Promotion of European Networks

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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The title of the Deliverable 9.2 in DoW "Final report on activities of international dissemination" is incorrect. The correct title has been communicated to the Commission previously.
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The project mascil has received funding from the European Union
Executive Summary

The mascil project aims to promote a widespread use of inquiry-based learning (IBL) in primary and secondary schools. The project’s major innovation is to connect IBL in school with the world of work, making science more meaningful for young European students and motivating their interest in careers in Science & Technology. Throughout the project period, training courses have been run, in which pre- and in-service teachers learned about IBL supported by teachers from vocational education, representatives from industry and informal learning. Teachers did experience IBL themselves and through iterative cycles of implementation followed by reflection tried to integrate this into their practice. To ensure widespread participation, a pyramid model have been used, in which a small number of teachers have been reached first, each of which worked with further teachers. Additionally, an innovative interactive e-learning platform has been developed, to profit from the international perspective offered by the project. Another aim was to initiate cooperation between teachers at a European level. This report aims to give an overview of the cooperation among involved teachers that took place during the project period.

Experience in previous projects points to the fact that a project which is European in nature ensures a dimension that a national project cannot have: Teachers and teacher educators are keen to expand their horizons and become part of a European community striving to improve learning across their own and other partner nations. In order to support European teachers’ networks, mascil have promoted existing European teachers’ networks through shared activities, online communication and virtual conferences. Mascil has facilitated exchanges of experiences across participating countries. To facilitate international teacher communication, mascil set up a European on-line platform (for registered users) allowing teachers to share tasks designed during professional development courses, building a repository of tasks and activities, and to share experiences via an online forum and chat. The two project conferences (mid- and final conference) also allowed for face-to-face meetings of participating teachers. Between these two conferences mascil facilitated several virtual conferences, where teachers and students from different countries met. Further, during the implementation phase of the professional development activities, each month a “problem of the month” (PoM) was published in all countries and on the international platform. This allowed teachers to work on selected common problems across different countries with their students and then to reflect on and discuss experiences and solutions on a European level.
The main objectives of WP9 in mascil were to:

- Promote existing European teachers’ networks
- Set up a European teachers’ thematic network on inquiry-based science teaching within the project
- Set up an on-line platform which allows teachers’ exchange on an international level
- Invite teachers participating in our professional development activities to participate in our international conferences to allow face-to-face meetings on an international level
- Enhance teacher collaboration by having them work on an international “problem of the month”

In terms of promoting European teachers’ networks, national teacher organisations were elicited in all participating countries and a comprehensive list was set up accordingly, which have been used for teacher communication on European and national level.

With the help of the European on-line platform, participants have been able to publish their work, receive feedback, comment and pose question to others, thus developing a European thematic network on inquiry-based science teaching. In addition, widespread promotion has been performed across the countries’ own learning communities. Virtual meetings (video-conferences) have been organized in which students and teachers have been given the opportunity to exchange their approaches to selected mathematics and science problems, to discuss the content of the problem and potential solutions.

Starting in month 22, the “problems of the month” have been published once a month. Teachers from all participating countries, and their students/classes, have had the opportunity to share possible solutions. In order to reach as many teachers and students as possible with the “problem of the month”, the problems were promoted via all project activities and networks. A European forum on the platform (asynchronous communication) allows teachers and schools to initiate cooperation: for example, teachers can work in parallel on a problem and then exchange experiences via synchronous communication means.

The main goal of this report is to provide an overall picture of how the teacher networks have been developed and promoted in each country, according to the aims of mascil. The report is based on participating countries’ national reports on teacher networking. Each country had to address how they connected to existing national and international networks.
teachers’ networks. Each country was also asked to describe and reflect on their participation in virtual conferences, their use of PoMs in terms of teacher communication, and their participation in online discussion forums.

Main dimensions of this report are:
1: National and international teacher networks
2: Virtual conferences
3: “Problem of the month” (PoM)
4: The mascil national and international (online) discussion forum

Promoting and sustaining a network at European level is a very challenging task. One needs to take into consideration the different cultures, languages, and school systems, as well as the different approaches to dealing with similar problems across countries. However, to profit from the international perspective offered by the project, promoting European teachers’ networks is a core task in the mascil project, and mascil has provided an infrastructure for the potential to work together and exchange ideas on something that from the outset the teachers may not feel totally confident in, like inquiry based learning (IBL).

Data from national reports confirm that in all mascil countries, the mascil project has links to networks for teachers at different levels, including links at the academic level. Most mascil partners also have connections to other projects either at the national or the international level. It thus seems that mascil is well situated within an international community of mathematics and science teacher educators and researchers focusing on IBL.

Virtual conferences facilitated the exchange of interesting teaching and learning experiences on an international level. The meetings seemed to raise students’ level of confidence and motivation, and all teachers saw the value of including these activities in a broader perspective, e.g. an internationalization program, like in a student and/or teacher exchange program or a school partnership involving two or more countries.

In most mascil partner countries, the “problem of the month” has contributed to teacher communication at several levels, including initiating/generating discussions; sharing experiences, e.g. adaptation to level, class, results/student outcome, implementation, modification and adaptation; creating new networks; strengthen existing networks; participation in conferences, seminars or competitions.

The mascil Moodle platform has been conceived as a meeting place for teachers who share a common interest in developing and enriching their practices. In addition, mascil partners used several existing forums for communication, with the main purpose of sharing tasks and ideas, and cooperate in designing activities. Important challenges that
had to be overcome for teachers to participate in the international discussions were time pressure (teachers generally do not have much spare time in school!), heavy workload (teachers are in general working hard already), and lack of confidence in speaking foreign languages (mainly English). By providing excellent tasks and themes that teachers could see the use of in their everyday teaching and benefit of in their everyday work, the two first mentioned challenges could be overcome. The language barrier is more often than not an imagined one rather than a material one, and experience shows that teachers and students are perfectly good at communicating as soon as they give it a go.

Due to cultural differences, cross-country collaboration and building of international networks of teachers may be seen as a difficult task. At the same time, international collaboration is necessary to face the challenges of modern society. To establish successful national and international teacher networks, it is crucial to provide an infrastructure for the potential to work together and exchange ideas. The infrastructure may be provided by such international collaborative projects like mascil. The first step, though, might be to support teacher networks within schools and communities or municipalities.

Virtual conferences provide opportunities to exchange experiences, increase the possible points of views and investigate into common grounds for solutions to tasks. To succeed with virtual meetings, it is helpful to use a facilitator, to give clear guidelines for preparation and completion of the meeting, to test the technical equipment in each country before students and teachers meet, to establish contact between students and teachers before they meet virtually, to include online communication in a long-lasting exchange program, or at least meet more than once. It is also recommended to discuss tasks that bring forward the differences among participating countries, tasks that inspire discussion of cultural and societal perspectives and thus give virtual conferences an added value, compared to traditional classroom practice.

Designing tasks that are meaningful to discuss across countries, cultures, curricula, grades and subjects is a challenge. To have teachers and students in different countries to work on some common problem from their own national points of view and within their culture, you need to choose an issue that is relevant for all, despite context. Regularly given tasks, like PoMs, can contribute to valuable teacher communication across countries, nevertheless it is recommended to use a facilitator to initiate contact between teachers.

Among mascil partner countries, most teachers prefer face-to-face communication. National and international online communication may seem as a faraway activity if it comes on top of all other compulsory activities. In this regard, the choice of communication platform is also important. Inventing new platforms takes a lot of time.
and effort that by far surpasses the use value compared to using already existing platforms which teachers (and students) are already familiar with. Taking experiences from the mascil project into consideration, a recommendation is to strive to use existing platforms that are known to teachers (and students).

1. Main Report

Research indicates that communicative and cooperative activities represent the core factors fostering sustainable impact of professional development programmes (Lerman and Zehetmeier 2008). Lerman and Zehetmeier (2008) also states that, in particular, providing rich opportunities for collaborative reflection and discussion (e.g., of teachers’ practice, students’ work, or other artifacts) presents a core feature of effective change processes. Since the 1990s Internet have introduced the possibility of online collaboration among teachers, using synchronous (occurring at the same time) and asynchronous interaction with different modes of communication such as chat rooms, forums, wikis, videoconferences and multimodal modes in which text, pictures, video and voice are combined in different ways (Borba and Gadanidis 2008). These tools can be embedded in interactive learning environments that support the creation of virtual communities and networks. These new communication tools not only facilitate access to information, but also have the potential to change the personal and social relations amongst individuals and the way we understand the process of becoming a mathematics teacher (Borba and Villareal 2005). The text-based, read-only online world of a few years ago is rapidly evolving into a multimodal, read/write social networking environment (Maddux et al. 2007).

Interestingly, parallel to the growth of online learning in mathematics teacher education and in teacher education in general, there has been a growing interest in collaboration of teachers (Borba and Gadanidis 2008). Krainer (2003), for example, notes that “Increasingly, papers in teacher education refer to some kind of ‘communities’ among teachers” (p. 94). There is also growing evidence that collaboration among teachers is a key ingredient for their professional development (e.g. Krainer 2001, Peter-Koop et al. 2003). A gap in the literature on the collaboration of practicing mathematics teachers is the role of virtual environments and tools both as factors mediating teacher collaboration and as cofactors in the collaborative process (Borba and Gadanidis 2008).

Llinares and Olivero (2008) states that the use of information and communication technologies in higher education and in initial teacher education programmes has increased over the last few years. What emerges from the literature is on the one hand the scarcity of research in this area, and, on the other hand, the attempts to use theoretical constructs from sociocultural perspectives of learning to explain the
processes taking place when new communication tools are implemented (Llinares and Olivero 2008).

The use of communication technologies in teacher education has seen an attempt by researchers to develop a view of teacher learning as a social and cultural phenomenon (Llinares and Olivero 2008). Schuck (2003) concluded that for those who used a forum (with the aim of developing their understanding of mathematics and of mathematics teaching), the discussions were useful to encourage reflection, to share teaching experiences without having to be on campus, and they also encouraged the process of justifying and explaining points of view. Schuck (2003) therefore argues that accessibility to a forum is an important factor in developing a community of learners.

Ponte et al. (2007) have shown that different teachers have different experiences with virtual environments. Although some teachers are positive about online experience, there are others who are far from that, for reasons which include the fact that once you “say/write” something it is recorded electronically and accessible for everyone to read.

Studies mentioned by Llinares and Olivero (2008) start shading light on the processes of creating and sustaining communities of practice through online environments. Four factors that emerge are: (i) the provision of accessible and flexible online forums, discussions and bulletin boards which can be appropriated and adapted to satisfy the teachers’ needs; (ii) the participation of both prospective teachers and practicing teachers to the same community, together with ‘experts’, which may enable the construction of professional knowledge and practices, together with the creation of a shared repertoire of mathematics resources; (iii) the co-existence of online and face-to-face interactions, which also enables the creation of emotional and personal connections that foster continuous participation in the exchanges and discussions and the development of a shared history; and (iv) the provision of models of professional exchanges and interactions to get the teachers started and provide an initial structure for the discussion (Llinares and Olivero 2008, p. 163).

Rapid development of new online technologies coupled with the rapid growth of Internet access and bandwidth is likely to have an impact on the virtual collaboration of practicing teachers. The question is how widespread this impact will be (Borba and Gadaniidis 2008). The next paragraphs give an overall picture of how the teacher networks have been developed and promoted in the mascil countries during the last four years, according to the aims of mascil.
1.1 National and international teacher networks

Promoting European teachers’ networks is a core task in the mascil project. National teacher organisations were elicited in all participating countries and a comprehensive list was set up (http://www.mascil-project.eu/teachers/teacher-networks). The list has been used to facilitate teacher communication on European and national levels. Contact persons were established in each participating country. These persons had the responsibility of liaising with their national teacher networks in local languages as required. Ideas on how and when teachers can communicate on the platforms or with their networks were listed and distributed to the consortium contact persons. Contact with teacher networks has been useful not only for the launch of the “problems of the month”, but also for the wide-spread dissemination of the midterm and final conferences. At these conferences, mathematics and science teachers and educators have been/will be able to meet face-to-face and exchange ideas and practices.

The national team in each participating country was asked to answer the following:

Describe how mascil (in your country) is connected to other national and international projects/networks for teachers (Including direct or indirect cooperation with other projects, the use of links from/to the mascil website, suggestions for improvement)

The data collected confirms that in all participating countries the mascil project has links to networks for teachers at different levels, including links at the academic level. Most mascil partners also have connections to other projects either at the national or the international level. It thus seems that mascil is well situated within an international community of mathematics and science teacher educators and researchers focusing on inquiry based learning (IBL).

International projects that mascil partners are connected to include Primas, S-TEAM, INSTEM, March, Make Science Real in Schools., BigPicnic (Horizon 2020), SAILS, STEM Teacher Training Innovation for Gender balance, Mind the Gap, FasMed, M3EaL, ENGAGE, TEMI, PARRISE; and additionally several international mathematics and science associations (e.g. ERME, PME).

Connections to national projects include MATHElino (Germany), PIISA (Spain), Educating trainers of science centers, Continuing Teacher Professional Development to Support the Teaching about Nature of Science, Akyaka Nature and Science Camp (Turkey).

Several partners are connected to national science and mathematics teacher education expertise centres, and also the national mathematics or science teacher associations, often including representatives in these organizations in the National Advisory Board.

The project mascil has received funding from the European Union
Other national networks include Jet-Net network (NL), NCETM, NRICH, MEI, ASE (UK), MNU, Klett-MINT (Germany), HMS, GARMEL (Greece), IMST, NAVI (Austria).

Learning and teaching, also in mathematics and science, is deeply rooted in culture (e.g. Kaur, Anthony, Othani, & Clarke 2013). This suggests that cross-country collaboration and building of international networks of teachers may be a difficult task. At the same time, international collaboration to face the challenges of modern society is necessary. The EU report Science Education for responsible Citizenship (Hazelkorn 2015) says that „Collaborating and sharing knowledge of and about science and science communication, as well as identifying solutions for global societal challenges facing humankind, should be actively pursued with international partners” (p. 11). With mascil, this task has been taken at face value. Mascil have provided an infrastructure for i) working in IBL ways ii) making connections between school subjects and WoW; iii) the potential to work together and exchange ideas on something that from the outset the teachers may not feel totally confident in, like IBL. The success of mascil stems in no small part on the common ground idea of IBL. For most teachers working in IBL is a new thing and at the same time something they would like to do (see e.g. Sikko, Lyngved and Pepin 2012). Help is needed, and may be provided by such international collaborative projects like mascil.

1.2 Virtual conferences

Preparation and implementation of virtual conferences

Once teachers got involved in the various mascil learning programmes, virtual conferences provided opportunities for more focused discussions and communication about the different aspects of the project (e.g. mathematics and science tasks; “problem of the month”; e-learning; the toolkit).

The main aims of the virtual conferences were to:

- Encourage teachers to try out some mascil tasks and share their experiences with colleagues on an international level, fostering their professional development
- Support teachers in their use of inquiry approaches, connecting mathematics and science to authentic contexts
- Promote the exchange of interesting teaching and learning experiences on an international level
- Empower students and foster their motivation for science and mathematics learning through the exchange of outcomes with other European students

The project mascil has received funding from the European Union Seventh Framework Programme (FP7/2013-2017) under grant agreement n° 320693.
• Develop students’ competences related to inquiry, problem-solving, group work and communication

Supported by ICT personnel, a technical solution for the virtual conferences were set up, viz. Skype for business (previously called Lync). The use and participation in this system only requires a web browser, similar to Skype. Via the Skype for business application participants can talk, chat, use video to see each other and share documents. A Survey monkey was developed to collect data on partners’ technical equipment suitable for a smooth running of virtual conferences. A conference pilot with three schools across Europe (Lithuania, Greece, Norway) was set up, hosted and run in spring 2015. In addition to teachers and pupils from the three countries, one expert teacher from Bulgaria participated, as well as selected mascil colleagues and ICT personnel. Experiences from this pilot revealed that it was important to run a test meeting with each of the participating teachers before a real meeting could take place. This new way of meeting administration also requires a special set of rules and structure, both for practical and technical reasons. Evaluation meetings with the ICT staff did end up with a set of suggestions on how to proceed.

Based on experiences from the pilot conference, each consortium partner was offered a test session, with the aim of testing the schools’ technical equipment before a real conference with students took place. Guidelines for the conferences were distributed to participants before each meeting (see Appendix 1). Based on ideas from the mascil European Advisory Board, suitable and engaging themes and tasks for virtual meetings were constructed. The tasks used should be meaningful to discuss across countries, e.g. energy consumption during different periods of the year in different parts of Europe was an issue in several conferences.

The real conferences took place from April 2015 to June 2016. A maximum of three student groups met at the same time, usually only two groups. The maximum number of teachers in each meeting was five. Conferences were videotaped in all cases where parents and students gave their allowance.

Below is an overview of the overall implementation (Virtual conferences in numbers):

• Number of meetings per country: 0-5 (in total 11 meetings, 10 countries)
• Number of meetings with students and teachers: 8
• Number of meetings with teachers only: 3 (9 teachers in total, 8 countries)
• Number of teachers involved: 15 (of these: 3 multipliers, 2 mascil consortium members), 0-3 per country (most often 1)
• Number of mascil consortium members involved: 12
• Number of students involved: 2-50 per teacher (most often 4-5 per teacher), 6-54 per meeting (132 in total)
• Number of tasks discussed: 3 (PoM Counting people, PoM Bicycle insurance, Energy consumption)

Consortium members’ experiences

Based on their own participation in conferences, observations of conferences, or communication with participating teachers, the consortium members considered the following aspects as the positive outcomes of the virtual conferences:

• The virtual conferences were considered as valuable experiences for the students, conferences motivated them, they enjoyed it, students were excited and actively engaged, and expressed their desire to keep the communication and extend the collaboration
• Students experienced that their English was better than they originally believed
• Students appreciated that a second class had worked on the same task and thus the task became valuable for them
• Conferences were starting points for continuing cooperation (e.g. partnership, exchange of students, teacher cooperation)
• Students participated in interesting discussions and learnt about differences in culture, energy consumption and production
• Virtual conferences elicited many of the 21st century skills and competences, as well as competencies relevant for future working life

Partners elaborated on any constraining or hindering factors and came up with the following challenges:

• Language barrier (students and teachers need to speak, respond and understand in English, which is seen as a real barrier for most countries)
• Choosing participating students (age, knowledge of English and other foreign languages)
• Finding time for preparation and for the meeting (different type of logistical problems within schools)
• Synchronize the time for discussions between schools and time zones
• Technological weaknesses (many schools are not supported with good internet and digital equipment like external microphones and web cameras; e.g. unstable internet connection, poor sound)
• Teachers’ lack of experience with the approach
Teachers’ experiences

With the aim of collecting participating teachers’ experiences, virtual teacher conferences were arranged to discuss the potential of such meetings and reflect upon the teachers’ own and their students’ values and outcomes of the participation. Teacher meetings were arranged in May and June 2016, and teachers were given the opportunity to reflect on the issues for discussion before the meeting took place.

Questions given to teachers before the meeting:
   1. What potential do virtual conferences have?
   2. What kind of added value can it give to your students or to you as teacher?
   3. What kind of wishes (if any) do you have for further cooperation?
   4. What did your students feel about the participation in a meeting like this? Which experiences did they get after communicating with students in other countries (from your point of view)?

Additional questions (if time allowed):
   1. What did your students feel about working with the energy consumption task? Was this kind of task new for them or not? Are they used to this kind of tasks, that they have to explore something at home? From real world?
   2. What do you consider as the outcome/value of the virtual conference(s)?
   3. What do you consider as the strengths and weaknesses of the virtual conference(s)?
   4. Do you have any suggestions for improvements?
   5. Any more comments on your experiences in general?

Summary of the teachers’ reflections:

Potential of virtual conferences: Participants saw this as an ideal way to start learning, or to collaborate on an international scale. They considered these type of meetings extremely important for both teachers and students, e.g. they mentioned the relevance for their further life and further education and highlighted both the collaboration aspect and the knowledge aspect. They mentioned that such conferences represent a realistic atmosphere for students, that it is a chance to share their ideas and learn a lot (subject oriented, topic oriented, language skills, collaboration skills, communication skills, cultural aspects). During such meetings, students had to learn science in English as well. Other potentials mentioned: share tasks, do live experiments together, work together in for example Google docs, write science reports together; e.g. to take the cooperation further on. In some countries, competitions are rather important and common, and it is of course a potential for virtual conferences as well, to include a competition aspect.
Added value for students and teachers: The students that participated gained a lot of confidence. Before the virtual meeting several pupils were nervous, scared and a bit shy, but most often they were very proud and positive after the session. Most teachers said that their students really enjoyed it. Some teachers see such meetings as a big chance to share tasks and course material, to share experiences that colleagues from other countries have, and to learn how colleagues run courses and tasks.

Wishes for further cooperation: In general teachers were positive and wanted to continue to cooperate with teachers in other countries. They would appreciate to cooperate over a longer period of time, making it more than a onetime happening. For instance, it could be done on an annual basis between schools in different countries. One option is to include different kinds of social media, like Facebook. Teachers see the value of including these activities in a broader perspective, i.e. like in an internationalization program, like in an exchange program or a partnership. If it is a onetime exercise, they don’t think it has a lot of value. They think the value will be stronger when you repeat it and ideally include face-to-face contact. By having a group of students from one school meeting the other and visa versa. In order to do it even more productive, they suggest that teachers talk to each other and get to know each other before they enter into such a virtual meeting. In fact, two participating teachers established a partnership based on their first mascil virtual conference (Spain and The Netherlands). It opened for collaboration in the future. Teachers have already met in Germany and within next school year they are planning physical exchange of students.

Students’ experiences (from teachers’ point of view): The meetings seemed to raise students’ level of confidence and motivation. Some teachers mentioned that one specific activity (energy consumption task) increased the motivation of the students, they liked the practical application and real context of the task. Some teachers also experienced that parents got more involved in this task, than they normally do. Most students learned more about themselves, about how they live, their own homes; they got reflective. Teachers felt the activity was good for learning and teaching science and also for languages. Some pupils were practicing both English and Spanish language skills. It was seen as a great experience for them to communicate with people from other cultures.

Examples of teachers’ quotes:

“I consider these type of meetings extremely important for both teachers and students. Whatever the students gonna do in their lives, or in their further education, they will run
into these kind of meetings. With multiple participants, with multiple countries, with technical problems, where you need to have a proper agenda bla bla bla. So this is an ideal way to start learning, or to collaborate on an international scale. For teachers the same, because I see that teachers in our way should change, but perhaps this is a topic on its own. By doing this, you know, they will learn from it. So it is the collaboration aspect and it is the knowledge aspect.” (Video recording, T1, 17:56)

“The students that participated gained a lot of confidence. I explicitly asked students, I asked for teacher English, pupils who were a bit shy, … But they were so proud after the session, and so strong, and so positive that they were glad that we had picked and chosen these people. In addition to increasing raising your level of confidence and motivation, they learned something and you know, this of course is topic related, but yes they learned that Spain is much more further ahead in durable energy than in our country… so there were a couple of eye openers, for the children which I thought could be content related, subject related, so they learned a lot.” (Video recording, T1, 21:50)

«Before the actual conference session, the students were extremely nervous, but after the session they felt like HEROES… such an improvement of their confidence!!» (Written feedback, national report, T1)

“In our case it was useful because it started the contact with (T1). It opened for collaboration in the future. Within next school year we are planning a physical exchange of the students. And it started here from this project.” (Video recording, T3, 27:12)

“I think it was so exciting for them that they will never forget it. Those who took part were very excited about it. Before the meeting they weren’t so motivated about it, but after the meeting some were a bit jealous because they couldn’t take part. Tomorrow we will decide upon who will take part in the next one.” (Video recording, T5, 07:03)

«The students have never had a task before, where they were forced to use skills they have gained in different subjects in such a way (physics, mathematics, english)(…) This rose their sensibility for the fact, that in the world of work it does not help if you are good in only one singular subject, but that a lot of subjects might be relevant for your future working life» (Written feedback, national report, T5)

“To have the students to be able to communicate with another class outside the country is probably more beneficial than I can even explain. They can interact with other students outside the school, without the schools and the country, but be outside the country virtually, and you see something when using their computer or skype, I think that is a lot more added value there than you can probably explain now” (Video recording, T6, 13:00)
1.3 “Problem of the month” (PoM)

Learning and teaching of mathematics and science are deeply rooted in the culture (see e.g. the Learner’s perspective study, Kaur et al. 2013), and as such cross country comparisons are problematic. Despite this obvious fact, international test like TIMSS and PISA dominate the discourse in many countries and in particular this is true for those countries that happen to score lower than expected. On the other hand, international solutions to common problems, like the climate change, necessitates building common understanding and exchange of ideas across countries. International collaboration and at academic and school level is not to enforce common school curricula, but to provide opportunities to exchange experiences, enhance the possible points of views and thereby investigate into common grounds and possible best solutions to big problems. The mascil project sees the possibility to launch a selected task or activity among all participating countries in the form of a “problem of the month”, as a chance for teachers and students in the different countries to work on some common problem from their own national points of view and within their culture.

The “problem of the month” was designed to be a mathematics and/or science task and activity that included IBL and the world of work. The problems were prepared by the consortium partners for teachers in all participating countries to implement in their classrooms. The problems were released one by one over a period of approximately 15 months, with the first problem, Brine, released in October 2014 and the last, Routing school buses, released in April 2016.

During months 19-28 of the project, i.e. July 2014 to April 2015, the Work Package 9 team collected potential candidates for “problem of month” from the mascil project partners. For this, the requirement set was that each partner was to submit (at least) two potential PoMs, with one mainly focusing on mathematics and one on science, or as a problem that combined both mathematics and science foci. The problems proposed by the partners, were evaluated, amended and finalized in an English language version. A final version of each PoM suitable for translation into partner country languages were distributed to each national team.

Starting October 2014, the “problem of the month” was published on the International communication platform the 1st of each month (http://teacher-communication.mascil-project.eu/course/view.php?id=237). In addition, the Work package team ensured that the PoMs were published on all national websites as well as on the international website (http://www.mascil-project.eu/), and in the mascil classroom materials database (http://www.mascil-project.eu/classroom-material/classroom-material-2).
The main challenge for the selection of “problem of the month” from the submitted tasks, was to balance the subject content - more mathematics than science tasks were submitted - and the target groups, as there were more tasks for lower secondary than primary school or upper secondary school submitted. Hence, the tasks were edited/amended, and changed to become more interdisciplinary, in addition to providing advice for adjustments to lower and higher levels in the accompanying teacher guides. On the international website the “problems of the month” were published in a classroom materials database, with a separate and visible heading. Each “problem of the month” is also linked to the specific forum for this problem, on the international teacher communication platform. To facilitate teacher communication on the platform, international and national discussion forums have been provided for each “problem of the month”. Each consortium partner has been asked to submit discussion topics together with their tasks. Additionally, selected multipliers have used the mascil platform during their professional development courses. However, it appears that teachers are mainly using already existing platforms. It has therefore been difficult to create large amounts of discussion activity on the international mascil teacher communication platform. Consortium partners also report that use of other platforms /communication tools is common, like e.g. local Moodle platforms, learning management systems like It’s learning, Twitter and Facebook. In response to this challenge, we have introduced another approach: to publish possible solutions on tasks (pupil answers) and asked teachers for feedback.

At the virtual conferences, teachers and multipliers were given the opportunity to share possible solutions of PoMs, and “best solutions” that could subsequently be published on the project website.

All mascil partners have translated the “problems of the month” to their national languages, with UK as an exception since they would use the English version directly. Most partners have translated all the available “problems of the month”.

Partners were asked to describe how the mascil PoMs contributed to communication between teachers, nationally and internationally, including how the PoMs generated networking locally, nationally and internationally, what kind of communication was initiated (e.g. online, face-to-face), what kind of networks have participated etc.). It is apparent that in most mascil partner countries, the PoM have contributed to teacher communication at several levels, including initiating/generating discussions; sharing experiences, e.g. adaptation to level, class, results/student outcome, implementation,
modification and adaptation; creating new networks; strengthen existing networks; participation in conferences, seminars or competitions.

Partners were asked to give their reflections on the PoMs potential for generating communication (in general), including what they considered as the outcome/value of the PoMs with regard to networking, strengths and weaknesses, suggestions for improvement etc.)

Supporting factors for teacher communication involving PoM that were identified were

- Mediators to initiate contact
- Technical assistance in case of virtual meeting
- Possibility to work with one PoM over longer time (more than one month)
- Interdisciplinary tasks
- Well-suited tasks for comparison between classes
- Tasks appealed to and motivated teachers

Factors for generating (more) discussions, sharing results, reflecting & sharing experiences, e.g. on:

- Quality criteria with respect to classroom materials and their connection to WoW and inquiry
- Adaptation to different classes/levels
- Implementation in different subjects (math & science)- interdisciplinary tasks.

Challenges connected to

- Cultural, educational, curricular issues
- Timing and choice of PoM
- Language

In summary, the set of mascil problems of the month have reached a wide audience across Europe, having engaged teachers and students in working on common tasks and activities. Having collected tasks from all participating countries, the work package 9 leaders have ensured a wide selection of cultural backgrounds inherent in the tasks. This is in itself an important outcome, as it has given teachers and students insight into what types of science and/or mathematics tasks are considered relevant in other countries. It also shows that problems or situations described are indeed of a nature that is relevant across countries and cultures, thus providing teachers and students with important knowledge about international nature of science, mathematics and society.
1.4 National and international (online) discussion forums

To promote teacher communication within mascil, a European online platform\(^2\) with access for ‘open’ use, ‘registered’ use, and ‘right to edit’ use for selected facilitators was established. The platform (configured with Moodle) was furnished with a task repository, forum and chat, and provisions for e-learning facilities (Milestone M9.1) (Figure 1). These were the features that each country’s national ‘teacher communication platform’ were furnished with, as well as a possibility to communicate Europe-wide.

Figure 1: Mascil Moodle platform

The mascil platform has been conceived as a meeting place for teachers who share a common interest on developing and enriching their practices by adopting inquiry-based learning approaches and/or exploring connections to the world of work. Mascil platform aims at connecting teachers, both internationally and nationally.

The platform serves three main purposes:

\(^2\) [http://teacher-communication.mascil-project.eu/](http://teacher-communication.mascil-project.eu/)
1. To create a space for teachers to communicate about inquiry-based learning and connections to the world of work. This is the 'International Teacher Communication' part.
2. To spread and communicate about mascil Problems of the months.
3. To host the mascil ePD toolkit, to support e-learning communities in professional development courses. This is the 'Teacher Professional development' part.

Besides, the platform is linked with the mascil main website, the mascil classroom materials database, mascil twitter and mascil newsletter.

In addition to the mascil Moodle platform, mascil partners used the following forums for communication: forums on national websites, forums on the E-learning platform, Skype, Facebook, Twitter, email and Dropbox. The most used forums were email and Skype, with the main purpose of sharing tasks and ideas, and cooperate in designing activities.

The participants’ main outcome from their participation in online discussions can be summarized as follows:

- they started to communicate their ideas and plans with other teachers and the multiplier
- they started to work collaboratively and build on the others’ ideas and approaches (enriched their perspectives)
- they were challenged to start thinking what is IBL and what issues emerge when designing and implementing IBL tasks in the classroom
- they started to recognize the complexity of issues emerging when attempting to integrate the WoW in the teaching of mathematics and science in the classroom
- they build progressively a more widened view of the issues influencing their teaching

Several countries highlighted that teachers are not used to communicate online and that most of the participating teachers prefer face-to-face communication. Teachers’ daily practices are characterized by a heavy workload and time pressure. They are busy during the school day and don’t have time and motivation to exchange their ideas online. It is a bit far away from their daily practices and thus they do not feel the necessity to do so. If they are to participate, they need a clear purpose. Almost all countries report that perceived language competence is a hindrance for teachers to join international discussion forums. In all, 630 teachers registered as users on the international platform. Of these, 341 used the platform actively. The platform registered 298 802 hits. The numbers indicate that the mascil international discussion forum was used in a rather limited scale. Language was reported to be the main constraint. We refer to the WP5 report for further details on the use of the e-learning facilities.
Even if the international teacher communication platform was used to only a limited degree, there are several examples of successful online teacher communication experiences:

**E-learning communities**

Mascil e-learning courses represent online communication and can be characterized as cyclic processes of designing and sharing of ideas, sharing comments, classroom experiences and their reflections on them. Among the countries that used these kind of courses, Spain and Greece represent two of the success stories.

In Spain every e-learning PD course, as well as most of the face-to-face ones, included one or several forums where teachers could interact and exchange information. Especially intensive was the collaboration between teachers on the e-learning phase of a course they organized together with the National Ministry of Education (September 15th-November 15th, 2015). The reason was that the e-learning materials specifically encouraged teachers to share ideas and discuss. Although not all of them participated to the same extent, it is worth to mention some interesting and deep conversation that took place between some of them. For instance, in the forum in which teachers had to view a video of an IBL-lesson and make comments, there were 37 posts, and 36 replies.

According to their experience, teachers need a clear purpose to go to a forum and communicate. That happened in the e-learning courses, because the materials included, as specific instructions, to post something in a forum, or to comment on the entries posted by others. Elaborating on the example above, first of all teachers had to write a brief report about what they think are essential ingredients of IBL-oriented classrooms. In this way, the facilitators wanted them to make explicit their beliefs and already existing knowledge. Then, a video of an IBL lesson was provided. They were asked to watch the video and write an entry in the forum. This entry should include their previous brief report (as an attachment), and a comment about features of an IBL classroom that they would include or change in their reports after watching the video. Teachers were invited to read other participants’ reports and ideas, and to comment on them. Some interesting conversations took place while sharing their ideas. Besides, it was quite powerful for the group facilitator, since he could intervene in the conversations to address teachers’ doubts, misconceptions, and concerns.

In Greece one main forum were created in the e-learning platform. The forum is being actively used by the members of the group (187 posts in total until month 38). The main topics of discussion concern task design, features of IBL, connections to workplace, task implementation in the classroom (e.g., classroom management, connections to the curriculum, available time). One successful example of online teacher communication appeared in the e-learning group consisted of 10 secondary school teachers (5 teachers
of mathematics and 5 teachers of physics) and the multiplier. Early in the PD activities, the multiplier had invited teachers to propose ideas for their first design and the subsequent implementation. One teacher working in a lower secondary school in small Greek city introduced the idea of working on an existing mascil task (Parking Problem). She proposed her modification of this task consisted of the following features: reference to a real open-air parking place in her city in which parking was not organized; use of the corresponding lows so as to enhance the realistic character of the situation; students’ experimentation with manipulatives (e.g. paper models of parking and cars) and digital tools.

Online teacher communication about the design of this task and its implementation, challenged two more participating teachers to investigate how this would work in one of their 8th grade mathematics classrooms. These teachers were living in different small cities so they were motivated by the fact that they could attempt to further modify it by referring to real parking places in their cities. At this phase through online communication the teachers were engaged in a cyclic process of designing and sharing of ideas and comments. Later on, after the first classroom implementation of one of the teachers, online teacher communication was enriched by teachers’ sharing of their classroom experiences and their reflection on them. Since classroom implementation did not take place in the same period of time, online communication helped teachers’ transformation of their tasks taking into account the experiences of the preceding implementations (e.g. made changes in the tasks and the accompanied worksheets taking into account identified constrains or time limits).

Joint work on a “problem of the month” (PoM)

One intention with the mascil PoMs was to generate communication between teachers, nationally and internationally. In Austria and Bulgaria one of the PoMs actually initiated long-term teacher networking, including initial cross country online communication, a virtual meeting, followed by online and face-to-face communication nationally and internationally, and a joint presentation at a conference.

The idea of this networking arose during the 5th consortium meeting in Vilnius (May 2015) when two teacher trainers exchanged their content-related experiences with the PoM Bicycle Insurance. Since one of the trainers implemented this task in his own class, he could present different approaches to the problem and also some more elevate findings using simple simulation programs. Later, an Austrian teacher got in contact with three Bulgarian teachers. They exchanged experiences via email and Skype. In July 2015 a virtual conference was arranged. In Austria, one teacher and nine students participated on the meeting; in Bulgaria, one teacher with four students. Before the meeting took place, the Austrian and the Bulgarian teacher exchanged the approaches of their students (reports and slides) to the PoM Bicycle Insurance. The aim
of the meeting was then to give feedback and to ask questions regarding the reports and the slides. The Austrian students were quite astonished that students from another European country were working on the same task as they did. They tried to understand the different assumptions and calculations from the Bulgarian students as they used more complicated models to estimate the annual fees. The Austrian students prepared some questions in German and right before the virtual meeting, they translated them into English. During the meeting, which was organised by the Norwegian partner, the Austrian students could ask their question, but they were quite nervous so the teacher had to support and encourage them. The students had difficulties to understand the answer form the Bulgarian students since they explained their reasoning on the formulas. Fortunately, the conference tool provided also a whiteboard function and so the students could argue with the formulas. However, the Bulgarian students were fascinated by the simulation programme written by the Austrian teacher in order to test the students’ solutions with randomly generated data. As a consequence, the Bulgarian teacher asked for a revised version of the simulation programme to test also her students’ approaches. This adapted version was then exchanged a couple of weeks later.

Working on the PoM Bicycle Insurance offered a fruitful exchange of ideas for the teacher trainers, the teachers and also the students. Especially, the different approaches from the Austrian and Bulgarian students led to a deeper insight of possible solutions for all students. The simulation programme, which was designed as a modest supplementary tool to check the results, was very interesting for the older students from Bulgaria. The discussion was continued between the two teachers and finally, the 6th project meeting in Sofia (December 2015) allowed a face-to-face meeting of the two teachers. In December 2015, all four teachers also met each other during a national conference on IBL in Sofia, Bulgaria, where they had a joint presentation. They are also planning a joint presentation at the Educating the educators II conference December 2016.

Establishment of partnership
Mascil aims at promote teacher collaboration, and between two of the participating countries a real partnership between schools was established. Based on a virtual conference between schools in Netherlands and Spain, teachers exchanged ideas, met face-to-face, participated in a teacher virtual meeting, and are now planning to exchange students.

The virtual meeting was organized and held between a Spanish teacher with two different student groups and a Dutch teacher with his student class. The virtual meeting was attended and supported by one mascil partner from the Spanish team, two mascil partners from Norway and two mascil partners from the Czech Republic.
For the schools and teachers, it was the first time to be involved in one of the mascil tasks. This was also the first time the students participated in this kind of chat/video-session. The teachers reported that it was a wonderful and positive experience for both the pupils and for themselves. The Dutch students even practised Spanish, since 3 out of the 4 follow classes in Spanish.

The two secondary school teachers taking part in the virtual meeting had previously introduced the same mascil task (Usage of Electricity in a household) into their classroom and challenged their students to solve it. In order to do so students had to inquiry about:

- Energy production and the main energy sources in their region and their country
- Their electricity bill and how it changed over time (short-term and medium-term changes)
- Different electrical devices and electricity consumption
- Consumption habits within their family
- Seasonal changes in the electricity consumption
- Average energy consumption in their country over the last years. Evolution over time and trends

Various Dutch and Spanish students took turns and presented their work to the rest of attendees in English. They used visual presentation and videos to support their finding and raised some questions to their foreign mates, promoting an enriching whole group discussion afterwards. The comparison of results and the questions raised by students revealed that although the average consumption of electricity was similar in Spain and The Netherland, there were other interesting differences to discuss. The experience offered the opportunity to discuss differences in culture and in energy consumption and production. Cultural differences were also identified in relation to the average electricity consumption at winter and summer. Other outstanding outcome of the virtual conference was to find out that Spain has a higher rate of electricity coming from renewal energy than The Netherland.

In summary, the experience was highly appreciated by the participants. Students and their teachers were excited and actively engaged in the virtual meeting and expressed their desire to keep the communication and extend the collaboration. The session fitted perfectly into the Internationalization program of the Dutch school, and the activity elicited many of the 21st century skills and competences. The teachers are now continuing cooperation for a Partnership to exchange a small group of students.
2. Summary

As confirmed by Gatt and Costa (2009), promoting and sustaining a network at European level is a very challenging task. One needs to take into consideration the different cultures, languages, and school systems, as well as the different approaches to dealing with similar problems across countries. However, they conclude that “there is also potential for great contribution from the rich European diversity to work together in achieving one common goal: that of improving the type and quality of science education experiences which students across Europe are receiving” (p.503) (Gatt and Costa, 2009). Promoting European teachers’ networks is a core task in the mascil project. Mascil has provided an infrastructure for the potential to work together and exchange ideas on something that from the outset the teachers may not feel totally confident in, like IBL.

The data collected confirms that in all participating countries the mascil project has links to networks for teachers at different levels, including links at the academic level. Most mascil partners also have connections to other projects either at the national or the international level. It thus seems that mascil is well situated within an international community of mathematics and science teacher educators and researchers focusing on inquiry based learning (IBL).

Virtual conferences facilitated the exchange of interesting teaching and learning experiences on an international level. The meetings seemed to raise students' level of confidence and motivation, and teachers saw the value of including these activities in a broader perspective, e.g. an internationalization program, a student and/or teacher exchange program or a school partnership involving two or more countries.

In most mascil partner countries, the “problem of the month” has contributed to teacher communication at several levels, including initiating/generating discussions; sharing experiences, e.g. adaptation to level, class, results/student outcome, implementation, modification and adaptation; creating new networks; strengthen existing networks; participation in conferences, seminars or competitions.

The mascil Moodle platform has been conceived as a meeting place for teachers who share a common interest in developing and enriching their practices. In addition, mascil partners used several existing forums for communication, with the main purpose of sharing tasks and ideas, and cooperate in designing activities. Important challenges that had to be overcome for teachers to participate in the international discussions were time pressure, heavy workload, and lack of confidence in speaking foreign languages (i.e. English). By providing excellent tasks and themes that teachers could see the use of in their everyday teaching and benefit of in their everyday work, the two first mentioned
challenges could be overcome. The language barrier is more often than not an imagined one rather than a material one, and experience shows that teachers and students are perfectly good at communicating as soon as they give it a go.

### 3. Recommendations

Recommendations are given according to the four dimensions of the report.

**National and international teacher networks**

Due to cultural differences, cross-country collaboration and building of international networks of teachers may be a difficult task. At the same time, international collaboration to face the challenges of modern society is necessary. To establish successful national and international teacher networks, it is crucial to provide an infrastructure for e.g. the potential to work together and exchange ideas on something that from the outset the teachers may not feel totally confident in, like IBL. Help is needed, and may be provided by such international collaborative projects like mascil. The first step might be to support teacher networks within schools and communities/municipalities.

**Virtual conferences**

Virtual conferences provide great opportunities to exchange experiences, enhance the possible points of views and thereby investigate into common grounds and possible best solutions to big problems. To succeed with such virtual meetings, it is helpful to use a facilitator, to give clear guidelines for preparation and completion of the meeting, to test the technical equipment in each country before students and teachers meet, to establish contact between students and teachers before they meet virtually, to include it in a long-lasting exchange program, or at least meet more than once. It is also recommended to choose tasks that bring forward the differences among participating countries, a task that inspire to discussion of cultural and societal perspectives and thus give virtual conferences an added value, compared to traditional classroom practice.

**“Problem of the month” (PoM)**

“Problem of the month” provided an excellent opportunity for teachers and students across Europe to work on a carefully selected task involving IBL and with WoW aspects. However, designing tasks that are meaningful to discuss across countries, cultures, curricula, grades and subjects is a challenge. To have teachers and students in different countries to work on some common problem from their own national points of view and within their culture, you need to choose an issue that is relevant for all, despite context.
Regularly given tasks can contribute to valuable teacher communication across countries, but it is recommended to use a facilitator to initiate contact between teachers.

**The mascil national and international (online) discussion forum**

Across mascil partner countries, most teachers prefer face-to-face communication. National and international online communication seems to be a bit far away from their daily practices and thus they do not feel the necessity to do so. Inventing new platforms takes a lot of time and effort that by far surpasses the use value compared to using already existing platforms which teachers (and students) are already familiar with. Taken experiences from the mascil project into consideration, a recommendation is to strive to use existing platforms that are known to teachers (and students).

4. References


5. Appendices

5.1 Appendix 1: Guidelines for virtual conferences
INSTRUCTIONS FOR MASCIL VIRTUAL CONFERENCES

Technical rules/recommendations when using Skype for business:

1. Always test - in advance - the exact equipment you will use during the meeting, in the same room. Testing within the same conditions is necessary to be able to know whether it will work properly or not. Be sure that you can use the chat, mute your microphone and video, and present a powerpoint file. The Norwegian mascil team will set up a test meeting for you.
2. We recommend that you use only 1 PC actively during the meeting, and preferably an external microphone or headsets. More than one microphone in the room will give a disturbing kind of echo.
3. When the other country/countries do their presentations, please turn off/mute your microphone to avoid background noise.
4. If you get problems with your picture or video (probably due to limited internet connection), turn off your video function. In such cases the emergency solution is to use sound only.
5. Please use the chat function actively to ask questions and to tell the others that you would like to say something. Try to follow the chat all the time. To see the latest messages in your chat window, it might be necessary to scroll down when using the app. If we get trouble with the sound, we will use the chat to ask each other questions.
6. Always upload - in advance - the powerpoint file(s) you will be using during the meeting.
7. In case you lose the sound or video, please try to leave the meeting and then join the meeting again.

Recommendations on what to do before the meeting:

1. Inform each other about yourselves (name of teacher and students, name of school, name of city, localization in your country, age of students, the teacher’s disciplines), so that the other group knnow who they are going to meet.
2. Send each other a short powerpoint presentation about what you have done, so that the other group can prepare suitable questions to you.
3. Prepare 4-5 questions to the other group(s), and write down the questions in a powerpoint file. It might be difficult for the students to remember their questions during the meeting.

Program for the meeting (time schedule about 45 minutes):

1. The facilitator of the meeting welcomes the participants, introduce the participants and presents the program for the meeting. Participants shortly present themselves (names).
2. School 1 (x) present what they have done, say something about local adjustments or changes they have done within the task and finally they present their results shortly. Here you can also share a powerpoint presentation if wanted. About 10 min in total.
3. School 2 (y) present what they have done, say something about local adjustments or changes they have done within the task and finally they present their results shortly. Here you can share a powerpoint presentation if wanted. About 10 min in total.
4. The classes ask each other questions that they have prepared before the meeting. You ask questions every second time and the other group answer immediately. The facilitator is passive during this phase, unless you need help to progress. About 10 min in total.
5. Discussion of results and eventually methods. Maximum 10 min in total.
6. The facilitator gives a final comment, agreements on further cooperation are discussed/agreed upon and the facilitator closes the meeting.

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