# International 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.

## Project Information

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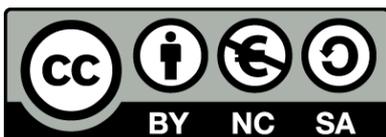Funding scheme: FP7

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# International report and policy paper

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## Executive Summary

**Background**

The current European policy agenda gives particular emphasis on the ***improvement of quality and efficiency of educational and training systems***, under the scope of of enhancing employability, of promoting active citizenship and of enhancing creativity and innovation. Among other challenges to be addressed for the achievement of this strategic objective is the ***reduction of low achievement in basic skills,*** *the* ***strengthening of the development of transversal skills and key competences,*** *and the* ***promotion of equity.*** The work pertaining to policy issues within the mascil project focuses on STEM, an area that is interrelated with the EU strategic priorities in education and training. Amongst the proposed approaches to achieve the set targets is the promotion of ***inquiry-based teaching strategies;*** the ***opening of schools to the world of work; the effective initial teacher education and continuous professional development*** for science and mathematics teachers.

This document provides a detailed overview of the work pertaining to policy issues that was conducted in the frame of the mascil project. It concerns the promotion of inquiry-based teaching strategies, the opening of schools to the world of work, and the effective initial teacher education and continuous professional development. The focus of the work has been on the ***identification of the contextual factors that affect the mediation of policy envisions to actual educational practice***. *The work covered* **13 national policy contexts in Europe** (Germany, Greece, the Netherlands, UK, Spain, Cyprus, Norway, Romania, Czech Republic, Turkey, Lithuania, Austria and Bulgaria) with 2013 as the reference year**,** and concerned the analysis of contextual factors at **national** and **cross-national levels**.

**Aims and purpose**

The utility of the document comes to serve two purposes:

a) ***From an operational perspective***, to facilitate the consortium to actively involve policy makers in the project's endeavour, by informing on the factors that impede upon effective policy implementation and by proposing recommendations for policy engagement in the project's endeavours;

b) ***From a conceptual perspective***, to inform the development of future policy in national and European settings, by articulating recommendations for policy makers and policy making under the in scope of supporting a more widespread uptake of inquiry based learning in vocational contexts

The work conducted and outcomes achieved through an analytical perspective between context and policy intentions can ***provide the basis for the establishment of dialogic process between research, policy and practice.*** On such a basis, educational stakeholders may reflect on their own policy context and consider how the aims of strategic policy priorities are not only achieved but also negotiated for further educational improvements*.*

**Method used**

The work reported in this document concerns the mapping the outcomes of the negotiation process with educational stakeholders – reflections and proposals – onto the outcomes of the cross-national analysis of educational contexts. The mapping was conducted with the aid of the analytical framework and builds on the multidimensional analysis of policy contexts conducted in the second phase of work:

a) ***Mapping in terms of the three levels of systematic analysis***: the cross-national analysis of the contexts in terms of macro, meso and micro levels resulted in the identification of prominent issues relating to policy priorities, managing/mediating mechanisms and actual implementation. Insights from the negotiation with educational stakeholders provided valuable new perspectives on the factors that embed upon effective mediation of policy envisions to educational practice

b) ***Mapping in terms of the main areas of focus***: the cross-national analysis of contexts in terms of main areas of focus resulted in the identification of prominent issues for consideration in relation to 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. Outcomes from the negotiation with educational stakeholders provided new insights on the hindering & supportive factors to facilitate teachers in the implementation of IBL in WoW contexts

c) ***Mapping in terms strategic priorities for education***: the cross-national analysis of contexts in terms of strategic priorities of education lead to the identification of issues pertaining the remaining challenges for the promotion of equity, the enhancement of students' achievement and the promotion of entrepreneurship. Insights from the negotiation with educational stakeholders provided valuable new perspectives on whether and up to what degree inquiry approaches in a WoW context can be a lever towards achieving broader policy priorities

**Summary conclusions & Recommendations**

***Effective mediation of policy envisions into practice:*** 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. **Factors that seem to impede upon effective mediation of** policy envisions to educational practice are: the **existence of short-term cycles of policies in education,** which lead practitioners to intervention fatigue; the **lack of policy coherency between proposed pedagogies, curricula and assessment system,** which lead practitioners to confusion in terms of purposes; the **lack of coordination between educational policies and actors responsible for teacher training**, which results in lack of coherence in policy rhetoric between expectations of students' learning and expectations of teachers' training**.**

❖ *Recommendation*

In order to increase the chances of effective mediation of policy envisions to educational practice, **educational reforms should be implemented under a long-term vision**, as short term and rapidly changing cycles of policies lead practitioners to intervention fatigue. For practitioners to understand what educational change involves and build capacities to implement envisioned changes confusion in terms of purposes should be avoided, by a **stronger alignment between proposed pedagogies, curricula and assessment systems**. Policy coherence between expectations of students' learning and expectations of teachers' training should also be established, by **fostering cooperation and coordination between educational policies and actors responsible for teacher training.**

***Supporting the implementation of inquiry approaches:*** 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 learning is not incorporated in the school culture. **Schools' culture seems to be resistance to change**, while **traditional teaching focusing on the transmission of content knowledge seems to dominate everyday classroom practice** in many countries of the consortium. Factors that impede upon implementation of inquiry approaches in classroom practice are: **Non-flexible national curricula** in science and mathematics that do not allow space and time for inquiry based approaches; **The exam- orientation of many educational systems with subject-oriented assessment objective**s, which do not acknowledge and reward inquiry as an important part of what constitutes

knowledge in the mathematics and science subjects; **Lack of corresponding materials incorporated in the textbooks and in some cases lack of guidelines** for teachers for successful implementation if inquiry approaches; **Reluctance to implement classroom activities under inquiry approaches, not only from the part of teachers but also from parents**, in the view that these are not a subject in the national exam system.

❖ *Recommendation*

In order to increase the chances of inquiry based approaches to be implemented in actual classroom practice, there is a need for **more flexible science and mathematics curricula** that allow space and time for inquiry approaches. **Assessment systems should acknowledge and reward inquiry** as an important part of what constitutes knowledge in the mathematics and science subjects, in order to reduce teachers and parents' reluctance to the implementation of inquiry based activities. For successful implementation of inquiry approaches, there is a need to **help teachers in enriching their repertoire towards inquiry based learning,** by incorporating corresponding materials in the textbooks and by providing them with concrete guidelines on how to implement new practices effectively.

*Supporting the connection of schooling and the world of work:* Connections between schooling and the world of work seem to be prioritized more in vocational than in general education, both at primary and secondary levels. **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**. For the vast majority of the national contexts there is evidence of a **lack of appropriate teaching recourses** in science and mathematics subjects relating to the world of work, while in terms of **assessment practices**, they are **rarely related to the work of work** in most national contexts*.

❖ *Recommendation*

There is a need to **value the connections between schooling and the world of work**, by **including aspects of the world of work in the national curricula**. Policy makers should consider the potential of such a connection, on the basis of an appropriate preparation of pupils for the career entry and in the view of enhancing employability. However, simply including aspects from the world of work is not sufficient;

in order to emphasize the high significance of vocational competences, **specifications for implementation and appropriate measures for assessing them should be integrated in the curricula as well**. Towards this end there is **a need to support the development of educational materials to help teachers enrich their repertoire** towards making connections between schooling and world of work aspects. **The strengthening of the cooperation between general and vocational education** is also of importance, as it would enable the exchange of good practices and experiences.

*Ensuring quality in 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**. Factors that seem to impede upon ensuring quality in teacher training are: the **existence of short-term cycles of teacher training** mainly project driven**,** which are unsustainable and inefficient in creating long-term learning impact; the **discrepancy between teachers', researchers' and policy makers' perceptions** in relation to the overall orientation and the issues that should be broached at professional development courses; the **absence of structural conditions that allow teachers participating** in professional development courses, such as the possibility to be absent from school duties, as well as the possibility for financial compensation for covering costs incurred in connection with their participation in PD courses.

❖ *Recommendation*

For ensuring high quality teaching, there is a need for capacity building activities that are aimed at transforming teachers to informed, reflective and engaged mediators of educational change. Important in this respect is the provision of more coherent and learning-oriented professional development programmes for teachers, in order to improve their confidence and capacities. Effective teacher professional development requires time, space, coherent structures and close cooperation between policy, research, CPD providers and teachers. On-off events are rarely successful in embedding new practices, which require time for reflection and on-going peer learning processes.

*Addressing strategic policy 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 unsatisfactory. 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 cased, though, support for teachers to implement entrepreneurship activities is still required. The above indicate an incompatibility between wider policies envisions and concrete policy actions for implementation.

❖ *__Recommendation__*

**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.**

*Reinforcing policy engagement in mascil endeavour:* In the process of planning and implementing policy workshops – in order to negotiate with educational stakeholders over the issues emerged from the analysis of the national and EU educational contexts – we confronted **two main challenges**: a) to actively engage of policy makers – defined as influential stakeholders in each country – in the process of reflecting on/for inquiry based learning and world of work  issues during national workshops and b) to address diversity among the participant countries in the effort to meet project objectives (i.e. cultural, thematic, applied methodology). The methodological procedures that we

followed allowed to successfully address the two main challenges that we faced during the conduction of the work: the active engagement of policy makers – achieved by the **careful selection of participants with the aid of the national advisory boards (NABs)** – and the diversity among the participants countries – addressed by **allowing flexibility in workshop methodology, in the target groups selection and in thefocus on the topics discussed in each workshop**.

❖ *Recommendation*

The diversity among the participants' countries (cultural, thematic, applied methodology) is a big challenge that should be faced by **flexibility in future action plans** (in terms of methodology, in the target groups' selection and in the focus on the topics). Action plans for realisation of recommendations that emerged from the policy workshops should – at a first level – be national/local taking into consideration national conditions. On the other hand, lot of changes and reforms take place in relation to curricula in recent years in most countries. In order **the outcomes and recommendations of the policy workshops** to attract the attention of broader policy audiences – and not be anticipated as short term initiatives that will be out of date in the near future –, they **should be embedded in the frame of broader education priorities** (such as equity, achievement, entrepreneurship) and communicated to the policy makers under such a rationale.

The work conducted and outcomes achieved through an analytical perspective between context and policy intentions can provide **the basis for the establishment of dialogic process between research, policy and practice**. On such a basis, educational stakeholders may reflect on their own policy context and consider how the aims of strategic policy priorities are not only achieved but also negotiated for further educational improvements.

# 1. Main Report

The current European policy agenda gives particular emphasis on the ***improvement of quality and efficiency of educational and training systems***, under the scope of of enhancing employability, of promoting active citizenship and of enhancing creativity and innovation (Education and Training 2020). Among other challenges to be addressed for the achievement of this strategic objective is the ***reduction of low achievement in basic skills,*** the ***strengthening of the development of transversal skills and key competences,*** and the ***promotion of equity*** (2015 Joint Report on the implementation of ET 2020 – New priorities for European cooperation in education and training).

The work pertaining to policy issues within the mascil project focuses on STEM, an area that is interrelated with the EU strategic priorities in education and training. The priorities concern students' achievement, the strengthening of the development of key competences and the promotion of equity. Amongst the proposed approaches to achieve the set targets is the promotion of ***inquiry-based teaching strategies,*** 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); the ***opening of 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, like entrepreneurship capacities (see for example Hoyles at al., 2010).; ***the effective initial teacher education and continuous professional development*** for science and mathematics teachers, as a key requirement for mediating policy intentions to actual educational practice(see for example Education and Training 2020).

This document provides a detailed overview of the work pertaining to policy issues that was conducted in the frame of the mascil project. It concerns the promotion of inquiry-based teaching strategies, the opening of schools to the world of work, and the effective initial teacher education and continuous professional development. The focus of the work has been on the ***identification of the contextual factors that affect the mediation of policy envisions to actual educational practice***. The work covered ***13 national policy contexts in Europe*** (Germany, Greece, the Netherlands, UK, Spain, Cyprus, Norway, Romania, Czech Republic, Turkey, Lithuania, Austria and Bulgaria) with 2013 as the reference year***,*** and concerned the analysis of contextual factors at ***national*** and ***cross-national levels***.

The utility of the document comes to serve ***two purposes***:
  a) From an operational perspective, to facilitate the consortium to actively involve policy makers in the project's endeavour, by informing on the factors that impede

upon effective policy implementation and by proposing recommendations for policy engagement in the project's endeavours;

b) From a conceptual perspective, to inform the development of future policy in national and European settings, by articulating recommendations for policy makers and policy making under the in scope of supporting a more widespread uptake of inquiry based learning in vocational contexts

The work conducted and outcomes achieved through an analytical perspective between context and policy intentions can provide ***the basis for the establishment of dialogic process between research, policy and practice***. On such a basis, educational stakeholders may reflect on their own policy context and consider how the aims of strategic policy priorities are not only achieved but also negotiated for further educational improvements.

## 1.1 Aim and objectives

The document "International report and policy paper" stems from work developed in the frame of the mascil project's second work package (WP2), entitled 'Educational systems and policy contexts'. Activities within WP2 were conducted under the ambitious aim of fostering consensus building among policy, research & practice field - in the view of supporting the widespread uptake of inquiry-based learning (IBL) in a world of work (WoW) context.

The objectives of the work were:
- To investigate the contextual and regulatory conditions in each of the 13 participant countries, in which teachers work and are called upon to implement (or not) inquiry-based approaches to their teaching in world of work context;

- To develop a thorough understanding of current policy intentions and actual practice in prominent areas of STEM education at EU level, by identifying hindering and supportive factors to attain the main project goal, namely to support teachers in the implementation of inquiry based learning in vocational contexts;

- To negotiate with educational stakeholders over the issues emerged from the analysis of the national and EU educational contexts, in order to articulate recommendations for policy makers and policy making under the in scope of supporting a more widespread uptake of inquiry based learning in vocational contexts;

- To structure the outcomes of the negotiation process with educational stakeholders –reflections and proposals - in the outcomes of the negotiation

process with educational stakeholders in order to create a policy-relevant framework for connecting mathematics and sciences with the work of work via inquiry approaches.

The achievement of the above objectives aim to contribute towards facilitating *the building of thinking for action taking*, under the scope of providing insights for achieving policy intended educational goals.

## 1.2   Methodology

The activities within WP2 were structured in four phases, in respect to the main objectives presented in the previous section. Figure 1 provides an overview of the methodology followed in each phase in relation to the work objectives and the main outcomes.

***The first phase*** of the work related to the first objective, i.e. the investigation at a national level of the contextual and regulatory conditions in which teachers work and are called upon to implement (or not) Inquiry Based Science and Mathematics teaching approaches in world of world contexts.  For the accomplishment of this objective a common framework for the analysis of the national contexts was developed (see Appendix 1) consisting of the following major elements:  **a)** it covered 13 national policy contexts within Europe (Germany, Greece, the Netherlands, UK, Spain, Cyprus, Norway, Romania, Czech Republic, Turkey, Lithuania, Austria and Bulgaria); **b)** it examined 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 considered 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 was 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 drafted and completed by each of the 13 mascil country groups, with respect to their own country. Each country group conducted document analysis of national policy documents and extant literature, on the following themes: institutional setting and context; state of affairs/recent changes; schooling and

the world of work; science and mathematics curricula and IBL; pre-service and in-service teacher training in relation to IBL and the world of work; equity specific issues; addressing low achievement; promoting entrepreneurship.The outcome of this process was 13 national working papers of the policy contexts on the following themes reported in mascil Deliverable D2.1.

**Figure1:** Outline of work relating to policy issues in mascil
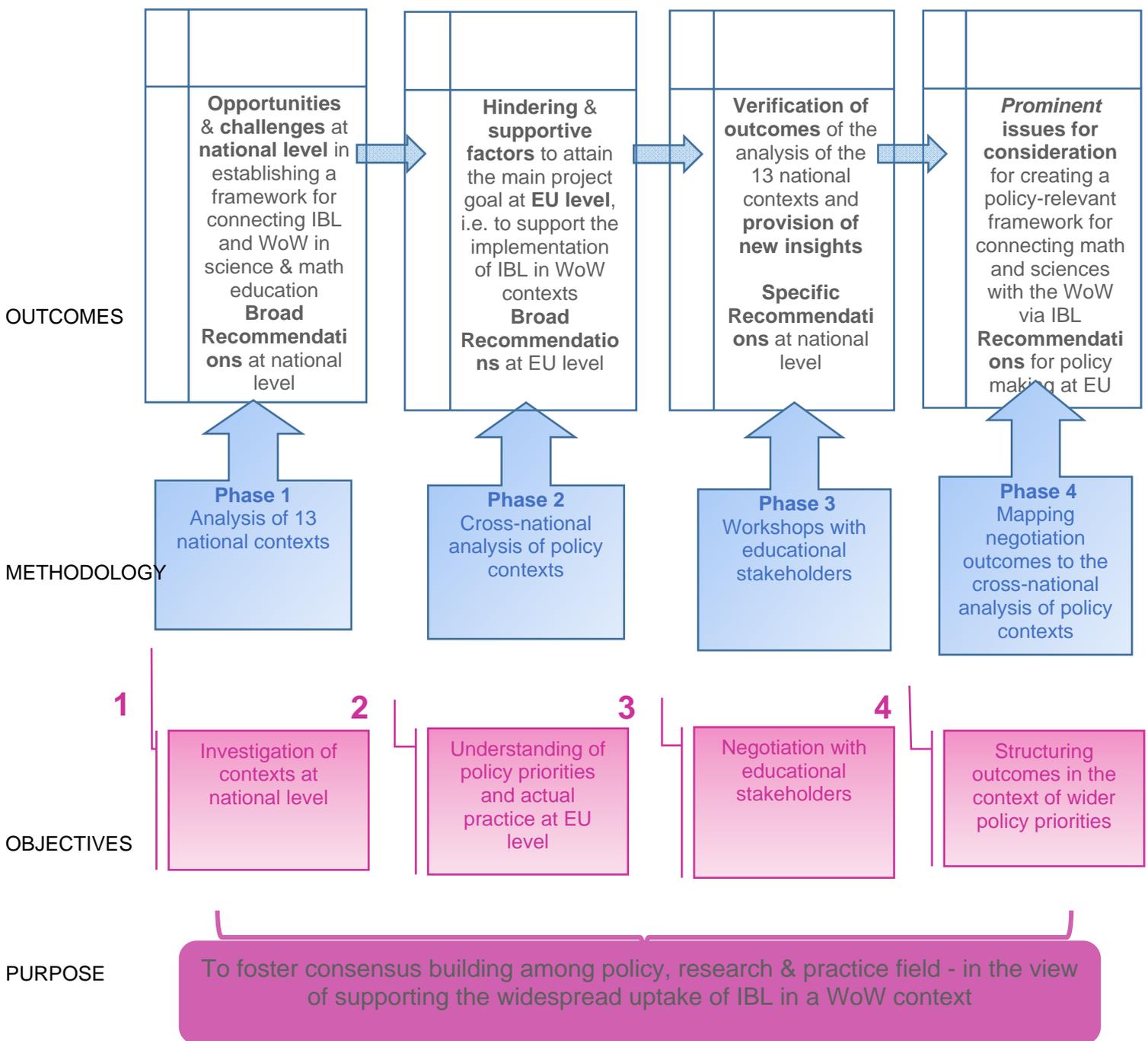
The 13 national working papers were the basis for conducting a mapping and analysis of the thematic orientation of the National Reports in terms of levels (the micro-level in terms of policy orientation; the meso-level in relation to schools and institutes; the micro-level regarding the current situation in classrooms). This was done under the guidance of the analytical framework. For each level, a first set of conclusions relating to the changes required to support the Inquiry- Based Learning approaches in vocational contexts in each country was produced, and issues pertaining to strategic aims and priorities for education (promoting equity, students' achievement and entrepreneurship) in each country highlighted. A first set of recommendations relating to the changes required to support the Inquiry- Based Learning approaches in vocational contexts was also provided and are reported in D2.1.

*The second phase* of the work related to the second main objective, i.e. to develop a thorough understanding of current policy intentions and actual practice in prominent areas of STEM education at EU level, by identifying hindering and supportive factors to attain the main project goal, namely to support teachers in the implementation of IBL in vocational contexts. For the accomplishment of this objective we synthesized the information provided in the national working papers, identifying differences and commonalities among the participant countries. The analysis was conducted from multidimensional perspectives, with the aid of the analytical framework (see Appendix 2):

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.

In respect to each dimension of analysis, a set of conclusions was reached, leading to a set of recommendations for the development of future policy in national and European settings (reported in D2.2).

*The third phase* of the work related to the third objective, i.e. to negotiate with educational stakeholders over the issues emerged from the analysis of the national and

EU educational contexts, in order to articulate recommendations for policy makers and policy making under the in scope of supporting a more widespread uptake of IBL in vocational contexts. For the accomplishment of this objective, we confronted **two main challenges**: *a) to actively engage of policy makers* – defined as influential stakeholders in each country- in the in the process of reflecting on/for inquiry based learning and world of work issues during national workshops and *b) to address diversity* among the participant countries in the effort to meet project objectives (i.e. cultural, thematic, applied methodology).

With a view to address these challenges so to facilitate the establishment of a dialogic process through national workshops with policy makers in each country, the following methodological steps were made in the planning, implementation and documentation phase: We developed a briefing paper "National policy workshops and National policy papers", guidelines for planning and implementation of National Policy workshops (see D2.3), which provided information on the focus, the planning and the implementation of the national workshops, as well as the tasks and deadlines, for both implementation and documentation of the workshops. With the aid of this document each national group produced initial plans for their national workshops, which undergo an iterative cycle of improvements with the active engagement of the National Advisory Boards (NAB). This process resulted in the implementation of national policy workshops in 12 out of 13 countries, engaging in a dialogic process more than 250 educational stakeholders, investigating in more detail and depth their own policy context and considering how the strategic aims of policy priorities can not only be achieved but also negotiated for further educational improvement. The exchange of workshop experiences in a project meeting in May 2015, resulted in the identification of strengths, weaknesses, opportunities and threats (SWOT) in each national context in the dimensions of: planning, networking, implementation, outcomes and reporting of workshops.

The methodological procedures that we followed allowed to successfully address the two main challenges that we faced during the conduction of the work: the active engagement of policy makers – achieved by the careful selection of participants with the aid of the national advisory boards (NABs) – and the diversity among the participants countries – addressed by allowing flexibility in workshop methodology, in the target groups selection and in the focus on the topics discussed in each workshop. The documentation of the processes and outcomes of the national workshops as well of the SWOT analysis was reported in D2.3.

The **fourth** –and last- **phase** of the work related to the fourth objective, i.e. to map the outcomes of the negotiation process with educational stakeholders –reflections and proposals – onto the outcomes of the cross-national analysis of educational contexts, in order to create a policy-relevant framework for connecting mathematics and sciences with the world of work via inquiry approaches. The mapping was conducted with the aid

of the analytical framework and builds on the multidimensional analysis of policy contexts conducted in the second phase of work:

a) ***Mapping in terms of the three levels of systematic analysis***: the cross-national analysis of the contexts in terms of macro, meso and micro levels resulted in the identification of prominent issues relating to policy priorities, managing/mediating mechanisms and actual implementation. Insights from the negotiation with educational stakeholders provided valuable new perspectives on the factors that embed upon effective mediation of policy envisions to educational practice (see Figure 2).

**Figure 2:** Schematic illustration of mapping outcomes from policy workshops into outcomes of the cross-national analysis in terms of levels of systematic analysis
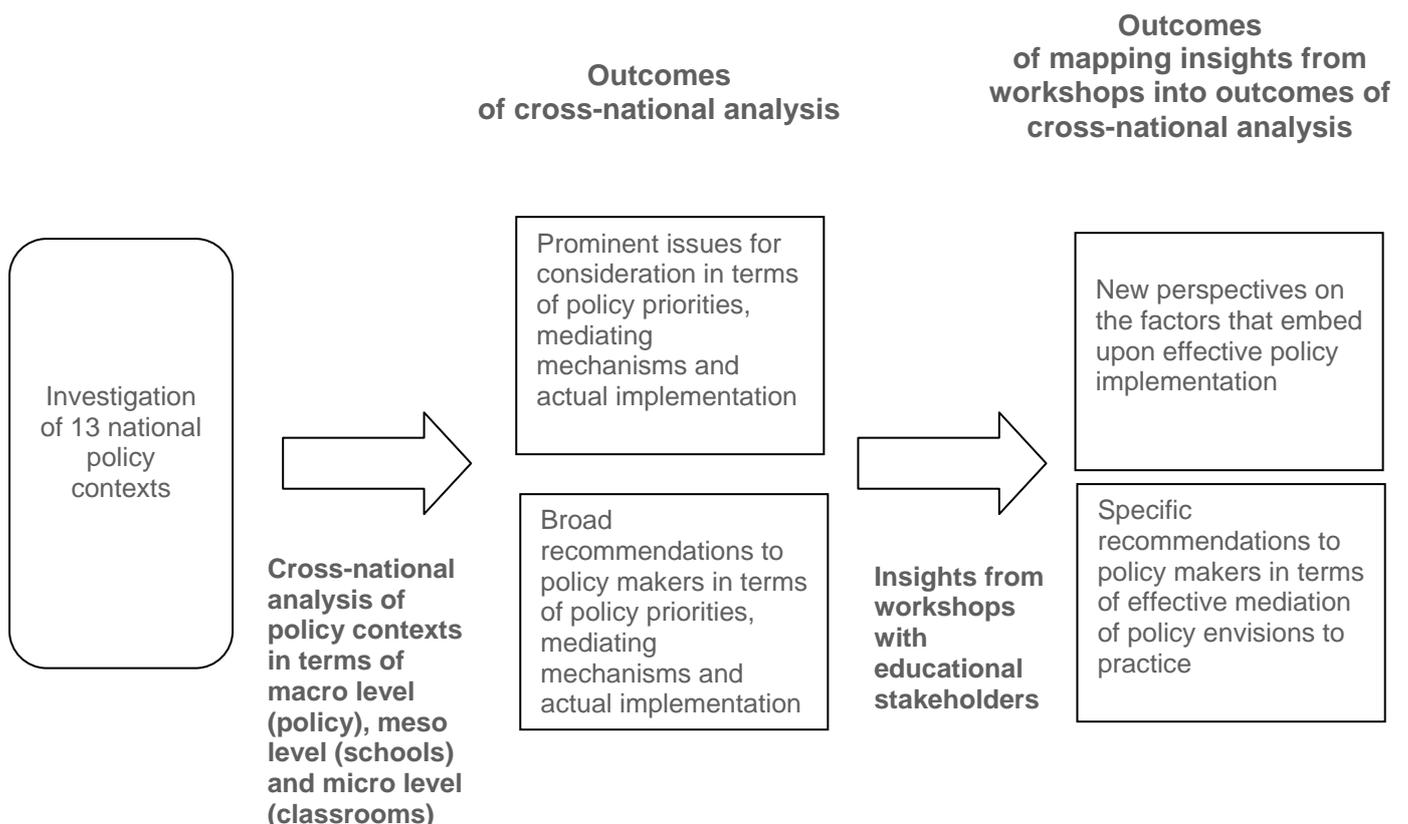
**Outcomes
of cross-national analysis**

**Outcomes
of mapping insights from
workshops into outcomes of
cross-national analysis**

Investigation of 13 national policy contexts

**Cross-national analysis of policy contexts in terms of macro level (policy), meso level (schools) and micro level (classrooms)**

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

Broad recommendations to policy makers in terms of policy priorities, mediating mechanisms and actual implementation

**Insights from workshops with educational stakeholders**

New perspectives on the factors that embed upon effective policy implementation

Specific recommendations to policy makers in terms of effective mediation of policy envisions to practice

b) ***Mapping in terms of the main areas of focus:*** the cross-national analysis of contexts in terms of main areas of focus resulted in the identification of prominent issues for consideration in relation to 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. Outcomes from the negotiation with educational stakeholders provided new insights on the hindering & supportive factors to facilitate teachers in the implementation of IBL in WoW contexts (see Figure 3)

**Figure 3:** Schematic illustration of mapping outcomes from policy workshops into outcomes of the cross-national analysis in terms of major areas examined
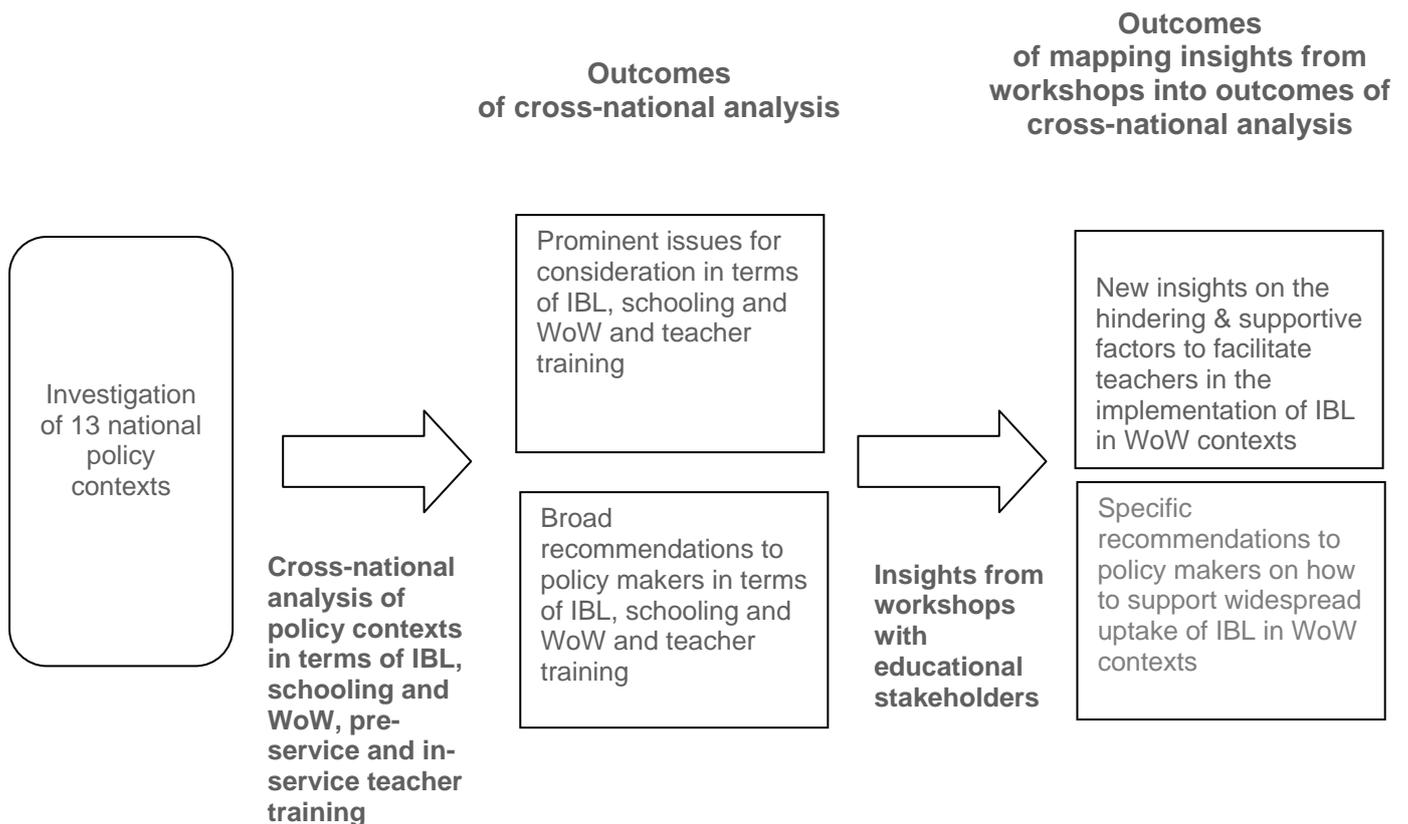
c) ***Mapping in terms strategic priorities for education:*** the cross-national analysis of contexts in terms of strategic priorities of education lead to the identification of issues pertaining the remaining challenges for the promotion of equity, the enhancement of students' achievement and the promotion of entrepreneurship. Insights from the negotiation with educational stakeholders provided valuable new perspectives on whether and up to what degree inquiry approaches in a WoW context can be a lever towards achieving broader policy priorities (see Figure 4)

**Figure 4:** Schematic illustration of mapping outcomes from policy workshops into outcomes of the cross-national analysis in terms of strategic priorities of education
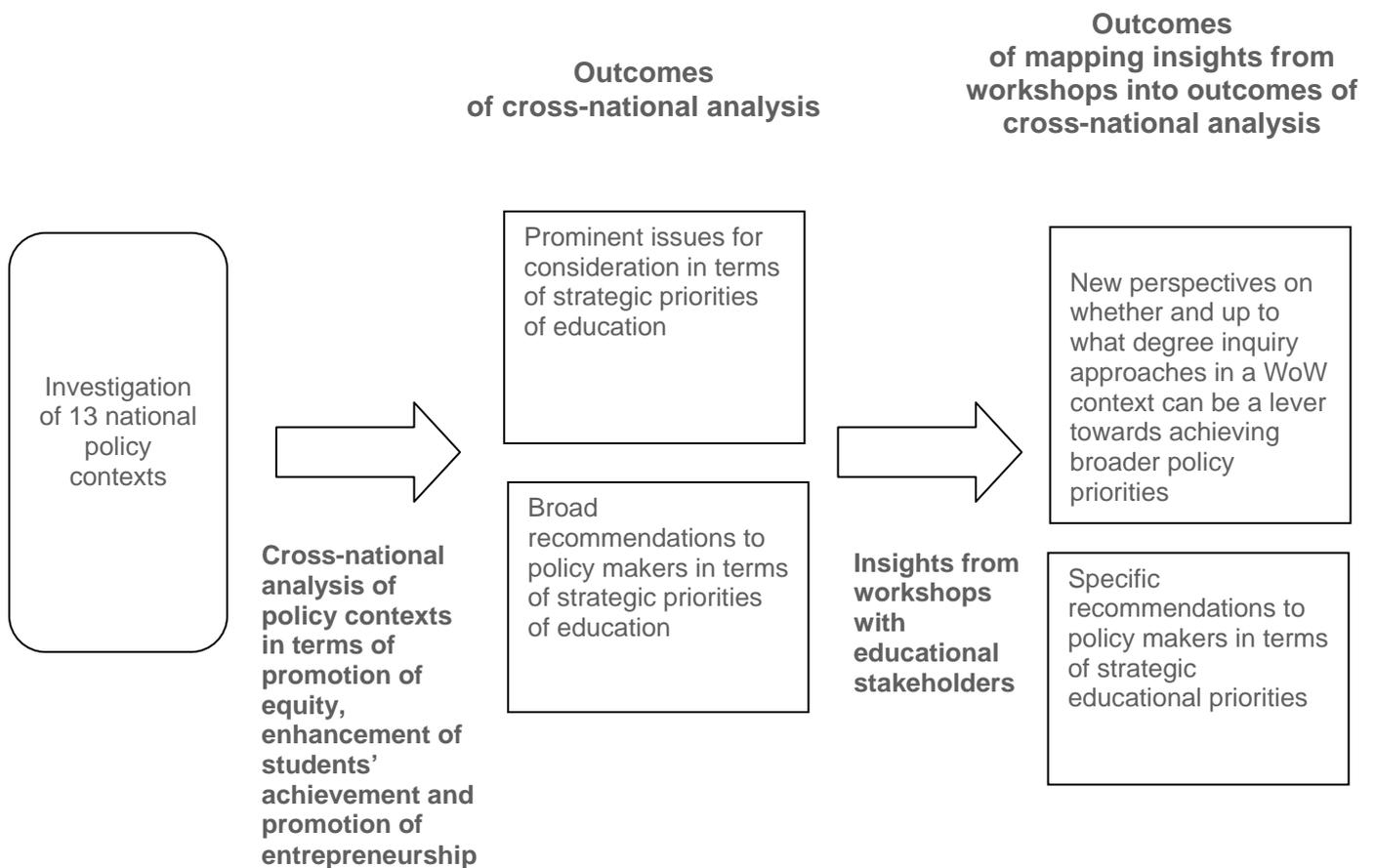
**Outcomes
of cross-national analysis**

**Outcomes
of mapping insights from
workshops into outcomes of
cross-national analysis**

Investigation of 13 national policy contexts

**Cross-national analysis of policy contexts in terms of promotion of equity, enhancement of students' achievement and promotion of entrepreneurship**

Prominent issues for consideration in terms of strategic priorities of education

Broad recommendations to policy makers in terms of strategic priorities of education

**Insights from workshops with educational stakeholders**

New perspectives on whether and up to what degree inquiry approaches in a WoW context can be a lever towards achieving broader policy priorities

Specific recommendations to policy makers in terms of strategic educational priorities

Section 1.3 of this document outlines the results of the mapping process of the outcomes from policy workshops into the outcomes of the cross national analysis, conducted under a multidimensional perspective: in terms of levels of systematic analysis; in terms of areas of focus and in terms of strategic priorities of education. In respect to each dimension of analysis, conclusions reached are provided in Chapter 2, leading to recommendations for the development of future policy in national and European settings.

## 1.3 Mapping insights from policy workshops onto the outcomes of the cross-national analysis of policy contexts

This section of the document outlines the results of the mapping process of the outcomes from policy workshops into the outcomes of the cross national analysis. The mapping was conducted under a multidimensional perspective: in terms of levels of systematic analysis; in terms of areas of focus and in terms of strategic priorities of education. Results of the mapping process are of importance to policy stakeholders, as they inform on the factors that impede upon supporting the wisespread uptake of inqury approached in world of work contexts.

### 1.3.1 Issues pertaining to mediation of policy envisions into practice

The comparative analysis of the national contexts provided evidence that *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.

The gap between policy intentions and practice was an issue that discussed in a number of national workshops (for example in Spain, the Netherlands, Greece, Cyprus , Norway and Turkey) under the scope of identifying factors that impede upon bridging the gap and of proposing strategies for reducing it. Feedback from workshop participants indicate that a major factor that impede upon effective mediation of policy envisions to practice is *the existence of short term cycles of policies in education*, which leads educational stakeholders from meso and micro levels (heads of schools, science and math advisors, and science and math teachers) to "*intervention fatigue*". In Turkey for example workshop participants pinpointed the luck of long term cycles of policies, as "over little more than a decade, the minister of education changed five times, and each person in that role had different priorities and agendas in science and mathematics education". In a similar vein, the Romanian workshop report states that "the rate of changes inside the system is too big and this leads to a high resistance on teachers' side".

Another constraining factor towards bridging the gap between what is envisioned in theory and what is implemented in practice, as emerged from workshop discussion is the *lack of policy coherency between proposed pedagogies, curricula and assessment systems*. In the Norwegian workshop for example, one of the main outcomes was the need "to make the alignment of policy visions more clear, by the

establishment of curricula and assessment systems that support pedagogies proposed in policy documents". Incompatibility between pedagogies, curricula and assessment was an issue that also emerged from educational stakeholders' discussions in Greece, Cyprus and Turkey. In these workshops, participants highlighted that policy makers should ensure that assessment reflects new teaching methods and that curriculum facilitates them rather than constraining them. The lack of coherency in policy orientation between pedagogies, curriculum and assessment may lead educational practitioners to **confusion in terms purposes**, resulting in low chances of attainment of policy visions and expectations.

Outcomes of the comparative analysis of the national contexts in terms of the levels of systematic analysis, also provided evidence that there is a **lack of coherence in policy rhetoric between expectations of students' learning and expectations of teachers' training**. 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.

In the Germanic policy workshop among the proposed recommendation towards bridging this gap was that the **programs of CPD courses should be designed in cooperation between researchers and representatives of educational policy**. Teachers' perspective is recommended to also be taken into account by those who are designing processed. Such an interactive process may guarantee that important issues to policy are incorporated into professional development and - vice versa - pre-service and in-service teacher training orientation is incorporated into policy agendas. For such a cooperation to take place among other challenges to be confronted is **the establishment of a common vocabulary** between policy makers and teacher training developers and providers, an issue that was raised in the workshops of Cyprus and the Netherlands.

In short, factors that seem to impede upon effective mediation of policy envisions to educational practice are:
- the **existence of short-term cycles of policies in education,** which lead practitioners to intervention fatigue;
- the **lack of policy coherency between proposed pedagogies, curricula and assessment system,** which lead practitioners to confusion in terms of purposes;
- the **lack of coordination between educational policies and actors responsible for teacher training**, which results in lack of coherence in policy rhetoric between expectations of students' learning and expectations of teachers' training*.*

The mediation of policy envisions into practice is neither a liner nor a "quick-fix" procedure, as it requires time for teachers to understand what educational change involves, to build capacity to implement envisioned changes and –ideally- to feel some involvement with and ownership of the policy. Also, the compatibility between policy envisions regarding the teaching of mathematics and sciences as evident in policy documents and policy orientations regarding teacher training, can be a step towards bridging the gap between what is envisioned in theory and has is implemented in practice.

### 1.3.2  Issues pertaining to inquiry based learning

The comparative analysis of the national contexts provided evidence that 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. It has been expected that feedback from policy makers during workshops could provide elaborations on the reasons for such an orientation. Yet, this was not an issue explicitly raised during the workshops. However, discussions among workshop participants provide indications that a reason of such an orientation maybe that policy makers luck information on how IBL can contribute towards wider policy priorities. In the Czech Republic workshop, for example, policy makers stated that they luck information on the actual impact of inquiry approach to support students' content knowledge. They held the view that inquiry approaches lead to uncertain learning results. In the Greek workshop, on the other hand, participants raised the question on whether inquiry approaches can provide inspiration for young people to choose science-based careers - an issue which has been at the core of policy priorities the recent years. Actually, as recommended by a report on an extensive review of documents of STEM education projects (INSTEM project, Summary Report 2015), a crucial factor towards this end is students' sustained engagement with scientific activity over long periods, rather than one-off visits to science centers or the citation of scientists role models. In the view of the above, it is recommended that in order the outcomes of research and project work to attract the attention of policy, they should be embedded in the frame of broader education priorities and communicated to the policy makers under such a rationale.

At a school and classroom levels, findings from the cross-national analysis of policy contexts 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 learning is not incorporated in the school culture. ***Schools' culture seems to be resistance to change***, and ***traditional teaching focusing on the transmission of content knowledge seems to dominate everyday classroom practice*** in many countries of the consortium. This was an issue discussed in most of national workshops (for example in Spain, the Netherlands, Turkey, Cyprus, Lithuania, Greece, Czech Republic, Norway and Bulgaria) under the scope of identifying ***factors that impede upon implementation of inquiry approaches in classroom practice***. Feedback from workshop participants verified the outcomes of the analysis of the policy contexts: The ***reasons*** evoked 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 objective***s 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.

An important outcome of the negation with educational stakeholders, was the articulation of recommendations in order to support the implementation of inquiry approaches in classroom practice. As an outcome of the Norwegian workshop, it was recommended that "for IBL approaches to become an integrated part of teaching in mathematics and science, a 'culture change' appears to be necessary. Such change relies on the ***active participation of the communities of teachers in schools***. This can only be accomplished through the ***active facilitation by school authorities at all levels***, by providing the necessary resources, not least by setting off adequate time for teachers to engage in professional development and collegial communities of practice". In this workshop highlighted was that 'the way subjects are taught in school is to a large extent dependent on what is assessed in exams. To advance the uptake of inquiry approaches, it is therefore essential that ***the national curricula and examinations acknowledge and reward inquiry*** as an important part of what constitutes knowledge in the mathematics and science subjects". In the Romanian workshop, on the other hand, educational stakeholders focused on the need "to ***give teachers more freedom, more autonomy and less administrative work and less centralized curricula*** in

order to stimulate teachers in experimenting new teaching methods". In the Czech Republic workshop it was recommended "to **ensure stronger and concrete support of implementation of IBL in curricula documents, including renovation of textbooks and other study materials**". In the Greek workshop, participants proposed ways of **taking advantage existing opportunities in the system** (for example proposed that the teachers' guidelines book should contain exemplars of IBL activities for specific curriculum lessons), as well as recommended proposals for overcoming obstacles (for example that **the curriculum** should be more focused -teaching less topics- and **more flexible so as to allow IBL approaches** and that in the exams, an open-problem should be added to **allow assessment of IBL outcomes**).

In short, factors that impede upon implementation of inquiry approaches in classroom practice are:

- **Non-flexible national curricula** in science and mathematics that do not allow space and time for inquiry based approaches;

- **The exam- orientation of many educational systems with subject-oriented assessment objective**s, which do not acknowledge and reward inquiry as an important part of what constitutes knowledge in the mathematics and science subjects;

- **Lack of corresponding materials incorporated in the textbooks and in some cases lack of guidelines** for teachers for successful implementation if inquiry approaches;

- **Reluctance to implement classroom activities under inquiry approaches, not only from the part of teachers but also from parents**, in the view that these are not a subject in the national exam system.

An essential precondition for inquiry based approaches to be implemented in actual classroom practice is to value the learning of inquiry process in schools, by identifying and including the assessment of these processes in national exams. There seems to be a need for a better alignment between inquiry pedagogy, curricula orientation, textbook materials, teachers' guidelines and assessment, ensuring that assessment reflects new teaching methods and that the curriculum facilitates inquiry rather than constraining it.

### 1.3.3 Issues pertaining to schooling and world of work

The comparative analysis of the national contexts provided 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.

The feedback of the participants of the national workshops verified the above results of analysis of contexts, in relation to the connection between schools and the world of work. In the Germanic second policy workshop, the participants dealt with the issues of how this connection currently appears in the national context and how different key players can more strongly support the cooperation between schools and industry/economy with the aim of ensuring that school students will have the most optimal start into their future, professional lives. Participants pointed out the *crucial role of information transfer between the groups concerned*. According to the participants of this workshop, *the knowledge about existing professions and possible professional training pathways is very poor* – not only among students, but also among their teachers and parents. It was recommended that there is *a need for more and better communication between parents, teachers and representatives of the industrial and business sector* in order to provide school students with a real perception of what the current world of work looks like.

Additionally, participants in the Germanic workshop stressed that *information about the world of work should not only be integrated into the curricula, but also be part of teachers' day-to-day teaching practice and    PD*. Increasing the cooperation between vocational schools and general schools was another issue participants in this workshop addressed. Within this workshop, a particular focus was on structural obstacles that hinder teachers from including world of work elements into their day-to-

day teaching - and on possible solutions for this situation. Participants emphasised that the culture of changes that has been dominating the school policy for several years now, contributes to teachers having an **overall attitude of mistrust and a lack of teacher engagement/initiative**. An additional feature of the second workshop was a lively discussion on **competences currently demanded by the labour market**. The representatives of the industry who attended this workshop stressed that in particular, small and medium-sized enterprises need employees with a high degree of ability and capacity to learn. They are looking for trainees and employees who have interest and curiosity, and are deployable in diverse positions in order to manage the day-to-day challenges found in the increasingly complex and dynamic business world.

The workshop in the Netherlands, on the other hand, addressed the issue of **the lack of cooperation between general and vocational education.** Discussions focused on how connections between primary, secondary and vocational education can be enforced with respect to IBL in WoW contexts. Feedback from the participants indicate that we can learn a lot from what is happening at primary schools, as children learn to collaborate and work on projects together. In secondary schools many of these initial developments are not continued. Participants stated that there is a need to **clarify this continuous learning lines** with respect to the use of WoW contexts. Especially, more explicit experiences about the use of discipline knowledge and skills in the workplace is needed in lines from secondary to vocational education.

Outcomes of the workshops of Cyprus, Greece and Czech Republic emphasized that – although the linking of math and sciences to everyday life is prioritized in policy documents – **connections between schooling and the world of work are not part of the curriculum and that relevant evidence for practice is missing**. Participants in these workshops stressed the need to value the incorporation of wold of work in schools, by integrating information about the world of work in the curricula and by including corresponding materials in the textbooks. In the Greek national workshop in particular, participants focused on how to **take advantage of existing opportunities in the educational system in order to reinforce connections between school and the wold of work**, proposing that one of the project works should be on the theme of WoW and that one of the laboratory activities should be connected with the WoW.

In short, insights from the national workshops on the theme schooling and the world of work verified the main outcomes of the cross-national analysis of policy contexts. Connections between schooling and the world of work seem to be prioritized more in vocational than in general education, both at primary and secondary levels. **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*. For the vast majority of the national contexts there is evidence of a *lack of appropriate teaching recourses* in science and mathematics subjects relating to the world of work, while in terms of *assessment practices*, they are *rarely related to the work of work* in most national contexts. There is a need to *value the connections between schooling and the world of work*, by *including aspects of the world of work in the national curricula*, and providing specifications for implementation and assessment measures. *The strengthening of the cooperation between general and vocational education* is also of importance, as it would enable the exchange of good practices and experiences

### 1.3.3 Issues pertaining to pre-service and in-service teacher training

The comparative analysis of the national contexts provided evidence that 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.

Issues pertaining to teachers training was discussed in many national workshops (for example Germany, Spain, Greece, Romania, Turkey). The Germanic policy workshop focused on the quality of CPD courses in the country, as well on the quality of the preparation of the people in charge (meaning those who commission the professional development courses and make decisions about the main topics/structure of the PD, as well as the educators who carry out the courses). Discussions were around the structure of the existing PD courses was discussed in detail in order to find out *which conditions ensure the best possible outcomes and which structure model should be followed in future PD courses*. Also discussed was *what knowledge and preparation of people in charge of CPD should hold in order to ensure the highest quality of teachers' education was discussed extensively*. Participants exchanged ideas on how to best support teachers' acquisition of basic, content-oriented competences and inquiry-oriented competences. An important outcome of the discussions was that there is *a big discrepancy between teachers', researchers' and policy makers' perceptions related to the issues that should be broached at professional development courses*. Participants agreed that all perspectives should be taken into account when designing professional development courses. Participants

also addressed preconditions for successful professional development during the workshop. This discussion included *challenging issues like gaining teachers for PD courses or overcoming the structural obstacles.*

The feedback of the participants in this workshop provide insights in terms of how to ensure quality in CPD courses. It was recommended that in *order to ensure the highest possible quality of teachers' professional development, the people in charge of PD courses* – both policy makers who commission the courses and the educators who carry them out – *should be best prepared and possess knowledge about new relevant approaches and concepts*. In addition, *the programme of PD courses should be designed in cooperation between researchers and representatives of educational policy.* Teachers' perspective should also be taken into account by those who are designing processes. Only such interactive processes guarantee that all important issues will be included into professional development. Also recommended was that in order to gain participants for PD courses, *it is necessary to ensure that teachers receive the best possible structural conditions*, such as the possibility of being permitted to be absent from school for the duration of the PD courses, *as well as financial compensation* for covering the costs incurred in connection with their participation in PD courses. For the workshop participants it is preferable to *offer long-term professional development courses that take place on a regular basis*. Reflection phases between meetings allow for participants' knowledge acquisition and help the teachers to elaborate good practices. It is desirable to *guarantee the continuity of the learning community* so that after completing a PD course, participants can benefit from the gained confidence and the social network on a long-term basis.

In the Spanish workshop, on the other hand, an issue discussed was whether there were specific policies in relation with the professional development of mathematics and science teachers in the country. Participants' feedback on the issue is in line with the outcomes of the cross-national analysis, indicating that while there is an overall policy that draws a general picture of the kind of teachers the system is aiming at, *there are not concrete orientations in relation with specific skills and methodologies teachers should have as mathematics and science teachers.* Among the proposed recommendations from the participants was *the need to progress in the definition of a mathematics and science teacher profile within the educational system, coherent with current policies* and *to orient professional development policies and actions towards this ideal profile*.

In Greece, Romania and Turkey, a common issue that emerged from workshop participants was that current professional development programs are too short to make impact. The *unsustainable short-term cycles of training initiatives* were considered by participants as the major hindering factor towards ensuring high quality teaching.

Among the proposed recommendations was that teacher training and professional development should be obligatory and be conducted under ling-term cycles of training initiatives, under the close cooperation of policy, research and PD providers. To this respect the promotion of synergies between schools, University and Research centres and institutions responsible for provision of CD is imperative.

In short, factors that seem to impede upon ensuring quality in teacher training are:

- the ***existence of short-term cycles of teacher training*** mainly project driven***,*** which are unsustainable and inefficient in creating long-term learning impact;
- the ***discrepancy between teachers', researchers' and policy makers' perceptions*** in relation to the overall orientation and the issues that should be broached at professional development courses;
- the ***absence of structural conditions that allow teachers participating*** in professional development courses, such as the possibility to be absent from school duties, as well as the possibility for financial compensation for covering costs incurred in connection with their participation in PD courses.

For ensuring high quality teaching, there is a need for capacity building activities that are aimed at transforming teachers to informed, reflective and engaged mediators of educational change. Important in this respect is the provision of more coherent and learning-oriented professional development programmes for teachers, in order to improve their confidence and capacities. Effective teacher professional development, requires time, space, coherent structures and close cooperation between policy, research, CPD providers and teachers. On-off events are rarely successful in embedding new practices, which require time for reflection and on-going peer learning processes.

### 1.3.4  Issues pertaining to strategic educational priorities

The comparative analysis of the national contexts provided evidence that 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 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.

Issues pertaining to strategic educational priorities were discussed only in the Greek workshop, with the impetus of the following question: "Could the connection of science and math to the WoW via IBL approaches be a vehicle towards meeting broader educational priorities, such as equity, achievement and entrepreneurship? How?"
At the beginning, discussions focused on *the theme of entrepreneurship* with a participant raising the issue of whether (and if yes up to what degree) we consider entrepreneurship as an educational priority and whether it connects with innovation. Different views were communicated in the plenary on the issue: some participants supported that entrepreneurship should not be considered as an educational priority – since it just relates to making profit – while others argued the opposite – since it covers societal needs. Among the opinions expressed was that entrepreneurship should be a priority in education as it allows student feel innovative and inventive. In this case, *connecting math and science education to the WoW via IBL promotes entrepreneurship, by the development of students' competences and skills*.
.
Participants also focused on the theme of equity, and on the consideration on whether IBL approaches could promote equity. Gender differences in terms of learning were mentioned, with the participants drawing on their personal experiences to support whether or not boys or girls seem to benefit more from IBL. Other participants expressed the view that *we should not reproduce stereotypes in terms of gender and that we should focus on equity in terms of some students' disadvantage background and low achievers*.

Discussions were also directed in the *theme of achievement* and participants expressed their concerns that they have *no guidelines on how to deal with students' disadvantage background and low achievers.* Some pointed out that teachers have practically *no flexibility due to curriculum requirements and tight schedule to deal with these students;* other participants draw on their personal experiences and shared in the plenary that when they tried connections with the WoW some of the low-achievers students were highly motivated and engaged. There seemed to be consensus that in any case *making connections to everyday life is highly motivating for the majority of the students and this may contribute to higher students' achievement.*

Input from this workshop verified the main outcomes of the cross-national analysis, as it highlighted the need for concrete guidelines to the teachers on how to address the promotion of equity, the enhancement of low-achieving and the promotion of equity in science and math education. Important in this respect is to support teachers practice with appropriate so as to transform classrooms in a way the above priorities are matters of everyday practice.

## 1.4 Opportunities and challenges for the engagement of policy in the project endeavours

The previous section of this document outlined the results of the mapping process of the outcomes from policy workshops into the outcomes of the cross national analysis. This was done under the scope of informing the development of future policy in national and Euopean setting. This session aims to *inform the mascil consortium on opportunities and challenges to enage policy in the project's endeovor* towards promoting a widespread impelmenation of inquiry approaches in world of work contect.

For achieving this aim, we draw on the outcomes of the exchange of workshop experiences, which took place in a project meeting in May 2015. The exchange of experiences resulted in the identification of strengths, weaknesses, opportunities and threats (SWOT) in each national context in the dimensions of: planning, networking, implementation, outcomes and reporting of workshops (reported in D2.3). Based on the identification of the elements that contributed to the success of the work conducted and as well as of the difficulties that have been addressed in order to meet work objectives the following lines provide *recommendations for the mascil partners* in order to *guide further activities in the project*, in particular those that involve policy makers.

In the process of planning and implementing policy workshops – in order to negotiate with educational stakeholders over the issues emerged from the analysis of the national and EU educational contexts -  we confronted *two main challenges*:  *a) to actively engage of policy makers* – defined as influential stakeholders in each country- in the in the process of reflecting on/for inquiry based learning and world of work  issues during national workshops and *b) to address diversity* among the participant countries in the effort to meet project objectives (i.e. cultural, thematic, applied methodology). The methodological procedures that we followed allowed to successfully address the two main challenges that we faced during the conduction of the work: the active engagement of policy makers – achieved by the *careful selection of participants with the aid of the national advisory boards (NABs)* – and the diversity among the participants countries – addressed by *allowing flexibility in workshop methodology, in the target groups selection and in the focus on the topics discussed in each workshop*.

In specific, *helpful conditions for enagaging policy makers* in reflecting and negotiating on mascil priorities are:
- To take advantage of new curricula that align to the projects aims;
- To take advantage of connections and collaboration with other projects;
- To participate in regional events that engage policy makers;

- The careful selection of target groups with a  focus on influential people;
- To take advantage of NAB and PD networks within the mascil project mascil

In the same time, the following **obstacles should be taken into consideration** when planning activities that involve policy stakeholders:
- Difficulty in fixing dates that are convenient for all;
- It is difficult for policy makers to create ownership of projects' aims and outcomes
- Conservative educational systems that do not promote innovation.

The diversity among the participants' countries (cultural, thematic, applied methodology) is **a big challenge** that should be faced by **flexibility** in future action plans (in terms of methodology, in the target groups' selection and in the focus on the topics). Action plans for realisation of recommendations that emerged from the policy workshops should – at a first level - be national/local taking into consideration national conditions.  On the other hand, lot of changes and reforms take place in relation to curricula in recent years in most countries. In order **the outcomes and recommendations of the policy workshops** to attract the attention of broader policy audiences – and not be anticipated as short term initiatives that will be out of date in the near future- , they **should be embedded in the frame of broader education priorities** (such as equity, achievement, entrepreneurship) and communicated to the policy makers under such a rationale.  These recommendations are believed to be helpful in the course of **further networking activities with policy makers** within the mascil project.

# 2. (Summary) Conclusions & Recommendations

## Effective mediation of policy envisions into practice

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. *Factors that seem to impede upon effective mediation of* policy envisions to educational practice are:

- the *existence of short-term cycles of policies in education,* which lead practitioners to intervention fatigue;
- the *lack of policy coherency between proposed pedagogies, curricula and assessment system,* which lead practitioners to confusion in terms of purposes;
- the *lack of coordination between educational policies and actors responsible for teacher training*, which results in lack of coherence in policy rhetoric between expectations of students' learning and expectations of teachers' training*.*

The mediation of policy envisions into practice is neither a liner nor a "quick-fix" procedure, as it requires time for teachers to understand what educational change involves, to build capacity to implement envisioned changes and –ideally- to feel some involvement with and ownership of the policy. Also, the compatibility between policy envisions regarding the teaching of mathematics and sciences as evident in policy documents and policy orientations regarding teacher training, can be a step towards bridging the gap between what is envisioned in theory and has is implemented in practice.

*Recommendation*
In order to increase the chances of effective mediation of policy envisions to educational practice, *educational reforms should be implemented under a long-term vision*, as short term and rapidly changing cycles of policies lead practitioners to intervention fatigue. For practitioners to understand what educational change involves and build capacities to implement envisioned changes confusion in terms of purposes should be avoided, by a *better alignment between proposed pedagogies, curricula and assessment systems*. Policy coherence between expectations of students' learning and expectations of teachers' training should also be established, by *fostering cooperation and coordination between educational policies and actors responsible for teacher training.*

## Supporting the implementation of inquiry approaches

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 learning is not incorporated in the school culture. ***Schools' culture seems to be resistance to change***, while ***traditional teaching focusing on the transmission of content knowledge seems to dominate everyday classroom practice*** in many countries of the consortium. Factors that impede upon implementation of inquiry approaches in classroom practice are:

- ***Non-flexible national curricula*** in science and mathematics that do not allow space and time for inquiry based approaches;
- ***The exam- orientation of many educational systems with subject-oriented assessment objective***s, which do not acknowledge and reward inquiry as an important part of what constitutes knowledge in the mathematics and science subjects;
- ***Lack of corresponding materials incorporated in the textbooks and in some cases lack of guidelines*** for teachers for successful implementation if inquiry approaches;
- ***Reluctance to implement classroom activities under inquiry approaches, not only from the part of teachers but also from parents***, in the view that these are not a subject in the national exam system.

An essential precondition for inquiry based approaches to be implemented in actual classroom practice is to value the learning of inquiry process in schools, by identifying and including the assessment of these processes in national exams. There seems to be the need for a better alignment between inquiry pedagogy, curricula orientation, textbook materials, teachers' guidelines and assessment, ensuring that assessment reflects new teaching methods and that the curriculum facilitates inquiry rather than constraining it.

### *Recommendation*
In order to increase the chances of inquiry based approaches to be implemented in actual classroom practice, there is a need for ***more flexible science and mathematics curricula*** that allow space and time for inquiry approaches. ***Assessment systems should acknowledge and reward inquiry*** as an important part of what constitutes knowledge in the mathematics and science subjects, in order to reduce teachers and parents' reluctance to the implementation of inquiry based activities. For successful implementation of inquiry approaches, there is a need to ***help teachers in enriching their repertoire towards inquiry based learning,*** by incorporating corresponding

materials in the textbooks and by providing them with concrete guidelines on how to implement new practices effectively.

## Supporting the connection of schooling and the world of work

Connections between schooling and the world of work seem to be prioritized more in vocational than in general education, both at primary and secondary levels. ***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***. For the vast majority of the national contexts there is evidence of a ***lack of appropriate teaching recourses*** in science and mathematics subjects relating to the world of work, while in terms of ***assessment practices***, they are ***rarely related to the work of work*** in most national contexts.

### *Recommendation*
There is a need to ***value the connections between schooling and the world of work***, by ***including aspects of the world of work in the national curricula***. Policy makers should consider the potential of such a connection, on the basis of an appropriate preparation of pupils for the career entry and in the view of enhancing employability. However, simply including aspects from the world of work is not sufficient; in order to emphasize the high significance of vocational competences, ***specifications for implementation and appropriate measures for assessing them should be integrated in the curricula as well***. Towards this end there is ***a need to support the development of educational materials to help teachers enrich their repertoire*** towards making connections between schooling and world of work aspects. ***The strengthening of the cooperation between general and vocational education*** is also of importance, as it would enable the exchange of good practices and experiences.

## Ensuring quality in 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***. Factors that seem to impede upon ensuring quality in teacher training are:

- the ***existence of short-term cycles of teacher training*** mainly project driven**,** which are unsustainable and inefficient in creating long-term learning impact;
- the ***discrepancy between teachers', researchers' and policy makers' perceptions*** in relation to the overall orientation and the issues that should be broached at professional development courses;
- the ***absence of structural conditions that allow teachers participating*** in professional development courses, such as the possibility to be absent from school duties, as well as the possibility for financial compensation for covering costs incurred in connection with their participation in PD courses.

*Recommendation*

For ensuring high quality teaching, there is a need for capacity building activities that are aimed at transforming teachers to informed, reflective and engaged mediators of educational change. Important in this respect is the provision of more coherent and learning-oriented professional development programmes for teachers, in order to improve their confidence and capacities. Effective teacher professional development, requires time, space, coherent structures and close cooperation between policy, research, CPD providers and teachers. On-off events are rarely successful in embedding new practices, which require time for reflection and on-going peer learning processes.

## Addressing strategic policy 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 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.

### Recommendation
**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.**


## Reinforcing policy engagement in mascil endeavour

In the process of planning and implementing policy workshops – in order to negotiate with educational stakeholders over the issues emerged from the analysis of the national and EU educational contexts -  we confronted **two main challenges**:  *a) to actively engage of policy makers* – defined as influential stakeholders in each country- in the in the process of reflecting on/for inquiry based learning and world of work  issues during national workshops and *b) to address diversity* among the participant countries in the effort to meet project objectives (i.e. cultural, thematic, applied methodology). The methodological procedures that we followed allowed to successfully address the two main challenges that we faced during the conduction of the work: the active engagement of policy makers – achieved by the **careful selection of participants with the aid of the national advisory boards (NABs)** – and the diversity among the participants countries – addressed by **allowing flexibility in workshop methodology, in the target groups selection and in the focus on the topics discussed in each workshop**.

### Recommendation
The diversity among the participants' countries (cultural, thematic, applied methodology) is *a big challenge* that should be faced by **flexibility in future action plans** (in terms of methodology, in the target groups' selection and in the focus on the topics). Action plans for realisation of recommendations that emerged from the policy workshops should – at a first level - be national/local taking into consideration national conditions.  On the other hand, lot of changes and reforms take place in relation to curricula in recent years in most countries. In order **the outcomes and recommendations of the policy workshops** to attract the attention of broader policy audiences – and not be anticipated as short term initiatives that will be out of date in the near future- , they **should be**

***embedded in the frame of broader education priorities*** (such as equity, achievement, entrepreneurship) and communicated to the policy makers under such a rationale.

The work conducted and outcomes achieved through an analytical perspective between context and policy intentions can provide ***the basis for the establishment of dialogic process between research, policy and practice***. On such a basis, educational stakeholders may reflect on their own policy context and consider how the aims of strategic policy priorities are not only achieved but also negotiated for further educational improvements.

# 3. References

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# 4. Appendices

## 4.1 Appendix 1: The Framework for the analysis of the policy contexts

**13 national policy contexts**

DE · NL · UK · ES · TR · CZ · RO · NO · CY · GR · AT · BG · LT

**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

## 4.2    Appendix 2: Multi-dimension analysis of policy contexts

**Schematic illustration of the horizontal form of cross-national analysis, in terms of the tree levels of systematic analysis.**
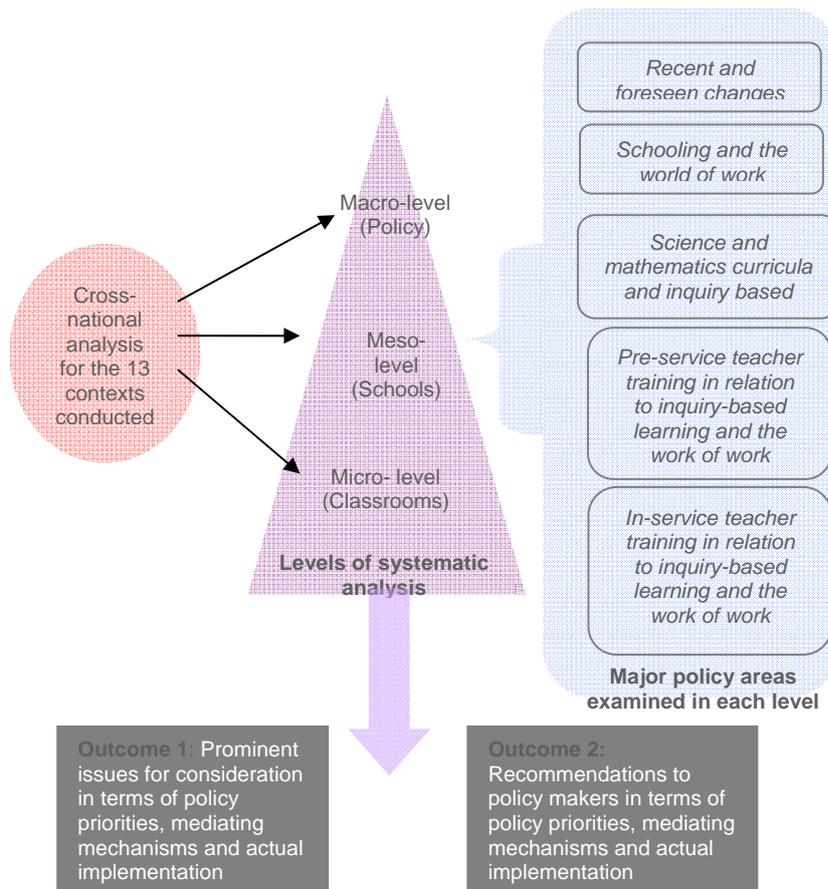
**Schematic illustration of the vertical form of cross-national analysis, in terms of the major policy areas examined.**

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

*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*

**Major policy areas examined**

Macro-level (Policy)

Meso- level (Schools)

Micro- level (Classrooms)

**Systematic level of analysis in each policy area**

**Outcome 1**: Prominent issues for consideration in terms of major policy areas examined

**Outcome 2**: Recommendations to policy makers in relation to major policy areas examined

**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**

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

**Major policy areas examined**

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

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