Tamara Bianco, M.A.
University of Augsburg
Chair for Didactics of Mathematics

Needs Analysis Report for InnoMathEd – Innovations in Mathematics Education

1. Focus of the Project

InnoMathEd[1] aims at substantial **inno**vations in **math**ematics **ed**ucation on European level. Pupils should be given the chance to develop deep mathematical understanding, to acquire key competences that are essential for lifelong learning and to use ICT, especially dynamic mathematics, for individual and cooperative learning processes. For that purpose didactic concepts, pedagogical methodologies and innovative learning environments for pupils are developed, tested, evaluated, disseminated and exploited on European level. They focus on pupils' active, self-responsible and exploratory learning.

To implement these innovative concepts and tools in the educational practice in Europe the project includes the development of strategies and courses for effective initial and in-service teacher education as well as various concrete educational activities for students of mathematics education and teachers in practice. Educational staff in the European area of learning is made acquainted with didactic concepts for teaching and learning with dynamic mathematics fostering pupils' key competences. This process and the products are regularly evaluated with the aid of a specific online evaluation tool to ensure high quality outcome.

The long term impact of the project on the European educational system will be ensured by a wide variety of valorisation strategies: Innovative didactic concepts will be spread out in initial and in-service teacher education, best practice learning environments will be disseminated and exploited via web-based offers and print media, the public as well as decision-makers in policy and education administration will be included in dissemination processes and scientific results will be made public in the scientific community so that further research in the fields of didactics and pedagogy can build on the outcome of InnoMathEd.

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[1] The project is funded with the support of the Lifelong Learning Programme of the European Union.

2. User Requirements

InnoMathEd has various target groups which will have direct or indirect contact with the project and its aims. In the following the main target groups are named accordingly:

Target-groups are

- teachers,
- pupils,
- teacher educators,
- students of mathematics education,
- decision-makers in politics and the education administration

in whole Europe.

All those groups of people have different needs in respect to the project. Therefore the specific requirements for all instances will be listed separately.

2.1 Teachers

InnoMathEd involves teacher training which will be held by seven partners of the project. It is planned to train approximately 20 teachers per partner, which equals a total of 140 persons. In order to help those teachers not only to learn the *didactical concepts* themselves but also to bring them into the classroom and help their pupils to get new insights on how mathematics can be explored and learned in a more cooperative and self-responsible way, it is necessary to initiate some kind of "conceptual change" (cf. e.g. Schnotz, Vosniadou & Carretero, 1999) with the teachers. They have to understand and internalize the importance of a shift of their role as a teacher from an instructor to a coach.

In these trainings the teachers will learn what possibilities *ICT* offers for teaching in mathematics. The use of dynamic mathematics will be an integral part of the skill enhancement of the teachers. It is important to not only to show how the software might be used but also how the teachers in future will be able to use these tools in their day-to-day teaching. There is evidence that today's teachers sometimes struggle with ICT and new media, therefore it is crucial to help them with their provisos and show them, that the use of computer in classrooms can be an effective support for their pupils to improve their transfer of learning in mathematics. Otherwise inert knowledge is produced (Renkl, 1996).

Furthermore it is important that the teachers use *pedagogical methods* that support the use of ICT and foster the key competences of pupils. Research studies like PISA or TIMMS show that pupils are often unable to transfer the abstract knowledge of mathematics to common contexts or new situations. Their ability to see similarities between mathematical principles acquired in school and a new assignment which is given to them is oftentimes not sufficient. A more constructive view of teaching and learning might support the pupils' ability to make this important transfer (cf. Perkins & Salomon, 1992). Teachers therefore have to be aware of a more constructive way of teaching which includes a more active part of the pupil in learning. The responsibility to learn new things shifts somewhat from the teacher to the pupil himself and the teacher is – after an initial input - only supporting the learning process if

necessary. Also cooperation between pupils is an important factor. Teachers need to help their classes in working together in teams instead of being "lone warriors".

For teachers to be able to use the new concepts and methods in class it is of course fundamental to have an *appropriate infrastructure*. Computers accessible for students and for the teacher are a basic requirement. Moreover access to high-speed internet is helpful to download or use the offered software or material which will be produced within InnoMathEd. In respect to the various partners participating in InnoMathEd it is of particular importance that each partner country will have similar access to new technologies and equipment in order to use the newly acquired methods and programmes efficiently. In the long run this of course applies for other European countries which are not direct members of the consortium as well.

A recent survey undertaken with a group of teachers who had in-service training within the project of InnoMathEd showed that 13 of 14 teachers use to a computer at work and all of them use a computer at home. Regarding the use of the internet there is also a very prevalent use to be seen, since seven out of 14 state to use the internet several times a day, five once a day and the rest (two persons) at least several times a week. For working purposes the computer is in this specific group mostly used for information research (12 mentions) and e-mail-communication (11 mentions). The computer is also used for preparing individual lessons and to hold the lesson afterwards. This is of course no representative study but it still shows some tendencies for the access and use of the computer in school.

Teachers will meet in training and then leave again to their individual schools to – considering the best case – use the new software and methods they have been trained in. The possibility to reflect on the learning and to get some kind of exchange with people who might experience similar challenges in class can be a very helpful thing for teachers to bridge the gap between knowledge and action (Mandl & Gerstenmaier, 2000). This is why there should be some kind of tool which will foster reflection and exchange between teachers, first and foremost within the original training group but also between the teachers in the different countries. Not only will this produce deeper insights to dynamic mathematics but also contribute to the intercultural exchange between the partner countries. A teacher from Germany might be able to learn from the experiences his or her colleague in for example Bulgaria has. Likewise teachers from Norway could help their counterparts in Greece to solve a didactical ambiguity.

2.2 Pupils

As mentioned above pupils are dependent on the teacher's ability to bridge the gap between the knowledge they will learn during their training within InnoMathEd and their normal workday. Once the teacher has introduced the new methods in an appropriate manner the pupils have to be given the chance to learn self-responsible and cooperative. For many pupils this might be a new challenge, since classroom teaching often is still carried out in a different way. There are observable changes in the attitude towards learning but there is still a long way to go from letting the pupils be a passive observer to making them an active learner. Pupils

have to acquire strategies not only for learning for the next test in class but for *lifelong learning*[2].

InnoMathEd aims especially at the development and extension of pupils' key competences. One major factor is the fostering of *mathematical literacy* which is proven to be severely lacking with many European pupils (OECD, 2007).

The technical infrastructure is an important factor for the use of ICT. Pupils have to be familiar with computers and their technologies and have to have access to them in school or in their homes in order to accomplish *digital competence*. PISA 2003 shows that in advanced economies as a general rule about half to two thirds of all households have access to the internet (cf. OECD, 2006, p. 19). Still there are adolescents that do not have access to computers and the internet - especially at home (ibid., p. 23). This phenomenon is known as "digital divide" and indicates a disadvantage for those pupils that are excluded from ICT and access to internet and new technologies (cf. e.g. Servon, 2002; Arnhold, 2003). The consequences of exclusion are far-ranging: In today's world we are shifting towards a knowledge based society – work in advanced economies is more and more done by or with the help of computers. Today's pupils who will form the workforce of tomorrow have to have excellent knowledge about new technologies to be able to participate in social and economical activities. What has to be kept in mind is that not every family will have the financial resources to provide their child with an own computer. Therefore at least in school there ought to be access to a computer room so that the pupils can train and use their newly acquired knowledge and skills in dynamic mathematics.

Language is another important factor for the development of key competences. InnoMathEd is carried out in eight European countries and the project language is English. All material developed and collected within InnoMathEd will therefore be in English. Pupils (and of course their teachers) will profit from the use of a foreign language (the United Kingdom is of course excluded in these considerations) since there will be not only everyday language but also technical terms which might be helpful for the pupils' future. To motivate the pupils to use English in the project as well as in the classroom it is crucial to create the material in an easily understandable manner and to explain difficult terms in the mother tongue as well. By using the material and documents provided pupils will learn English "en passant" (Reischmann, 1986) without actually having the impression of "grubbing for grades".

Connected with language is of course the development of *communicative and social skills*. It is a pronounced goal of InnoMathEd to help pupils by developing deeper competences in regards of communication and social abilities. To achieve this target it is necessary to create the output material with which pupils will work in future according to these requirements. For example this has to be kept in mind during the creation of dynamic worksheets: If pupils should be able to use these documents and materials not only for their individual work but also for group or team work it is beneficial to incorporate cooperative assignments or instructions here. Didactic concepts might also include duties and responsibilities for the learner to exchange solutions with partners or help classmates who are obviously not as fast

[2] This is also a specific goal of the European Union. Within their different activity lines, the COMENIUS-Program specifically aims at lifelong learning in school education. URL: http://www.lebenslanges-lernen.eu/comenius_2.html [30.05.09].

and need extra time and help to understand the new lesson. Social context is very important for learners to refine their skills. If there is not only the teacher but also others like peers or classmates who function as models it is easier to understand that there may be more than one way to solve a complex problem. Learners with different degrees of knowledge will be encouraged to work on their own progress in order to keep up with class (cf. Collins, Brown & Holum, 1991). This is one way to improve the use of the pupils' mothers tongue as well: by explaining others complex facts the individual can train to use technical terms and find out what strategies help to make others explain what he or she is intending to get across.

2.3 Students of mathematics education

The members of this target group are not pupils anymore and not yet teachers. They can best relate to both of the other target groups since they probably still remember well how it is to learn and to be taught mathematics. Now they themselves are trained to be teachers and therefore are more sensitive and open for new didactic concepts and pedagogical methods.

Here lies the chance to equip them with new ideas in teaching as well as methodical thinking. Teachers who have been working in their profession for several years are sometimes less open to changes within their routines. The prefer methods from their standard repertoire – simply because they believe in them and are of the opinion that since they have worked well in the past there is no need for change. This narrow view hinders the chance to reflect on new and more modern ways of teaching and learning. With students who are eager to become teachers for mathematics the motivation is quite different since they are more amenable to changes and innovative impulses.

Students who will not have the chance to become directly trained or educated with the innovative concepts of InnoMathEd should be given the chance to have easy access to the outcome-material. The project-website is an adequate way to distribute and disseminate the ideas that are developed within the project. The material should of course be open source – it would be counterproductive to apply fees or restrictions for accessing the material.

2.4 Teacher educators

Teacher educators are expected to have a head start in terms of what teachers should know or acquire during their time of being a student of mathematics education. It is therefore essential to provide this target group with excellent and precise material which will help them to spread the word about what will be developed within InnoMathEd. Within the project the partners should focus on various strategies to disseminate the material and information. Besides providing the products and material on the website of the project for an easy download (pull-strategy) there has to be an involvement of media and educational institutions to inform the public about the project and its aims (push-strategy). This assists in getting a teacher or a teacher educator interested in the subject and automatically lowers the risk of high barriers in getting information for the target group.

The material which will be provided should be easy to handle and understand and planned in a manner which allows instant usage but also modifications for various likings or needs. It

will be useful to have material that can be used for a more autodidactic way but also documents and products that are better be used in an instructional session.

Persons who are assigned to train people in dynamic mathematics should be selected with care: They are the link between the product or services and the people who are supposed to use them in an effective way. This involves a high level of motivation with the trainers on the one hand but also an excellent knowledge about the aim of the project and its specific components. They have to be able to answer the questions that will arise and find solutions for most problems. The trainees have to get the impression of a competent counterpart and should not have any reservation in regards of asking questions or recess more complex problems

Language plays an important role here as well: First of all trainers ought to have outstanding knowledge of the terms used in the materials and programmes to be able to serve not only as a translator in case of misunderstandings but also to function as role models (cf. Bandura, 1971). By actively using English within the trainings the trainees will become more fluent in talking and by using the terms they will acquire the necessary skills to effectively use the language in the classroom situation with their pupils.

Considering the *infrastructure* with this target group it is a basic requirement to have suitable training rooms which will provide computers and the programs needed for the training.

2.5 Decision-makers in politics and the education administration

Politicians and people working in educational administration receive numerous requests for educational programs or so called innovations. Oftentimes they are overwhelmed by what the market has to offer. Since the project is funded by the European Union it has proven to be of social and educational relevance. But still: In order for the program to have a serious impact on a European level it is crucial to inform the public of the existence of InnoMathEd. Therefore throughout the project but also afterwards it is of utmost importance to get in contact with media representatives to tell them about the project and intrigue them to publish about the innovations of InnoMathEd.

In times of PISA and other research studies that alarm the public about pupils not properly being prepared for the working environment politicians and representatives from educational administrations are very eager to find out about new ways to educate children and students. This chance should be used to strike up conversations with the decision makers in Europe. In order to make good case for the project there should be attendant news for the duration of the project. Interested persons should get the chance to register for a newsfeed to get new information of InnoMathEd instantly. People interested in the project should moreover be actively informed (without demanding the information) by the partners of the project. The relevance of InnoMathEd and its worth has to be communicated permanently to raise the awareness of the project.

Attention for the project should also be drawn in conferences and meetings for educational purposes. This way, relevant contact persons will hear about the innovations of dynamic mathematics.

3. Conclusion

There are many possible ways to satisfy the needs of the various target groups. The aim of this need analysis was to give an overview of what the single groups might need for the success of the project and what problems they are currently facing. Besides providing the infrastructure for computer-supported-learning for example by having computers accessible for teachers, pupils and students it is also the didactical input which is especially important for teachers. In order for them to actually know how to teach in an effective way it is important to train them continually. Especially for students of mathematics there lies a great opportunity to acquire knowledge and skills that can be very helpful for their future careers in teaching. They can be seen as the interface between pupils and actual teachers and they might even be able to implement new ideas "bottom-up" in schools.

Within the project there has been and still is a lot of discussion about the best way to help fostering the competences of pupils, students and teachers and to inform politicians in Europe about the outcomes of the project. In the current phase of the project the several partners have different activity lines on which they work on, always having this need analysis in mind to ensure a positive outcome for all people involved.

4. Literature

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