Cross-national report and policy paper

mathematics and science for life

mascil

mascil aims to promote a widespread implementation of inquiry-based teaching (IBL) in math and science in primary and secondary schools. It connects IBL in schools with the world of work making math and science more meaningful for young European students and motivating their interest in careers in science and technology.
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Cross-national report and policy paper

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Executive Summary

Background
This report stems from work developed in the frame of the mascil (mathematics and science for life) project’s second work package (WP2), entitled ‘Educational systems and policy contexts’. One of the main goals of this workpackage is to initiate a dialogue process with policy makers at national and European level, aiming to make out and remove obstacles and tap possibilities of cooperation and synergies between circles or research, policy and practice. To address this objective, previous work within this workpackage reported in September 2013 (see D2.1 National working papers on analysis of policy contexts) provided a detailed account of policy contexts in the 13 European countries of the consortium under the scope of investigating the contextual and regulatory conditions under which teachers are called to implement (or not) inquiry based and context based approaches to their teaching. The current study builds on previous work conducted within WP2 of the mascil project, by synthesizing the information provided in the national working papers, identifying differences and commonalities among the participant countries and by providing recommendations to inform the development of future policy in national and European settings.

Aims and purpose
In recent years, the European policy agenda has prioritised the promotion of equity, the enhancement of students’ achievement and the promotion of entrepreneurship. With a view to addressing these challenges, educational policy discourse has focused on the promotion of inquiry-based teaching approaches, on opening schools to the world of work and on ensuring high quality teaching. The work reported in this study is concerned with the above-mentioned strategic priorities in education and links closely to the main areas of current educational policy discourse, by providing a comparative overview of the policies and strategies in place in the area of science, mathematics and technology education.

The comparative overview covers 13 European countries, namely: Germany, Greece, Netherlands, United Kingdom, Spain, Cyprus, Norway, Romania, Czech Republic, Turkey, Lithuania, Austria and Bulgaria. The study takes the reference year 2013, while changes and reforms planned for the coming years have also been taken into account.

The scope of the comparative overview is twofold: on the one hand, it attempts to develop a thorough understanding of current policy intentions and actual practice in science, mathematics and technology education; on the other hand it aims to inform the
development of future policy in national and European settings, by identifying factors that impede upon effective policy implementation.

**Method used**

This study has been conducted under the influence of the *Engaged Theory*, which *has informed the work conducted in two levels*: in a first level the theory guided *the structure of the analytical framework developed* for the investigation of the national educational contexts; in a second level, the theory has informed *the method of analysis* that was conducted for the data gathered with the aid of the framework.

The framework for analysing the educational systems and the policy context within the mascil project consists of the following major elements: **a)** it covers 13 national policy contexts within Europe; **b)** it examines five major policy areas that are relevant to prominent concerns of current educational discourse and closely link to priority areas in the frame of the project -1. Recent and foreseen changes and reforms, 2. Schooling and the world of work, 3. Science and mathematics curricula and inquiry based learning, 4. Pre-service teacher training in relation to inquiry-based learning and the work of work 5. In-service teacher training in relation to inquiry-based learning and the work of work; **c)** it considers three levels of systematic analysis 1. *the macro-level* regarding wider policy envisions, 2. *the meso-level* – relating to the way schools mediate the implementation of policies and 3. *the micro-level* – regarding actual classroom implementations, in an effort to uncover probable contradictions of implementation in relation to intensions and  **d)** it is embedded to three major strategic aims/priorities for education, i.e. the promotion of equity, the enhancement of students’ achievement and the promotion of entrepreneurship.

A questionnaire based on the framework was completed by each of the 13 mascil country groups, with respect to their own country. The outcome of this process was 13 national working papers of the policy contexts reported in mascil Deliverable D2.1. The current study *synthesizes the information provided in the national working papers, identifying differences and commonalities among the participant countries*. The analysis was conducted from multidimensional perspectives:

**a)** With an *analysis* taking a horizontal form *in terms of the three levels of systematic analysis*, prominent issues for consideration arise - relating to policy priorities, managing/mediating mechanisms and actual implementation.

**b)** By taking a vertical direction in the *analysis in terms of areas of focus*, conclusions are reached for each of the major areas examined in this study – namely recent and foreseen changes and reforms; schooling and the world of work; science and mathematics curricula and inquiry based learning; pre-service
and in-service teacher training in relation to inquiry-based learning and the work of work.

c) Finally, the synthetic analysis under the scope of the strategic aims/priorities for education leads to the identification of issues pertaining the remaining challenges for the promotion of equity, the enhancement of students achievement and the promotion of entrepreneurship.

Summary conclusions
In respect to each dimension of analysis, a set of conclusions have been reached, leading to a set of recommendations for the development of future policy in national and European settings.

Emerging issues pertaining to levels of systematic analysis

- Educational reforms across the countries currently seem to remain at the level of policy rhetoric and have not yet been introduced across the meso-level relating to schools and teachers – not to mention the micro level of actual implementation in classrooms. The need for policy making to build bridges between what is envisioned in general and how it can be implemented in practice becomes apparent.
- Important in this respect is the existence of coherence in policy rhetoric between expectations of students' learning and expectations of teachers' training, which seems to be lacking. Pre-service and in-service teacher training is not an area of focus at policy agenda, while policy envisions regarding the teaching of mathematics and sciences as evident in policy documents are not always in accordance will policy orientations regarding teacher training; such in incompatibility is a major hindering factor for bridging the gap between what is envisioned in theory and has is implemented in practice.

Emerging issues pertaining to major policy areas of focus

Inquiry based learning:
- Inquiry based teaching and learning is generally prioritized in mathematics and sciences policy agenda in the vast majority of the countries. However, if attention is turned to the countries for which inquiry based learning is not a policy priority, an interesting outcome appears: for countries that seem to have a tradition on implementing activities relating to inquiry based learning, policy orientations seem to move towards more content-based curriculum
objectives and emphasis on content knowledge. Feedback from policy makers during workshops that are planned to be conducted within the mascil project mascil will provide elaborations on the reasons for such an orientation.

- At a school level, findings indicate that in many countries policy rhetoric and official positioning in relation to inquiry base leaning hides another type of reality: in many countries, there is strong evidence that inquiry based teaching and leaning is not incorporated in the school culture. Schools' culture seems to be resistance to change; this is particularly challenging for the expected impact of the mascil project.

- At classroom level, traditional teaching focusing on the transmission of content knowledge seems to dominate everyday classroom practice in many countries of the consortium. The reasons evoked seem to be a mixture of the following, with different weight depending on the national context: the lack of corresponding materials and in some cases lack of guidelines for teachers for successful implementation; the exam-orientation of many educational systems with subject-oriented assessment objectives; the reluctance to implement classroom activities towards such aims, not only from the part of teachers but also from parents. It is evident that for successful implementation of inquiry based learning teacher professional development should be accompanied with the actual engagement of parents, something that represent a real challenge for the policy makers.

Schooling and the world of work

- There is evidence of wide variation among the countries in relation both to the degree to which they prioritise connections between schooling and the work of work and the way that such a priority is evident in policy practice: out of the 13 national contexts analysed, in five countries it has been explicitly stressed in the national report papers that such connections is not a priority in general schools both at primary and secondary general education level.

- Connections between schools and industries or providers of informal education (museums, science centres, bodies aiming to promote science and technology) are more evident in vocational education. For general education, relations between schools and providers of informal education are evident, but not between schools and industries; in most cases these take the form of extra-curriculum activities. In addition, the vast majorities of the countries reported lack of cooperation between general and vocational education.

- At a classroom level, for the vast majority of the national contexts that have been explored there is evidence of a lack of appropriate teaching recourses in science and mathematics subjects relating to the world of work. In a similar vein, in terms of assessment practices, they are rarely related to the work of work.
in most national contexts. In the view of the significance of appropriate teaching materials and assessment tools to day-to-day teaching, the work within the mascil project aims to provide high quality support on the area.

Pre-service and in-service teacher training

- There is a wide variation in relation to the systems responsible for providing pre-service teacher training and the orientation of science and mathematics training initiatives. In most countries the systems responsible for providing teachers training are the ones that define goals and expectations; as such overall national policy envisions in the area are still missing.
- Especially for in-service teachers, training is being conducted in short-term programs which are mainly project-driven. Both the luck of concrete policy orientations regarding teacher training and the unsustainable short-term cycles of training initiatives are considered a major hindering factor towards ensuring high quality teaching.

Emerging issues pertaining to strategic educational priorities

- For the vast majority of the national contexts that have been explored gender related issues have been prioritized in policy making and official rhetoric; yet in most cases these remain at a general level, without concrete guidelines or measures on how this is to be achieved in science and mathematics education. Support for teachers to implement the policy envisions is still lacking. It is notable that in most cases training in inquiry based approaches does not take into consideration gender differences in terms of interests, learning styles, motivation, despite evidence that inquiry based learning contributes to reducing gender stereotypes.
- In a similar vein, the prioritization of tackling low achievement in the policy discourse is evident in the vast majority of the national contexts. Yet, it is the minority of the countries have set national standards to boost achievement levels in mathematics, while in science education, no member state has specific national support policies.
- In relation to entrepreneurship, many member states have strategies addressing the implementation of entrepreneurship education into general education at primary and secondary level. In most of the cased, though, support for teachers to implement entrepreneurship activities is still lacking. The above indicate an incompatibility between wider policies envisions and concrete policy actions for implementation.

Recommendations to policy makers...

The project mascil has received funding from the European Union
...pertaining to levels of systematic analysis:

- The priorities that are evident in the national policy agendas are in line with wider European policy strategic aims, indicating a conductive context on which national policy practices can build on.

- There is a need for coherence in policy rhetoric between expectations of students’ learning and expectations of teachers’ training, which seems to be lacking at the moment. The proposed compatibility between policy envisions regarding the teaching of mathematics and sciences as evident in policy documents and policy orientations regarding teacher training, will be a step towards bridging the gap between what is envisioned in theory and has is implemented in practice.

...pertaining to Inquiry based learning:

- Inquiry based learning seems to be prioritized more in primary and general secondary than in vocational education. Policy makers should consider the potential of the methodology in vocational contexts, and make more effort in promoting inquiry based learning in vocational contexts.

- In countries with a tradition on implementing activities relating to inquiry based learning, policy orientations seem to move towards more content-based curriculum objectives and emphasis on content knowledge; discussions among policy makers in different countries would benefit the re-consideration and the negotiation of major strategic aims in education in each country for further improvement.

- School cultures are resistant to change. Careful and in-depth analysis of different parameters pertaining to school culture will benefit the successful accomplishment of policy envisions in relation to inquiry based methodology to school practice.

- There is a need to value the learning of inquiry process in schools by identifying and including the assessment of these processes in national assessments.

- There is a need to support the development of educational materials and teaching methods to help teachers in enriching their repertoire towards inquiry based learning.
There seem to be a reluctance to implement inquiry classroom activities not only from the part of teachers but also from parents. For the successful implementation of inquiry based learning teacher professional development should be accompanied with the actual engagement of parents.

...pertaining to connecting schooling and the world of work:

- The connections between schooling and the world of work seems to be prioritized at a level of a general rhetoric in some counties without concrete action plans, especially in primary and general secondary education. Policy makers should further consider the potential of such a connection, in the view of enhancing employability.

- The rethinking and redefining of the concept of the “world of work” is the basis for an appropriate preparation of pupils for the career entry.

- Strengthening the connections and cooperation between general and vocational education would enable the exchange of good practices and expertise.

- There is a need to value the connections between schooling and world of work by identifying and including it in the national curriculum.

- There is a need to support the development of educational materials and teaching methods to help teachers in enriching their repertoire towards making connections between schooling and the world of work.

- Vocational schools should be supported in integrating further work in their school activities (for example visits to workplaces, development of teaching materials, practicum, and visits of experts to schools).

...pertaining to teacher training:

- Well educated teachers are the foundation of any system of formal science, mathematics and technology education. Systems to ensure the professional development of teachers should be a national policy priority, and a coherent national policy orientation of training initiatives should be evident and prioritized.
Transforming teacher practice should be a long-term project, requiring significant and sustained investment in continuous professional development. Short-term cycles of training initiatives have proven to be unsustainable and of little effect in transforming classroom practice.

...pertaining to strategic educational priorities

- Concrete guidelines or measures on how equity, low-achievement and entrepreneurship issues are to be addressed in science and mathematics education are needed. Important to this respect is the consideration on how specific teaching methodologies (such as inquiry based learning) may be a lever towards the accomplishment of such aims.

- There is a need to support teachers through effective pre-service and in-service teacher training and appropriate materials so as to transform classrooms in a way that equity, low-achievement and entrepreneurship issues are matters of day-to-day practice.

In the next phase, all consortium partners will engage in dialogue with policy makers in their countries, investigating in more detail and depth their own policy context and work with stakeholders to consider how the strategic aims of policy priorities can not only be achieved but also negotiated for further educational improvement. Within the frame of the mascil project, this report attempts to provide a guide and useful briefing material towards this end.
1. Main Report

1.1. Introduction

In recent years, the European policy agenda has prioritised the improvement of quality and efficiency of educational and training systems, under the scope of enhancing employability, of promoting active citizenship and of enhancing innovation (Education and Training 2020). Among other challenges to be addressed for the achievement of these strategic priorities is the promotion of equity, the enhancement of students’ achievement and the promotion of entrepreneurship (EC Communication, 2012).

With a view to addressing these challenges, educational policy discourse has focused on the promotion of inquiry-based teaching approaches – especially within science, mathematics and technology education – as a means towards ensuring learners’ acquisition of key and transversal competences, as well as towards engaging more learners in science careers (see for example Rocard, 2007; Lord P. et al., 2005). Also evident in the policy discourse has been the concern for opening schools to the world of work, by the promotion of context-based teaching approaches, which are more likely to help students develop essential capacities for real world settings (see for example Hoyles at al., 2010). Additionally, ensuring high quality teaching through effective initial teacher education and continuous professional development for science and mathematics teachers constitutes a prominent area in the policy agenda, as a key requirement for mediating policy envisions to educational practice (see for example Education and Training 2020).

The work reported in this study is concerned with the above-mentioned strategic priorities in education and links closely to the main areas of current educational policy discourse, by providing a comparative overview of the policies and strategies in place in the area of science, mathematics and technology education. The scope of the comparative overview is twofold: on the one hand, it attempts to develop a thorough understanding of current policy intensions and actual practice in science, mathematics and technology education; on the other hand it aims to inform the development of future policy in national and European settings, by identifying factors that impede upon effective policy implementation.

The comparative overview covers 13 European countries, namely: Germany, Greece, Netherlands, United Kingdom, Spain, Cyprus, Norway, Romania, Czech Republic, Turkey, Lithuania, Austria and Bulgaria. The study takes the reference year 2013, while changes and reforms planned for the coming years have also been taken into account.
In line with areas of focus that seem to be prioritized in current educational policy discourse, the comparative overview of the policies and strategies provided in this study is primary focused on a set of 5 concerns/themes on major policy areas within science, mathematics and technology education: 1. Recent and foreseen changes and reforms, 2. Schooling and the world of work, 3. Science and mathematics curricula and inquiry based learning, 4. Pre-service teacher training in relation to inquiry-based learning and the work of work, 5. In-service teacher training in relation to inquiry-based learning and the work of work.

Each of the themes is addressed in three levels of systematic analysis: a) the macro-level regarding wider policy envisions, b) the meso-level – relating to the way schools mediate the implementation of policies and c) the micro-level – regarding actual classroom implementations, in an effort to uncover probable contradictions of implementation in relation to intensions. The themes are also investigated in a synthetic way, focusing on the links and interrelations among them under the scope of addressing remaining challenges for the achievement of strategic educational priorities, i.e. the promotion of equity, the enhancement of students' achievement and the promotion of entrepreneurship.

The report stems from work developed in the frame of the mascil (mathematics and science for life) project’s second work package (WP2), entitled ‘Educational systems and policy contexts’. One of the mail goals of this workpackage is to initiate a dialogue process with policy makers at national and European level, aiming to make out and remove obstacles and tare possibilities of cooperation and synergies between circles or research, policy and practice. To address this objective, previous work within this workpackage reported in September 2013 (see D2.1 National working papers on analysis of policy contexts) provided a detailed account of policy contexts in the abovementioned 13 European countries, under the scope of investigating the contextual and regulatory conditions under which teachers are called to implement (or not) inquiry based and context based approaches to their teaching.

The current study builds on previous work conducted within WP2 of the mascil project, by synthesizing the information provided in the national working papers, identifying differences and commonalities among the participant countries and by providing recommendations to inform the development of future policy in national and European settings. In the next phase, all consortium partners will engage in dialogue with policy makers in their countries, investigating in more detail and depth their own policy context and work with stakeholders to consider how the strategic aims of policy priorities can not only be achieved but also negotiated for further educational improvement. Within the
frame of the mascil project, this report attempts to provide a guide and useful briefing material towards this end.
1.2. Methodology

1.2.1. Theoretical Methodological orientation

This study has been conducted under the influence of the Engaged Theory, which is situated among the broad tradition of critical theory. Engaged Theory is a methodological framework for understanding social complexity, which moves from detailed empirical analysis about things, people and processes of the world, to abstract theory about the constitution and social framing of those things, people and processes. Engaged theory is reflexive in a number of ways. Firstly, it recognises that even something as basic as collecting data already entails making theoretical presuppositions. Secondly, it names the levels of analysis from which theoretical claims are made. Thirdly, it makes a clear distinction between theory and method, suggesting that a social theory is an argument about a social phenomenon, while an analytical method or set of methods is defined a means of substantiating that theory. Engaged theory in these terms works as a ‘Grand method’, as it provides an integrated set of methodological tools for developing different theories of things and processes in the world (Cooper, 2002). Engaged theory works across four levels of theoretical abstraction, which move from the most concrete form of analysis - empirical generalization - to more abstract levels of analysis. These levels of analysis are presented and described in Figure 1.

Engaged theory has informed this study in two levels: in a first level the theory guided the structure of the analytical framework developed for the investigation of the national educational contexts, given that its contents were organized under the presupposition that the themes/areas of focus selected are the most relevant in relation to the aims that the framework seek to achieve. In a second level, the theory has informed the method of analysis that was conducted for the data gathered with the aid of the framework (moving from Conjunctural to Categorical analysis). Both the analytical framework developed and the method of analysis will be presented in the lines below.
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Figure 1: The four levels of theoretical abstraction within the Engaged Theory

<table>
<thead>
<tr>
<th>Levels of theoretical abstraction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st level Empirical analysis</td>
<td>It entails drawing out and generalizing from on-the-ground detailed descriptions of history and place. This first level either involves generating empirical description based on observation, experience, recording or experiment—in other words, abstracting evidence from that which exists or occurs in the world—or it involves drawing upon the empirical research of others.</td>
</tr>
<tr>
<td>2nd level Conjunctural analysis</td>
<td>This second level of analysis, involves identifying and more importantly examining the intersection (the conjunctures) of various patterns of action (practice and meaning).</td>
</tr>
<tr>
<td>3rd level Integrational analysis</td>
<td>It examines the intersecting modes of social integration and differentiation. These different modes of integration are expressed in terms of different ways of relating to and distinguishing oneself from others—from the face-to-face to the disembodied.</td>
</tr>
<tr>
<td>4th level Categorical analysis</td>
<td>This level of enquiry is based upon an exploration of the ontological categories. If the previous level of analysis emphasizes the different modes through which people live their commonalities with or differences from others, those same themes are examined through more abstract analytical lenses of different grounding forms of life. At this level, generalizations can be made about the dominant modes of categorization in a social formation or in its fields of practice and discourse. It is only at this level that it makes sense to generalize across modes of being and to talk of ontological formations.</td>
</tr>
</tbody>
</table>

1.2.2. Analytical framework

The main aim of this study is to provide a comparative overview of the policies and strategies in place in the area of science, mathematics and technology education, under the scope of developing an understanding of current policy intensions and actual practices and of informing the development of future policy in national and European settings.

For the accomplishment of this aim an analytical framework was developed, focusing primary on a set of 5 concerns/themes on major policy areas within science, mathematics and technology education. The five concerns/themes on major policy areas addressed in the analytical framework are the following:

1. Recent and foreseen changes and reforms
Rationale: Several countries are currently or recently been engaged in reforms, especially focused on science and mathematic education. We seek to gain an understanding of the changing educational scenery as an overview of policies and practices in place in the 13 European countries that the study covers. In the frame of the mascil project, the exploration of the theme provides the contextual basis on which the project is implemented.

2. Schooling and the world of work
Rationale: The concern for opening schools to the world of work by the promotion of context-based teaching approaches is a key issue in educational policy agenda. In the frame of the project, the theme relates to one of mascil’s main objectives, namely the connection of schools with the world of work, making science and maths more meaningful to students ad motivating their interest in science careers. The focus is on general education and its connections to the world of work, as well as on vocational education.

3. Science and mathematics curricula and inquiry based learning
Rationale: The promotion of inquiry based science and mathematics teaching in primary and secondary schools - with a main emphasis on connecting inquiry approaches in schools and the world of work - is prioritized in European policy agenda. In relation to mascil, the theme links to the main aim of the project, namely to promote a widespread use of inquiry based methods in rich vocational contexts. Curricula are to be reviewed in the scope of the extent to which they prioritise science and mathematics education, as well as inquiry based approaches.

4. Pre-service teacher training in relation to inquiry-based learning and the work of work
Rationale: The theme links closely both to the policy priority of ensuring high quality teaching and to the mascil aim of providing effective and efficient pre-service teacher training courses. A descriptive account of the kind of pre-service teacher training across the 13 countries is foreseen, with the target groups being primary teachers, secondary science and mathematics teachers for both general and vocational schools. Emphasis is to be given on the relations between the kinds of professional development, inquiry based teaching methods and the world of work.

5. In-service teacher training in relation to inquiry-based learning and the work of work
Rationale: The focus is turned on the in-service teacher training, under a similar rationale to the previous theme. A descriptive account of the kind of in-service teacher training (PD) across the 13 countries is foreseen, with the target groups being in-service primary teachers, secondary science and mathematics teachers for both general and vocational schools. Specific attention is to be given to teachers in the induction stage (first years as a teacher), given that the issue of supporting teachers in this transitory phase has gained
increasing attention by policy makers recently. Emphasis is to be given on the relations between the kinds of professional development, inquiry based teaching methods and the world of work.

Each of the themes is addressed under three levels of systematic analysis:

a) the macro-level regarding wider policy envisions;
b) the meso-level – relating to the way schools mediate the implementation of policies and
c) the micro-level – regarding actual implementation in the classrooms,
The multilevel systematic analysis has been taken into consideration, in an effort to uncover probable contradictions of implementation in relation to intentions.

The themes under investigation were also aimed to be viewed in a synthetic way, focusing on the links and interrelations among them under the scope of addressing remaining challenges for the achievement of strategic educational priorities, i.e. the promotion of equity, the enhancement of students’ achievement and the promotion of entrepreneurship. As such, the second part of the analytical framework provided a set of three areas for reflection, them being:

Equity specific issues
Rationale: The promotion of equity has been one the main priority areas in European policy discourse. Yet, the percentage of women in science, mathematics and engineering higher education is still lower than for men, with the gap increasing when the focus is turned to the field of scientific careers. Despite these, PISA results indicate that in some countries girls outperform boys in terms of science and mathematics achievement. Teacher training is vital to overcome the gender gap in our society, but is in some cases inadequate in this respect. We seek to gain an understanding in terms of whether and how the issue is addressed in each European country in relation to inquiry based learning and professional development.

Addressing low achievement
Rationale: Low achievement in mathematics and science is a common concern for all European countries. It is an issue associated not only with the effectiveness of teaching and learning, but also with providing an equitable system of education. A range of approaches have been developed to support under-performing students and to attempt to close the persistent gap between the highest- and lowest-achieving students. Partners are asked to provide information/comments with a view to inform policy makers in their country for tackling low achievement in science and mathematics in relation to inquiry based learning and professional development.
Promoting entrepreneurship

Rationale: Entrepreneurship key competence refers to an individual’s ability to turn ideas into action. It includes creativity, innovation and risk taking, as well the ability to plan and manage projects in order to achieve objectives. The overall goal of promoting entrepreneurship in education is to give students the attitudes, knowledge and skills to act in an entrepreneurial way, for either a commercial or non-commercial objective.

Many member states have strategies addressing the implementation of entrepreneurship education into general education at primary and secondary level. Yet only in a quarter of the member states did the majority of adults believe that they have the right skills and knowledge to start a business. Partners are asked to provide information/comments with a view to inform policy makers in their country for promoting entrepreneurship in relation to inquiry based learning and professional development.

The main elements of the analytical framework described above are summarized in Figure 2. In short, as illustrated in the figure, the framework for analysing the educational systems and the policy context within the mascil project: a) covers 13 national policy contexts within Europe; b) examines five major policy areas that are relevant to prominent concerns of current educational discourse and closely link to priority areas in the frame of the project; c) considers three levels of systematic analysis and d) is embedded to three major strategic aims/priorities for education.

The full framework is described in more detail in the first report of work package 2 within the mascil project (mascil Deliverable D2.1).
Figure 2: The main elements of the analytical framework for investigating educational systems and policy contexts within the mascil project.

13 national policy contexts

Major policy areas examined

- Recent and foreseen changes and reforms
- Schooling and the world of work
- Science and mathematics curricula and inquiry based learning
- Pre-service teacher training in relation to inquiry-based learning and the work of work
- In-service teacher training in relation to inquiry-based learning and the work of work

Levels of systematic analysis

- Macro-level (Policy)
- Meso-level (Schools)
- Micro-level (Classrooms)

Strategic aims/priorities for education

- Promotion of equity
- Enhancement of students’ achievement
- Promotion of entrepreneurship

The project mascil has received funding from the European Union Seventh Framework Programme (FP7/2013-2017) under grant agreement n° 320693.
1.2.3. Method of analysis

A questionnaire based on the framework described in the previous section (see APPENDIX I) was completed by each of the 13 mascil country groups, with respect to their own country. The outcome of this process was 13 national working papers of the policy contexts reported in mascil Deliverable D2.1. A preliminary analysis of the 13 documents was then conducted under the guidance of the analytical framework aiming at pointing out the conditions and constrains on the various dimensions of the national educational system that can foster or hinder the realization of the mascil project. The above resulted to a preliminary set of recommendations to the consortium for a successful implementation of the mascil project in the contexts of the 13 countries. The processes and the outcomes of this work are provided in detail in the first report of work package 2 within the mascil project (mascil Deliverable D2.1).

The current study builds on this previous work conducted within WP2 of the mascil project, by synthesizing the information provided in the national working papers, identifying differences and commonalities among the participant countries. The method of analysis has been informed by the engaged theory - roughly presented previously in this chapter - and entailed the movement from Conjunctural to Categorical analysis. The scope of this analysis is to provide a mapping and a comparative overview of current policy intensions and actual practice in science, mathematics and technology education, under the aim of informing the development of future policy in national and European settings.

For achieving this aim the following processes were followed:

At first, the preliminary analysis (summary) of the 13 national working papers reported in D2.1 was revised and verified by each national group in respect to their country, with the close cooperation of each country national advisory board (NAB). This was conducted under the rationale that the outcomes of the work should undergo an iterative cycle of improvement and triangulation by different stakeholders. The revised summaries of the national contexts are documented in the APPENDIX II of this report, aiming to provide the policy makers with an overview of current policy orientation and actual practice in science, mathematics and technology education in their country.

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1 Within the mascil project, in every country a national advisory board has been set up. This board comprises at least 4 or more persons from the following groups: representatives from industry, vocational schools, school authorities, politicians, teacher’s associations, parents associations, stakeholders from other groups interested in school education. The national advisory group acts as an advisory group bringing a fresh view and a wider perspective to the work of the project.
Following the revision of the summaries, the 13 national contexts were analysed in terms of three levels of systematic analysis: the micro-level relating to policy orientation; the meso-level in relation to schools and institutes; the micro-level regarding the current situation in classrooms. For each level, the five policy areas were taken into consideration and examined (recent and foreseen changes and reforms, schooling and the world of work, curricula and inquiry based learning, pre-service and in-service teacher training in relation to inquiry based learning and the world of work).

This work resulted in the provision of a mapping and a comparative overview of the policies and strategies in place in the area of science, mathematics and technology education within 13 national contexts across Europe and is reported in Chapter 1.3. In this chapter provided are results on the above mentioned thematic areas - namely recent and foreseen changes and reforms; schooling and the world of work; science and mathematics curricula and inquiry based learning; pre-service and in-service teacher training in relation to inquiry-based learning and the work of work- in terms of:

a) the priorities that national policy give in relation to European policy priorities;

b) how systems and structures mediate and manage the implementation of the national and European policy envisions and

c) what is the actual practice in relation to European and national priorities.

In addition, a cross national synthetic analysis under the scope of the strategic aims/priorities for education was conducted and reported.

The results presented in Chapter 1.3 are viewed and analysed from multidimensional perspectives:

a) With an analysis taking a horizontal form in terms of the three levels of systematic analysis, prominent issues for consideration arise - relating to policy priorities, managing/mediating mechanisms and actual implementation (see Figure 3);
The project mascil has received funding from the European Union Seventh Framework Programme (FP7/2013-2017) under grant agreement n° 320693.

Figure 3: Schematic illustration of the horizontal form of cross-national analysis, in terms of the tree levels of systematic analysis.

Levels of systematic analysis

- Cross-national analysis for the 13 contexts conducted
- Micro-level (Classrooms)
- Meso-level (Schools)
- Macro-level (Policy)

Major policy areas examined in each level

- Recent and foreseen changes
- Schooling and the world of work
- Science and mathematics curricula and inquiry based
- Pre-service teacher training in relation to inquiry-based learning and the work of work
- In-service teacher training in relation to inquiry-based learning and the work of work

Outcome 1: Prominent issues for consideration in terms of policy priorities, mediating mechanisms and actual implementation

Outcome 2: Recommendations to policy makers in terms of policy priorities, mediating mechanisms and actual implementation
b) By taking a vertical direction in the *analysis in terms of areas of focus*, conclusions are reached for each of the major areas examined in this study – namely recent and foreseen changes and reforms; schooling and the world of work; science and mathematics curricula and inquiry based learning; pre-service and in-service teacher training in relation to inquiry-based learning and the work of work (see Figure 4).

**Figure 4: Schematic illustration of the vertical form of cross-national analysis, in terms of the major policy areas examined.**
c) Finally, the **synthetic analysis under the scope of the strategic aims/priorities for education** leads to the identification of issues pertaining to the remaining challenges for the promotion of equity, the enhancement of students' achievement and the promotion of entrepreneurship (see Figure 5).

**Figure 5: Schematic illustration of the synthetic analysis under the scope of the strategic aims/priorities for education**

Cross national analysis of the 13 contexts was conducted in terms of:

- Promotion of equity
- Enhancement of students' achievement
- Promotion of entrepreneurship

Strategic educational objectives

Major policy areas examined:

- Recent and foreseen changes and reforms
- Schooling and the world of work
- Science and mathematics curricula and inquiry-based learning
- Pre-service teacher training in relation to inquiry-based learning and the work of work
- In-service teacher training in relation to inquiry-based learning and the work of work

Outcome 1: Prominent issues for consideration in terms of strategic educational objectives

Outcome 2: Recommendations to policy makers in terms of strategic educational objectives

The project mascil has received funding from the European Union
In respect to each dimension of analysis, a first set of conclusions reached is provided in Chapter 2, leading to a set of recommendations for the development of future policy in national and European settings.
1.3. Results: Comparative overview of educational and policy contexts

1.3.1. Cross-national mapping of context at policy level

Recent and foreseen changes: Across the 13 national contexts that are covered in this study, the vast majority of the countries are under current or foreseen for the near future educational reforms, relating to educational objectives, structures and governance, curriculum and qualifications. A common element among the various orientations of these reforms is that the disciplines of science, mathematics and technology seem to gain renewed interest and are identified as having high importance within education. In the United Kingdom, for example - where there is much policy change across all areas at the same time –policy envisions in education explicitly advocate a prioritisation of mathematic and science from the point of view ensuring well-qualified future workforce. There are cases, though, like in Cyprus where there are no explicit references in current reforms with regard to making mathematics and science education a priority. However, in this country there is a trend among students to follow studies in Sciences, Medicine and Engineering and as such there has not been a need to further promote mathematics and science. In short, the degree in which science, mathematics and technology disciplines are prioritized in the majority of the national contexts seems to be in line with the European strategic objective of promoting excellence in science as evident in Education and Training, 2020 and Horizon 2020 policy statements.

Schooling and the world of work: In terms of overall policy orientations, there is evidence of wide variation among the countries in relation both to the degree to which they prioritise connections between schooling and the work of work and the way that such a priority is evident in policy practice. There seem to be three trends among the counties: In some cases, the importance of such a connection is identified in the general aims of the curricula and in the same time specific measures to support such an aim are envisioned by policy. In Germany, for example, education ministries have sought to initiate and expand cooperation within private forms and other actors of civic society in order to promote the world of the work within schools. Similarly in Netherlands, there is a plan to improve connections between education the world of work and regional collaboration between schools and companies, called Techniekpact. In other countries, although the aim to connect schools with the world of work is evident in the policy documents, it seems to lie on a theoretical level, without being accompanied with specific lines of actions for the realization of such an aim. In Bulgaria, for example, recent changes in the curricula foresee connections between schools and the world of work – indirect in general schools and more direct in vocational ones – yet, the way that this connection is to be enhanced is currently under discourse. It is important to note that out of the 13
national contexts analysed, in five countries it has been explicitly stressed that such connections are not a priority in general schools both at primary and secondary general education level. In Greece and Cyprus for example, vocational education receives less prioritization by policy and usually attracts low-ability students. In a more positive note, though, in some of these countries the focus on the world of work is evident in vocational education.

Science and mathematics curricula and inquiry based learning: In contrast to the variations that are evident among the national contexts in relation to the degree to which connections with schools and the world of work are promoted by national policies, the vast majority of the countries report that inquiry based teaching and learning is generally prioritized in mathematics and sciences policy agenda. Indeed, elements of inquiry approaches are evident in most of the national curricula – which are mainly reported in the national working papers as competence-oriented – both for primary and general secondary education. In Turkey, for example, these elements are mainly referred as ‘science process skills’ in the discipline of science and ‘problem solving skills’ for mathematics. In Czech Republic, on the other hand, inquiry based learning is evident in the policy documents as a general reference, without concrete explanations and expected outcomes to the students. Yet, inquiry based approaches do not seem to receive equal priority across primary, secondary and vocational education: in most of the countries while it is explicitly or implicitly evident at a primary and secondary level, there are no such references for vocational education. Maybe this is due to the fact that in vocational education diversities and differences are evident even in the grounds of each country; therefore, it is difficult to make general statement on the issue (for example in the case of Germany). Nevertheless, if attention is turned to the countries for which inquiry based learning is not a policy priority an interesting outcome appears: for countries that seem to have a tradition on implementing activities relating to inquiry based learning (for example United Kingdom and Netherlands), policy orientations seem to move towards more content-based curriculum objectives and emphasis on content knowledge. Feedback from policy makers during workshops that are planned to be conducted within the mascil project mascil will provide elaborations on the reasons for such an orientation.

Pre-service teacher training in relation to inquiry based learning and the world of work: As it might have been expected across nations there is a wide variation in relation to the systems responsible for providing pre-service teacher training and the orientation of science and mathematics training initiatives. In some cases University Departments on the subjects of science and mathematics are the responsible bodies for pre-service teacher training, in other cases the responsibility lies on Pedagogical Departments and
Colleges (mainly for primary education), while informal initiatives by bodies aiming to support mathematics and science teaching and learning also offer teacher training courses project driven. In most countries the systems responsible for providing teachers training are the ones that define goals and expectations; pre-service teacher training does not seem to be an area of focus at policy agenda. Indeed, policy rhetoric mainly focuses on expectations of students’ learning, whereas expectations of teachers’ training are not mentioned. Exceptions to this are evident; for example in Norway where a recent reform aimed at enhancing the quality and relevance of initial teacher education in terms of solid subject knowledge, teaching skills and teachers’ practice. Even in cases though where teacher training is evident in policy discourse and declarations, objectives regarding the support of inquiry based learning and connections between schooling and the world of work are not prioritized as a goal in teacher training programmes. The opportunity for mascil to built bridges between wider policy orientations for students’ learning and policy envisions for pre-service teachers’ training becomes apparent.

In-service teacher training in relation to inquiry based learning and the world of work: The following quotation from the national report of Germany summarizes the state of affairs in terms of in-service teacher training in most countries: “…the issue of teachers’ training does not appear in any policy documents…except for teachers’ training on the induction phase, there are no policy recommendations both in general and vocational education…policy priorities concerning the induction stage the training of vocational teachers are rather sparse…” In a similar vein, in Cyprus there are no agreed standards for professional development training programmes, while in Norway traditionally teaching and learning strategies are on the personal responsibility of the teachers and the provision of curriculum is the responsibility of the government. At the other edge of the spectrum, in a few cases like in Spain priorities in teachers’ professional development are mainly structured in the domains of competence oriented teaching, in which elements of inquiry based learning are found. In short it is notable that policy envisions regarding the teaching of mathematics and sciences as evident in policy documents are not always in accordance with policy orientations regarding teacher training. Indeed, in many countries objectives regarding the support of inquiry based learning and connections between schooling and the world of work may be evident in national policy documents, yet they are not prioritized as a goal in teacher training programmes.

1.3.2. Cross-National mapping of context at school and teacher level
Recent and foreseen changes: For the vast majority of the national contexts that have been explored in this study, the current educational reforms relate mostly to educational objectives and curriculum and to a lesser degree to the areas of schools structures and teachers’ qualifications. It is notable that although science and mathematics seem to gain renewed interest in policy agenda, this has not yet been reflected at a school level, for example by the provision of extra didactic periods in the curriculum. Nevertheless, in some countries there is evidence of implemented changes in the level of teachers’ training and qualifications. In Romania for example, there has been an attempt to reorganize the teacher training system, with master programmes in didactics of maths and science taking a major role in initial teacher training. In Norway on the other hand an educational reform is currently implemented, involving among other areas teacher training, with a view to better qualify teachers to teach particular subjects. Despite these cases, educational reforms across the countries currently remain at the level of policy rhetoric and have not yet been introduced across the meso-level relating to schools and teachers, so as to provide evidence on how schools and educators mediate and manage the implementation of policy envisions.

Schooling and the world of work: As it might have been expected, in most countries connections between schools and industries or providers of informal education (museums, science centres, bodies aiming to promote science and technology) are more evident in vocational education. The Netherlands for example report a strong collaboration between industry and vocational education, while in Norway the vocational education training system builds upon a close cooperation between schools and industries. In Lithuania, on the other hand, while such a connection is not evident, vocational education practical training tries to stimulate real working conditions. For general education, relations between schools and providers of informal education are evident, but not between schools and industries; in most cases these take the form of extra-curriculum activities (for example in Spain, Bulgaria and Cyprus). It is important to note that the vast majorities of the countries reported lack of cooperation between general and vocational education; connections where evident were reported in terms of similar curriculum for mathematics and sciences. Cyprus could be considered as an exception, as there are policy discussions at the moment to merge the two school lines – vocational and general secondary.

Science and mathematics curricula and inquiry based learning: “…changes in the curricula have caused some change in practice at a school level, but it seems to be at a surface level…” (Turkey). School cultures in all countries seem to be resistant to change. In some schools across the countries, initiatives to implement inquiry based learning mainly project-driven are evident; however, the goal to mainstream inquiry methods at a school level is far from being accomplished, mainly because of firmly rooted
existing didactical contract. Important in this respect are the management of initial teacher education and the policy consideration of how best to stimulate and facilitate a constantly evolving system of educational development, like a school system.

**Pre-service teacher training in relation to inquiry based learning and the world of work:** As stated in a previous section, there is **a wide variation in relation to the systems responsible for providing pre-service teacher training:** In some cases University Departments on the subjects of science and mathematics are the responsible bodies for pre-service teacher training, in other cases the responsibility lies on Pedagogical Departments and Colleges (mainly for primary education), while informal initiatives by bodies aiming to support mathematics and science teaching and learning also offer teacher training courses project driven. In most cases though, initial teacher education is mainly centred on academic input from university educators; as such **most of the programs reflect the research evidence base, including inquiry based learning. Context – base teaching though is rare.** Nevertheless, an important finding from the analysis is that some partners make references on the quality of new careers entrants’ qualifications in mathematics and science, especially in primary education. At this level new career entrants may have insecure subject knowledge although they have a sound pedagogical background. This might be an indication that **policy discourse in the future might be oriented towards securing teachers subject knowledge and to a lesser degree on the acquisition of pedagogical competences.**

**In-service teacher training in relation to inquiry based learning and the world of work:** In contrast to initial teacher education which is mainly based on academic input from universities and colleges, there is less in-service teacher training in most countries that is designed to reflect the research evidence base. Given the **lack of strategically targeted in-service professional development and the wide variation in relation to the systems responsible for providing pre-service teacher training,** it is hard to come to generalized conclusions on whether inquiry based learning and connections to the world of work are evident in according programs.

**1.3.3. Cross-National mapping of context at a classroom level**

**Recent and foreseen changes:** There is compelling evidence that the **current educational reforms** -reported in most of the countries in relation to educational objectives and curriculum - **have not yet an impact on classroom practices.** In terms of the teaching methods, partners of the mascil consortium provided data of the Teaching and Learning International Survey (TALIS) conducted by the OECD showing that
Structuring teaching practices are more often used than student oriented activities; therefore a gap between pedagogies promoted by policy and actual pedagogies used in the classrooms is apparent. In a similar vein, in terms of assessment, only two countries (Austria and Turkey) out of 13 reported a current or foreseen change in the assessment methods that encompass inquiry based methodologies or context based teaching. Actually, the problem with assessment has also been identified in previous studies (see for example D7.1 of the PRIMAS project reported in 2011); it is unfortunate to note that findings in this study do not advocate an improvement of the situation, despite the time that have passed. There is no question that introducing assessment that is supportive of inquiry and context based approaches might be difficult; however, the influence of assessment on day-to-day teaching is significant and as such the need to provide models of assessment that encompass envisioned teaching methodologies is of major importance.

Schooling and the world of work: For the vast majority of the national contexts that have been explored in this study there is evidence of a lack of appropriate teaching resources in science and mathematics subjects relating to the world of work. Norway and Bulgaria are an exception to this overall finding: In Norway a newly established project (FYR) provides resources for teachers on the theme; however the kind of materials provided to not seem to facilitate teachers in day-to-day classroom practice. In Bulgaria on the other hand, there are curriculum support materials for connecting schooling with the world of work, but room for significant improvement is existence. In terms of assessment practices, they are rarely related to the work of work in most national contexts. In the view of the significance of appropriate teaching materials and assessment tools to day-to-day teaching, the work within the mascil project aims to provide high quality support on the area.

Science and mathematics curricula and inquiry based learning: The following quotations from the national reports summarize the state of affairs in the area in most countries: “Despite recent initiatives a change towards IBL is hardly implemented in most schools mainly because of the lack of sufficient educational materials and curriculum overload.” (Netherlands); “Although IBL is prioritised by policy day-to-day practice shows that the intended curriculum is not implemented as such, because there is usually too much content to be covered in a small number of teaching periods”. (Cyprus); “Changes are declared in teaching methods towards IBL but the real educational conditions are changing slowly”. (Czech Republic); “In Primary education, newly recruited teachers are more flexible in adopting more active teaching methods in line with the new curriculum. But secondary and vocational teaching is characterized by more passive teaching methods” (Greece). Major constrains for the actual implementation of inquiry approaches in the classrooms found in the national reports are: the lack of appropriate
teaching materials, textbooks that are not in line with inquiry methodology, the incompatibility between envision outcomes and students’ assessment; lack of appropriate teacher training. The way that inquiry teaching and learning is (or is not) implemented at a classroom level is a prominent area for consideration in policy making, in the scope of attempting to eliminate the factors that hinder the widespread uptake of inquiry base teaching in the actual classroom practice.

Pre-service teacher training in relation to inquiry based learning and the world of work: One of the parts of the questionnaire completed by each partner of the mascil consortium related to a set of questions aims to uncover teachers’ beliefs, attitudes motivation, and interests in the areas of inquiry based methods and the world of work - through teacher interviews. The analysis of the teachers responses provided evidence-based information that was incorporated in the national reports in each country (see Deliverable 2.1 of the mascil project), so that the policy-makers that participate in the workshops gain a better insight on ‘how things are’ in the micro-level and in relations to teachers’ needs and attitudes. Evident in the teachers’ responses in these interviews is that inquiry based learning is a teaching methods become more and more popular among pre-service teachers, especially in primary education and for secondary education in the discipline of science. Another important outcome is that many pre-service teachers find connections between schooling and the world of work an issue that is important to be addressed in the curriculum, however many stated that they receive no training on the theme, and they have not come across related supported materials.

In-service teacher training in relation to inquiry based learning and the world of work: In contrast to the pre-service teachers’ responses in the interviews which uncovered a general positive attitude in relation inquiry based learning and the context-base teaching, in-service teachers mainly focused on the difficulties to implement such approaches in the classrooms. The reasons evoked vary from one country to another; however, they seem to be a mixture of the following, with different weight depending on the national context. One reason relates to the lack of corresponding materials and in some cases lack of guidelines for teachers for successful implementation. The exam- orientation of many educational systems with subject-oriented assessment objectives is also an issue. Last but not least, there seem to be a reluctance to implement classroom activities towards such aims, not only from the part of teachers but also from parents. This last remark makes evident that for successful implementation of inquiry based learning, teacher professional development should be accompanied with the actual engagement of parents, something that represent a real challenge for the policy makers.
1.3.4. Synthetic analysis under the scope of the strategic priorities in education

**Equity related issues:** The promotion of equity has been one the main priority areas in European policy discourse. Important in this regard has been the consideration of gender specific issues in science and maths education. For the vast majority of the national contexts that have been explored in this study *gender related issues have been prioritized in policy making and official rhetoric; yet in most cases these remain at a general level, without concrete guidelines or measures* on how this is to be achieved in science and mathematics education. In Germany for example, although the issue of equity is in the policy agenda, no actual changes can be detected at school level, and classroom activities. Similarly in Turkey, policy documents state that gender inequalities should be tackled but it is not explicitly specified how. Teacher training is considered as vital to overcome the gender gap in our societies. There is quite a great degree of variation though among the countries that have been studied in terms to whether and how the issue is addressed in professional development. Many countries report that there are no gender specific issues in teacher training activities (for example Greece and Turkey). In other countries with regard to professional development and gender issues there is an emphasis on how teachers can effectively deal with gender stereotypes, as to make the best possible learning environment for both genders (for example in Cyprus, United Kingdom, Lithuania). It is notable, though, that in most cases *training in inquiry based approaches does not take into consideration gender differences in terms of interests, learning styles, motivation*, despite evidence that inquiry based learning contributes to reducing gender stereotypes (see for example Rocard, 2007).

**Achievement related issues:** Low achievement in mathematics and science is a *common concern* for all European countries. It is an issue associated not only with the effectiveness of teaching and learning, but also with providing an equitable system of education. The prioritization of tackling low achievement in the policy discourse is also evident in this study in the vast majority of the national contexts. In the Netherlands for example recently a new protocol for tackling low achievement has been developed on behalf of the Dutch ministry of education for primary, secondary and vocational education. In Norway addressing low achievement is one of the main policy priorities currently, in particular at lower and upper secondary level. However, two reports presented at the European Commission in 2011 revealed that – for the countries covered in this report - in mathematics only United Kingdom, the Netherlands and Norway have set national standards to boost achievement levels in mathematics, although the majority of EU member states provide general guidelines to address pupils’
difficulties on the area. In science education, no member state has specific national support policies, although Spain, Bulgaria and Germany have launched programmes to tackle low achievement in general. **Support for teachers to implement the policy envisions is still lacking in the vast majority of the countries.**

**Entrepreneurship related issues:** Entrepreneurship key competence refers to an individual’s ability to turn ideas into action. It includes creativity, innovation and risk taking, as well the ability to plan and manage projects in order to achieve objectives. The overall goal of promoting entrepreneurship in education is to give students the attitudes, knowledge and skills to act in an entrepreneurial way, for either a commercial or non-commercial objective. **Many member states have strategies addressing the implementation of entrepreneurship education into general education at primary and secondary level.** In Germany for example, entrepreneurship education has been prioritized in policy making in Germany. Current initiatives and reform relate directly or indirectly to entrepreneurship education in general education at primary and secondary level; however, as it refers to the national curriculum developments seem to be slower. In Turkey, entrepreneurship education seems to have a tradition, as it has been introduced since 2009. The Scientific and Technological Research Council of Turkey (TUBITAK) has recently funded projects that target teacher education on the area. In most of the cases, though, **support for teachers to implement entrepreneurship activities is still lacking.**
2. (Summary) Conclusions and Recommendations

In an attempt to develop a thorough understanding of current policy intentions and actual practice, the previous chapter provided a mapping and a comparative overview of the policies and strategies in place in the area of science, mathematics and technology education within 13 national contexts across Europe. *This chapter aims to inform the development of future policy in national and European settings, by identifying factors that impede upon effective policy* implementation, as well as opportunities for further educational improvement. For the achievement of this aim, the results presented in the previous chapter are viewed and analysed here from multidimensional and comprehensive perspectives:

a) With an analysis taking a horizontal form in terms of the three levels of systematic analysis, prominent issues for consideration arise - relating to policy priorities, managing/mediating mechanisms and actual implementation.

b) By taking a vertical direction in the analysis in terms of areas of focus, conclusions are reached for each of the major areas examined in this study – namely recent and foreseen changes and reforms; schooling and the world of work; science and mathematics curricula and inquiry based learning; pre-service and in-service teacher training in relation to inquiry-based learning and the work of work.

c) Finally, a synthetic analysis under the scope of the strategic aims/priorities for education leads to the identification of issues pertaining the remaining challenges for the promotion of equity, the enhancement of students achievement and the promotion of entrepreneurship.

In respect to each dimension of analysis, a set of *conclusions* reached is presented below, leading to *recommendations* for the development of future policy in national and European settings.

2.1. Emerging issues pertaining to levels of systematic analysis

The comparative analysis of the national contexts discussed in the previous chapter provides evidence that the disciplines of science, mathematics and technology seem to gain renewed interest and are identified as having high importance within education in the national policy discourse and agenda. This interest seem to be in line with the European strategic objective of promoting excellence in science as evident in Education and Training, 2020 and Horizon 2020 policy statements. The fact that wider European policy envisions are also prioritized in the national policy agendas provide a strong advantage for the mascil project, as it can built on all these values. However, it is notable that although science and mathematics seem to gain renewed interest in policy
agenda, this has not yet been reflected at a school level, for example by the provision of extra didactic periods in the curriculum. Educational reforms across the countries currently seem to remain at the level of policy rhetoric and have not yet been introduced across the meso-level relating to schools and teachers – not to mention the micro level of actual implementation in classrooms. The need for policy making to build bridges between what is envisioned in general and how it can be implemented in practice becomes apparent. Important in this respect is the existence of coherence in policy rhetoric between expectations of students’ learning and expectations of teachers’ training, which seems to be lacking. Indeed, pre-service and in-service teacher training is not an area of focus at policy agenda, while policy envisions regarding the teaching of mathematics and sciences as evident in policy documents are not always in accordance will policy orientations regarding teacher training; such incompatibility is a major hindering factor for bridging the gap between what is envisioned in theory and has is implemented in practice.

1st set of Recommendations to policy makers:

- The priorities that are evident in the national policy agendas are in line with wider European policy strategic aims, indicating a conductive context on which national policy practices can build on.

- There is a need for coherence in policy rhetoric between expectations of students’ learning and expectations of teachers’ training, which seems to be lacking at the moment. The proposed compatibility between policy envisions regarding the teaching of mathematics and sciences as evident in policy documents and policy orientations regarding teacher training, will be a step towards bridging the gap between what is envisioned in theory and has is implemented in practice.

2.2. Emerging issues pertaining to major policy areas of focus

Inquiry based learning: Inquiry based teaching and learning is generally prioritized in mathematics and sciences policy agenda in the vast majority of the countries; yet, it seems to be prioritized more in primary and general secondary than in vocational education, despite evidence on the potential of the methodology also in vocational contexts. In addition, if attention is turned to the countries for which inquiry based learning is not a policy priority, an interesting outcome appears: for countries that seem to have a tradition on implementing activities relating to inquiry based learning, policy
orientations seem to move towards more content-based curriculum objectives and emphasis on content knowledge. Feedback from policy makers during workshops that are planned to be conducted within the mascil project mascil will provide elaborations on the reasons for such an orientation. At a school level, findings indicate that in many countries policy rhetoric and official positioning in relation to inquiry base leaning hides another type of reality: in many countries, there is strong evidence that inquiry based teaching and leaning is not incorporated in the school culture. Schools’ culture seems to be resistance to change; this is particularly challenging for the expected impact of the mascil project. At classroom level, traditional teaching focusing on the transmission of content knowledge seems to dominate everyday classroom practice in many countries of the consortium. The reasons evoked vary from one country to another; however, they seem to be a mixture of the following, with different weight depending on the national context. One reason concerns the pre-service teacher training that has been provided in the previous years, given that envisioned changes towards more inquiry based methods are rather recent. Another reason relates to the lack of corresponding materials and in some cases lack of guidelines for teachers for successful implementation. The exam-orientation of many educational systems with subject-oriented assessment objectives is also an issue. Last but not least, there seem to be a reluctance to implement classroom activities towards such aims, not only from the part of teachers but also from parents. This last remark makes evident that for successful implementation of inquiry based learning teacher professional development should be accompanied with the actual engagement of parents, something that represent a real challenge for the policy makers.

2nd set of Recommendations to policy makers:

- Inquiry based learning seems to be prioritized more in primary and general secondary than in vocational education. Policy makers should consider the potential of the methodology in vocational contexts, and make more effort in promoting inquiry based learning in vocational contexts.

- In countries with a tradition on implementing activities relating to inquiry based learning, policy orientations seem to move towards more content-based curriculum objectives and emphasis on content knowledge; discussions among policy makers in different countries would benefit the re-consideration and the negotiation of major strategic aims in education in each country for further improvement.
School cultures are resistant to change. Careful and in-depth analysis of different parameters pertaining to school culture will benefit the successful accomplishment of policy envisions in relation to inquiry based methodology to school practice.

There is a need to value the learning of inquiry process in schools by identifying and including the assessment of these processes in national assessments.

There is a need to support the development of educational materials and teaching methods to help teachers in enriching their repertoire towards inquiry based learning.

There seem to be a reluctance to implement inquiry classroom activities not only from the part of teachers but also from parents. For the successful implementation of inquiry based learning teacher professional development should be accompanied with the actual engagement of parents.

Schooling and the world of work: There is evidence of wide variation among the countries in relation both to the degree to which they prioritise connections between schooling and the work of work and the way that such a priority is evident in policy practice. It is important to note that out of the 13 national contexts analysed, in five countries it has been explicitly stressed in the national report papers that such connections is not a priority in general schools both at primary and secondary general education level. Connections between schools and industries or providers of informal education (museums, science centres, bodies aiming to promote science and technology) are more evident in vocational education. For general education, relations between schools and providers of informal education are evident, but not between schools and industries; in most cases these take the form of extra-curriculum activities. In addition, the vast majorities of the countries reported lack of cooperation between general and vocational education. At a classroom level, for the vast majority of the national contexts that have been explored there is evidence of a lack of appropriate teaching recourses in science and mathematics subjects relating to the world of work. In a similar vein, in terms of assessment practices, they are rarely related to the work of work in most national contexts. In the view of the significance of appropriate teaching materials and assessment tools to day-to-day teaching, the work within the mascil project aims to provide high quality support on the area.
3rd set of Recommendations to policy makers:

- The connections between schooling and the world of work seems to be prioritized at a level of a general rhetoric in some counties without concrete action plans, especially in primary and general secondary education. Policy makers should further consider the potential of such a connection, in the view of enhancing employability.

- The rethinking and redefining of the concept of the “world of work” is the basis for an appropriate preparation of pupils for the career entry.

- Strengthening the connections and cooperation between general and vocational education would enable the exchange of good practices and expertise.

- There is a need to value the connections between schooling and world of work by identifying and including it in the national curriculum.

- There is a need to support the development of educational materials and teaching methods to help teachers in enriching their repertoire towards making connections between schooling and the world of work.

- Vocational schools should be supported in integrating further work in their school activities (for example visits to workplaces, development of teaching materials, practicum, and visits of experts to schools).

Pre-service and in-service teacher training: There is a wide variation in relation to the systems responsible for providing pre-service teacher training and the orientation of science and mathematics training initiatives. In most countries the systems responsible for providing teachers training are the ones that define goals and expectations; as such overall national policy envisions in the area are still missing. Especially for in-service teachers, training is being conducted in short-term programs which are mainly project-driven. Both the luck of concrete policy orientations regarding teacher training and the unsustainable short-term cycles of training initiatives are considered a major hindering factor towards ensuring high quality teaching.
4th set of Recommendations to policy makers:

- Well educated teachers are the foundation of any system of formal science, mathematics and technology education. Systems to ensure the professional development of teachers should be a national policy priority, and a coherent national policy orientation of training initiatives should be evident and prioritized.

- Transforming teacher practice should be a long-term project, requiring significant and sustained investment in continuous professional development. Short-term cycles of training initiatives have proven to be unsustainable and of little effect in transforming classroom practice.

2.3. Emerging issues pertaining to strategic educational priorities

For the vast majority of the national contexts that have been explored gender related issues have been prioritized in policy making and official rhetoric; yet in most cases these remain at a general level, without concrete guidelines or measures on how this is to be achieved in science and mathematics education. Support for teachers to implement the policy envisions is still lacking. It is also notable that in most cases training in inquiry based approaches does not take into consideration gender differences in terms of interests, learning styles, motivation, despite evidence that inquiry based learning contributes to reducing gender stereotypes (see for example Rocard, 2007). In a similar vein, the prioritization of tackling low achievement in the policy discourse is evident in the vast majority of the national contexts. Yet, it is the minority of the countries have set national standards to boost achievement levels in mathematics, while in science education, no member state has specific national support policies. In relation to entrepreneurship, many member states have strategies addressing the implementation of entrepreneurship education into general education at primary and secondary level. In most of the cases, though, support for teachers to implement entrepreneurship activities is still lacking. The above indicate an incompatibility between wider policies envisions and concrete policy actions for implementation.
5th set of Recommendations to policy makers:

- Concrete guidelines or measures on how equity, low-achievement and entrepreneurship issues are to be addressed in science and mathematics education are needed. Important to this respect is the consideration on how specific teaching methodologies (such as inquiry based learning) may be a lever towards the accomplishment of such aims.

- There is a need to support teachers through effective pre-service and in-service teacher training and appropriate materials so as to transform classrooms in a way that equity, low-achievement and entrepreneurship issues are matters of day-to-day practice.

Within the mascil project, it is planned that the consortium partners will use this report and the above-mentioned recommendations, in order to explore at a national level the implications for policy developments in their own countries and what they might learn from the approaches of other nations. This is to be done in the frame of the second workpackage of the project, in which it is planned in the following phase that all consortium partners will engage in dialogue with policy makers in their countries, in order to consider how the strategic aims of policy priorities can not only be achieved but also negotiated for further educational improvement. This report has attempted to provide a guide and useful briefing material towards this end.
3. References


EC Communication, 2012. Rethinking education: investing in skills for better socio-economic outcomes


4. Appendices
4.1 Appendix I: The Analytical Framework
Part I: Descriptive account of the national contexts

**Theme 1: Recent and foreseen changes in science and mathematic education**

| Q1.1 | In what ways is science and mathematics education prioritized (or not) by policy makers in your country as expressed in policy making national documents? Are there any recent (or foreseen) changes? Please specify (in relation to primary, general secondary education and vocational education). If not, please describe briefly current priorities. |
| Q1.2 | What is the main focus of the science and mathematic national curricula in your country in terms of the general aims, content and expected learning outcome? Are there any recent (or foreseen) changes? Please specify (in relation to primary, general secondary education and vocational education). |
| Q1.3 | Are there any recent (or foreseen changes) in relation to initial teacher education (pre-service teachers' training in science and mathematics)? If yes, please specify which aspects these changes refer to (general aims and objectives, who offers initial teacher education, who receives initial teachers training, criteria for selection, content, methods of teaching). Also, please specify in relation to primary, general secondary education and vocational education. |
| Q1.4 | Are there any recent (or foreseen changes) in relation to in-service teachers training in science and mathematics? If yes, please specify which aspects these changes refer to (general aims and objectives, who offers initial teacher education, who receives initial teachers training, criteria for selection, content, methods of teaching, provision for teachers in the induction stage, i.e. newly recruited teachers). Also, please specify in relation to primary, general secondary education and vocational education. |
| Q1.5 | In what ways is science and mathematics education prioritized (or not) in relation to curriculum organization at a school/institute level? (For example how more time is allocated to mathematics and science than other subjects, new curriculum support materials in science and mathematics). Are there any recent (or foreseen) changes? Please specify (in relation to primary, general secondary education and vocational education). |
Q1.6 Are there any recent (or foreseen) changes in the way science and mathematics are mainly being taught at schools? (active or passive *teaching methods*). If yes, please specify (in relation to primary, general secondary education and vocational education).

Q1.7 Are there any recent (or foreseen) changes in relation to the ways science and mathematics are *assessed*? (Assessment at a school and classroom level, national exams for students being allowed to progress to the next phase of education). If yes, please specify (in relation to primary, general secondary education and vocational education).

Q1.8 Are there any implications in relation to the aims of MASCIL project (as a whole and in relation to WP8 implementation and WP10 evaluation)?

Q1.9 Please insert your policy references

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**Theme 2: Schooling and the world of work**

Q2.1 To what extent (if any) is the connection between general education and the world of work a priority of the policy makers in your country, as evident in *policy making national documents*? Please refer to primary and secondary general education.

Q2.2 To what extent (if any) is the connection between general education and the world of work a priority of the policy makers in your country, as evident the *national curriculum*? Is vocational guidance (if any) a separate subject in the curriculum (if yes what is its place in the curriculum?) or does it have an interdisciplinary character (or both)? Please refer to primary and secondary general education.

Q2.3 To what extent (if any) there is evidence in science and mathematics curricula in your country of the connection between schooling and the world of work in terms of aims and objectives of science and mathematics education? (for example explicit references to skills/competences that are set as aims in the curriculum and relevant to the world of work?) Please refer to primary and secondary general education.
| Q2.4. | Are there any connections in your country between general schools and the industry? If yes, what kind of? (please specify in relation to primary, general secondary) |
| Q2.5. | Are there any connections in your country between general schools and providers of informal education (informal learning institutions include zoos, botanic gardens, museums, science centers, Kinds/Young University, outdoor education programs). If yes, what kind of? |
| Q2.6 | To what extent (if any) there is evidence in science and mathematics curricula of the connection between schooling and the world of work in terms of content? (for example curriculum support materials that are provided, certain topics in mathematics/sciences). Please refer to primary and secondary general education. |
| Q2.7 | To what extent (if any) there is evidence in science and mathematics curricula of the connection between schooling and the world of work in relation to science and mathematics assessment? (for example assessment of skills/competences relevant to the world of work). Please refer to primary and secondary general education. |
| Q2.8. | What is the place of vocational education in the school system in your country? In what ways is vocational education prioritized (or not) by policy makers in your country? |
| Q2.9. | Please describe briefly vocational school system in your country. What kinds of schools/institutes are they? Do science and mathematics exist as separate subjects or not? |
| Q2.10. | Are there any connections between vocational school system and the industry? If yes what kind of? |
| Q2.11 | Are there any connections in your country between vocational school system and providers of informal education (informal learning institutions include zoos, botanic gardens, museums, science centers, Kinds/Young University, outdoor education programs). If yes, what kind of? |
The project mascil has received funding from the European Union Seventh Framework Programme (FP7/2013-2017) under grant agreement n° 320693.

| Q2.12 | What are the main teaching methods in vocational schools (active of passive teaching methods)? Please specify in relation to science and mathematics, in case these are taught as separate subjects. |
| Q2.13 | Please describe briefly the nature of students’ assessment, at school and classroom level and at national exams in vocational schools (method, contents, aims). Please specify in relation to science and mathematics, in case these are taught as separate subjects. |
| Q2.14 | Are there any implications in relation to the aims of MASCIL project (as a whole and in relation to WP8 implementation and WP10 evaluation)? |
| Q2.15 | Please insert your policy references |

**Theme 3: Science and Mathematics curricula and IBL**

| Q3.1 | To what extent (if any) do policy making national documents prioritize inquiry based teaching and learning approaches in your country? Please specify in relation to primary, general secondary and vocational education. |
| Q3.2 | To what extent (if any) do national curricula prioritize inquiry based teaching and learning approaches, in general and in specific in science and mathematics subjects in your country? Please specify in relation to primary, general secondary and vocational education. |
| Q3.3 | To what extent (if any) does school implement policy priorities in relation to inquiry based teaching and learning approaches, in general and in specific in science and mathematics subjects in your country? Please specify in relation to primary, general secondary and vocational education. |
Q3.4 To what extent (if any) there are curriculum support materials and certain topics in science and mathematics education that support inquiry based teaching and learning approaches in your country? Please specify in relation to primary, general secondary and vocational education.

Q3.5 To what extent (if any) students’ assessment draws on and is based on notions of inquiry based learning? (i.e. skills/competences assessed that are related to inquiry based learning). Please specify in relation to primary, general secondary and vocational education.

Q3.6 Are there any implications in relation to the aims of MASCIL project (as a whole and in relation to WP8 implementation and WP10 evaluation)?

Q3.7 Please insert your policy references

Theme 4: Pre-Service teacher training, IBL and the world of work

Q4.1 Which are the policy priorities for prospective teachers’ training in your country? Why do we train prospective teachers for? Please refer to primary, general secondary and vocational education level.

Q4.2 Which are the responsible educational structures for pre-service teachers’ training in your country? Please provide any relevant information about institutions/universities, in relation to primary, general secondary and vocational education level.

Q4.3 Please provide relevant information in terms of the organization, the structure and the length of prospective teachers’ training programmes in your country. Please specify in relation to primary, general secondary and vocational education level.

Q4.4 Who are the people responsible for training prospective teachers? What are the criteria (if any) for selection? Please specify in relation to primary, general secondary and vocational education level.
Q4.5  Who are the people who receive training? What are the criteria for the selection (if any)? Please specify in relation to primary, general secondary and vocational education level.

Q4.6  What is the overall concept of the prospective teachers’ training in your country? Are there topics connecting school and the world of work? Please specify in relation to primary, general secondary and vocational education level.

Q4.7  What are the main teaching methods in pre-service teachers’ training? To what extent (if any) IBL is embedded in the training? Please specify in relation to primary, general secondary and vocational education level.

Q4.8  Are there any implications in relation to the aims of MASCIL project (as a whole and in relation to WP8 implementation and WP10 evaluation)?

Q4.9  What are your intentions for initial teacher training in the project, for facilitating WP 8 and WP10 (how teachers are to contacted, selection of multipliers, how do you intent to connect school and the world of work?)

Q4.10 Please insert your policy references

**Theme 5: In-service teachers’ professional development, IBL and the world of work**

Q5.1  Is teachers’ professional development finalized after their pre-service education or is there a vision for lifelong learning? Please specify in relation to primary, general secondary and vocational education level.

Q5.2  Which are the policy priorities for in service teachers’ training in your country? Why do we train prospective teachers for? Please refer to primary, general secondary and vocational education level.
Q5.3 Are there any specific references in the policy priorities in relation to the induction stage of teachers’ training (newly recruited teachers)? If yes please specify in relation to primary, general secondary and vocational education level.

Q5.4 Is professional development for in-service teachers voluntary or compulsory in your country? Are there incentives for teachers participating in professional development programmes? If yes what kind of? Please specify in relation to primary, general secondary and vocational education level.

Q5.5 Which are the responsible educational structures for in-service teachers’ training in your country? Please provide any relevant information about institutions/universities, in relation to primary, general secondary and vocational education level.

Q5.6 Please provide relevant information in terms of the organization, the structure and the length of in-service teachers’ training programmes in your country. Please specify in relation to primary, general secondary and vocational education level.

Q5.7 Are there any specific programmes for the induction stage (newly recruited teachers) in your country? If yes provide information on the organization, structure, length. Please specify in relation to primary, general secondary and vocational education level.

Q5.8 Who are the people responsible for training in-service teachers? What are the criteria (if any) for selection? Please specify in relation to primary, general secondary and vocational education level.

Q5.9 Who are the people who receive training? What are the criteria for the selection (if any)? Please specify in relation to primary, general secondary and vocational education level.

Q5.10 What is the overall concept of the in-service teachers’ training in your country? Are there topics connecting school and the world of work? Please specify in relation to primary, general secondary and vocational education level.
<table>
<thead>
<tr>
<th>Q5.11</th>
<th>What are the main teaching methods in in-service teachers’ training? To what extent (if any) IBL is embedded in the training? Please specify in relation to primary, general secondary and vocational education level.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q5.12</td>
<td>Are there any implications in relation to the aims of MASCIL project (as a whole and in relation to WP8 implementation and WP10 evaluation)?</td>
</tr>
<tr>
<td>Q5.13</td>
<td>What are your intentions for in-service teacher training in the project, for facilitating WP 8 and WP10 (how teachers are to contacted, selection of multipliers, how do you intent to connect school and the world of work?)</td>
</tr>
<tr>
<td>Q5.14</td>
<td>Please insert your policy references</td>
</tr>
</tbody>
</table>

Part II- Teachers’ questionnaires

Dear teacher,

We would like you to take part in this survey as part of the European project MASCIL (Mathematics and Science for Life). Please fill out the questionnaire anonymously.

MASCIL aims to promote a widespread use of inquiry-based science teaching (IBST) in primary and secondary schools. Our major target is to connect IBST in school with the world of work making science more meaningful for young European students and motivating their interest in careers in Science and Technology.
The aim of this survey is to find out about the European situation regarding inquiry based learning and teaching in relation to the world of work across different countries and disciplines.

Thank you for your help.
MASCIL Team

**Personal data**
*In this section we would like some information about you and your teaching experience (if any).*

1. I am □ male □ female

2. How old are you? I am ____ years old

3. I am a □ pre-service teacher □ in-service teacher

4. If you are an in-service teacher, how many years have you been in the teaching profession?
   □ 0-2 □ 3-5 □ 6-10 □ 11-15 □ 16-20 □ More than 20

5. I am (or being trained to be) a teacher in
   □ primary level □ secondary level general education □ vocational education

6. Which subjects do you teach (or being trained to teach):
   □ maths □ physics □ biology □ chemistry
   □ combined, balanced or general science □ other (please specify _____________)

7. If you are an in-service teacher, what age groups did you mainly teach during the last two years?
Professional training/development

The aim of teachers’ training programmes is to develop teachers’ competencies related to their profession. The events last at least half a day, but there are also long term trainings with for example several meetings within a period of two years. In the following section we would like to know about your attitude towards teachers training.

8. For how many days did you participate in professional training events over the past years? Please fill in the numbers. Please specify if the training concerns a period that you were pre-service or in-service (if applicable).

<table>
<thead>
<tr>
<th>Period</th>
<th>Pre-service</th>
<th>In-service</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2 years ago</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-4 years ago</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-6 years ago</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-8 years ago</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. I participated in teacher training because it is compulsory.

☐ mainly no  ☐ half and half  ☐ mainly yes

10. To what extent do you agree with the following statements?

Engaging in teacher training can help me to become a better teacher.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Through teacher training I can attain greater professional satisfaction.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
I would like more opportunities to undertake teacher training.

Teacher training is only necessary for those new to the profession.

Teacher training is only important for those seeking greater responsibility.

It is difficult for me to see the value of teacher training.

Teacher training is necessary to update my repertoire of teaching methods.

The provision of teacher training opportunities can increase staff morale.

Teacher training is necessary in order to update subject knowledge.

Engaging in teacher training can make me more confident in performing in my role.

Teacher training is necessary to update pedagogical skills.

Teachers with a great deal of professional experience don’t need further training.

Inquiry Based Learning (IBL)
Inquiry based learning (IBL) is a student-centred way of learning content, strategies and self directed learning skills. Students
- develop their questions to examine,
- engage in self-directed inquiry (diagnosing problems - formulating hypothesis -identifying variables - collecting data - documenting their work - interpreting and communicating results)
- collaborate.
The aim of IBL is to stimulate students to adopt a critical inquiring mind and problem solving aptitudes.
11. Please indicate to what extent you agree with the following statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would like to implement IBL practices in my lessons.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Successful IBL requires students to have extensive content knowledge.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>IBL is not effective with lower-achieving students.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I see no need to use IBL approaches.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>IBL is well suited to overcome problems with students’ motivation.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>IBL provides material for fun activities.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>IBL is well suited to approach students learning problems.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

12. If you are an in-service teacher, please indicate the extent to which you agree with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have difficulties in implementing IBL, because...</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>the curriculum does not encourage IBL.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I don't have enough time to prepare IBL lessons.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I don't have adequate teaching materials.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>IBL is not included in textbooks I use.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I don't know how to assess IBL.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I don't have access to any adequate teacher training programs involving IBL.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
I worry about students' discipline being more difficult in IBL lessons.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

**I have difficulties in implementing IBL, because...**

- I don't feel confident with IBL.
- my colleagues do not support IBL.
- I think that group work is difficult to manage.
- there is not enough time in the curriculum.
- I don't have sufficient resources such as computers, laboratory, ...
- my students have to take assessments that don't reward IBL.
- the number of students in my classes is too big for IBL to be effective

13. If you are an in-service teacher, we would like you to think of one of your classes.

**13.1. Subject:**
- ☐ maths
- ☐ physics
- ☐ biology
- ☐ chemistry
- ☐ combined, balanced or general science
- ☐ other (please specify _____________)

**13.2. Age group:**
- ☐ 6 years and younger
- ☐ 6 to 8 years
- ☐ 8 to 10 years
- ☐ 10 to 12 years
- ☐ 12 to 14 years
- ☐ 14 to 16 years
- ☐ 16 years and older

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The project mascil has received funding from the European Union
13.3. When teaching the subject to this class, how often do the following activities occur in your lessons?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never or hardly ever</th>
<th>In some lessons</th>
<th>In most lessons</th>
<th>In almost all lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In my lessons...</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have my students working on their own consulting a classmate from time to time.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I encourage my students to use only the methods I teach them.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I give my students the opportunity to choose which questions they tackle.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I encourage students to work more slowly.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td><strong>In my lessons</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I teach the whole class at once.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I draw links between topics and move back and forth between topics.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I am surprised by the ideas that come up in a lesson.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I avoid students making mistakes by explaining things carefully first.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I tend to follow the textbooks or worksheets closely.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I try to teach each learner differently according to individual needs.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I try to cover everything in a topic.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>I try to remove students fear about failure.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
I enable students to make presentations.

I circulate and interact with students.

I use questioning strategies to respond to students’ questions.

I discuss variations in data collected by students following the experiments.

I have students ask questions about math/scientific phenomena addressed during experiments.

I have students engage in discussions among themselves.

13.4. When teaching the subject to this class, how often do your students do the following activities during the lesson?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never or hardly ever</th>
<th>In some lessons</th>
<th>In most lessons</th>
<th>In almost all lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In my lessons my students...</strong> learn through doing exercises</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>start with easy questions and work up to harder questions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>In my lessons my students...</strong> work collaboratively in pairs or small groups.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>are given opportunities to explain their own ideas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>have discussions about the topics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
do practical activities. ☐ ☐ ☐ ☐ ☐
draw conclusions from an experiment they have conducted ☐ ☐ ☐ ☐ ☐
do experiments by following my instructions. ☐ ☐ ☐ ☐ ☐
are allowed to design their own experiments. ☐ ☐ ☐ ☐ ☐
are asked to do an investigation to test out their own ideas. ☐ ☐ ☐ ☐ ☐
have opportunities to work with little or no guidance. ☐ ☐ ☐ ☐ ☐

Schooling and the world of work

One of the main emphases in the MASCIL project is the connection between inquiry based teaching and the world of work. We seek to gain an understanding of your views on the theme and current practices that support (or not) this connection.

14. Do you have any work experience, except from teaching experience?
☐ yes ☐ no
If yes, please specify (domain, how many years)
____________________________________

15. Please indicate to what extent you agree with the following statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is important that students acquire skills/competences needed for the world of work during schooling</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Connecting teaching subject to the world of work is only relevant to vocational education</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Curriculum materials supports me in connecting the topic that I teach with the world of work</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
I see no need to explain the relevance of math/science concepts to everyday life

It is important to use the math/science to help students understand the world outside school.

There should be connections and interaction between schools and the world of industry

I do not see any use of connecting schools and informal education settings (zoos, museums, science centres, outdoor educational programmes)

16. If you are an in-service teacher, please indicate the extent to which you agree with the following statements:

I have difficulties in making connections between the subject I teach and the world of work, because...
the curriculum does not support these connections.

I don't have enough teaching time.

I don't have adequate teaching materials.
such connections are not included in textbooks I use.

this is not an issue in relation to students’ assessment.

I do not think this is necessary.

17. If you are an in-service teacher, we would like you to think of one of your classes.
17.1. Subject:

☐ maths  ☐ physics  ☐ biology  ☐ chemistry  
☐ combined, balanced or general science  ☐ other (please specify _____________)

17.2. Age group:

☐ 6 years and younger  ☐ 6 to 8 years  ☐ 8 to 10 years  
☐ 10 to 12 years  ☐ 12 to 14 years  ☐ 14 to 16 years  
☐ 16 years and older

17.3. When teaching the subject to this class, how often do the following activities occur in your lessons?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never or hardly ever</th>
<th>In some lessons</th>
<th>In most lessons</th>
<th>In almost all lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>I use maths/science to help students understand the world outside school.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I clearly explain the relevance of math/science concepts to everyday life.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I explain how a school math/science idea can be applied to a number of phenomena in real work contexts</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I make evident the connections between the topic I teach and the world of work</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I include tasks that are related to a real work situation</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I assess skills/competences that I think are needed in the world of work</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Thank you!

Part III- Reflective account of the national contexts

Part 1: Gender specific issues

The percentage of women in science and mathematics higher education is still lower than for men. Mathematics and science are often considered to be masculine domains and parents, teachers and students are often convinced that boys have higher abilities in these subjects than girls. Teacher training is vital to overcome the gender gap in our society, but is in some cases inadequate in this respect. In class, girls are often treated in different ways than boys by teachers: boys may receive more praise, are allowed to contribute more to the lesson etc. Despite these, PISA results indicate that in some countries girls outperform boys in terms of science and mathematics achievement. Please provide information/comments in the following themes, with a view to inform policy makers in your country for tackling inequality issues in terms of gender.

1.1 Basic ability levels in science and mathematics in your country in relation to boys and girls (PISA results). Are any gender inequalities evident?

1.2 Gender specific issues as prioritized (or not) in policy making documents and the national curriculum in your country. Are there any national policies for tackling gender differences in learning science and mathematics and for tackling gender inequalities?

1.3 Professional development, IBL and gender specific issues. Are gender specific issues a part of teachers’ professional development? Does training in IBL approaches takes into consideration gender differences in terms of interests, learning styles, motivation?
Part 2: Addressing low achievement

Low achievement in mathematics and science is a common concern for all European countries. It is an issue associated not only with the effectiveness of teaching and learning, but also with providing an equitable system of education. A range of approaches have been developed to support under-performing students and to attempt to close the persistent gap between the highest- and lowest-achieving students. Please provide information/comments in the following themes, with a view to inform policy makers in your country for tackling low achievement in science and mathematics.

<table>
<thead>
<tr>
<th>2.1</th>
<th>Data on numbers of low achievers in your country in science and mathematics. Are there any specific groups that show significant low performance (for example boys, girls, students from disadvantaged background...)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>Low achievement issues as prioritized (or not) in policy making documents and the national curriculum in your country. Are there any national policies for tackling low achievement in science and mathematics education?</td>
</tr>
</tbody>
</table>

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1.3 Professional development, IBL and low achievement. Does teachers’ professional development cover issues on how to tackle low achievement? Does training in IBL approaches make specific reference to students that under perform?

Part 3: Promoting entrepreneurship
Entrepreneurship key competence refers to an individual’s ability to turn ideas into action. It includes creativity, innovation and risk taking, as well the ability to plan and manage projects in order to achieve objectives. The overall goal of promoting entrepreneurship in education is to give students the attitudes, knowledge and skills to act in an entrepreneurial way, for either a commercial or non-commercial objective. Many member states have strategies addressing the implementation of entrepreneurship education into general education at primary and secondary level. Yet only in a quarter of the member states did the majority of adults believe that they have the right skills and knowledge to start a business. Please provide information/comments in the following themes, with a view to inform policy makers in your country for promoting entrepreneurship.

2.1 Percentage of individuals who have the appropriate skills to start a business in your country (Rethinking education document).
1.2 The extent to which entrepreneurship education prioritized (or not) in policy making documents and the national curriculum in your country. Are there any current national strategies or initiatives addressing the implementation of entrepreneurship education into general education at primary and secondary level?

<table>
<thead>
<tr>
<th>1.3</th>
<th>Professional development, IBL and entrepreneurship. Does teachers’ professional cover issues on entrepreneurship education? Does training in IBL approaches include aspects of entrepreneurship education?</th>
</tr>
</thead>
</table>
4.2. Appendix II: National Reports-Summaries & Recommendations

1. Germany

In Germany, a new curricular reform is planned in 2015. According to the authors of the national report, the curricula will still remain competence-oriented, but the competences will be described in a more detailed level. As the developers of the national report comment, on the one hand, it is not a good change regarding the aims of MaSciL, given that the more exact the competences are defined, the less free space for interpretation exists; on the other hand, new perspectives and opportunities for MaSciL will occur. On the part of the Ministry of Education in the state of Baden Württemberg, a wide spectrum of professional development courses are planned to be offered, aiming at preparing teachers for the changes in the new curricula. The challenge for MaSciL is to offer new professional development courses, which build on the requirements of the new curricula and which can be seen as a valuable complementary offer.

At the policy-making level, science and mathematics education has been highly prioritized as expressed in policy making national documents and the several initiatives of the recent years. The strategic action lines encompassed equally primary, as well as secondary general and vocational education. In addition, of high priority for policy makers during the past years has become the close connection between schooling and the world of work. The MaSciL project will surely profit from the orientation towards the world of work, as visible in the focus on professional orientation, in particular for females.

It is further stated in the report that at the meso-level regarding the way policy envisions are reflected in schools, the degree to which science and mathematics is prioritized at the policy level is mirrored in national curricula, both in form of standards for learning outcomes and for assessment/testing. Yet, at the initial teacher training, the impact remains at a rather low level. In-service teachers are being increasingly offered further training and career development opportunities in science and mathematics, but to varying degrees and in highly heterogeneous ways. In relation to teaching methods there have been substantial efforts to improve the teaching styles of teachers at all school levels. Some projects implemented have attempted to introduce changes in teaching styles through the cooperation among teachers and the dissemination of materials on the topics, but these efforts remained at the level of pilot projects and have not been introduced across the board. Vocational schools have only partially benefited from these developments, since the focus of the projects was on general education. In relation to schooling and the world of work, it is pursued more often via extracurricular projects and initiatives than through the curriculum or classroom activities. All in all, in Germany/Baden Württemberg much change has taken place in this field during the past years in relation to the degree IBL is supported in schools, with the picture appearing very conducive for the implementation of IBL. Indeed, IBL is a teaching method that is becoming more and more popular and is being increasingly required at schools.

At the classroom level, it should be highlighted that although some IBL-oriented tasks already have their place in German teaching resources for primary and secondary schools, there is still a lot of work that can be done within the framework of the MaSciL project. On the one hand, there are still not enough materials about IBL available. In relation to vocational education, the existing textbooks are mainly based on traditional work methods and do not give pupils the opportunity for genuinely creative, autonomous work. No binding obligations concerning the use of specific textbooks at school gives MaSciL the opportunity to selectively provide needed materials. In relation to schooling and the world of work, teachers’ perception of pupils’ professional orientation at schools is often very simplistic and incomplete. Teachers associate school connection to the world of work with visiting enterprises or with technical preparations to the career entry (CV writing, doing job interviews, etc.). They are often not aware that they can give pupils a better understanding of the world of work by means of classroom tasks. This might derive from a general lack of
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materials on activities connecting schooling and the world of work. Against this background MaSciL can try to change teachers’ perception on how the connection between schools and the world of work should look like.

In relation to strategic aims and priorities for education, an important issue that emerges is that neither national curriculum nor teacher initial/further training has yet changed much, so as to be able to tackle gender differences and inequalities in science and mathematics education. Gender-related issues have been prioritized in policy-making and official rhetoric, yet no actual changes can be detected in school and classroom activities. This represents one crucial issue for further work in WP2, e.g., workshops with policymakers, etc.), and for MaSciL implementation activities (WP8).

Further, in terms of achievement, PISA results show a close relationship between performance level and social background. A review of teacher training curricula suggests that teacher training in Germany does only little in the sense of preparing future teachers to handle educational disadvantage of pupils. Looking at different dimensions related to this issue, two main aspects come to the fore: diagnosis, support and counselling regarding individual learning processes and individualised teaching, handling of heterogeneity and differentiation in classroom. However, the question arises as to their relevance and application in practice. Finally, entrepreneurship education has been prioritized in policy making in the country. Curriculum development, though, has included entrepreneurship education solely at a rather abstract level. This is also the case for teachers’ professional training and development, which only indirectly addresses issues around entrepreneurship education.

The current situation in the national educational system of Germany/Baden Württemberg indicates that there are some important implications for the MaSciL project. First of all the aims and purposes of MaSciL are strongly prioritised in policy documents and curricula of primary and secondary education. Therefore, it is a strong advantage for the project that it can build on all these values. Second, the cooperation with out-of-school institutions is explicitly required in Baden Württemberg’s Education Plan 2004 and the plan in preparation for 2015 will most probably continue to do so, so that MaSciL can contribute to the further development of cooperation between schools and out-of-school institutions. However, the common shared perception that IBL is present at schools and at teacher apprenticeships, can be a big hindrance for MaSciL teacher training. Chances for MaSciL will open up on the vocational level which will not be covered by the curricular reform. Many vocational schools have lost their popularity in society, so that they have to fight for surviving. Consequences are that they are ready to implement many new elements in their teaching practice in order to be more attractive for pupils on the educational market. In relation to teacher training, the national report emphasizes that overwork and lack of time are permanent companions of teachers in the induction stage. In-service training for those teachers is compulsory and very extensive, therefore, there is barely space for additional training in relation to this target group. Lack of time is an important hindrance for experienced teachers to participate in professional development, as well. Therefore, one of the great challenges for MaSciL will be to engage teachers for its training activities, despite their having not much time available for participation.

The phenomena of “passing the buck” can be observed in the group of the interviewed teachers. They often suggest that some duties should be done earlier or later, e.g., the acquiring of professional competences can occur after the general education, but the practice of group work can take place earlier, e.g., in primary education. To overcome teachers’ tendency to shift the responsibility to other persons or institutions can be a challenge for MaSciL. Without raising teachers’ awareness concerning the implementation of IBL, it will be very difficult to engage participants for MaSciL teacher training activities.

In addition, one important potential hindering aspect of the current situation on the part of the pupils that might pose one of the main hindrances for promoting IBL at schools is the overload of work and extra-
curricular activities. Since pupil-centred teaching methods shift almost the whole work to pupils, it also creates an imbalance. Pupils currently have more and more activities, both within and out-of-schools, to cope with and increasingly more content and competences to acquire. This may pose a serious challenge and can be a great hindrance for the implementation of MaSciL purposes.

In summary, the analysis of policy context in Germany/Baden Württemberg made evident a very conducive policy context to the implementation of the MaSciL project, especially in terms of

- a high priority for science and mathematics education as expressed in national policy making documents and in the numerous initiatives in recent years;
- a translation of the policy goals of prioritizing science and mathematics teaching into national curricula, both in form of standards for learning outcomes and for assessment/testing; and
- an increased awareness for the link between schooling and the world of work.

However, it also identified some potential constrains for the realization of the MaSciL project. These are mainly threefold:

- a discrepancy between policy rhetoric and actual implementation of IBL methods in classrooms;
- teachers’ capacity and motivation to be engaged in further professional development due to work overload;
- students’ capacity and motivation to be further engaged to learning methodologies that will further add to the existing overload of work.

Recommendations for German/Baden-Württemberg policy makers

New curricula reform
Each curricula reform poses a challenge for schools, head teachers and in particular for teachers regarding its implementation. Therefore, first, there is a need for a careful and smart supervision of teachers implementing the instructions of the new curricula and for the exchange of experiences and knowledge between policy representatives and teachers. Second, for each curricula reform policy makers should carefully reflect on whether it is really necessary or not.

Assessment
Changes in the structure and content of assessment are essential for supporting the successful implementation of the new curricula. The discrepancy between curricula and assessment always leads to troubles and miscarriages in implementing changes from new curricula. The assessment in Baden-Württemberg in many parts still focuses on knowledge recall and standard applications of rules and procedures especially in the general education and neither support nor encourage teachers to implement the new curricula. There is a need for integrating the IBL-oriented tasks and for introducing elements from the world of work into the structure of assessment. This step would make the gap between curricula and assessment smaller and help teachers to implement changes.

Professional development
Many professional development courses in Baden-Württemberg last only a few hours and don’t give deep insights into new topics. A new culture of professional development needs to be designed. Long-term teacher trainings with strategic support for teachers are necessary to ensure long-term curricular changes. Again and again teachers need to be reassured by policy on the way how they implement the new curricula. Additionally, the long-term professional development gives an opportunity to monitor the process of changes and to intervene smartly if needed. The more connected professional development is to teachers’
day-to-day teaching, the more impact it has on teachers. For this reason, professional development should be school-based or at least locally based and include several teachers from one school. New incentives should be created, which encourage teachers to participate in long-term professional development. More free slots for teacher training should be guaranteed in teachers’ work schedules.

**The concept of the “world of work”**

The understanding of the term “world of work” in Baden-Württemberg is very narrow. The rethinking and redefining of the concept of the “world of work” is the basis for an appropriate preparation of pupils for the career entry. However, the first step should be to communicate to the teachers, that technical preparation (CV writing, doing job interviews etc.) is not enough for the future career. There is a necessity to involve the “world of work” into the day-to-day teaching by means of appropriate tasks to bring the pupils closer to the whole spectrum of the “world of work”. In his way pupils can distinctly realize the relevance of knowledge for the future profession, become more motivated in learning and become better prepared for the prospective career.
2. Greece

Currently, a curriculum reform has been initiated by the Ministry of Education, with an emphasis on the development of students’ competencies, mathematical and scientific literacy. The reform also focuses on teachers’ active engagement in new forms of didactical design and implementation, with the aid of digital technologies, students’ engagement on project work, targeting challenge-based learning.

At a policy-making level, national documents seem to prioritize the connection between general education and society. These documents stress the importance for students to be able to participate efficiently in their future social and professional activities. In contrast, inquiry based teaching and learning approaches are not currently part of the national curricula: primary, general secondary and vocational education curricula are structured according to the content. The new curriculum, though, which has been developed as part of the reform of New School, prioritizes inquiry based teaching and learning approaches favoring the development of students’ mathematical and science literacy. It also prioritizes teaching methods involving students’ project work and integration of technology in the teaching of mathematics and science. No explicit reference in relation to IBL and the world of work are evident at policy-making level, in relation to teacher education. The overall concept of the prospective teacher training is that teachers need to become aware of the main theoretical ideas on science & mathematics teaching and to be able to apply this knowledge in real classroom settings. A privileged goal is the emergence of critical-reflective teacher. The world of work is absent in the primary science and mathematics, while only instances of the application of some ideas in real life and workplaces exist, especially in secondary science curricula. Therefore, teachers’ training generally does not involve such aspects. In vocational secondary schools, though, the world of work is more dominant in the school curriculum, as the intention is these students to become professionals.

At a meso-level relating to schools, despite the policy-making rhetoric, there is no evidence of the connection between general schools and industry. Visits to places that can support informal education are organized at all levels of education as an initiative of schools or particular teachers. In relation to inquiry based teaching and learning approaches, the schools in the country have not been committed to implement any policy priority. However, in the last two years a particular number of primary and secondary schools have been selected by the Ministry of Education for the pilot implementation of the new curriculum, which has been developed as part of the reform New School. These schools are committed to implement the new curriculum for one year and they attempt to use inquiry-based approaches that are supported in the curriculum. In addition, in terms of teacher education, the national report indicates that primary education prospective teachers are more willing to adopt IBL approaches, while this is more difficult in the case of secondary education. Similarly for in-service teachers IBL and connection of school with the world of work is beyond their classroom experiences (especially for the secondary teachers).

At a classroom level, primary and general secondary textbooks include some open activities targeting students’ exploratory stance towards Mathematics and Science. However, they are fragmented within the textbooks and they are not considered by the teachers as involved in the ‘official’ part of mathematics that is tested in the final examinations. Thus, it depends on the teachers if such activities are implemented in the classroom or not. In contrast, the new curriculum which has been developed as part of the reform New School, is accompanied by rich materials and resources (e.g. exemplary activities, digital resources, scenarios for exploiting digital tools) aiming to support inquiry based teaching and learning approaches. Currently, students’ assessment does not draw on notions of inquiry based learning. However, the new

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curriculum which has been developed as part of the reform New School adopts formative methods of assessment taking into account skills/competencies related to inquire based learning.

In relation to strategic aims and priorities for education, issues pertaining to equity and gender do not seem to be prioritized neither in the national curricula of science and mathematics, nor in professional development programs. Yet, according to PISA 2009 results for Greece, there are statically important differences between boys and girls in science and mathematics performance. In relation to low achievement, there is no evidence of such an issue in policy-making documents. Some schools offer extra teaching beyond the official teaching hours for low achievement students, but this provision is becoming more and more limited due to the economic crisis. There is also no evidence of how to tackle low achievement in professional development programs. In terms of entrepreneurship different activities have been organized from 2005 to 2009 with the aim to promote such an aim. These include summer schools where vocational students were engaged in designing business plans based on their own specialization. Recently, another idea has been introduced in both general and vocational education levels: the ‘career education’. Primary teachers and science and mathematics teachers in general secondary schools have no specific experience on the entrepreneurship issue.

In short, the aims of the mascil project are similar to those of the 'New School' reform. However, these aims are not yet implemented in the current everyday teaching practice; therefore, there is a challenge for the Greek group to explore if and how the mascil activities can be designed and implemented within our national educational context. A hindering factor for the accomplishment of the mascil objectives is that despite the foreseen reform, the educational system remains heavily exam oriented, with assessment objectives being focused on content knowledge rather than on the acquisition of skills.

The envisioned policy-making objectives of the ‘New School’ reform in Greece, which are in line with the aims of the mascil project, provide a good background for the implementation of mascil. However the assessment methods and the lack of relevant to the project objectives teacher training programs (especially for secondary teachers) are considered as barriers in the accomplishment of the mascil aims.

Recommendations

1. Support vocational schools in integrating further world of work in their school activities (e.g. visits to workplaces, development of materials, practicum, visits of experts to schools).

2. Dissemination of materials and resources being developed in Mascil to schools all over Greece.

3. School advisors should be educated in the spirit of mascil and disseminate these ideas to teachers through their professional role/channels.

4. School authorities and heads of schools should facilitate teachers’ participation in PD activities and open their schools to innovations in the context of Mascil.
3. Netherlands

Currently, all science and mathematics examination programmes for senior high schools have been reformed, the resulting programmes starting at the national level in 2013 and 2015. One of the aims of renewing the single disciplines was to make them more coherent. All programmes define common competences related to research, design and communication. Pre-service and in-service teacher training programmes that prepare for these reform programmes will certainly profit from the mascil project.

In relation to the macro-policy-making level, during the recent decades, various research projects have resulted in educational materials and strategies for implementing interdisciplinary teaching and use of IBL for science and mathematics. However some educational reform projects at the end of the twentieth century were less successful and consequently the Ministry of Education decided to reduce government interference with pedagogical and didactical aspects of education. The Ministry now mainly focuses on the core objectives of education. This concerns specifically arithmetic and mathematics. For example, the Ministry defined core objectives pertaining to mathematical skills for secondary education. Schools are at liberty to develop these according to their different educational perspectives and teaching styles.

At the school level, despite all recent initiatives, a change towards inquiry based learning is hardly implemented in most schools. Main reasons for this are that the teachers lack sufficient educational materials, are not trained to use them and lack insight into IBL teaching methods. Moreover, in lower secondary education more emphasis might be put on familiarizing students with inquiry based learning as a preparation for problem based interdisciplinary teaching.

In lower secondary education, mathematics and science are seen as distinctively separate disciplines in the Netherlands. Successful teacher training projects on IBL initiatives are rare. As such, efficient and effective pedagogical materials for inquiry based learning, and interdisciplinary and modelling approaches are needed. Specific training as well as well-planned dissemination is still required. In contrast, at the national level there is a strong collaboration between industry and vocational education.

In primary education in the final exam (a national test) a few questions in the area of science and technology are related to inquiry learning, but the relation could be stronger. In secondary education this is a diverse area, school disciplines have different histories in more or less inquiry based assessment. Some schools take their own responsibility in this area (part of the exams is the responsibility of the schools themselves). However, in vocational education exams are focused on work-related skills and this means that inquiry learning (within those specific work-oriented tasks) is part of the assessment.

In terms of strategic aims and priorities for education, issues pertaining to gender seem to be less prioritized at policy level, given that the participation of women in Science, Mathematics and Technology Education is improving; however, the trends are slow. In relation to low achievement, government-policy plans to implement new (diagnostic) assessments (from 2014 and onward) in secondary and vocational education in order to support the learning of basic skills by low achievers. The average training at the moment, in the Netherlands is hardly dedicated to processes of inquiry (e.g. creativity and problem solving), although the Primas project has made an evident difference in this area.

In short, the national report suggests that not all teachers in the country are willing and able to work in new areas like inquiry based teaching. Important to notice is that some individual teachers are able to work inquiry-based without support of professional programmes. Important issues that were raised in the meeting with NAB in Netherlands concern the following: a) It is difficult to make a strong connection between general secondary education and vocational education. Although general schools can learn from...
the expertise of ‘the World of Work’ from vocational education, there is no tradition in meeting each other; b) it is important to make immediate connections between the pre-service training of teachers and what mascil is going to do in in-service teacher training.

Evidence suggests that Netherlands have a tradition in IBL, as manifested from the various programmes implemented in the field. However – given that aspects of these programmes failed to achieve the expected outcomes – current policy making seems to be oriented towards more content oriented objectives. Inquiry based learning is hardly implemented in most schools, due to skill-oriented national assessments, a lack of sufficient educational materials, and teachers lack of insight into IBL teaching methods. In addition, although general schools can learn from the expertise of ‘the World of Work’ from vocational education, there is no tradition in meeting each other.

Recommendations

- Value the learning of inquiry processes in schools by identifying and including the assessment of these processes in national assessments.
- Support teachers in discussing with each other goals of education and successful teaching strategies in close cooperation with representatives of further (vocational) education and the world of work.
- Support the development of educational materials and teaching methods to help teachers in enriching their repertoire towards IBL and being able to foster connections with the world of work.
4. United Kingdom

As stated by the national report author, according to policy envisions in education mathematics and science should be prioritized from the point of view of ensuring a well-qualified future workforce so that the UK is well-positioned to compete in the world economy. Students are to be encouraged to study mathematics and science using an argument that highlights the potential financial reward it may offer in future careers. These prioritise a curriculum that has a renewed focus on fundamental academic knowledge, particularly in mathematics, science and language. The rhetoric is based on a call for getting ‘back-to-basics’, suggesting that students need instant recall of fundamental knowledge if they are ever to be well-positioned to solve problems.

The report also states that there is in general no emphasis on vocational education or connecting compulsory education, at both primary and secondary levels, with the world of work. This is reflected not only in the school curriculum, but also in structures of schooling in which, in general, there is no provision of vocational schools (although exceptions are emerging and are discussed below). In addition, in relation to science and mathematics curriculum, there is an emphasis on content knowledge, while the development of skills and competence relevant to inquiry based learning is also evident. Furthermore, a rich bank of materials for teachers’ and students uses has been developed during the previous years, both in regards to inquiry approaches and making connections with the world of work. According to the author, the lack of connectivity between school learning in mathematics and the sciences is not due to lack of resources, rather it is because of all the other policy priorities that value academic education above all else. In relation to “trainee teachers” the focus is very much on day-to-day classroom practice and the school as a work place. The predominant focus of school experience for trainee teachers concerned the pragmatics of ‘teaching and implementation of national policies rather than those aspects of pedagogy, reflection and critical analysis’.

In relation to strategic aims and priorities for education, issues such as promoting equity in relation to gender, the scope of students’ achievement and the promotion of entrepreneurship have a relatively low profile in policy circles, although they remain of interest to educators, educationalist and researchers. In terms of gender equity, although sciences and technology are more attractive to males than females, girls outperform boys, with the gender gap being traditionally low. The gender issue of is recognized as of key importance in the area of teachers’ professional development; yet there is no specific training in IBL offered to combat inequalities in participation due to gender. In terms of students’ achievement, it seems that UK students perform poorly in international tests in sciences and mathematics, with the scores having a major impact on policy rhetoric; as a consequence there has been an increasing emphasis on improving students’ achievement. Finally, in relation to the promotion of entrepreneurship, it seems that it is not an issue in a curriculum that focuses on the acquisition of subject knowledge, while there is no specific teachers’ training in the area.

In short, as this report highlights there is much policy change at present in UK, across all aspects of the governance of education: school systems, structures and governance, curriculum and qualifications, initial teacher and continuing teacher education. Policy change in any one of these areas might provide sufficient challenge for the implementation of a project such as mascil that seeks to bring about change in the learning experiences of pupils in mathematics and science. With change across all areas at the same time the challenge is potentially immense. On the other hand at a time when everything ‘is up in the air’

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there is also the potential to find new ways of working that exploit as far as possible new potentials for change and improvement.

**There is much policy change in United Kingdom at the time across school systems, structures and governance, curriculum and qualifications, initial teacher and continuing teacher education, with a renewed focus on fundamental academic knowledge. With change across all areas at the same time the challenge for the mascil project is potentially immense.**

**Recommendations for most successful implementation of the mascil project**

The table below indicates the major areas of policy change as identified and elaborated in this report and identifies how the mascil team might tackle the issues. In attempting to consider how best to tackle the challenges that each policy initiative provides attempts have been made to seek synergies across work in the project and with other initiatives the team is working on in this period as well as considering staff expertise and the networks of support on which they can call.

<table>
<thead>
<tr>
<th>Issue</th>
<th>MaSciL response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>School systems and structures</strong></td>
<td>There are opportunities to develop new partnerships with alliances of schools. This is already underway in relation to other projects we work on. For example, in researching curriculum innovation in projects such as MAP, Bowland/Nuffield and FasMed. Some of these partnerships provide the potential for working with new communities focused on professional learning that can be supported by the MaSciL professional learning toolkit alongside the toolkit that will be developed in the Nuffield Lesson Study project.</td>
</tr>
<tr>
<td>New systems of school governance support a wide range of school types with policy promoting the development of academies and in favour of chains or consortia of academies focused on schools judged to be outstanding.</td>
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<tr>
<td>A small number of schools designated as University Technology Colleges and Studio Schools have innovative features and curricula that are supportive of students working in ways that support links with the world of work and maybe less so support inquiry learning.</td>
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<tr>
<td>New models of collaboration are being initiated by those charged with oversight of professional development in mathematics and science. For example, the NCETM is developing Mathematics Education Strategic Hubs that are based in</td>
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</table>
### National Curriculum and assessment

The new specification of the curriculum in general is aimed to develop basic knowledge across all subjects. There is much policy rhetoric that favours a back-to-basics approach and which decries inquiry methods and attempts to connect learning with the reality of the worlds that students inhabit. This is often spoken of as ‘dumbing down.’

However, in the detail the new curriculum and particularly important the specification of assessment at age 16 (GCSE) which is acknowledged to drive the system due to it being key to the performance measures that rank schools in league tables, there are aspects that are supportive of inquiry approaches.

### Initial Teacher Education

Initial teacher education is shifting from its long-time and well-established base in the universities to schools. There are many implications of such a change in provision, not least of which is the proliferation of those now involved in provision: leading to potential challenges of the ‘reach’ of innovation of projects such as MaSciL. Also of concern is the potential for the profession to stagnate in terms of development with an apprenticeship model emerging where new entrants to the profession mimic ‘old hands’ who are considered expert. Schools are not necessarily sites of innovation.

### Continuing professional development (cpd)

With the allocation of funding direct to schools it is not clear how in the future schools will prioritise cpd in general and in mathematics in particular.

Local Authority (LA) networks of subject teachers have been affected by the curtailment of LA activity. Many schools are now directly funded by central government.

### Curriculum change

Curriculum change always provides the potential to ‘sell’ professional development as providing appropriate up-skilling towards implementation.

At a policy level it will be important to continue to promote problem solving and modeling in mathematics with awarding Bodies and pursue the work we have been doing in informing potential improvements in assessment in this regard.

The Nuffield Lesson Study project that supports the professional learning in the teaching of problem solving provides a parallel development and it will be important to look for overlap and synergies in work between the two projects.

### The project mascil has received funding from the European Union

and the LA does not have sufficient funding for the support activities it used to run. It is not only funding that is at issue but the lack of infrastructure to support cpd at a local level.

New models of community and partnership are merging often focused around newly designated national Teaching schools. A new network of Mathematics Education Strategic Hubs (MESH) is being initiated and supported by the NCETM.

The Science Learning Centres continue to provide cpd in science.

**Classroom practice: inquiry**

The curriculum in its implementation does not in general prioritise inquiry teaching. Reasons for this are deep-seated and firmly rooted in the didactical contract or cultural script for lessons in mathematics and science.

Teaching approaches are not specified by curriculum documents but there is much rhetoric that inquiry methods are not appropriate in a knowledge rich curriculum. The inspection service Ofsted that regularly inspects and grades schools, on the other hand is supportive of active approaches to learning that promote conceptual understanding and active engagement.

MaSciL has much expertise on which to draw and a national (and international) reputation on which to build. Most recently in relation to inquiry learning the PRIMAS project has successfully worked with over a hundred teachers who act as ambassadors/multipliers using the PRIMAS materials to work locally with colleagues in introducing inquiry learning in their classrooms.

**Classroom practice: vocational education**

There is little, if any, expectation for mathematics and science in compulsory school education to connect with the world of work. There are no vocational schools. An academic curriculum for almost all students is favoured.

There are emergent new models of schools and curricula that for proportionately very few students prioritise connections with business.

Early inquiries have identified interest from teachers who wish to motivate the learning of mathematics and science for those pupils who seek some utility of purpose and application of knowledge when they learn what can often be quite abstract ideas.

There is a wide range of materials from which teachers can draw if and when they adopt the MaSciL approach.

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and industry and favour thematic and project approaches to learning.

Our current and developing networks and partnerships should ensure adequate ‘reach’ during the project.
5. Spain
In Spain, a new law of education was published in December 2013. Accordingly to it, new developments for each educational level will be published soon. The new curriculum is competency-oriented, like the one it replaces. According to the authors’ analysis, the national curriculum is quite supportive for an inquiry-based orientation to the teaching of mathematics and science. Recent developments for the Primary School level (March 1st, 2014) support this statement. Both in the description of school mathematics and science, inquiry and problem solving processes are explicitly mentioned, and included within the educational standards. In addition, from the perspective of the educational law and official curriculum, there are no significant barriers for connecting mathematics and science with the world of work.

Yet, when coming down to what actually happens in the classroom, the authors see major challenges. Despite the positive orientation of the national/regional curriculum, they identify two major obstacles that should be considered: On the one hand, the inertia in the teaching practices (pedagogies) used by teachers. On the other hand, when the new assessment system will be introduced it will probably affect how mathematics and science are taught. If the assessment is not IBL-oriented, it might become an obstacle for mascil aims. On the other hand, an IBL-oriented assessment might be a strong opportunity, because it will challenge teachers’ current methodologies and create a need of change.

The report also states that an orientation towards a better articulation between school and the world of work is evident in the curricula. However, this orientation is described in a general level, without any specific measures. Vocational Studies are continuously prioritized in Spain from the national/regional governments, and they are continuously under reform. However, these reforms normally fail in enhancing connections between general education and vocational contexts. In terms of assessment, there are regional diagnostic tests, which will become into national test in the new law. These tests are mainly competency-oriented, built around the use of mathematics/science in daily life contexts (application). Sometimes these contexts can be related with the world of work, but there is not an explicit policy in this direction.

In relation to teacher training, considering that orientations for prospective teacher training are quite general, according to the authors there are not obstacles for the inclusion of IBL and connections between mathematics/science and the world of work. Moreover, considering that teachers should be trained to deliver the existing curriculum, which is quite supportive with IBL methodologies, we think that there is a real chance for mascil to have a positive impact in the system.

In Spain, there are no obvious obstacles for the inclusion of IBL and connections between mathematics/science and the world of work in teacher training programs, considering that teachers should be trained to deliver the existing curriculum, which is quite supportive with IBL methodologies, we think that there is a real chance for mascil to have a positive impact in the system.

Recommendations

- Because it is still quite difficult for teachers to find good materials for an IBL-oriented, world of work connected, teaching; Recommendation 1: to promote the design and dissemination of
well-engineered classroom materials. The sharing of good practices between teachers within this field could help to the dissemination of this kind of materials.

- Because teaching IBL is new for many teachers, and even many of them have never experienced IBL in the past as students; **Recommendation 2**: to promote teacher professional development oriented towards exploring student-centered methodologies necessary to teach IBL.
- Because a culture of collaboration is crucial for any educational change to happen, and for the professional development of teachers; **Recommendation 3**: to foster teacher collaboration through existing networks, or even creating new thematic ones. Particularly, it seems especially crucial to promote a climate of collaboration between teachers within the same school.
- Because knowing about the workplace context is important to create meaningful and powerful connections between these contexts and mathematics and/or science in school; **Recommendation 4**: to promote collaboration between schools and industry, through specific actions and activities, in order to bridge the gap between these two worlds. Particularly, it seems that enhancing the collaboration between Vocational Education teachers and mathematics/science teachers could be an easy way to connect these two worlds.
6. Cyprus

The Cypriot educational system is currently under reform. This reform covers all school subjects and all education levels, besides vocational education. However, there are no foreseen changes with regard to making mathematics and science education a priority.

As stated in the report, in 2011, the Ministry of Education of Cyprus introduced the New Curriculum for public schools in Cyprus, with a new agenda - the emphasis shifting from the acquisition of important skills and knowledge to the development of children's Critical Mathematics and Scientific Literacy. It is a change of paramount importance. IBL is clearly promoted in curriculum texts and also in the developed teacher and student materials. However, similar like in other countries, no time has been allocated for the suggested ‘discoveries’ and ‘explorations’ promoted in the mathematics and science curricula. The latter, in conjunction with the limited teacher training, is expected to restrain teachers from adopting a more contemporary, IBL based approach in their teaching. The problem mentioned above is even worse at the upper secondary level, when students are prepared to take the national examinations for entering the universities in Cyprus and Greece (similar with students taking the GCE and TOEFL exams). A strong emphasis on the procedural knowledge, in both mathematics and science, is a crucial component in mathematics and science teaching and learning.

At a policy making level, there is no actual connection between the general education and the world of work, and therefore this ‘connection’ is not a priority in policy documents. Further, there is no connection between schooling and the world of work in terms of aims and objectives of science and mathematics education. In contrast, policy documents, accompanying the new curricula (currently under reform) promote the use of inquiry based learning and teaching in both mathematics and science.

At the school and classroom level, there are not any actual connections at the primary and lower secondary school level. Connections, if any, take the form of ‘informal links’ between schools and providers of informal education. Similarly, there is no connection between schooling and the world of work in relation to science and mathematics assessment. Assessment in both subjects is structured around core (pure) concepts from mathematics and science, with no connection to actual problems/world of work. At the vocational school level, written examination is the almost same like in lower secondary school. Furthermore, especially in secondary school time constrains struggle IBL related approaches. with regard to national assessment (especially in high school), there are not any IBL related activities and tasks in national assessment tests and therefore all related factors (teachers, students, parents, policy makers) usually expose negative attitudes towards IBL related activities. On the other hand, the lack of national assessment in elementary school makes it more feasible to adopt and implement IBL teaching and learning approaches in Mathematics and Science.

A major barrier towards the implementation of the mascil objectives in Cyprus in relation to secondary education is the exam oriented system which does not assess skills relating to IBL and the world of work, and also the limited training that secondary school teachers have about the importance of IBL and WoW, and the pedagogical skills for implementing them.

In order for IBL to be implemented across all educational levels in Cyprus the following changes are required:
1. Teachers should be trained for a longer period of time (i.e., year-long seminar) on the importance of IBL in teaching science and mathematics, and the practical pedagogical skills required to teach IBL.

2. Teachers should be supported in more practical ways in their effort to implement IBL in their classes. Therefore, there should be exchange of good practice in IBL between teachers, and this could happen if communities of practice on IBL are created and maintained.

3. The format of the exams in secondary school should change to account for the changes in the curriculum, and to evaluate IBL skills and not only knowledge.

4. In order to promote the world of work the teachers need to be informed of the importance of including this as part of the curriculum, and also supported with the use of practical materials.
7. Norway

The case of Norway

In Norway, there is currently a reform on teacher education mainly aiming at enhancing teachers’ subject knowledge, their teaching skills and their social/cultural competence.

In relation to wider policy perspectives, policy documents state that the connection between schooling/teaching and industry should be strengthened, and teaching should be made more relevant for students. Priority is also given to inquiry based methodology both in sciences and mathematics.

At a school and classroom level though, it seems that teachers find it hard to adjust to the propositions. Teachers do not necessarily have the skills to use IBST in the classroom, as it demands not only methodological skills but also subject knowledge and confidence in one’s own subject knowledge. The lack of subject knowledge in the natural sciences and mathematics is therefore a common challenge and an obstacle for the use of IBST in the classroom. Until recent reforms of teacher education Norway has not had subject specification requirements for teaching natural science education at primary and lower secondary level (grades 1-10), whereas 30 credit points in mathematics has been obligatory.

Since 2010 student teachers have had to decide whether they want to choose the grades 1-7, or the grades 5-10 route, which has implications for their subject specialization: for primary teaching it is still largely left open to non-specialization, except for 30 credit points in mother tongue (Norwegian) education and mathematics. For lower secondary teaching students are required to specialize, and need 60 credit points to teach mathematics, and 30 credit points to teach natural sciences.

In relation to teacher training, the demands are now that student teachers should have 100 days of school practice, and there is an ongoing discussion about how much time/years spent on subject specialization (i.e. pure science or mathematics) as compared to mathematics or science didactics (education), or even general education. With the introduction of the new teacher education program from 2010 for primary and lower secondary education, these programs are expected to strengthen teachers’ subject knowledge and teaching skills in the subject area. However, in which ways these changes will influence the teaching strategies (of new teachers), in particular with respect to IBST, is not clear. Teacher education institutions have for a long time tried to influence student teachers’ views and practices, but it appears that as soon as student teachers are immersed into school life, as novice teachers, they lose confidence and conviction to promote and practice new approaches. Often experienced colleagues are not supportive of ‘new interventions’ and help novice teachers to ‘align’ their practices with that of colleagues- hence no prolonged influence of IBST.

There is a general conducive context in Norway for the implementation of the project and for the achievement of the mascil objectives. Constrain towards this aim is regarded the lack of teacher confidence in their subject knowledge, rather than lack of inquiry teaching skills. Another constrain may be the obligatory participation in government-initiated action programs, which make school leaders hesitant to add to their already loaded time schedule. Schools and teachers resistance towards change represents another constrain.
As to policy recommendations, we refer to
A) our Norway WP2 report, with the following quotes from one of the government’s white papers:

(1) Linking to the world of work:

Secondary senior teacher positions
“To strengthen the partnership and collaboration between the labour sector and educational institutions, the Government wishes to pave the way for personnel with a mathematics and science educational background in enterprises and organizations to be given secondary senior teacher positions in schools. In this way they may contribute in schools as role models and be useful resources. Various attempts involving exchanges between enterprises and schools have been made, but not in a particularly systematic way.”

(2) Professional development for the enhancement of teaching:

Relevant enhancement of skills for teachers of mathematics and science
“In line with the Raising of Standards in Mathematics and Science, it is important that teachers of mathematics and science receive relevant enhancement of skills in mathematics and science. Teachers must be updated both professionally and pedagogically so that pupils receive knowledge that they find interesting, thus developing the drive to do research we wish to encourage.”

In terms of In-Service teacher training in relation to i) IBL and ii)the world of work, we refer to our report where we stated the following:

Wider policy perspectives
The strategy for competence enhancement in common education (2005-2008) provided a new dimension. This competence strategy was developed in a cooperation between KS (organization for municipalities and counties), Utdanningsforbundet, Norsk lektorlag, Skolenes Landsforbund, Norsk Skolelederforbund and the central education administration. It provided a common foundation for the Knowledge Promotion Reform that was implemented 2005–2008.

The aims were that the teaching personnel must have a competence that can “ensure students and apprentices an education adapted to individual needs and which can make it possible for them to develop capabilities and talents in accordance with the curriculum”. Through this strategy to enhance the competence of school leaders, teachers and trainers in training establishments were seen to be stimulated and given a chance to meet the challenges posed by the changes of structure and content of the Knowledge Promotion Reform. As the implementation of the programme did not work satisfactorily (see below), a 2nd (2009- 20012) and 3rd (2013- 2015) cycle were initiated.

Implementation
The central government spent approx. 40 mill Euro per year, and the local governments were expected to use the same amount. The partners formed a central working group and the work was administrated by Directorate of Education. Most of the money were sent to counties and municipalities to be used according to local priorities.

An evaluation report in 2008 showed that in spite of the strategy the total amount of in-service training had not increased. However, there were some tendencies of improved culture for systematic learning within the school. On the negative side, teachers were not much involved in decisions at local level, and approximately 20 % of the money was used for formal learning. In general, those teachers and school leaders were more satisfied when more decisions are delegated to the school level. It became clear that there was a lack of consistency and long-time planning in choice of themes, and a disproportionate large part of the funds was used for school leaders.

B) The following has been extracted from our NAB board meeting minutes:

(1) To mascil and world of work:
- The summative assessment runs teachers priorities, WoW/Inquiry must be reflected in the assessment system.
- The national curriculum supports both WoW and Inquiry, talk to Matematikksenteret about the National tests?

(2) Teacher professional development:
- There are a lot of ongoing professional development projects, like FYR and "ungdomsskolesatsningen"- link to these should be established.
- Three important factors for success:
  1. The head of the school must support the project
  2. The whole collegium of the school must be involved
  3. Time for working with the project must be prioritised in the teachers’ schedule, hence flexibility in PD-courses in Mascil.
8. Romania

As stated by the authors of the national report, in national policy making documents there is no evidence of connecting the general education and the world of work. This connection is not even prioritized at the level of vocational education, the contents for these types of classes (e.g. art classes in upper primary, grades 5-8) is the same as in any other classes. In addition, there is evidence that neither IBL is prioritized, nor that the teacher training is a priority in Romanian policy orientation.

At the school and classroom level, it is further stated by the report authors that there are no support materials for connecting the world of work and general or vocational education at the level of mathematics and science, the assessment is the same for all categories of students and the teaching methods are not significantly different in vocational and in theoretical schools. Furthermore, the assessment is completely against IBL. According to the report, the mascil project needs a series of materials that fits the national curriculum and the aims of the projects, is not too far from the existing teaching tradition and helps the teachers to understand how they can better facilitate the learning of their students by using these materials. This seems to be a very difficult task both on the level of general and secondary education.

_in the current situation in Romania, IBL and connections between schooling and the world of work are not supported at all levels of systemic structure. Major constrains for the realization of the mascil project are considered: the lack of relevant policy orientations; the lack of appropriate teacher training; assessment methods and support materials that do not support such initiatives._
9. Czech Republic
Currently, a reform of the education system is taking place in the Czech Republic. The changes relate to wider policy perspectives (macro level), school level (meso-level) and classroom level (micro-level), and are evident in the following lines.

In relation to wider policy perspectives, new curricular documents for primary and lower secondary education include the field of “Man and world of work”. In curricular documents the call for inquiry-based methods has appeared, but only generally mentioned for the time being. Indeed, inquiry based teaching and learning approaches are prioritized in policy making national documents on general level only, without concrete explanation and comments in examples and expected competences. Consequently, the national curriculum prioritizes inquiry based teaching and learning approaches, in general and in specific in science and mathematics subjects, in the primary, general secondary and vocational education, but unfortunately, rather on general level, without concrete explanation and comments in examples and expected competences (as in the national curriculum).

Regarding professional development, teacher training on IBL has become the main policy priority a recommended trend. Although such an orientation is being declared in educational documents on all levels, it is hardly implemented in practice.

At the school level, there seem to be only sporadic relations between general education and industry, mostly in the form of joint projects or sponsoring (funding), both in the field of formal and informal education. Direct relation between the vocational schools and industry does exist. The extent to which schools implement policy priorities in relation to inquiry based teaching and learning approaches is not large, in general and in specific in science and mathematics education on all educational levels. In relation to teacher training, overall concept of prospective training includes both the theoretical background and topics connecting school and the world of work, on all levels of the education system. The main teaching method is active learning; the IBL is on start point.

On the classroom level, the evidence in science and mathematics curricula of the connection between schooling and the world of work in terms of content has not been applied to sufficient extent (if any). Assessment of skills/competences in science and mathematics in relation to the world of work in general education has been developed to a low degree only. Inquiry teaching methods are rather applied as predominant teaching methods in vocational schools in professional subjects. Regarding the nature of students’ assessment in vocational schools, mostly traditional approaches are evident to be applied. In addition, there are several examples of curriculum supporting materials for science and mathematics education that support inquiry based teaching and learning approaches. The existing materials are mostly outcomes of projects focused on innovations. As for the nature of students’ assessment in relation to inquiry based teaching and learning in science education, there exist hardly any. For the primary school mathematics the latest Czech textbook reflects not only basic calculation processes but also develops competence for inquiring and solving given problems, focusing on collecting experience in organization of single phenomena, data processing, joining ideas of mathematics, geometry and combinatory are included in the learning content. On the lower secondary level different programmes are supported by enthusiasts, sometimes financed by private or state companies and non-governmental institution. These programmes do not cover all population – the state policy neither supports, nor creates obstacles to the implementation of IBL approaches.

Gender specific issues in science and maths education are not prioritized in policy making documents and the national curriculum in the Czech education system. The gender specific issues are part of teachers’ professional development - mainly in the group of pedagogical and psychological subjects, which cover approx. 20 % in teachers’ preparation. The training in IBL approaches takes into
consideration gender differences in terms of interests, learning styles, motivation, on all school levels. In contrast, low achievement issues are prioritized in policy making documents and the national curriculum in the country. Teachers' professional development cover issues on how to tackle low achievement in selected chapters from general pedagogy and partly in field didactics focusing on a subject in question. In addition, the entrepreneurship education is declared in main curricular objectives (trends) on all levels of the education system but the concrete implementation is missing. Explicitly professional development and training are not provided to teachers neither in the content covering issues on entrepreneurship education, nor in training in IBL approaches including aspects of entrepreneurship education.

In the Czech Republic, the national educational context seems to be passive to some extent, and definitely more supportive efforts for the IBL implementation could be included in all documents. Although the implementation of the Mascil project objectives into the currently-designed educational reform on the policy making level is obvious, the objectives are not widely reflected in school and classroom practice yet. To improve this state significantly is one of the Mascil contributions to the Czech curriculum on all levels. Large space for IBL implementation in science and maths education should be provided within the currently-prepared system of teacher post-graduate training and its projection in the teacher career structure. Pedagogies and learning materials developed within the Mascil project are expected to provide significant support in the Czech Republic.
10. Turkey

In Turkey, the science and maths curricula have been very recently changed. Important features of the new curricula are that they intend to promote the use of inquiry based education as well as alternative assessment strategies. The envisioned policy-making objectives of the reform, which are in accordance with some of the aims of the mascil project, provide a good background on the field for the implementation of project. However, in relation to teacher training, faculties of education for secondary school science and maths in Universities (which are the main providers of in-service and pre-service teacher training) are planned not to get any more students and in the future they might be closed down. This raises questions on whether teacher training is a priority of educational policy making and is considered as a barrier for the accomplishment of the mascil aims.

In relation to wider policy perspectives, the connection between general education and the world of work is mentioned and emphasized in the national curriculum. Inquiry or elements of inquiry are also mentioned, to different degrees, in the primary and secondary maths and science curricula. It should be mentioned that IBL approaches are prioritized more in science and maths than in other subjects. However, in regard to pre-service teacher training there is no explicit reference to objectives relating to IBL and connections between schooling and the world of work: Prospective teachers’ training mainly aims to train teachers to have key concepts in mathematics and science, as well as pedagogical content knowledge. This is also the case for in-service teacher training, which seems to be highly subject-oriented.

At school level, it should be mentioned that although the curriculum encourages schools connection to industrial sites, in practice it is hardly implemented. In addition, no connections between vocational school system and general schools are evident. This is also the case in relation to IBL: emphasis is given in the curricula on the implementation of IBL methods; however this is not much reflected in school practice. The reasons for such diversity are mainly teachers’ lack of training in the new curricula, teachers’ resistance to apply change in teaching methodology and their limited knowledge about how to mediate students’ actions and how to design and implement inquiry activities.

At a classroom level, activities are mainly driven by the national exams and the type of assessment, which do not currently encompass issues relating to IBL skills and skills relating to the world of work. Although the new national curricula make provisions for such type of assessment, teachers and parents seem reluctant to implement new types of assessment. As such, IBL activities are rarely implemented in the classrooms. Another reason for this is that the new science and mathematics curricula are not accompanied with a teacher’s guidebook. Teachers have not given enough resources how to implement the activities, while there is lack of assessment tools that draws on notions of inquiry based learning.

In relation to issues pertaining to general educational aims, the policy documents and the curricula state that gender inequalities should be tackled; however, no explicit specification on how to accomplish such a goal is made. This is also the case in relation to low achievement. In contrast, entrepreneurship education seems to be of priority in Turkey and such a subject is being implemented in lower secondary level since from 2009.

In summary, new curricula seem to prioritize aims relevant to the ones of the mascil project. Since the new science and mathematics curricula promote the use of inquiry based education, teachers are expected to be willing to learn more about IBL. This is an advantage for Turkish partners to get teachers attention to the projects and disseminate the mascil. A possible constrain for the implementation of the...
project though, is that at the moment teachers often have limited knowledge about how to mediate students’ actions and how to design and implement inquiry activities. So, even though inquiry is mentioned in the curricula, the extent of its application in real practice is questionable. In addition, teacher training programs in Turkey are too short to make an impact. Due to short periods of training without any reflection afterwards, there is no evidence on the effectiveness of such training. A series of teacher professional development sessions over a time period would be more effective; such an approach used in the mascil project is recommended to be more beneficial. In relation to the connections among general education, vocational education and the world of work are not as strong as intended; therefore, the mascil project could stimulate the interactions among them.

*Recent changes in the Turkish science and mathematics curricula are relevant to the mascil objectives; yet, these are not currently reflected in school and classroom practice. Some constrains for the implementation of the mascil project involve: the lack of policy prioritization of teacher training; assessment methods that do not support such initiatives; teachers and parents reluctance to accept assessment methods that relate to IBL and world of the work skills due to the nature of nationwide exams.*

- More WoW (World of Work) like activities can be used in science and maths teaching and assessment tools should be aligned with these activities. Open-ended context-based questions can be used for assessment.
- Participant teachers who joined other FP7 projects expressed that short term Professional Development programs were not so effective. They suggested continuous professional development instead.
- There is not a long-term cycle policies. One of the challenge that Turkey faces with is the unsustainable short-term cycle of policies in education. Over little more than a decade, the minister of education changed five times and each person in that role had different priorities, agendas and different kinds of science and mathematics education. Several participants claimed that there is not a strong coordination and collaboration between Ministry of Education and Higher Education Council of Turkey.
- Companies that develop and support teachers how to use IBL materials should be supported with the coordination of Ministry of Education and Higher Education Council.
- To encourage teachers to use IBSL activities, sample IBL activities from the mascil project can be translated into mother language and those can be shared with teachers. Participating and presenting at teacher conferences would help teachers to implement this kind of activities in their teaching.
11. Lithuania

Changes in the primary and secondary curricula have recently taken place in Lithuania mainly focusing on expected students’ achievements and teaching methods. The student’s achievements are described in terms of attitude, skills, knowledge and content understanding, while the IBL methodologies are explicitly suggested to be implemented in the classrooms.

At the policy making level, the connection between general education and the world of work is not a priority; yet, the Lithuanian educational system provides conditions for students to acquire skills relating to the world of work by attending additional activities after compulsory lessons. Implicit reference about connecting schooling and the world of work can also be found in primary curricula. In contrast, IBL is explicitly prioritized in national curricula. Despite this, both for pre-service and in-service teacher training programmes there is no explicit reference to IBL as a programme objective. This is also the case in terms of schooling and the world of work, with an exception to vocational education.

At the meso-level regarding the way policy envisions are reflected in schools, vocational schools are the main providers of education linking schooling with the world of work. General schools are mainly oriented towards preparing students for the national exams, which are subject knowledge oriented. Based on this, it is not a surprise that no reference is made in the Lithuanian National report about formal or informal initiatives connecting schools with industries. In relation to the degree to which schools are in support of IBL, there seems to be a diversion between the official positioning and reality: in practice schools seem to be mainly exams oriented, in which the acquisition of IBL skills is not an issue. Despite this, exceptional cases in school level do exist.

The existing situation in terms of the schools is reflected at the micro-level of classroom practice, where the acquisition of subject content knowledge seems to be the main focus in accordance to the objectives of the national exams.

In relation to strategic aims and priorities for education, issues pertaining to gender inequalities are evident at the policy making documentation but are not prioritized. Yet, teacher training in IBL approaches takes into consideration gender differences in terms of interests, learning styles, motivation. Teachers’ professional development also cover issues on how to tackle low achievement, while training in IBL approaches makes specific reference to students who under perform. Finally, national strategies and initiatives addressing the implementation of entrepreneurship education in general education both at primary and secondary level are evident.

In short, the national educational context seems to provide more hindering than supportive factors for the implementation of the mascil project. Although the aims of the mascil project are obvious in the policy making level, they are not reflected in school and classroom practice. The reasons evoked are a combination of teacher training practices, the assessment orientation and the existing materials used in the classrooms, which make school and teachers resistant to the envisioned changes.
A lack of consensus between the policy views and actual practices in terms of the aims of mascil project indicate that there are more hindering than supportive factors for the implementation of the mascil project in Lithuania. The main constrain towards this aim seem to be the national exam system which is subject-knowledge oriented, and in which the acquisition of IBL skills and skills relating to the world of work is not an issue.

Recommendations:

- make several discussions and seminars among educators how to improve education at schools and implementation of inquiry based science and mathematics as well as informatics teaching and the connection of schooling and the world of work.
- reorganize Information technology (IT) education at school: more attention to informatics (computing), IT should be integrated in various subjects
- revise curricula of lower and upper secondary schools according to inquiry based learning and teaching and the connection of schooling and the world of work.

Feedback from NAB

Education Development Centre in Lithuania had prepared methodical recommendations of Employment skills and working knowledge of the WoW. The recommendations of Mascil are to implement these methodical recommendations together with Mascil methodical material into all general education schools in Lithuania.

The Mascil recommendation is to achieve that the IBL have to be involved in natural science and mathematical education: the projects of new exams forms based on developing of students research skills of elective natural science education in general education have to be implement; the students problem solving and advanced thinking skills depending on XXI century WoW have to be developed; the importance of higher technologies, natural science, engineering and mathematics educations have to be amplify in Lithuanian general schools.
12. Austria

According to a new law published recently, changes in the teacher education system are planned to be implemented in the near future in Austria: a master's degree will be required for all teachers and training dedicated to develop and improve in-service teachers’ subject knowledge and pedagogical content knowledge will be provided. The new law also plans an induction phase after the bachelor's study, for newly recruited teachers. Changes in the curricula for the New Secondary School are also foreseen, and each subject in sciences is expected to be taught separately. Changes in the assessment have already taken place focusing on competence-oriented examination.

At the wider policy-perspective level, many initiatives on science and mathematics education with partial political support have been established in the country and indicate that at this level science and mathematics education is prioritized. In relation to the connection between schooling and the world of work, in primary, general secondary and vocational curricula, the importance of students’ preparation to the world of work is explicitly stated. This is also the case regarding science and mathematics curricula and IBL in primary level, given that inquiry-based and discovery-based learning is explicitly mentioned within the general teaching principles. Yet, in secondary general schools inquiry based learning only appears in the section for the Gifted and Talented Students, while no explicit reference is made in the vocational curricula. In relation to pre-service and in-service teacher training and professional development, the new law published recently indicates that the field is prioritized at a policy-making level. The changes seem to be mainly oriented towards teachers’ acquisition of scientific qualifications. It is also worth noticing that while in the past the pedagogical institutes were responsible for providing professional development courses, according to the new law Science and Mathematics departments in Universities will be also eligible.

At a meso-level regarding the way the national policies are implemented at schools, mathematics is prioritized in all curricula as a main subject, in contrast to sciences, which are regarded side-subject and for which less teaching time is provided. Wider policy perspectives regarding the connection of schools and the world of work also seem to be in accordance with school practices, given that a number of initiatives of general school organizing events for connecting schooling and industries are provided in the National Report of the country. In relation to IBL, there are attempts to apply explicitly inquiry-bases learning methods in the courses teacher education; however whether school practices at the moment are oriented towards IBL methodology is an open question.

At the micro-level relating to classrooms, standardized tests that have recently been introduced are expected to influence the way mathematics is taught in schools. These tests are mainly competence-oriented, and are supported by new textbooks which are more IBL oriented. Although currently, there is no evidence that students' assessment is influenced by IBL methods, the new standardized and competence-oriented examination is a first step towards this direction.

In relation to issues pertaining to strategic aims and priorities for education in Austria, both general and vocational curricula explicitly state the promotion of gender equality as a goal. Within current teacher education curricula, gender specific issues are also mentioned and respective courses are offered. Several programs are implemented aiming to encourage girls pursue science and mathematical careers. In contrast, in relation to low achievement no initiatives explicitly tackling the issue in science or in mathematics are reported. Yet, low achievement in Austria is an issue especially for students from a
migrant or low socio-economic background. In terms of entrepreneurship education, it is highly prioritized at policy making level and is evident at primary, general and vocational curricula.

In summary, the national educational context seems to support the implementation of the mascil aims. Due to a new structure of the prospective teacher’s education, an integration of the aims of the mascil project to the new curricula of the prospective teacher's education is possible. The new standardised test in mathematics education is considered a first step towards assessing IBL skills and competences, while materials supporting IBL in classrooms are available. Connections between schooling and the world of work - in all systemic levels of science and mathematics education - are evident. Yet whether current school practices are oriented towards IBL methodology is an open question.

The national educational context of Austria provides mainly supportive factors for the implementation of the mascil project, in the dimension of connecting schooling and the world of work. In the area of supporting IBL methodologies, despite being prioritized in educational policies, the degree to which such methodologies are practically being implemented in classroom level is an open question.
13. Bulgaria

In Bulgaria, the educational system is currently undergoing reforms towards educational paradigms meeting the objectives of the mascil project in relation to the use of IBL approaches and the connection between schooling and the world of work. A new law for the regulation of the entire educational sphere is being introduced, including the educational structure, the curriculum and the syllabus. Implicitly, IBL is recommended as a means for achieving some of the goals of education in the country. Similarly, the connection between the general education (both primary and secondary) and the world of work is implicitly prioritized.

As evident in the national curriculum, such a connection is indirect and can be found in some school subjects, while a more direct connection, elevated in certain sense to a priority, could be observed in the vocational schools. Currently, discussions at a policy level on how to enhance the connection between general education and the world of work take place. In relation to pre-service and in-service teacher training and professional development, the main focus remains to teachers’ acquisition of the basic content knowledge of the corresponding scientific field. Acquiring knowledge about pedagogy and subject didactics is also considered, yet no explicit reference to inquiry methodologies and methods to connect subject and the world of work is made.

At a meso-level regarding the way the national policies are implemented at schools, it should be pinpointed that in the current syllabus the number of hours for mathematics has been reduced on the account of hours for Information Technologies (IT); yet, prioritized IT is considered to be related to mathematics. The systematic use of IBL methods is not widely supported at a school level, but there are schools and teachers (both in primary and secondary school level) who use active learning/teaching on regular basis. Such teachers have been educated and encouraged to use IBL in the frames of a number of European projects, providing a good opportunity for the selection of “multipliers” within the project. In relation to schooling and the world of work, connections are most evident at vocational schools. In general schools, there are connections between general schools and the providers of informal education, initiated both by schools and by the providers of informal education on voluntary base. Yet, the prevailing connections are short-term ones. As for IBL approaches, they are used by some schools or individual teacher on their own initiative and the good practices are spread at seminars, conferences, specialized educational journals or materials published in the frames of international educational projects. Finally, in terms of teacher training it should be mentioned that there are no special provisions for newly recruited teachers, while the professional development of teachers is voluntary, with intensives relating to the salaries. The level of teachers’ motivation to participate in professional development courses is an issue and should be seen in relation to wider societal perceptions, according to which the profession of the teacher is not regarded highly prestigious.

At the micro-level relating to classrooms, a major obstacle preventing teachers for adopting IBL methods is assessment: in Bulgarian schools the methods of assessment, remain unchanged and focused on the classical way of teaching and learning science and mathematics. This is also the case in terms of connecting the subject with the world of work, given that the assessment of skills/competences in science and mathematics within the general education is rarely related to the world of work. In addition, resources and especially textbooks do not provide explicitly IBL activities. Yet, some materials have been developed mainly as an outcome of European projects.
Finally, in relation to issues pertaining to strategic aims and priorities for education in Bulgaria, gender specific issues are not prioritized both in policy making documents and in the national curriculum in Bulgaria. This is mainly because there are no gender issues in this country. In contrast, to reduce the number of low achieving students at school age is highly prioritized, both at policy making level and the level of actual implementation. This is also the case in terms of entrepreneurship, given that, there is a subject *Entrepreneurship* in both vocational and non-vocational schools.

The current educational situation in the county has various implications in terms of the accomplishment of the aims of the mascil project. As stated in the national report, the aims of the mascil project are implicitly present in terms of policy making, but are not prioritized enough. Although there is an understanding among many teachers about the possible gains offered by IBL, and many educational policy makers share and express ideas close to IBL, the latter is not recognized and promoted enough in the official documents. In addition, the lack of enough curriculum supporting materials which are suitable for application of IBL methods mainly in vocational education could be an obstacle for the accomplishment of the mascil objectives. In this respect the Bulgarian mascil team relies on the experience and the good practices of the project partners as well as on the development, within the frame of the Project, of new educational resources tuned to the specifics of vocational schools. The assessment methods that do not take into account skills and competences in relation to IBL and the world of work in schools is also a major issue, as it reflects actual teachers’ practices.

**Added by the Bulgarian Team:**

Let us note that the *top down approach* (Policy Makers - Parliament – Ministry of Education – Regional Inspectorates in Education – Schools - Teachers - Students) in heralding and spreading a new educational strategy has not proved to be very efficient in our country – the strategy usually gets outdated before being completely implemented. Having in mind that the project runs only four years, we decided to work directly and simultaneously with all levels in this ladder, giving preference to the lower end - the work with Regional Inspectorates, Schools, Teachers and Students. Only changes which are deeply rooted in the basic levels could be considered as irreversible. Accordingly, we:

- Started the teacher training earlier (Autumn of 2013) by conducting a weekly seminar with prospective multipliers as well as short courses and workshops for other teachers;
- Had a two - day meeting with mathematics experts from all Regional Inspectorates in the country (Bankja, February 16-18, 2014) demonstrating to them the advantages of IBL;
- Started the development of a Virtual Mathematics Laboratory (VirMathLab) which is available online and supports the learning of students and the teaching of teachers. At the moment (March 16th, 2014) VirMathLab contains more than 700 units (see [http://www.math.bas.bg/omi/cabinet/](http://www.math.bas.bg/omi/cabinet/));
- We have established connections with the museum in Stara Zagora and the Professional school on woodcarving in Teteven for a closer cooperation on connecting mathematics knowledge with restoring of artefacts and making creative designs for new artefacts;
- Decided to place special emphasis on the „forth level of IBL“ (the open inquiry), i.e. on the work with highly achieving students in mathematics and informatics for whom the WoW (in terms of scientific research and work on open problems) is introduced at school age. This is done mainly in the frames of the High School Student Institute of Mathematics and Informatics (HSSI) which is affiliated to IMI-BAS. Every year about 130 students take part in its two conferences and a summer school (which from the next summer will have an international component).
This grassroots approach does not mean we underestimate the higher levels of the ladder mentioned above. We have good professional contacts with mathematics experts of the Ministry of Education and enjoy their support. This ministry recently launched the idea of introducing in Bulgaria the dual education (after the German model). This has brought the professional education in the focus of social attention. We are on the way to involve more closely the Bulgarian Academy of Sciences with the implementation of IBL (in all sciences, not only mathematics). The Union of Bulgarian Mathematicians (UBM) has set the dissemination of IBL as one of its priorities. At the forthcoming annual conference of UBM (April 2-6, 2014) there will be at least four events devoted to IBL, including a Mascil Workshop.