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EDUCATION IN MATHEMATICS AND ICT IN RELATION
WITH THE WORLD OF WORK –
THE LAST YEAR OF THE MASCIL PROJECT

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The paper provides retrospection on the activities of the IMI-BAS team of the Mascil project with emphasis on three events: the Mascil consortium meeting taken place in Sofia (from November 30 to December 3, 2016); the visit of representatives of the European STEM Professional Development Centre Network to IMI-BAS (December 4, 2015) and the meeting of the members of the National Advisory Board (NAB) of Mascil (January 28, 2016) at IMI-BAS. Based on the comments and suggestions of the NAB members the next activities for a wider dissemination and implementation of the Mascil ideas in the Bulgarian educational system (to be carried out till the end of the project) are considered.

1. Introduction – what is *Mascil* about? The *Mascil* European project (*Mathematics and science for life*) enters its fourth (the last one) year [1, 2]. Its main goal is the development of *Professional Learning Communities* that bring together teachers across schools to work in collaboration to explore (in their classrooms) the implementation of inquiry learning approaches that connect to the world of work. This goal has been in harmony of what recent research [3] has highlighted as very effective in the professional development of teachers in math and science: (i) *it should be sustained over time and not a one-off event*, (ii) *it should be based on collaborative communities of teachers working together*, and (iii) *the development of subject knowledge is integral*.

2. Achievements of the IMI-BAS Mascil team. The achievements of the Bulgarian Mascil partner, IMI-BAS, could be summarized in figures as follows: 55 dissemination events, 14 introductory courses, 35 own Professional Development (PD) courses for in-service teachers, more than 950 applets (educational environments) in the *Virtual Mathematical Laboratory* [4, 5].

What is hidden behind the figures is much more important – the building of a community of multipliers of the Mascil ideas. These are teachers who communicate intensively (on national and lately – on international basis), who modify the existing resources and create their own ones – an indicator that the IMI-BAS Mascil team is on the right track.

In the summer of 2015 two PD courses, organized by Ministry of Education and Science (MES) jointly with IMI-BAS, were conducted with 20 teachers in each group. A similar course (with 20 teachers) was conducted in the summer of 2014. Thus we have so far 60 teachers certified to conduct courses with other teachers on Inquiry Based Mathematics Education (IBME). Together with the group of other teachers the IMI-BAS

Mascil team has been working with during the last 6 years, we now have enough people to apply the cascade method for the dissemination of IBME. Having all this in mind the IMI-BAS team started to involve the multipliers directly in the professional development of teachers – at the beginning under the supervision of Mascil team members, and gradually – self-standingly, as separate learning communities.

The endeavor of the IMI-BAS Mascil team is to involve all the key players in the realization of the project: representatives of MES, Regional Inspectorates for Education (RIE), teachers, parents and **students**, bearing in mind that it is the today's students who will change the status-quo in the future. It is worth mentioning that a number of Mascil related ideas and activities were implemented in the context of RAABE PD courses, Regional academic centers of BAS, and Regional inspectorates thanks to their good understanding of the importance of the Project for modernizing the Bulgarian school system in harmony with the European educational strategies. Here an essential role has been played by the Mascil National Advisory Board (NAB) which has always been instrumental in terms of ideas, critical comments and suggestions about the further activities in the frames of the project.

A specific feature of the IMI-BAS Mascil team is its direct involvement in the fourth level of the inquiry based learning, the so called “open inquiry”, in which high school students work on their own research projects tackling open problems, and present them to various audiences [6, 7]. Such activities are in support of the belief that the students are also a major stakeholder in the process of implementing the inquiry based education and that they have to be given the proper attention. Especially the students of higher abilities need special attention because they can serve as multipliers for IBME among the rest of the students. A rather traditional Bulgarian activity in this direction is the High School Students' institute (HSSI) which has already celebrated its 15th anniversary [8].

Another (and a new) initiative aimed at involving larger groups of school students in using inquiry based learning is the online competition “VIVA Mathematics with Computer” [9, 10]. It was started a year and a half ago and was conducted three times as of December, 2015. The problems in this competition are designed in a way which implies the use of inquiry (with the help of dynamic mathematics software) and reflects, whenever possible, the connection with the world of work. There were 1040 participants (from grades 3 to 12) in the latest edition of the competition (December 19th, 2015).

3. The Mascil consortium and representatives of European STEM Professional Development Centre Network meet in Sofia. The latest Mascil consortium meeting took place in Sofia from November 30th to December 3th, 2016. It was opened by the coordinator of the project Prof. Katja Maass from the University of Freiburg. One of the first documents presented and discussed at the meeting was “Take-away messages for policy makers”. The feedback from the consortium indicated the relevancy of the content of the document to national and EU contexts. Some outcomes of the comparative analysis of the policy workshops reports were considered in terms of how best to address the improvement of the accessibility and the visibility of policy related issues in the respective national websites of the Mascil project partners. Fragments of the original and the national website are shown in Fig. 1.

The IMI-BAS team presented its most recent achievements in the context of the different work packages and organized a Folk-dances workshop with mathematical flavor



Fig. 1. Fragments of the original and the national website

for the guests.

The 3d Meeting of European STEM Professional Development Centre Network took place as a joint event of the Mascil meeting and was attended by the representatives of 16 European institutions. Günter Törner from the German Centre for Mathematics Teacher Education welcomed the participants and made a short review of previous meetings. Katja Maass presented the ongoing work and achievements. It was reported that the network has become well-known on a European level, with different groups of stakeholders. The meeting was followed by a visit to IMI-BAS and attendance of the poster session in the frames of the National seminar on mathematics and informatics education in inquiry based style [11]. The guests were greeted by the IMI-BAS Director, Acad. Julian Revalski, who emphasized on the involvement of this institution in educational activities at different levels, including PD of teachers in mathematics, informatics and IT.

Of special interest for the guests were also the presentations of the representatives of Shumen University (Assoc. Prof. Natalia Pavlova and Prof. Dragomir Marchev), and of the Faculty of Mathematics and Informatics at Sofia University (Assoc. Prof. Angel Angelov).

The meeting ended with active discussions between the guests, the teachers and the students participating in the National seminar (Fig. 2).

There was an international stand – Florian Stampfer (Austria) together with the Bulgarian multipliers Borianna Kuyumdzhieva and Neli Stoyanova presented their work on the Mascil Problem of the Month dealing with bicycle insurance (Fig. 3).

4. A meeting of the Mascil National Advisory Board – January, 2016. One of the immediate actions to be taken after the Mascil Consortium meeting was to get



Fig. 2. The international guests enjoy the teachers' poster presentations



Fig. 3. The discussions on the Mascil Problem of the Month continue

together the National Advisory Board (NAB) of the Project. This happened on 28th of January in IMI-BAS. The representatives of the Board were: Silvia Kancheva, Valentina Arabajieva, Kircho Atanasov, Angel Angelov, Evgenia Kovacheva, Pavlin Petkov, Angel Slavchev (representing Galia Kozhuharova), Radoslav Yoshinov, Toni Chehlarova.

In addition, two teachers-multipliers were invited – Rumiana Angelova, Mariana Velinova and two guests: Hristo Traykov (businessman) and Christina Atanasova (educator).

The members of the IMI-BAS team acquainted the NAB members with the most recent developments of the Project, gave them relevant materials and presented some recent Bulgarian contributions to the Mascil e-resources.

The Project coordinator on behalf of IMI-BAS, Petar Kenderov, underlined Mascil's major goal: wider dissemination and implementation of the IBME methods in the Bulgarian school system.

The Mascil multiplier Rumiana Angelova shared that her students, although not very good mathematicians, are very enthusiastic about the IBL, thanks to a great extent to the support of the Mascil community. At a specially organized Science Fair her students have demonstrated in front of the IMI-BAS Mascil team how they imagined the role of professional scientists in math, chemistry, physics. She finally shared her pride and satisfaction of belonging to the Mascil community – thanks to the general spirit of IBL she feels comfortable to provoke her students with questions (even open ones) and as a result she also gets provoked by students' questions.

Mariana Velinova, representative of a vocational school, said that she had attracted her colleagues to start implementing IBL, to attend the PD courses organized by the IMI-BAS Mascil team, sharing at the same time that the teachers from her school are

lacking the needed skills for documenting and spreading further their achievements and good practices. They would rather create a resource, then – improve it, but it would remain there for the lack of self-confidence to present it to others. . . Finally she expressed her strong conviction that it is when the students see some application of math in the world of work that they feel interested in studying it. . .

What follows are the main suggestions and recommendations of the NAB members present at the meeting:

- *The Mascil multipliers have shown a great enthusiasm and abilities to implement IBL in their work. What is still to be done is to develop around them teacher learning communities. A great help in this direction could be provided by the local school authorities (head-masters of schools, experts in RIE, members of the Union of Bulgarian Mathematicians).*
- *In order to make the Project ideas part of everyday life of the Bulgarian students and teachers, it is necessary to tune the e-resources in harmony with the math curriculum in such a way that every teacher could use them in class. We should not stop at the level of the multipliers who already are implementing the project ideas in a class setting. You should think of the technology behind making every available resource ready to be used by any teacher who would like this.*
- *The big goal is to enrich the instrumentarium in the form of learning environments. A more distant goal is to enrich the knowledge of the teachers in other fields. The teachers are still not “a sharing community” – they plough their own furrows. Such an attitude should be changed from the first years of the pre-service education.*
- *I meet teachers who are reluctant to the IBL. Such teachers would not involve additional efforts in their daily work and would not collaborate with others. The textbook should exist in e-versions with innovative ideas like the ones suggested by Mascil. The higher education institutions should also help in this direction, with specific developments in the style of half-baked resources.*
- *It is crucial that we make connections among the school disciplines, and the problems in IBL style are very appropriate for this. The half-baked e-resources are the solution, provided they are developed by specialists from different fields; we need a rich collection of such resources.*
- *To provoke the interest in school we need appropriate tools but this might result in not covering the syllabus and the fear is that the time in class is not sufficient. For solving this problem there should be a state policy in support of the project based learning. It has had a great success in the out-of-class activities. Such activities though should not be the core of European projects only; they should be a state policy!*
- *There is a generation gap between teachers and students. Most of the teachers want a template, a scenario, a scheme according to which to deliver their lesson, and these notions provoke the resistance of the students.*
- *The majority of teachers prefer a well digested textbook with recipes to follow. For them – the less efforts, the better. I know personally the Mascil multipliers, they are really enthusiastic, they use and develop the project resources, but having the current textbooks it is not easy to implement IBL. An additional obstacle is the potential complain of the parents that the teacher does not follow strictly the textbook. The administration avalanche is reaching the teachers, as well. IBL should start in the*

pre-service teacher education. This is important since very few of today's teachers make a difference between syllabus and curriculum.

- *It is true that it is easier for the teachers if everything has been digested for them. But wouldn't it be even better for them to get their students interested and enthusiastic about what they are doing/learning? Every teacher has something to say to the students but having to stick to the plans and the syllabus prompts even experienced teachers to make the students learn by heart. Thus our real challenge in implementation and dissemination of the Mascil ideas is how the teachers could express the best in themselves by changing the traditional "preaching facts" paradigm, by helping their students develop the key competences and still cover the state standard requirements.*
- *Contrary to the general idea that IBL has to be applied in its "pure form" we should not expect that everyone will become explorer. The curiosity and the inquiry are different things. The resources we develop should be attractive for the kids so that even teachers who have not been motivated originally would use them thanks to their students' motivation.*
- *It is crucial that the students get a result after the inquiry, that they create a product based on their explorations and investigations, a product that could be presented and shared – this is one of the key ideas of the constructionism. The students should participate in discussions. Some teachers are afraid that they would not know the answer. We have still to work on cultivating the endeavor of sharing with the learning community.*

At the end of the meeting the participants were asked to enter the role of optimists/pessimists about the dissemination of the Mascil ideas on a broader national scale. Here are some of their opinions expressed anonymously:

Optimistic views:

- *The start signal is given, a group of teachers is actively working and involving students in IBL.*
- *We could expect the avalanche effect.*
- *There are many people who are looking at the IBL as a possibility, we can create and have fun together.*
- *Taking examples from real life is very important and motivating.*
- *Competences reached in various ways are the solution!*
- *Provoking the curiosity of the students would enhance their interest towards mathematics.*
- *We have reached the bottom of the education and any change is good*
- *The applets developed in the Virtual Math Lab of IMI-BAS could and should be "dressed" in didactical clothes*
- *The Directors of the schools in the whole country should be involved (especially those of the vocational schools).*
- *The sections of the UBM should be involved more intensively.*
- *The interdisciplinary approach is decisive – modeling real life situation is much more motivating for the students than solving math tasks.*
- *A contest for the best resource in the style of Mascil should be organized. It is nice that the resources are useful for teachers and students alike.*

Pessimistic considerations:

- *Some teachers prefer the limitations rather than freedom – it is easier for them to teach that way and make their “limitations” a law.*
- *A deep reform of the syllabus is needed.*
- *Resources involving dynamic software are difficult to implement on a broader scale due to the lack of relevant equipment.*
- *Many teachers lack motivations – “why doing new things when the old style works for me...”*
- *The existing textbooks are in the traditional “preaching” style – laboratory workshops should be included in the school program.*
- *It is difficult to overcome the skepticism of the teachers as for getting better academic results in the context of IBL.*
- *The IBL requires the courage to leave your comfort zone, and many teachers are reluctant to this.*
- *It would be difficult to attract the teachers in the secondary school, especially those with a specific profile. The chance could be looked for in the innovative (future) schools.*
- *The information about the Project should reach the whole country – it is still not sufficient.*
- *The environment is very conservative; the teachers do not feel motivated to get their students enthusiastic about mathematics.*

5. Conclusions. Summarizing the Pros and Cons expressed by the participants in the NAB meeting we came to the following conclusions:

- To reach a larger scope of dissemination, the IBL resources developed should be user-friendly for a greater number of in-service teachers. In particular, these resources have to be equipped with didactical scenarios and good practices, provided also by teachers;
- More efforts should be devoted to the establishment of local teacher learning communities. An essential role in this direction could be played by the head-masters of the specialized Mathematics and Science High Schools, the head-masters of the vocational schools and the Sections of the Union of Bulgarian Mathematicians;
- The local teacher learning communities are to be networked in a natural way by the resources (both human and educational ones) developed in the frame of the Mascil Project.

“Mathematics and science for life” deserves all these efforts – we have almost a whole year till the end of the project!

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**ОБРАЗОВАНИЕТО ПО МАТЕМАТИКА И ИНФОРМАЦИОННИ
ТЕХНОЛОГИИ И ВРЪЗКАТА МУ С ПРОФЕСИОНАЛНАТА СФЕРА
– ПОСЛЕДНАТА ГОДИНА ОТ ПРОЕКТА MASCIL**

Петър Кендеров, Евгения Сендова, Тони Чехларова

Докладът представлява ретроспективно представяне на дейностите по европейския проект Mascil с акцент върху три събития: срещата на Консорциума на проекта, състояла се в София (30 ноември – 3 декември, 2015), посещението на представители на *Мрежата от центрове за професионална квалификация на учители по природо-математически дисциплини* в Института по математика и информатика, БАН (4 декември, 2015) и срещата на членовете на Националния съвет на Mascil в ИМИ-БАН (28 януари, 2016). Въз основа на коментарите и предложенията на членовете на Националния съвет се набелязват следващите дейности в рамките на оставащия период до края на Mascil за по-широко внедряване на идеите на проекта в българската образователна система.