Arvi Hamburg	President of the Estonian Association of Engineers. Professor, Dean of the Faculty of Power Engineering of the Tallinn University of Technology	1	1	1	1	1
Terje Tuisk	Head of Science Communication Department, Estonian Research Council	1	1	1	1	1
Signe Ambre	Head of Communications, manager of the InGenious project, Information Technology Foundation for Education	1	1	1	1	1
Belgium						
Julie Verstraete	ABVV Oost Vlaanderen	1	1	1	0	0
Inge Vandyck	ABVV West Vlaanderen	1	1	1	0	0
Isabella Herteleer	RTC Oost Vlaanderen	1	1	1	0	0
Portugal						
João Brás	Sonae Retail School, Direção de Recursos Humanos Centro Corporativo	1	1	1	1	1
Denmark						
Camilla Wang	Dean at Metropolitan University of Applied Sciences	0	1	1	0	0
Laust Joen Jakobsen	Vice-Chancellor at UCC University of Applied Sciences	0	1	1	0	0
Hanne Løngreen	Head of Department, Dept. of Education, Aarhus University	0	1	1	0	0
Nils O. Andersen	Professor at the Nils Bohr institute and former Dean of Science at the University of Copenhagen	0	1	1	0	0
Taskforce inGenious						
Mikkel Bohm	Director Danish Science Factory	1	1	1	1	1
Nanna Seidelin	Director Jet-Net DK & Naturvidenskaberneshus	1	1	1	1	1
Hans Colind Hansen	Consulent Danish Science Factory	1	1	1	1	1
Kim Lansford	Senior Policy Adviser ERT (European Round Table of Industrialist)	1	1	1	1	0

Alexa Joyce	Senior Adviser EUN	1	1	1	1	1
Sebastiaan Smit	Project Manager Jet-Net	1	1	1	1	1
Others						
Hein van der Zeeuw	Managing Director Jet-Net	0	1	1	0	0
Emilie Schultink	Project Manager Jet-Net	1	1	1	1	1
Daphne van Deursen	Project Manager Jet-Net	0	1	1	0	0
Roel Endert	Deputy Director Secondary Education, Ministry of Education NL	0	0	1	0	0
Fatima Tahtahi-Post	Ministry of Education NL, Secondary Education	0	1	1	0	0
André van Aperen	Project Manager Jet-Net & Education Shell in NL	1	1	0	0	0
Marco de Bruin	Jet-Net Coordinator Shell Rijswijk	1	0	0	0	0
Jules Croonen	Vice President HR Shell Benelux/France, Chairman Jet-Net	1	0	0	0	0
Marjolein Verhage	Teacher Aloysius College The Hague	1	0	0	0	0
Ted Vernooij	Teacher Aloysius College The Hague	1	0	0	0	0
Joanne Kuipers	Senior Project Manager Platform Beta Techniek	0	1	1	0	0
Pieter Waasdorp	Director Entrepreneurship at Ministry of Economic Affairs NL	0	1	0	0	0
Jurgen Geelhoed	Ministry of Economic Affairs - Technology Pact	0	1	0	0	0
Astrid Bottenberg	Ministry of Economic Affairs - Technology Pact	0	1	0	0	0
Hans van der Loo	Partner - Global Resource Security & Resilience Initiative	1	0	0	0	0
Micaela Dos Ramos	Managing Director KIVI					
Taco Bresser	Managing Director Bresser	0	0	0	1	0

5.2. Conclusions

The participants found the Study Mission very useful, simply by experiencing activities and having the time to ask questions on both practical and political level.

A short questionnaire was distributed to the participants after the Study Mission. Answers to the question “What is the most valuable insight from the Study Mission” were among others:

> “People make the difference”
>
> “Understanding the process of involving public and private actors”
>
> “Important to have clear government goals and visions”
>
> “A solid base for our next steps back home”
>
> “Cooperation between Ministry of Education and Ministry of Economic Affairs”
>
> “We need a national alignment at home that STEM is important and it should be a priority of both the Ministry of Education and the Ministry of Economic Affairs

A National Platform must be national – it cannot be done by individual companies or schools”

> “The way different initiatives were coordinated centrally, and how it didn’t kill the activities on a local level”

Asked which European supporting actions could help the formation of a national platform in a member state, answers were among others:

> “Creating a network of National Platforms”
>
> “Share good practise between countries”
>
> “We can’t copy/paste activities, but we can learn from each other”
>
> “Learning from real examples with real people in action – can’t get this experience from reading a report”
>
> “Understand the differences between each country”

6. Future perspectives and recommendations

The NPTF was created to test an alternative way of communicating and sharing best practise by focusing on stakeholder meetings.

This methodology has proved successful, in particular in Estonia where a national STEM platform and an Estonian Technology Pact now has financial support, and people are being hired to do the planning.

Compared to many other European dissemination initiatives the “people” approach of the NPTF seems to work. Instead of producing reports and websites, the idea of getting the right people together and talk seems fruitful.

Seen from a cost/benefit perspective, the NPTF has been extremely cheap, with costs narrowed down to travel expenses and some preparation. Nothing expensive was produced - it was simply just people meeting and communicating. However, it takes skills and experience to do so.

The NPTF were successful in Estonia and less so in Portugal. More can be learned about approaching and understanding the individual member state and to facilitate the best process tailored to one particular country's needs.

If this process should be continued and the service of a NPTF travelling team should be offered to other member states, it must be coordinated by a European body – a "platform of platforms" to support good practise exchange and facilitate meetings between platforms. This can be done with a relatively low budget.

From the experience of the NPTF, a successful National Platform stakeholder meeting is characterized by the following do's and don'ts for the European organizer of such meetings:

1. The initial contact must be made with government officials with a clear decision mandate to prepare the stakeholder meeting
2. There must be a very clear value proposition to establish the right expectations before the meeting
3. Make sure that more ministries besides the Ministry of Education are involved in preparing the meeting, eg. The Ministry of Industrial Affairs and the Ministry of Employment.
4. Collaborate with the national hosts to invite a broad range of public and private stakeholders with decision mandates
5. Make sure to present very concrete experiences at the meeting
6. Make sure to present both successes and failures from the processes of establishing NP's in other countries,
7. Avoid to present a "one size fits all" model for a National Platform, but respect the national agendas
8. Make sure to facilitate ample time for discussions among the stakeholders at the meeting – preferably in the national language
9. Try to make action-based decisions/conclusion on next steps with a clear understanding of who's responsible (preferably a Ministry)
10. Follow-up after the meeting in order to support the national hosts and take care to create exchange of experiences between countries that are working to create National STEM Platforms.

7. Annex

8.1. Signatures NPTF meetings

To document the participation of the NPTF members at the four meeting, please see the signature sheets below:

1. Meeting Madrid, March 8 2013

inGenious National Platform Task Force

First meeting
Time: 1-4 PM. March 8, 2013
Place: HOTEL CATALONIA GRAN VIA, Madrid

Name, organisation and e-mail	Signature
Mikkel Bohm, Danish Science Communication (chair), mb@formidling.dk	
Kim Lansford, ERT, klansford@ert.eu,	
Sebastiaan Smit, Jet-Net, s.smit@jet-net.nl,	
Franziska Hutzler, Wissensfabrik, Franziska.Hutzler@wissensfabrik-deutschland.de,	F. Hutzler
Anna Artigas, UAB, anna.artigas@uab.cat,	
Raquel Rios, UAB, raquel.rios@uab.cat	
Stephanie Parsons, FutureLab, stephanie.parsons@futurelab.org.uk,	
Hans Colind Hansen, Danish Science	

inGenious National Platform Task Force

Second meeting
Time: 10-16, June 12, 2013
Place: Danish Science Factory, Copenhagen

Name, organisation and e-mail	Signature
Mikkel Bohm, Danish Science Communication (chair), mb@formidling.dk	
Kim Lansford, ERT, klansford@ert.eu,	
Sebastiaan Smit, Jet-Net, s.smit@jet-net.nl,	
Franziska Hutzler, Wissensfabrik, Franziska.Hutzler@wissensfabrik-deutschland.de,	F. Hutzler
Anna Artigas, UAB, anna.artigas@uab.cat,	
Raquel Rios, UAB, raquel.rios@uab.cat	
Nanna Seidelin, House of Natural Sciences ns@NVHUS.dk	Nanna Seidelin
Niel Mclean n.mclean@nfer.ac.uk	
Hans Colind Hansen, Danish Science Communication, hch@formidling.dk.	

This meeting was very short and informal in connection with the Needs Analysis event, for signatures please refer to the documents for that meeting.

4 . Meeting Brussels, November 18 2013

inGenious National Platform Task Force

Fourth meeting including representatives from the pilot countries, Estonia and Portugal
Time: 19:30, November !8, 2013
Place: Brussels in relation to the inGenious conference.

Name, organisation and e-mail	Signature
Mikkel Bohm, Danish Science Communication (chair), mb@formidling.dk	
Kim Lansford, ERT, klansford@ert.eu,	
Sebastiaan Smit, Jet-Net, s.smit@jet-net.nl,	
Franziska Hutzler, Wissensfabrik, Franziska.Hutzler@wissensfabrik-deutschland.de,	
Anna Artigas, UAB, anna.artigas@uab.cat,	
Raquel Rios, UAB, raquel.rios@uab.cat	
Geert Paemen, Telefonica, geert.paemen@telefonica.com,	
Stephanie Parsons, FutureLab, stephanie.parsons@futurelab.org.uk,	
Hans Colind Hansen, Danish Science Communication, hch@formidling.dk.	
Terje Tuisk , Terje.Tuisk@etag.ee, Estonian Research Council	
Margit Lehis, Margit.Lehis@etag.ee, Estonian Research Council	
Orlando Figueiredo orlando.figueiredo@dge.mec.pt, Direção de Serviços de Projetos Educativos Direção-Geral da Educação , Portuguese Ministry of Education and Research	
Beatrice Boots, Platform BetaTekniek b.boots@deltapunt.nl	
Niel McLean , n.mclean@nfer.ac.uk, Future Lab/ National Foundation for Educational Research	
Jette Rygaard Poulsen, Jette.Rygaard.Poulsen@uvm.dk, Danish Ministry of Education	
Roser Pintó Casulleras, UAB roser.pinto@UAB.CAT	
Nanna Seidelin, NVHUS	
Arjen Schat, Philips	