# PROJECT FINAL REPORT

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[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

[2] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

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# 1 Executive summary

The European Coordinating Body (ECB) in Science, Technology, Engineering and Mathematics (STEM) - is a large scale strategic response to the FP7 call to reinforce links between science education and science and technology careers in the private sector through reinforcing the partnership industry - education. The partnership for the ECB project is a multi-stakeholder consortium and includes Ministries of Education, major European companies and organisations representing the interests of industry, national science platforms and universities.

**INGENIOUS 1 – Achievements and lessons learned**

inGenious 1 enabled to set up a multi-stakeholder platform where collaboration between industry and schools has:

- improved students' knowledge of STEM careers
- created more appealing learning experiences for schools by providing access to company facilities and experience (e.g. laboratories).
- brought the world of science, technology and business closer to schools through innovative activities.
- shared and evaluated science initiatives, and enhanced, enriched and widened access to best practice.

More information about InGenious 1 can be found at http://www.InGenious-science.eu and some videos presenting InGenious 1 can viewed via the following links: http://www.youtube.com/watch?v=xBYkxZzt8-M and http://www.youtube.com/watch?v=BdJvHu6Yikg

The concrete achievements of InGenious 1 include the following:

- The production of the InGenious code which provides specific guidelines for collaboration between schools and industry - http://www.InGenious-science.eu/web/guest/InGenious-code.
- Workshops for teachers, summer schools and academies where industry and schools worked together to develop new approaches to STEM teaching that included industry practices.
- Online events, gathering more than 600 teachers and students with industry representatives to debate key STEM topics, e.g. energy, artificial intelligence, robotics, chemistry.
- Conferences gathering major stakeholders - government, industry & academic representatives focusing on good practice, policy, lessons learned in STEM education-industry cooperation.
- An online community of 1,500 STEM educators - teachers exchanging practice with industry.
- One oonline training course for 2,000 teachers - 8 modules covering STEM career issues, setting up school - industry cooperation, etc. Experts from industry & academia leading each module.
- A policy and practice database with more than 150 industrial practices proposed for schools to be experimented.

By the end of the project, more than 250 teachers from 28 countries tested practices with 2,200 classes involving 20,000 pupils.

# 2. Summary description of project context and objectives

The European Coordinating Body (ECB) in Science, Technology, Engineering and Mathematics (STEM) - is a large scale strategic response to the FP7 call to reinforce links between science education and science and technology careers in the private sector through reinforcing the partnership industry - education. ECB started officially on 1 February 2011. The partnership for the ECB project is a multi-stakeholder consortium. It includes Ministries of Education, major European companies and organisations representing the interests of industry, national science platforms and universities.

European Coordinating Body is used as the formal title of the project; however the brand name inGenious has been developed for communication purposes. All public documents and dissemination materials use the name inGenious, whereas the internal management group of the project (all initial consortium partners included), use ECB as the official name. In this document ECB and inGenious will be used interchangeably, always referring to the same project.

There are three key areas of work performed in the inGenious project: (1) **Development of an online observatory** of industry - education cooperation, guidance and good practices in Europe. **(2) Establishment of a pilot school network** of primary and secondary schools, with a leading core pilot network of schools. These pilot schools tested, experimented and validated the activities provided by industry partners. Moreover workshops, academies and summer schools were organised for teachers, career counsellors, HR managers, industry representatives and all stakeholders engaged in the school/industry cooperation effort. For more information please consult WP3 Deliverables. **(3) Dissemination and communication** to support and develop inGenious activities through reaching out to a wider public and to mainstream and sustain school/industry collaboration. All communication activities are designed to increase the number of youngsters opting for STEM in schools, which ultimately would lead to an increased number of researchers, scientists and STEM professionals across Europe. For more information please consult WP5 Deliverables.

**Overall objectives of inGenious**

The overall aim was to increase young Europeans' interest in STEM education and careers, addressing two challenges: lack of interest in the subjects and the future skills gap. By having addressed these challenges, a significant part of the ECB budget is devoted to dissemination and impact activities carried out by leveraging innovative industry initiatives and by improving existing and developing new school/industry partnerships in the field of STEM education. ECB developed a repository of STEM practices highlighting industry practices integrated in the teaching activities of the class.

The final objectives of ECB were to stimulate implementation of good practices across European schools and to encourage the development of new school – industry practices linked to real life scenarios which would bring the world of STEM professionals closer to students.

**Summary of work performed and main results achieved**

During the second part of the inGenious project, the project management team continued paying a lot of attention to the integration of new team members and Associated Partners (16 in total) to reassure that all partners worked effectively together. All information and conclusions of the General Assemblies held in the second part of the project have been integrated in the Deliverable D5.8 in which all activities leading to the sustainability strategy of ECB have been outlined. Also please see Chapter 3 of this second interim report.

The partnership developed a needs analyses framework (Deliverable 2.4 – Needs Analyses Regular Updating) which gathered comprehensive understanding and identified gaps and challenges within current school/industry collaborations in STEM Education. This needs analysis supported the work of the established Task Force National Platforms (TFNP) in November 2012. Dedicated national platform events and high level political meetings with Estonian representatives and with Portuguese high level staff at Ministry of Education level have taken place and resulted amongst other in the creation of a new National STEM platform in Estonia. All information gathered and exchanged in Work Package two activities have been consolidated in a European Synthesis Report (see D2.6) and presented to the public during the Towards 2020 event in the 19$^{th}$ of

November 2013 and during the Jumping the Skills Gap event on the 20th of November 2013 in Brussels organised by the European Round Table of Industrialists.

The needs analysis outcomes formed an integral part of the agenda during European policy makers' and high level lunch meeting, held in Brussels on the 19th of November 2013 and also during the General Assembly in Warsaw on 21-23 September 2014.

Overview of ECB teacher's activities:

- 3 online calls for schools launched and 340 schools in total were in the pilot
- A total number of more than 1500 teachers in the online Teacher Community
- Collaboration total number of 159 practices in the gallery, including 29 testable practices on school – industry collaboration, coming from inGenious partners
- 16 Communities of Practice
- 16 online Chats
- 9 teacher Workshops
- 3 inGenious Summer School
- 3 inGenious Academies

Pilot testing of practices within schools continued from August 2012 onwards. In the second part of inGenious the total number of industry – school practices went up to 159. As for the testable practices, 16 more were added to the 13 practices that were offered in the first year of inGenious. Teachers were selected online from European primary and secondary schools throughout Europe in collaboration with the Ministries of Education and ECB partners. ECB selected 164 pilot school teachers from the partner countries in the first cycle and 172 teachers in cycle 2 and 153 teachers in Cycle 3. In total, the number of teachers, in pilot or extended network, participating into any kind of inGenious activities reached 1760.

InGenious had the principal objective to become the European science platform promoting school/industry cooperation in STEM, in order to contribute to a better image of science in schools and to encourage young students to take up science studies and later science jobs.

Overview of ECB corporate and institutional activities included among others:

- EMINENT 2012, Genoa, Italy, 2013, Helsinki and 2014, Rome
- BETT 2012, 2013 and 2014, London United Kingdom
- Intel International Science and Engineering Fair 2012 Pittsburgh, Pennsylvania
- Excite Annual Conference, France, 2013 in Goteborg and 2014 in The Hague
- Intel Educator Academy EMEA 2012, 23-26 September 2012, Bratislava, Slovakia and 2014 in Warsaw
- EUCYS 2014 European Union Contest for Young Scientists in 2014 Warsaw
- Participation in the EPCA Annual Meeting 2013, 2014
- Cluster event in Badhofgastein, Austria, September 2013
- Meet the Boss event, Eindhoven, The Netherlands, March 2014
- Towards 2020 event in the 19th of November 2013 in Brussel
- Jumping the Skills Gap event on the 20th of November 2013 in Brussels

Overview of ECB dissemination and marketing activities:

- Website: total of 127,378 visits, 69,982 unique visits
- Design and dissemination of 9 inGenious newsletters, with unique visitors of around 8000
- Videos: see ingenious-science.eu
- Photos: see ingenious-science.eu
- Brochures: inGenious general brochure update in 8 languages (en, fr, de, es, it, pt, nl, se, de)
- Pull-up banners: 8 extra inGenious banners

- Contact with the press and marcom agencies (see D5.7)

**Final inGenious results and potential impact and use**

InGenious had the principal objective to become the European science platform promoting school/industry cooperation in STEM, in order to contribute to a better image of science in schools and to encourage young students to take up science studies and future science jobs. In order to achieve this output, all actors involved in the project have interacted and communicated effectively. Given the different starting points of inGenious teachers and the different education structures across the project participants, a range of views across regions as to the impact on practice have been detected and not all regions supported the very positive figure of **86% of inGenious teachers who saw a positive impact on their teaching**, by participating in inGenious. In southern Europe and in the EU partner countries the majority of teachers reported high/medium impact on their teaching. Teachers in northern Europe however, were a bit less positive. Half of these teachers, perceived only moderate impact.

Teachers expressed their views about their expectations of the inGenious project. Broadly 89% of them wanted to obtain knowledge of new teaching resources, such as activity kits for teaching STEM subjects and 70% wanted to improve their knowledge and skills in teaching STEM. Just over half of them thought that it might be important for the project also to improve teachers' interest in teaching STEM subjects.
77% of the inGenious teachers expressed the desire to engage with others in their school and the wider scientific/industrial community and through that engagement learn to improve their own knowledge/skills and those of others'. Improving their practice through gaining access to industrial resources either via visiting speakers, or using hands on activity in their own classrooms was an expectation expressed by up to 85% of teachers. Some teachers expressed the desire to widen their collaboration with other schools in Europe and saw sharing practice through the project as a key objective for them.

In addition, for some teachers, being able to address the gender gap, particularly in students' aspirations towards STEM careers, was a professional development need. A small proportion of others saw the project as a way to improve their own and students' language skills. Some teachers' in this situation saw the opportunity to collaborate with other colleagues in English departments in their school as an important goal.

Overall, teachers reported a very positive view of the impact of inGenious on their classroom practice, knowledge and skills. Almost all, (96%) of them regarded to have some impact.

***Quote from one inGenious teacher:***

*Dear inGenious team,*[3]

*I would like to thank the organizing team at inGenious for their encouragement and for the privilege to be part of a group of entrepreneurs, who were lucky-enough to share with each other unique educational experiences. The cooperation with fellow teachers from around the world expanded limits of my scientific knowledge. Throughout the years, I introduced my pupils with the world of creation and I challenged them to increase their science and industrial knowledge. At my school, I motivated my fellow teachers to be highly focused on teaching science and ecology and I was concentrated on expanding this knowledge beyond the school and throughout the community. I confirmed with The Ministry of Education and my fellow teachers that they have full access to the knowledge and material accumulated by inGenious. I will continue to maintain and deepen the school-industry collaborations and my involvement with school pilot activities and of course, I will stay connected to European Schoolnet.*

*I am looking forward to working with you again in the future! Best regards, LA*

[3] The best way to illustrate the impact and use of the project is given by our inGenious teachers

# *3.* Main S&T results/foregrounds,

The European Coordinating Body (ECB) in Science, Technology, Engineering and Mathematics (STEM) - is a large scale strategic response to the FP7 call to reinforce links between science education and science and technology careers in the private sector through reinforcing the partnership industry - education. ECB started officially on 1 February 2011. The partnership for the ECB project is a multi-stakeholder consortium. It includes Ministries of Education, major European companies and organisations representing the interests of industry, national science platforms and universities.


List of Consortium and Associated Partners in inGenious in October 2014

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Given the different education structures across the project participants, a range of views across regions as to the impact on practice have been detected even though not all regions supported the very positive figure of 86% of inGenious teachers, who saw a positive impact on their teaching, by participating in the project.

Before further analysing the impact and evaluation figures, please find the main results of the inGenious regarding the analysis of the practices and policy actions:

- School - industry collaborations are especially addressed to Factor A (students' engagement in the study of STEM) and also to Factor B (career information). There is a need to analyse how Factors C (personal characteristics and interests) and D (social perception) could be further improved.

- The actions collected in inGenious are mainly targeted to pupils from secondary school. There is also a need to analyse the interest of pupils from primary school in STEM related subjects which may lead to future STEM related studies and careers.

- Scientific and communication skills are the most stressed in the identified practices. An analysis is needed on how to give more importance to the promotion of scientific attitudes, such as creativity and curiosity.

- Most practices collected in inGenious take hours or some days (according Archer *et. al*. 2012, "one-off" events do not have long-term impact on the process of career choice).

- Over 50% of the collected actions in inGenious claim to have an evaluation process, but few really evaluate if the proclaimed goals are effectively achieved (instead, the number of people attending actions and integration of activities in existing curricula is often considered)

Several "difficulties to overcome" in current school/industry partnerships, according to their typology under the following categories have been formulated:

- Difficulties related to the **political context**: those based on the feeling of lack of support from the political institutions to the parties involved in school-industry relationships, or on the lack of coordination between municipal, regional and national actions targeted at the development of school-industry relationships.

- Difficulties related to the **reasons for establishing school-industry collaborations**: those mainly due to a lack of willingness of the potential stakeholders to get involved in these partnerships (benefits not clear enough for both parties to cooperate, time expenditure for both teachers and STEM professionals, overlapping with school calendar, etc.).

- Difficulties related to the **procedures for the establishment of collaborations**: those related to the ways or paths that make possible to initiate a school-industry partnership (finding the right contacts to establish the partnership, maintaining collaborations with companies despite changing of the contact person, requirement of long-term commitment, etc.).

- Difficulties related to the **implementation of practices**: those related to the practical issues faced during the performance of activities (connection between the content of the practice and the school curriculum, logistical and organisational obstacles, technological barriers, etc.),

- Difficulties related to **financial barriers**: those due to economic limitations (mainly, lack of financial support to schools for collaborations, and low business involvement in times of crisis).

The 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.

**Recommendations for improving the effectiveness of initiatives involving school-industry partnerships are:**

- 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 realise 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 school - industry partnership activities in order to confirm their effectiveness.

**Recommendations for facilitating the establishment of school - industry partnerships are:**

- 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.

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

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

Following these recommendations, in order to design or to assess initiatives involving school - industry collaboration that can positively contribute to the factors influencing career choice a set of *criteria for good practices* was developed in the frame of the inGenious project. These criteria were categorised 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.

The inGenious project also addressed existing practices to be transferred across Europe. In this sense, when thinking on the adaptability of existing school - industry 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.

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.

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.

S**trategic 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 Task Force National Platforms

In order to face the challenges related to school - industry partnerships at different levels, organisations have been established in some countries which contribute to promote stronger links between the worlds of STEM education and business. Some examples of such organisations 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 school - industry 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 **TFNP – Task Force National Platforms** has been created. Main conclusions of this TFNP give room to next steps in the promotion of school-industry partnerships at European Level, but bearing in mind the local needs:

- Given the differences of the member states, each 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".

Conclusions from the TFNP after 2 years of experience, a successful national stakeholder meeting is characterised by the following do's and don'ts for the European organiser of a National Platforms stakeholder meeting:

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

### Teacher Workshops, academies and summer schools

During the inGenious project 9 teacher workshops, three inGenious Academies and 3 inGenious Summer Schools have been organised. To give the reader an idea of the impact of these teachers events, we share here the results from the 3 Summer Schools, which were the largest events organised with teachers, i.e. namely the events in Istanbul (ss1 - dots), Barcelona (ss2 - squares) and Split (ss3 - triangles). In Figure1 we show the % of teachers that provided positive feedback to the events. As it can be seen, the lowest percentage is still over 70%. The largest differences are to questions 5.4 - I learnt more on how to teach mathematics / science / technology in the context of real life) and 5.5 - I learnt a lot about teaching mathematics / science/ technology from talking to other teacher participants. As it can be seen, as the events progressed, more speakers understood the importance of using examples connected to real life. Also, following requests from the participants, the event in Split (3$^{rd}$ summer school) had a larger part of the programme devoted to exchanges among the participants.

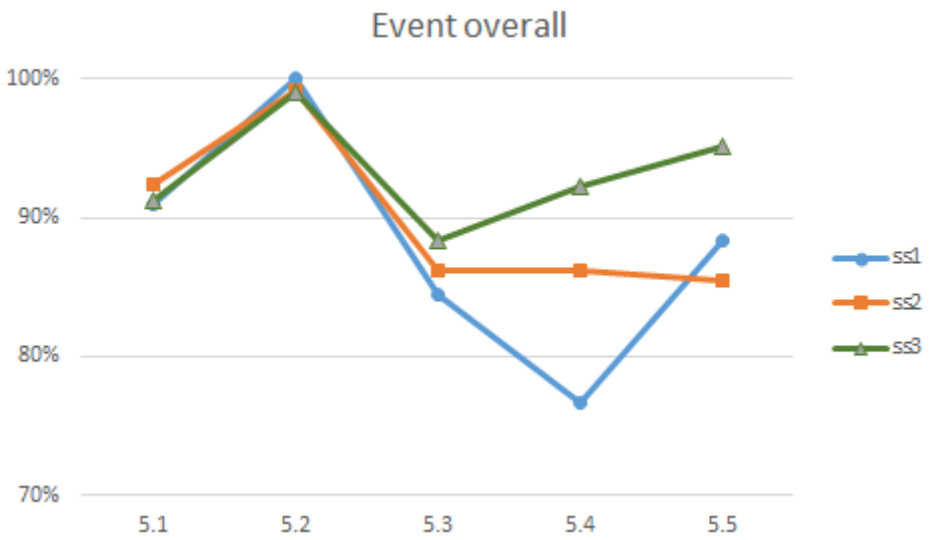



**Figure1: Overall feedback on the 3 summer schools**

In Figure2 we show the impact of the events in their classes. In all cases, the events seemed to have a positive impact on over 87% of the participants, and improve with time (with the 3rd event being better than the 2nd and this one, better than the 1st). The one exception is: 11.4. to improve pupils' interest in STEM subjects, which appears to have been best the first time. This could be the result of more and more emphasis being placed in the events on the teachers and not so much on the practices themselves, i.e. more on the professional development aspect rather than introducing the practices which by the end of the project were fairly familiar to all.

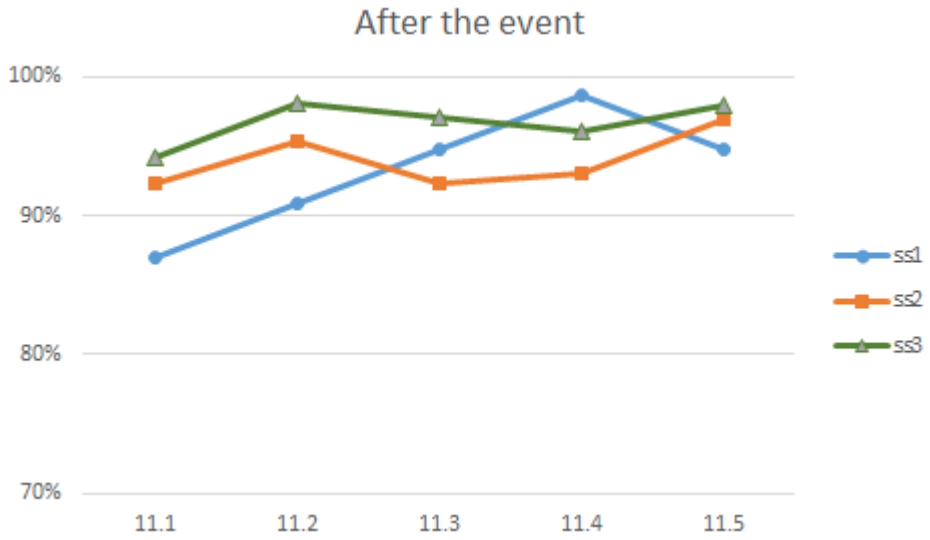



**Figure2: Impact of the 3 summer schools**

During its years of pilot activities, the inGenious project has organised 15 face to face events addressing a variety of audiences. Teachers, industrial partners, career counsellors and Heads of schools have been invited and participated to different types of events, all aiming to address their respective needs. The programme of these events has always been composed by EUN with the close collaboration of co-organising inGenious partner with the ultimate goal of training the participants and providing them with opportunities to develop, exchange with other colleagues and come close to industry representatives and their STEM supportive initiatives.

The evaluation of these events reveals that the majority of the participants found them beneficial and useful. More than 90% of the attendants are clearly stating that they would recommend these types of events to their colleagues. Such statements reveal the importance of the organisation of high quality events that bring industry close to STEM educators, Heads of schools and career counsellors allowing them to exchange, learn from each other and foster further collaborations.

### inGenious case studies

A close look at the outcomes of the inGenious case studies reveals that the impact of the inGenious practices to students are multiple and differ on intensity. More specifically:

- **InGenious practices are particularly efficient when combined with other related to the subject of interest events i.e. science fairs, expert visits etc.** This approach provides students with a complete experience and a connection to the real world and STEM applications that is particularly motivational.

- **The implementation of inGenious practices has a longer lasting impact to students when the leading teacher is not carrying out the practice on his own but is collaborating with other teachers of the school.** IT teachers, technical teachers and language teachers can all contribute during different parts of the practices, providing students with tailored to the practice support and once again demonstrate the variety of skills that are needed and can be combined to a successful STEM career.

- **The impact of the practices has a long lasting effect and intensity when the practice itself has a continuity or it is repeated over several years.** In this way, students have the possibility to continue working on their skills, improve, share their knowledge and comprehend how STEM subjects continually evolve and lead to new developments.

- **The participation of STEM experts and their involvement to the implementation of the inGenious practices has a great impact on students' motivation.** Understanding the importance of the STEM subjects they are being taught and their connection to future careers and real life professions is of great importance to students and encourages their interest to STEM subjects.

- **Practices that provide students with hands on activities are particularly motivating.** During the practical work, students have the unique opportunity to discover how the theoretical knowledge applies to reality, the adaptations that are needed and become familiar industry related processes connected to STEM subjects.

The collection of the inGenious case studies and the analysis of the related evidence has provided us with useful conclusions regarding the impact of the inGenious practices. The implementation of the inGenious practices has affected students' motivation and knowledge but also had an impact on the involved teachers' motivation and knowledge. The intensity and the duration of this impact are highly related to a variety of factors. Hands on practices and the interaction with STEM role models have a great impact on students. At the same time, practices following a longer life cycle or practices that are slowly turning into school projects or are combined with other, STEM related, activities/events also have a longer lasting impact.

Teachers' commitment and motivation also play an important role in the whole process. Teachers' own motivation has also been affected and as we have seen in the case studies, has on numerous occasions led to the initiation of activities addressing the whole school or even the local communities. Particularly interesting is the fact that in some schools, teachers' positive experience and outcomes has led to the revision of curriculums, providing STEM subjects either with a more prominent role or by introducing activities like coding or practical work to low secondary education in place of upper secondary. These changes reveal not only the power of the practices but the importance of supporting teachers and classrooms realising these activities which provide teachers and schools with evidence on the importance of school-industry collaboration,

practical work and connection between STEM and real life activities, which they use in order to influence their schools' practices and the national curricula and priorities.

### Communities of Practice (CoP) and Chats

During the inGenious project a total of 16 COPs and 16 Chats were successfully organised. Throughout the duration of the COPs there were a total of **3,504 posts** posted by participants and a total of **194,898 views**. The COP that received the greatest number of views and posts was COP 8 entitled 'Technology knowledge in the classroom' with a total of **410 posts** and **33,613 views**. This highlights the fact that teachers and education leaders recognise the fact that technology is not an option that schools may or may not choose for their students, but that technological competency is a requirement for entry into the global economy and the faster it is embraced and mastered by the educational system the more it equips students with the 21st Century Skills required for the present and future STEM careers.

It can be concluded that students and teachers from across Europe enjoyed and benefited from the chats with STEM experts as it gave them the possibility to communicate with interesting STEM professionals and at the same time to get a glimpse into their day-to-day working life. 321 schools participated during the online chats, the ECB online chat with the most participating schools was Chat 14 entitled 'Introduction to Neuroscience' with a total of 38 schools followed by Chat 13 'Entitled insight into crop protection' with a total of 30 participating schools and Chat 10 entitled 'Why choose a career in Information and Communication Technology' as indicated the in diagram below. Given that for each participating school represents approximately 15 students per school, it can be estimated that approximately 4,815 students participated during the ECB online chats. The most participating countries per country were Portugal with 12% followed by 11% for Estonia and Slovakia as shown in the diagram below.

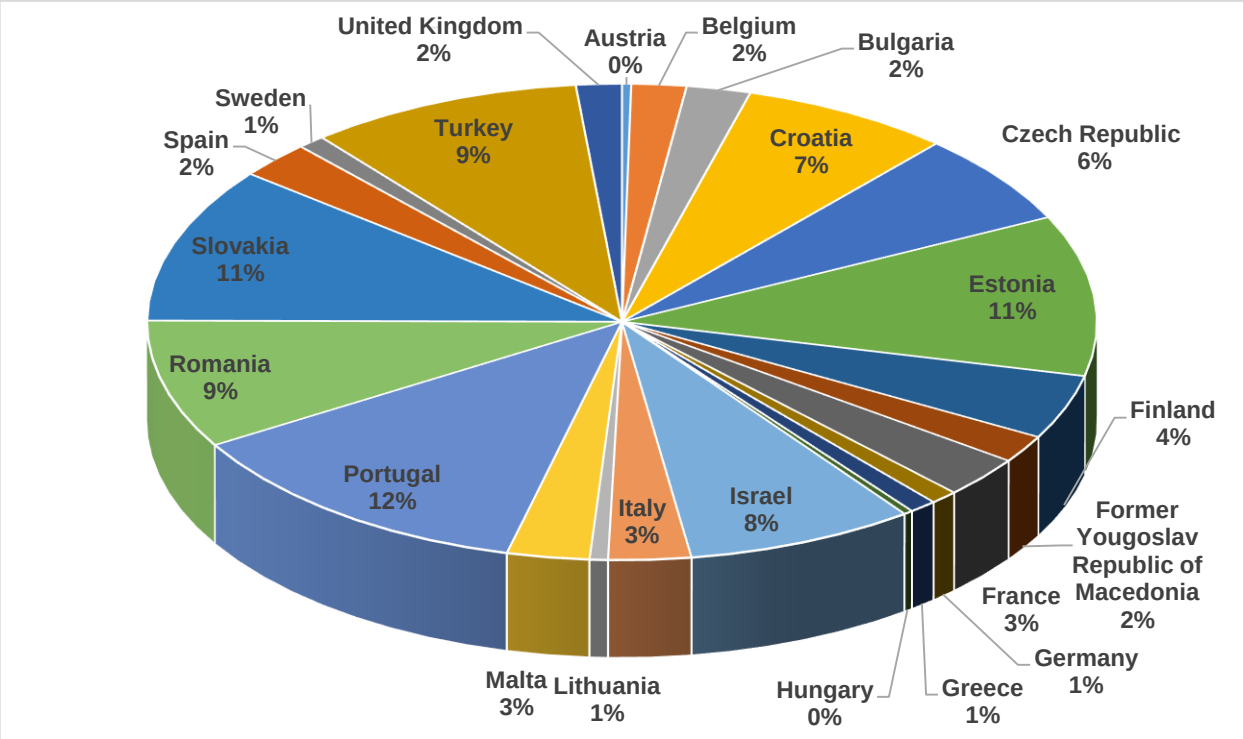



Diagram 1 Total Percentage of participating countries during the ECB 16 online chats

### MOOC s

The Innovative Practices for Engaging STEM Teaching MOOC (STEM MOOC) was developed and delivered as part of the inGenious project. The scope of the STEM MOOC was to provide teachers, school counsellors and career advisers with resources and ideas to increase pupils' interest for STEM (Science, Technology,

Engineering and Mathematics) subjects and careers. The course was designed in response to the worrying disengagement of young people from STEM subjects in school, and their decreasing interest in related careers.

The course was structured into eight modules which develop a learning path from the analysis of the reasons behind pupils' disaffection for STEM to the development and experimentations with innovative practices to overcome it. The first five modules focused on motivating and engaging students in the STEM area through different approaches such as taking part in virtual visits to research centres and the use of virtual and remote labs and other innovative tools in the classroom. The last three modules explored career counselling aspects, providing guidance on how to inform pupils on STEM careers prospects and to support them in their choice.

The STEM MOOC was animated by a European Schoolnet and a panel of external experts who contributed according to their specific expertise and engaged participants through collaborative activities.

The course was open to anybody interested in STEM subjects, however, it was mainly addressed to science, engineering, technology and math teachers, career advisers and school counsellors.

A total of 1078 users registered to participate in the Innovative Practices for Engaging STEM MOOC. Additionally a total of 766 started the course and a total of 263 participants finished the course. The table below provides an overview of the number of participants who started and finished per module.

| | Module | Number of participants who started the MOOC | Number of participants who finished the MOOC |
|---|---|---|---|
| | Course Introduction | 658 | 658 |
| 1 | Increasing students' engagement to study STEM | 705 | 447 |
| 2 | Original teaching practices in the STEM classroom | 506 | 382 |
| 3 | Innovative STEM teaching: using STEM resources from across Europe | 423 | 370 |
| 4 | Discovering virtual & remote labs and how to use them in the classroom | 401 | 350 |
| 5 | Exploring STEM in the real world - Virtual visits to research centres | 363 | 332 |
| 6 | Helping students to understand what STEM jobs are - Career counselling | 348 | 321 |
| 7 | Meeting real life STEM professionals | 341 | 307 |
| 8 | Dealing with stereotypes | 319 | 292 |

**Table 1 Number of participants per module who started by number of participants who finished**

Overall 1078 people had enrolled in the course of which 65% or 705 had actually started the course. The countries most highly represented on the course (more than 10% of participants) were Italy, Portugal, and Spain. Females were clearly in the majority with 67%, although less so than on the Future Classroom Scenarios course. 77% of participants were secondary teachers with 61% teaching a STEM subject. Most participants were also experienced professionals with 49% having worked in the educational field for at least 16 years and another 21% with at least 11 years of experience.

Participant engagement was manifested by a closed-knit community of professionals engaging with the topics of the course via discussions of topics and questions raised. That this resulted in a positive experience for the participants is confirmed by the evaluation survey (n=164) where 64% rated the course with the highest mark ("very good") and another 35% with the 2nd highest mark ("good"). Encouraging is also that only 7.2% did not participate in the discussions while 30% made more than 5 contributions per module.

Results of the course evaluation survey also suggest a substantial impact on classroom practice with 78% reporting to have tried out a new form of teaching since attending the course and 83% reporting they have succeeded in motivating more effectively their students in the STEM area. The scope of the STEM MOOC was to provide teachers, school counsellors and career advisers with resources and ideas to increase pupils' interest for STEM subjects and careers. In conclusion from the overall feedback provided from participants the MOOC had a substantial impact on classroom practice and exposed participants to new form of STEM teaching leading participants to motivate more effectively their students in the STEM education and careers.

## inGenious marketing messages

As part of the ECB communication and dissemination plan, inGenious developed brochures targeting different audiences, with the central objective of creating public and stakeholders' awareness. One brochure informed new Associate Partners, providing information on STEM opportunities and the benefits of associating to the project. Translations of the inGenious brochures, and editing of all language versions, have been realised in 9 languages.

Key slogans and inGenious marketing messages have been developed and the slogan *"Ignite your future. You are inGenious!"* has been used across different communication channels and tools to address pupils and to increase recognition and visibility of inGenious brand and pupils' interest in STEM education and careers. Moreover 6000 inGenious pens, 2000 inGenious highlighters and 2000 inGenious bookmarks have been disseminated through our teacher network. To further improve the visibility of the project during European events, 1000 inGenious bags were distributed and also provided each inGenious teacher, teacher coordinator and HR staff from partners with a colourful t-shirt. Posters have been designed in 3 languages and about 6000 have been produced and disseminated to schools.

Specific events, reports and workshops have been organised in order to informing parents, student counsellors, school head masters and teacher educators on the relevance of further improving STEM education for their pupils in order to boost STEM careers. In line with these objectives, relevant communication and dissemination materials and activities in order to engage new stakeholders in the project have been produced.

### InGenious Newsletter

Along the project lifecycle 9 newsletters were produced, translated in 9 languages to inform school practitioners, education experts and industry professionals on the inGenious activities and engage their interest and active participation. The inGenious newsletter mailing list has been continuously growing through registration on the website (671 at this stage, 10-09-2014) as visible in the graphic below covering the period May 2013 – September 2014. Newsletters were produced, involving over 10 ICT and industrial multinationals, 2 Ministries of Education in Europe and over 700 inGenious teachers. The total number of unique visitors of around 8000, can be regarded as a big achievement for the project partners and engaged teachers (and school classes) in Europe.

### Use of Social Media, twitter, Facebook and Flickr

The inGenious Twitter account @inGenious_eu has 785 followers. According to social media management tool Sprout Social, from the date of its creation (19 June 2013) until 31 October 2014, the inGenious account had 1,400 interactions by 404 unique users, with a total number of impressions (how many times a post was seen) reaching up to 1,3 million. During the second reporting period, the account had 17,056 link clicks, 578 mentions and 844 retweets.

The purpose of the inGenious Facebook fan page is to reach out to teachers and school communities, through the online community that discusses STEM matters and shares experiences, content, videos and pictures. It is also the tool to promote inGenious' activities at large. Since its launch date (20 March 2013) and until 31 October 2014 the page had 733 new likes (1079 total likes) and a total of 232,300 impressions (how many times a post was seen) by 104,900 users. Web address of the inGenious Facebook Page: https://www.facebook.com/inGeniousScience

InGenious pictures were uploaded on European Schoolnet Flickr account to share online, with an inGenious tag so project-specific materials could easily be retrieved. InGenious photography has also been sourced from partners and via dedicated photo shoots. In total 377 photos have been included and they have received 1166 visits. Links to inGenious photo albums on the European Schoolnet Flickr account:

- First inGenious summer school for teachers: https://flic.kr/s/aHsjBZ1gRL inGenious practice deep dive – Intel skoool football: https://flic.kr/s/aHsjCupwwy
- inGenious Academy: https://flic.kr/s/aHsjCNJAvp

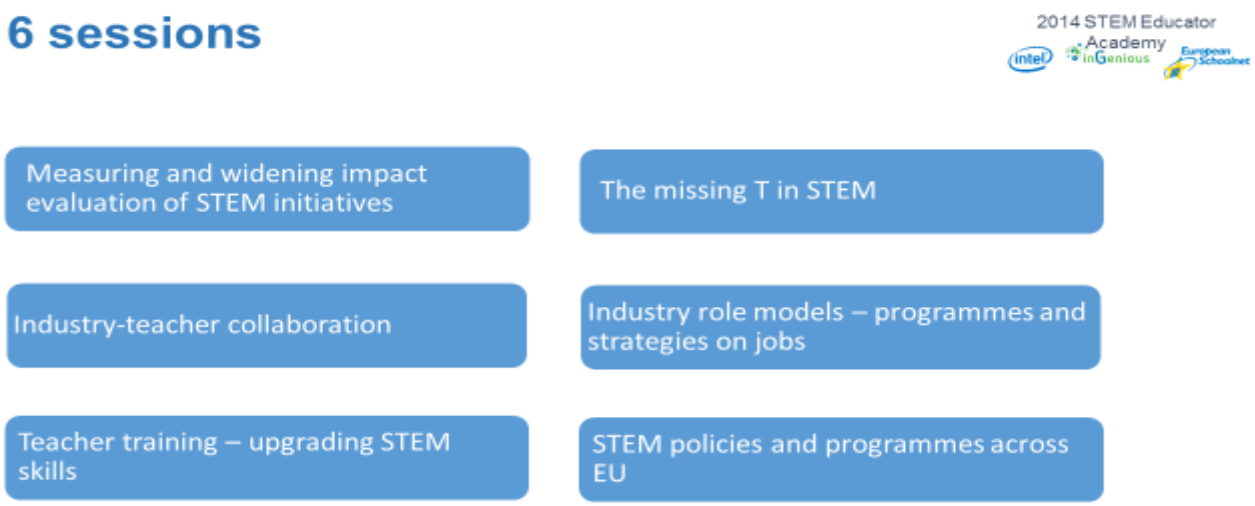
- Ignite your future video shoot: https://flic.kr/s/aHsjELUrLu
- Towards 2020: Priorities for STEM education and careers in Europe: https://flic.kr/s/aHsjNbh2e4
- STEM Educator Academy: https://flic.kr/s/aHsk3QWXjY

### European Level campaign and (closing) conferences

A dedicated European web campaign in cooperation with the EC, competitions, dedicated articles in the printed press were developed during the lifetime of the ECB project, and campaign results and efforts in the inGenious project. The main aim of all activities, was to integrate a set of activities (from competitions for schools to national or regional conferences for stakeholders) in order to increase brand recognition and participation from school and industry on one side, and to enhance STEM debate in policy agenda's across Europe on the other hand. It was a strategic decision in the ECB network, not to limit the campaigns to single weeks, but to stretch campaign durations if needed, in order to ensure more time and opportunities to articulate activities, co-brand and join existing activities with partners and allow the largest audience possible to be exposed to inGenious messages.

During the STEM Educator Academy 21- 23 September 2014, 6 Calls for Actions sessions were held during the closing conference of inGenious, the STEM Educator Academy in Warsaw 2014.

Please find below the lessons learned from the sessions as below stated:




From the Calls for Action it was clear that a lot of ideas and knowledge about activities related to STEM education and careers were confirmed and that other issues related to policy should be further elaborated and further strategies should be developed in order to maintain and further improve the current situation in Europe.

# Confirmations

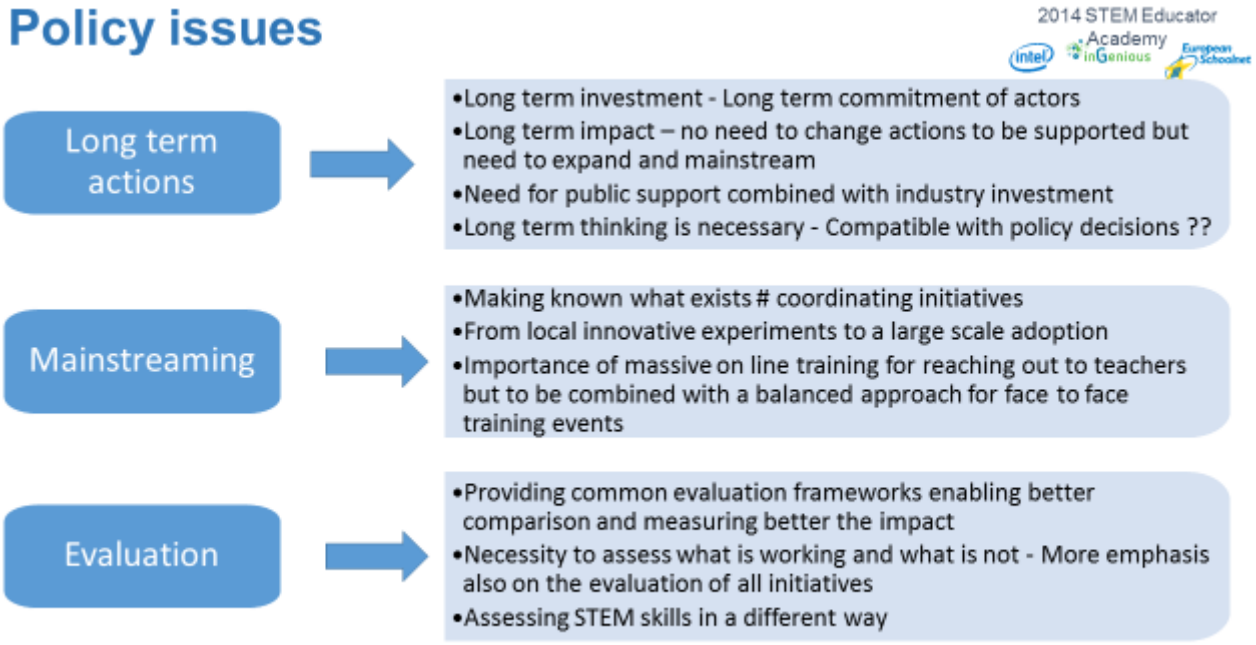
2014 STEM Educator Academy

| | |
|---|---|
| Motivation | •Teachers, head of schools, students<br>•Motivation of companies – more than a CSR involvement<br>•Willingness to continue and evolve |
| Role of teachers | •Teacher as the vector change<br>•Giving time and recognition to teachers<br>•Appropriate training for teachers ("teachable" skills – subject specific skills to be complemented by transversal skills). |
| Training | •Improve teacher training – revising the curriculum (coding – missing T)<br>•Issue of innovative teaching methodologies<br>•Issue of primary school teacher (not only an issue of upgrading but also providing basic STEM skills).<br>•Issue of pre service training of teachers – preparing the teacher of tomorrow |

# Confirmations

2014 STEM Educator Academy

| | |
|---|---|
| Formal versus Informal | •Confirmation regarding the necessity to encourage better bridges between formal and informal education<br>•Embed innovative activities in the curriculum |
| Exchange of practices | •Training alone is not enough<br>•Need to offer an ecosystem with communities of teachers |
| Role and engagement of industry | •Contribution of industry is key - Importance of role models<br>•Contextualization of STEM teaching to real world - Relevance of content to the pupils' lives and future careers<br>•Political commitment of industry linked to the STEM challenges |



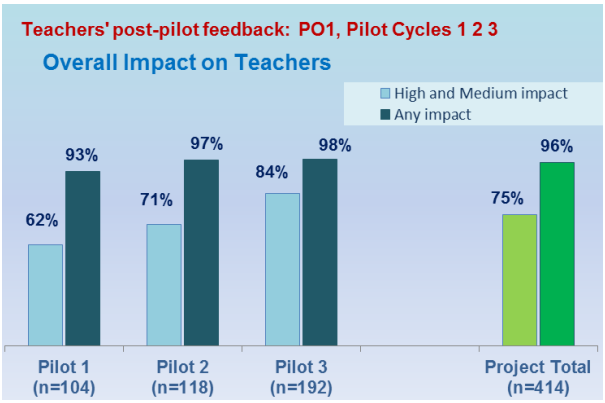

### Impact of inGenious project on European teachers

In baseline surveys, teachers expressed their views about their expectations of the inGenious project. Broadly 89% of them wanted to obtain knowledge of new teaching resources, such as activity kits for teaching STEM subjects and 70% wanted to improve their knowledge and skills in teaching STEM. Just over half of them thought that it might be important for the project also to improve teachers' interest in teaching STEM subjects.

A large proportion of them also expressed the desire to engage with others in their school and the wider scientific/industrial community (77%) and through that engagement learn to improve their own knowledge/skills and those of others'. Improving their practice through gaining access to industrial resources either via visiting speakers, or using hands on activity in their own classrooms was an expectation expressed by up to 85% of teachers. Some teachers expressed the desire to widen their collaboration with other schools in Europe and saw sharing practice through the project as a key objective for them.

In addition, for some teachers, being able to address the gender gap, particularly in students' aspirations towards STEM careers, was a professional development need. A small proportion of others saw the project as a way to improve their own and students' language skills. In particular this view was expressed where materials could not be provided in the home language of the participating schools but were provided in English. Some teachers' in this situation saw the opportunity to collaborate with other colleagues in English departments in their school as an important goal. Overall, teachers reported a very positive view of the impact of the project on their classroom practice, knowledge and skills. Almost all, (96%) of them regarded there to have been some impact.

Figure 8 below shows the level of impact in different pilot years. As stated in the last chapter, and indeed as a theme running through the whole evaluation, this impact seems to have been accumulative, with higher levels of impact being reported as the project progressed. For example, in year one 62% of participants felt that the impact on their practice was high and by year three this had climbed to 84%. This is a remarkably high proportion, given the large number of teachers who took part in the project.



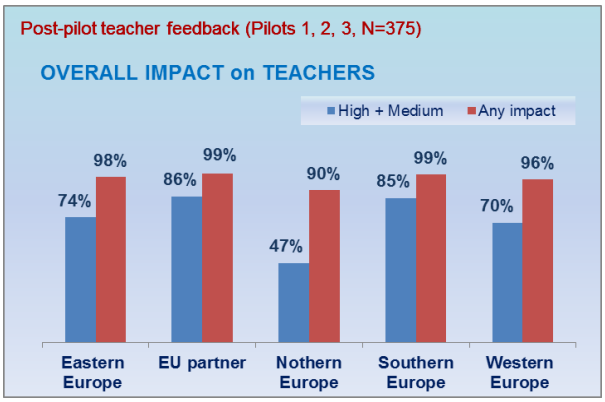




**Figure 8. Overall impact on teachers by year and region**

## Evaluation of practices

One of the key outputs of the project is the production of a bank of tried and tested activities and practices for use in STEM lessons across Europe. Teachers' and students' opinions on each of these practices are available to help others. In that sense the aims related to the evaluation of testable practices have been achieved. Tables 7 and 8 provide cumulative feedback from teachers and students on various benefits of testable practices.

| Teacher evaluation feedback: all practices | ALL | Pilot1 | Pilot 2 | Pilot3 |
|---|---|---|---|---|
| – *The practice fully achieved its expected learning outcomes* | **94%** | 93% | 93% | 96% |
| – *Pupils enjoyed the practice* | **97%** | 95% | 96% | 98% |
| – *Pupils showed that they improved their understanding of mathematics / science / technology from the practice* | **89%** | 87% | 89% | 91% |
| – *Pupils showed that they learnt about the career opportunities in industry* | **65%** | 53% | 63% | 71% |
| – *Pupils showed more interest in the career opportunities in industry, science or technology* | **70%** | 60% | 70% | 74% |
| – *Pupils learnt about industrial processes* | **63%** | 56% | 61% | 66% |
| – *Pupils learnt how STEM subjects relate to everyday life* | **93%** | 88% | 95% | 94% |

Source: Teacher practice evaluation survey NA2, pilots 1,2 and 3 (N=1117)

**Table 7. Teachers' views of the benefits to students from engaging with the practices**

| Students' Feedback | Pilot 1 | Pilot 2 | Pilot 3 | OVERALL | Girls | Boys |
|---|---|---|---|---|---|---|
| N= | 3167 | 6594 | 9726 | **19487** | 9748 | 9739 |
| 1.This practice helped me to: | | | | | | |
| – *Improve my understanding of topics that we study in our science, maths or technology lessons* | 67% | 71% | 72% | **71%** | 69% | 73% |
| – *Learn new things about jobs in industry and science* | 58% | 65% | 67% | **65%** | 62% | 68% |

| | | | | | | |
|---|---|---|---|---|---|---|
| – *Learn about industrial processes* | 55% | 59% | 64% | **61%** | 57% | 64% |
| – *Learn about practical applications and real life use of science and maths knowledge that we study in school* | 69% | 73% | 73% | **72%** | 71% | 74% |
| – *Learn about personal and professional qualities of people who work in science, industry and technology* | 60% | 65% | 67% | **65%** | 62% | 68% |
| 2. I enjoyed the practice | 81% | 84% | 83% | **83%** | 82% | 84% |
| 3. I would like to do more of this type of practice | 77% | 81% | 81% | **81%** | 79% | 82% |

Source: Student Practice Evaluation Survey, NA3

**Table 8. Students' views of the benefits they received from engaging with the practices**

Teachers evaluated the inGenious practices in detail. Participants provided a clear story of how they used inGenious practices and what best practices were in their classrooms in the context of industrial collaboration.

So **what is best practice?** Practices are, overall, more successful and achieve more sustainable impact on students, teachers and schools, when they are well integrated with other activities, linked to the school curriculum and provided different types of learning to challenge the range of students that teachers meet. In addition the more flexible they are the better, so that they can be used with a variety of abilities and age ranges. In the context of this evaluation and the industrial focus of the work they also need to be flexible enough for teachers to adapt to different varieties of school/industry collaboration from visits to films to on-line meetings with practitioners. There also needs to be a variety of student tasks available, but what is essential, is hands on activities, and those that provide opportunities for interactive learning, challenging stereotypes, and stimulating creativity and inquiry. The evaluation demonstrated teachers' creativity. They adapted practices to suit their own teaching styles and conditions. Nevertheless, when using materials which they have not themselves created, teachers value clear guidance – statements about learning objectives, conditions of use, resources (including technical specifications) and subject knowledge required of the students prior to commencement. In the context of a Europe wide project such as this, teachers assert that materials available in the students' home language are best to ensure full understanding.

However, notice needs to be taken of what teachers said as they evaluated practices. They stressed the need for translations into home languages for all the practices. They reminded providers about the need for clear guidance and taking into account the limited resources available in some schools for the provision of additional equipment. They reminded the project leaders that practices need to develop over time and can only do so if teachers and students work with them actively. In other words, the production of a bank of resources is not enough. That bank needs active management. It needs to be updated, translated, developed and worked with. It needs that community of teachers using it as part of their culture.

### Teachers' professional development and wider issues

One of the projects' main successes was the enhanced professional development of teachers. Teachers regarded the impact of the professional development activities to be one of the highlights of the project for them. In particular, contact and sharing ideas with others, be they industrialists, teachers or project leaders was a key feature, which teachers reported upon enthusiastically.

What became clear as they provided views or commentary on the development of their practice, was that the best practice develops within a community of teacher learning and sharing – where a culture of continual improvement is the key feature of teacher advancement in that community. Where professional development is sustained and seamlessly integrated through interactive and on-line resource as well as face to face opportunities to address issues with both colleagues and experts. Having a bank of well tried and tested materials and resources is not enough. For teachers to progress in their understanding and embrace new opportunities for their students, this sustained and seamless professional development is a critical factor. The

responsibility for engagement with professional development lies with teachers and these teachers took that very seriously. But the responsibility for provision of this development lies with senior staff in schools, policy makers, professional development experts in individual countries and ultimately, governments. Without the promotion of that culture of progressive change, student learning cannot improve over time.

**Teachers' views were unequivocal. They enjoyed the development opportunities they were offered in inGenious and no matter how much they participated they still wanted to engage. The opportunity to learn from their peers, influence future development opportunities and question and understand industry experts was critical for them. In that context it is clear inGenious' aim has been achieved.**

# *4.* Potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and exploitation of results.

### Mainstreaming ECB results and sustainability strategy

The central goal of the project was to ensure a sustainable ongoing European Coordination Body for Maths, Science and Technology, which would be one of the major players in promoting the STEM cause in Europe. During the project lifetime it became clear to all stakeholders involved, that such a Coordination Body would require a sustained long-term campaign. InGenious needs to continue to address the fundamental challenges highlighted and concluded in project events and pilot testing phases, but also should the network concentrate further efforts to effectively communicate and disseminate good practices and impressive results to a wider audience and during a longer term than the years ECB was funded.

Sustainability of the project will therefore be dependent on the continuing collaboration between project members, European Schoolnet and other main players in the area. The continuing role of the inGenious portal and the continuing availability and vitality of resources within it will be a central factor. The inGenious strategy group had as its remit to provide with a strategic plan to mainstream and sustain the project results after project ending. The group met during various occasions and organised peer learning workshop sessions, or lunch meetings in conjunction with main events organised in the project for all stakeholders involved.

The way in which inGenious activities and network would be sustainable in the future, taking into account all discussions and feedback received, can be strategically formulated and organised around 4 major building blocks. The main building blocks are presented below.

### A. Industry initiatives in the STEM area strengthening industry-education cooperation (common evaluation framework and information to schools)

The objective were as follows: Continue and strengthen (in cooperation with STEM national platform) all what has already been done in InGenious by collecting and describing all initiatives run by companies regarding school-industry cooperation in the STEM area (developing a structured framework presenting all initiatives led by industry and enabling exchange and discussion between companies on these programmes). Improving the existing common European evaluation framework developed in InGenious in order to systematically collate the feedback on and the results of all these initiatives on a European basis. Promoting all these initiatives with major results obtained within a yearly European publication and a European STEM policy event associating all major stakeholders.

### B. Development of industry activities in STEM education within classrooms in Europe

The objective of this building block would be to continue to develop the large-scale repository of practice already tested in InGenious and offer a collaboration space where: practices from industry can be uploaded and then tested by any school; and where feedback can be given so that we can progressively build a community around all these practice activities. More specifically the following actions should be considered:

- Offering any company the possibility to upload an industry activity that could be used in teaching STEM. EUN will propose such a service to companies and will also implement a Pedagogical Board and an appropriate tool for filtering and curating all proposals.
- Offering any science teacher the possibility to download any activity and associated materials and use them with their class.
- For each activity downloaded and tested in school, supporting the collection of feedback on the practice at school level so that a global analysis can be considered and appropriate feedback can be provided to the company that has uploaded the related activity.
- Offering support and input to STEM teachers through community activities (e.g. webinars, forums)
- Considering an ecosystem around these practices involving the expansion of the number of industrial activities by collecting more practices, and via more animation of the community (the activity of the month, organization of some prizes, potential face-to-face training seminars, etc).
- Offering science teachers access to massive open line training courses in this area (Innovative STEM teaching, contextualization of STEM teaching, etc).

### C. Initiatives to develop attractiveness of STEM jobs

In InGenious, the promotion of STEM jobs was supported by very popular activities such as online webinars between companies and schools. Therefore, some possibilities could be continued in order to develop specific activity programmes with the support of companies, where:

- Schools could register for a programme of webinars aiming to increase the attractiveness of STEM jobs.
- Develop massive online courses for guidance counsellors in schools who are in charge of promoting and developing the attractiveness of STEM jobs. These courses could also support the creation of a network of STEM guidance counsellors in schools.

### D. Support for volunteering programme and mobility activities between industries and schools in Europe

Quite a lot of companies have put into place volunteering programmes and initiatives, where, for example, engineers offer support to science teachers and even to partner with specific schools which may be interested to develop new approaches of teaching science with the support of InGenious. The objective of this building block would be to propose a pilot brokerage system aimed at strengthening education-industry mobility, in order to determine the value of such a system and what would be required in order to implement a full brokerage service. Four companies interested in testing such an approach will constitute this first pilot and the scale of the initiative for each company (how many schools, which geographical area, etc) will be agreed with each partner.

This action will:

- Offer any school the possibility for students to have a short duration placement in a company (could be called a **Student Discovery Placement**).
- Offer any teacher the possibility to spend up to two - four weeks in a company, in order to update his/her technical skills in specific domain. It can also be extended to guidance counsellors so that they are better informed concerning STEM jobs in companies. It could be called a **Science - Industry Teacher Scheme**.
- Offer any school a coaching system to strengthen the contextualisation of STEM teaching for primary and secondary schools. This specific scheme could be called a **Science Pedagogy Coaching Scheme**. The objective would be to offer either online or on a physical basis the possibility that a teacher could benefit from the advice of a technician or engineer in a company in order to contextualise much more his/her teaching with the school.

## Potential indicators & economic models for inGenious sustainability

In terms of indicators, a new initiative, inGenious 2, will seek to involve around 25 companies and 15 Ministries of Education and to open the multi-stakeholder platform to other companies. The objective would be to: collect more industry practices to be used by schools in STEM teaching; engage a network of 3,000 schools in more than 15 countries; attract more than 10,000 science teachers through various activities; organise a minimum of two high level events for teachers per year; build a European network of STEM guidance counsellors; and organise 10 webinars/online chats per year for schools with the support of companies for the promotion of STEM jobs and careers.

Within InGenious, the economic model was based on a multi-annual commitment of companies with different levels of involvement, depending on the type of participation by the company. The same model would be maintained, where the objective would be to have a multi-annual commitment of companies, but with the possibility to organise different levels of commitments, where companies or other relevant stakeholders (such as education bodies, non-profit organisations, SMEs, etc.) may opt for one building block (see above A – D) rather than another one.

The objective of a multi-stakeholder initiative, inGenious, is not to replace national activities, neither to impose an extra European layer but more to complement all what already exists and built a European STEM strategic platform where industry will have a European visibility, promoted via the multi stakeholder platform. All various initiatives developed by the company, offer real life industry situations, which can be integrated in science lessons, participate actively to training activities for science teachers, promote any volunteering programme organised by the company and benefit from a European evaluation framework, benefit from the production of tools and guides helping to reinforce and professionalise school-industry cooperation in STEM education (such as the inGenious code, access via the multi-stakeholder initiative to a policy platform where companies contribute to elaborate strategic recommendations for policy makers regarding the challenge of STEM education).

## Overall impact evaluation

The post-pilot surveys indicated that teachers felt there had been, in general, an impact from the project on teaching and learning STEM subjects and careers, with 99% of them indicating that this was the case. In addition, well over three quarters (86%) of the respondents to the post-pilot survey rated the overall impact as being high or medium. (Figure 8 below).

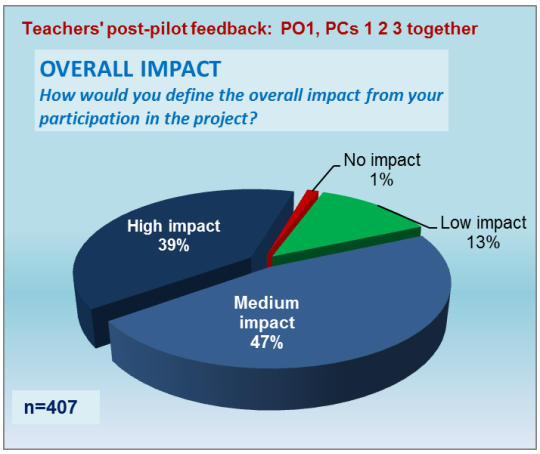



**Figure 8. Teachers' views of the overall impact of the project**

Whilst the figure 8 above shows the cumulative results across all pilot years, there were noticeable differences between pilot years in terms of the impact on their practice reported by teachers. This was particularly noticeable in the second and third years as shown in Figure 9 below. This may have been due to a number of reasons:

- those were full academic years (the pilot in year one lasted only five months)

- more practices were offered for testing in year three and teachers implemented more of them in school
- there were more opportunities for professional development as the project progressed, such as organised professional development events, two workshops, summer school, teacher academy and 2 online communities of practice that took place b/n Feb 2012 and Oct 2013

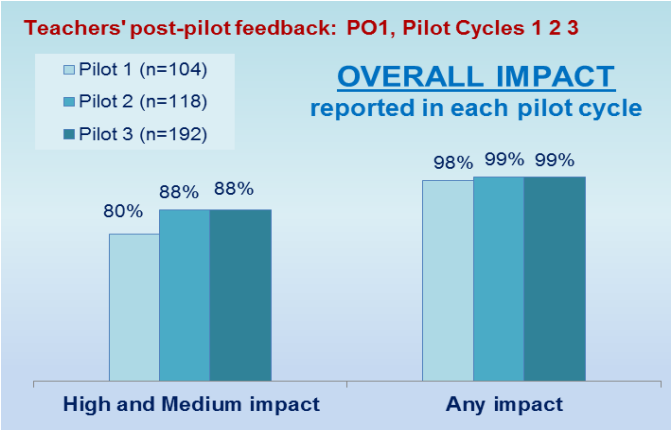



**Figure 9. Teachers' views of the impact of the project by year**

## Towards the model of positive change delivered by inGenious

inGenious was able to enunciate the starting point for teachers and students in terms of enthusiasm, understanding and expectations and use this as a basis for comparison once the practices were completed. The evidence is clear that engagement with the project enhanced teachers' capacity to know, understand and use industrial materials to contextualise their teaching.

This in turn resulted in an enhanced understanding of the social context of science for students as well as an increased liking for STEM subjects and increased knowledge and understanding of STEM topics. Nor was it merely knowledge and understanding of STEM that was affected by the practices. Teachers reported seeing a range of multiple positive outcomes for their students including the development of some of the 'soft' skills necessary for future career success, such as ability to work in a group and to communicate effectively.

Comparisons of pre and post pilot data provided some robust findings. The strongest impact of any part of the project was that on **students' knowledge of and aspirations towards STEM careers**. This was not just the observations of teachers. Students too reported that their access to STEM-related career information improved over the life of the project and that this was assisted by contextual teaching about careers and practices within the project.

Year-on year, there was an increase in the number of students who showed interest in learning about STEM-related careers and aspired to select such a career for themselves. This impact could be discerned across all age groups and both genders with the biggest attitudinal change in primary schools (13% vs 7% in secondary) and among girls (11%- all age groups). This latter finding is substantial. It is clear that teaching about STEM-related careers within the context of STEM lessons has helped to reduce the gender gap in career aspirations. Given the strong effect of social stereotyping which many female students brought to the classroom at the start of the project, this is a significant finding. Girls' aspirations towards STEM careers at the beginning of the project were lower than those expressed by boys. However, despite such a change, there is still a large proportion of girls who still believe that such careers are not for them. For these young women, social stereotypes are hard to break.

Student views on the social value and attractiveness of STEM industries and jobs, which were highly positive at the start of the project, remained high but mainly unchanged. This is an interesting finding. One might have expected that as students career aspirations increased over the period of the project, especially during the last year, then so too would the attractiveness of STEM jobs. After all, students are now aspiring to them in higher numbers than previously. But the attractiveness of the jobs remains unchanged. This is an area which is worthy of greater examination. What social stereotyping is still being retained here, despite the impact of

the project on aspirations? Is it that in modern society, with its fascination with a celebrity lifestyle, there are few celebrity role models which can be celebrated in STEM jobs to attract young people?

A very clear and important finding when pre and post data was compared and students' views on more than one aspect of the survey considered, was that an interest in STEM subjects and lessons was confirmed as a necessary but not sufficient factor for motivating students towards STEM careers. More was required than just being interested in and liking STEM subjects. In addition, the findings have shown that learning about STEM careers in the context of STEM subject teaching in school is an important factor that affects student career aspirations. inGenious had a positive impact on the provision of career information related to STEM.

There were some findings within the project that remain issues for further consideration. For example, there were gender differences discovered. Some of these dissipated over the time of the project, but others proved quite stubborn. In the case of girls for example, who professed to enjoy science and science lessons but would not consider a career in science. For some reason, they continued, despite their immersion in the project to find science based jobs unattractive. This is an area which is worthy of greater examination. What social stereotyping is still being retained here, despite the impact of the project on aspirations? Is it that in modern society, with its fascination with a celebrity lifestyle, there are few celebrity role models which can be celebrated in STEM jobs to attract young people? Further research is required here. There have been numerous reports, and attempts to engage role models in scientific endeavour to influence learners. However, despite individual success stories, like the Jet-Net project in the Netherlands or STEMnet in the UK, these findings indicate such attempts may not yet have hit the mark.

Similarly, there were regional differences discovered. These, as has been stated before may be suspect due to the conditions pertaining in some Northern European countries at the time. However, this is not the first project to find that in general countries with well developed economies and relatively established STEM support stimulated by the government, nevertheless experience difficulties persuading their young learners to consider careers in science. Is this that such careers are unattractive in a successful economy? Or is it that successful economies, like successful football teams can acquire their players from many nations, where the economy is not so advanced and wages not so high. When the world is your market place perhaps there is not the incentive to ensure your own young people focus their attention on scientific careers. This issue needs further investigation.

### Recommendations for future actions in inGenious and next steps

- Extend the project ECB-inGenious to ensure the maintenance of the European platform for school-industry and school-to-school collaboration in STEM education
- Encourage STEM industry partners to participate in the provision of sustained professional development opportunities (online and face to face) for teachers of STEM
- Disseminate the research and evaluation findings regarding best practices in school-industry collaboration in STEM education to all stakeholders and encourage teachers to include/increase learning of STEM industries and careers in school lessons
- Ensure the establishment of a managed bank of evaluated teaching materials which can contribute across Europe to the development of STEM activities in classrooms and promote engagement with industry

In order to progress, first two major elements have to be ensured; (1) the political readiness of companies to continue investing (financially and staff capacity) in a European multi-stakeholder initiative in cooperation with European Schoolnet and its Ministries of Education, and (2) Validating that the current inGenious activity proposed fully meets the expectations and the needs of companies. In this context and in order to facilitate stakeholders' decision, a working meeting will take place on the 29th of January 2015 for which already 25 companies have registered, to define more concretely the basis of further cooperation and how inGenious 2 could be launched.

## *5.* Address of the project public website

www.ingenious-science.eu