Primas

PROMOTING INQUIRY
IN MATHEMATICS AND SCIENCE
EDUCATION ACROSS EUROPE

Guide of supporting actions for teachers in promoting inquiry-based learning

SEVENTH FRAMEWORK PROGRAMME

Seventh Framework Programme | Theme Science in Society | Support action GA n° 244380
www.primas-project.eu

PROMOTING INQUIRY IN MATHEMATICS AND SCIENCE EDUCATION ACROSS EUROPE

PRIMAS stands for Promoting inquiry in mathematics and science education across Europe. PRIMAS is an international project within the Seventh framework Program of the European Union. Fourteen universities from twelve different countries are working together to further promote the uptake of inquiry-based learning (IBL) in mathematics and science.

	University of Education Freiburg Germany
	University of Geneva Switzerland
	Utrecht University Netherlands
	University of Nottingham United Kingdom
	University of Jaén Spain
	Constantine the Philosopher University in Nitra, Slovakia
	University of Szeged Hungary
	Cyprus University of Technology Cyprus
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Guide of supporting actions for teachers in promoting inquiry-based learning

PRIMAS has compiled actions suitable to support the uptake of inquiry-based learning in schools. Providing training and classroom materials to teachers are key to fostering the implementation of IBL. However, a range of broader and lower-level measures is essential to create interest, and open up and develop spaces that support IBL uptake. This guide introduces key issues in implementing supporting actions and presents concrete examples of actions that were carried out within the PRIMAS project.

Lead partner: Assoc. prof. Soňa Čeretková, Dr. Janka Melušová, Dr. Ján Šunderlík, Constantine the Philosopher University in Nitra

PRIMAS Project
University of Education Freiburg, Germany (Pädagogische Hochschule Freiburg), Coordinator
www.primas-project.eu
Contact: Katja Maaß,
University of Education Freiburg, Germany

The project PRIMAS -- Promoting Inquiry in Mathematics and Science across Europe (www.primas-project.eu) has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement nº 244380. This publication reflects only the authors' views and European Union is not liable for any use that may be made of the information contained herein.

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1. EXECUTIVE SUMMARY

PRIMAS, the acronym of Promoting Inquiry in Mathematics and Science Education across Europe, is an international project running under FP7, within the scheme 'Science and Society'. The project aims to effect a change across Europe in the teaching and learning of mathematics and science by supporting teachers to develop inquiry-based learning (IBL) pedagogies. Through teachers' new experiences with IBL pedagogies, the project reaches their students, who in return will gain first-hand experience of scientific and mathematical inquiry.

The project outcomes are activities that offer high quality support for, and training of, teachers and teacher trainers; in this way the project aims are secured. Besides the selection of high quality materials and the collection of methods based on IBL pedagogies, supporting actions addressed to teachers play a very important role during the whole project. These actions are dedicated to the promotion of IBL and are intended to encourage teachers' attendance on professional development courses (CPD).

Supporting actions for teachers are designed for teachers of mathematics and science and also can be directed towards other groups within this frame: professional development providers, head teachers, teachers' networks and associations, school authorities, curriculum and assessment developers, teacher educators, university teachers, researchers, individuals and groups, who are interested in active IBL dissemination among teachers.

The guide briefly introduces the PRIMAS project, shows the main principles of inquiry-based teaching and learning culture in mathematics and science education and offers a definition of the supporting action for teachers. Readers of the guide will also be introduced to the theoretical background of the dissemination activities. Knowledge about the purpose and precise target group of a concrete dissemination action, about important contextual factors and appropriate communication strategies and suitable design of action (programme format) are central dimensions to reflect upon, when carrying out dissemination action aimed to increase the knowledge about inquiry-based learning and its use. Therefore, these dimensions are treated within the theoretical part of the guide.

The PRIMAS project partners have disseminated PRIMAS ideas on more than 90 dissemination actions in the category "supporting actions for teachers" during the first 18 months of the project run. The best practices were selected in each partner's country and described in detail within the case studies. The guide offers three of these case study analyses. The other case study analyses can be found at www.primas-project.eu. It describes how to plan supportive actions for teachers and offers the underlying theoretical framework for this work.

2. INTRODUCTION

2.1. About this guide – Aims and purpose

The guide is based on the experiences of PRIMAS project partners. It is a condensed and reflected synthesis of the PRIMAS project partners' experiences in promoting supporting actions for teachers.

The purposes of this guide are

- to clarify our understanding of IBL in mathematics and science education
- to set out a framework of supporting actions for teachers to promote IBL pedagogy
- to give advice and instructions on how to organise supporting actions for teachers successfully and to illustrate some general types of actions to review and reflect supporting actions for teachers as they have been carried out in the PRIMAS project

This guide focuses on dissemination actions for teachers that can be carried out in addition to the project's direct delivery of the classroom materials and professional development courses. We are convinced that this guide will help you to organise and conduct your IBL promoted activities. Together we can make the IBL pedagogy more popular among teachers in your environment.

2.2. About the PRIMAS project

PRIMAS is the acronym of the European project *Promoting Inquiry in Mathematics and Science Education across Europe*. Founded under the 7th Framework Programme, PRIMAS brings together mathematics and science educators from 14 universities in 12 different European countries.

PRIMAS aims to:

- Provide insight into approaches to mathematics and science teaching that are motivational and enjoyable for learners;
- Support teachers with inquiry-based learning (IBL) pedagogies in mathematics and science;
- Provide resources and coordinate professional development for teachers and teacher educators;
- Support teachers, students and parents in their efforts to better understand the nature and importance of inquiry-based learning;
- Develop and work with networks of teachers and professional development providers in participating countries;
- Analyse and understand current policies in relation to inquiry-based learning and inform and work with policy makers to support improved practice.

Our aim is to reach the critical amount of teachers, students, parents and policy makers that will ensure a real and perceivable impact on daily teaching practices, students' learning, parental perception of school mathematics and science, and current and future policies.

Among the different actions PRIMAS is promoting, the successful implementation of a wide scale and long-term professional development (PD) programme in every country is absolutely crucial. Teachers are probably the most important actors in promoting a change in the way mathematics and science are conceived and taught across Europe. And together with the support they will get from students, parents and policy makers, they are the only ones capable of making this change really happen.

In order to support teachers in this challenging and fascinating journey, the PRIMAS site offers a wide variety of professional development resources and exemplary classroom materials.

2.3. Inquiry-based learning in mathematics and science education

According to the National Research Council (2000), inquiry in education is 'a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in the light of experimental evidence; using tools to gather, analyse, and interpret data; proposing answers, explanations and predictions; and communicating results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations' (p. 23).
In a narrow sense, IBL may be defined as a teaching approach which intends to promote learning by engaging students in any of the processes or activities typically involved in scientific research. These include: making observations, formulating hypothesis, defining problems and key guiding questions, designing and performing experiments and communicating results and evidence-based conclusions.
Within the PRIMAS project, there is a multifaceted understanding of IBL which does not only focus on the processes related to scientific inquiry, but on other key aspects considered essential for an efficient IBL implementation. These characteristic IBL features are briefly outlined below:

Student activity

Inquiry based learning is a student-centred methodology which stresses the importance of the active construction of learning. Therefore, students are expected to pose questions, make decisions, design plans and experiments, discuss, collaborate, communicate results and provide justified answers and explanations when engaged in the inquiry process.

The teacher's role

Teachers are not considered as knowledge providers, but as motivators and facilitators of students' learning. For this purpose, specific teaching competences are required to subtly guide students and help them work in profitable ways. The use of questioning is one of the key teaching competences in inquiry methods. Appropriate questions can enhance students' reflection, critical and logical thinking and self-regulation. To this end, the ability to prompt constructive interaction between students when holding a discussion is crucial for ensuring the social construction of knowledge. Teachers should also know how to design and use unstructured tasks which offer appropriate challenges and provide rich contexts and scenarios to facilitate learning.

The classroom atmosphere

The classroom atmosphere is considered to be a key feature in the efficient implementation of IBL. It is important to establish a culture where there is not a knowledgeable authority but instead, ideas are respected and accepted according to their foundation and how they are supported by evidence and logical thinking. In this atmosphere, mistakes are considered to be learning opportunities and there is a shared sense of ownership and purpose.

The expected learning outcomes

Students are expected not only to acquire conceptual understanding of science topics and mathematical tools, but also to develop process skills and competences.

Since IBL requires a student-centred, approach it encourages autonomous and life-long learning.

PRIMAS considers IBL as an essential ingredient to successful education.

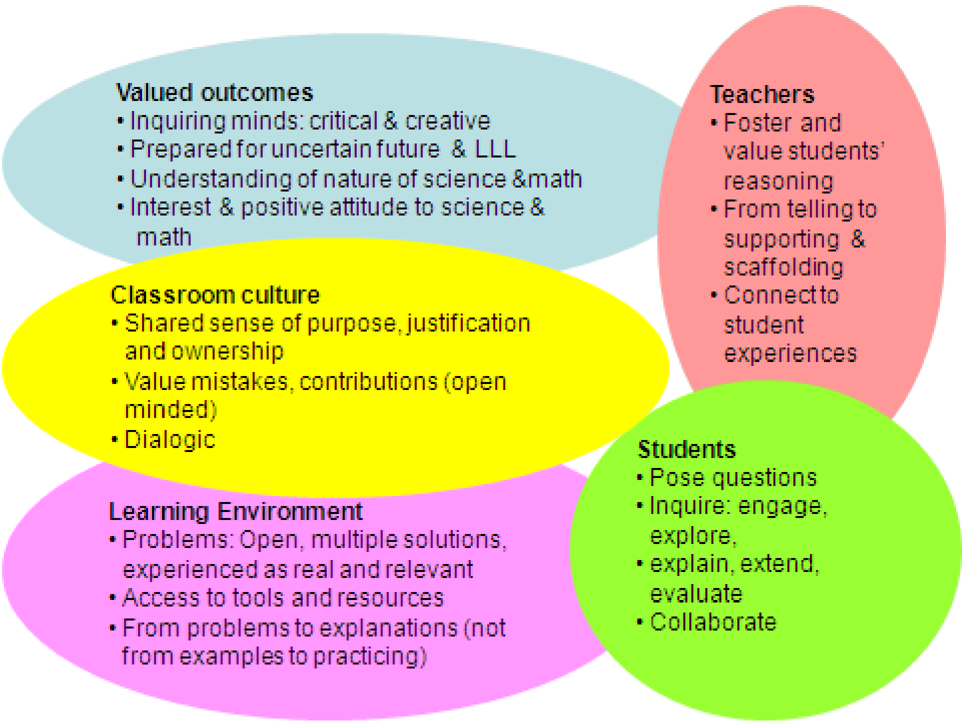


Figure 1. Five key aspects of IBL

The following diagram shows five key aspects of IBL and highlights specific features that are characteristic of each perspective (Figure 1).

2.4. Definition: What are supporting actions for teachers?

Supporting actions for teachers are predominantly aimed at informing the whole target group - practising teachers, student teachers, teacher educators, school authorities and other individuals and groups with close connection to education and everyday school practice - about the principles of IBL pedagogies. Furthermore, the target group should get familiar with possibilities to integrate IBL in teaching practice as well as with materials to implement IBL pedagogy in the classroom.

Supporting actions for teachers can be split into two areas:

1. They can be directed to teachers and can be designed to:
   a. give an insight into inquiry-based learning to a wider audience of teachers,
   b. help to motivate teachers to participate in professional development courses (including e-learning modules) on IBL pedagogies and the use of IBL tasks and materials in their teaching practice,
   c. encourage teachers to take IBL pedagogies as part of the teachers' regular teaching repertoire they employ in the classroom.
2. They can be directed towards 'supportive groups' for teachers in their uptake of IBL teaching strategies – these groups are in close connection to the school system and, therefore, play a significant role in supporting teachers to use IBL.

There are some model types of activities, which can be carried out as supportive actions for teachers: conferences, educational fairs, exhibitions, information days, workshops, open lessons, talent days and competitions for pupils. Which of these types of the events will be chosen in each individual case depends on the pre-defined event objectives. For example big events such as conferences, educational fairs, exhibitions and information days are visited by a large number of visitors and serve the purpose to inform large number of people. Alternatively, there are active pedagogical methods, with the direct involvement of participants, support actions such as workshops, open lessons, talent days and competitions for pupils. Participants are touched by IBL pedagogies directly; learning by doing is a basic principle of this kind of activity for small numbers of participants.

In summary, supportive actions for teachers are very important events in order to promote IBL pedagogy. They create a setting that supports other dissemination activities, which focus on inquiry-based learning practises and content. They open doors for courses aimed at the professional development of teachers in schools, regions and countries. They open minds and hearts of teachers and their students for new exciting experiences with the inquiry-based materials and pedagogies. Some teachers' knowledge and skills can be influenced by short-term activities, such as a plenary lecture followed by discussions or workshops, but mostly it is the longitudinal process linked with practice that can cause the changes of teachers' ways of teaching.

3. THEORETICAL BACKGROUND

Research into the diffusion of innovation - here innovative teaching methods like inquiry-based learning -, have suggested that there is a significant lag of approximately 15 years between the invention of a scientific result and its use in general practice (Lomas, 1991; Utterback, 1974). This gap can be even bigger in education, where some ideas are rediscovered and disseminated in several waves over longer periods of time. One example of this is project-based learning defined by Kilpatrick in 1918 (Kilpatrick, 1918) and rediscovered in the 1970's. In some countries it has only recently become a part of the curriculum.

For this reason there is a need to inform and to involve teachers, teacher trainers, heads of schools and other relevant key players in relation to schools in the process of adopting new knowledge in common use via active dissemination processes. **Dissemination** is understood to be more than just the distribution of information or processes of making information available. Dissemination also implies that action has been taken to embed and upscale for example IBL within its own context (discipline, institution, country) and/or to replicate or transform IBL in a new context and to embed it in that new context.

3.1. The importance to take action at different systemic levels

An individual person is embedded in many social-ecologic systems: microsystem (family, friends, classes…), organisation (schools, societies, associations…), localities (neighbourhood, villages, towns…) and macro system (culture, religion, mass media…). To ensure a successful transfer of knowledge, dissemination should be guaranteed on all systemic levels. If there is a need to change somebody's behaviour or beliefs, the most successful influence strategy is to deal across all levels. (Dalton et al., 2007) Especially, the proximal systems which family, friends, colleagues and other small groups belong to, do not only have direct contact to the individual, but a huge possibility of influence on them. By planning our supporting activities for teachers we should try to reach not only the teachers but also groups of regional or local authorities, teacher trainers or students.

3.2. The importance to be aware of the process of knowledge adaptation

If we want to encourage teachers to change their way of teaching, we have to acknowledge that often this is not as easy as it seems, for example due to many challenges that teachers face (see below). Research shows us that the process of adopting innovation, such as implementing inquiry-based teaching methods in day-to-day teaching, normally takes a long time and happens in several stages.

The five stage model of the Innovation-Decision Process by Rogers (Rogers, 1995) builds a theoretical framework for supporting actions for teachers. The model captures five stages, which describe how knowledge (in the specific case knowledge about IBL) can be adapted into practice. In the following the five stages are presented:

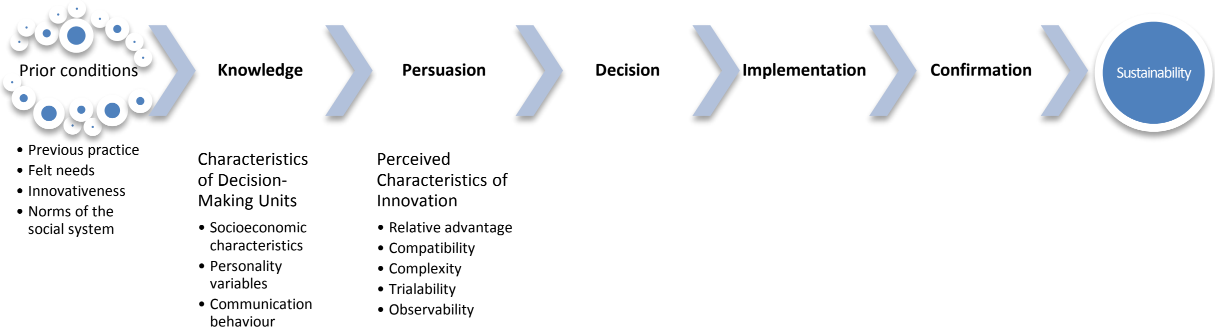


Figure 2. Model of five stages in the Innovation-Decision Process (Rogers, 1995)

According to Rogers' model the first step is to give the teacher initial information about IBL and so they can gain an understanding of how it functions (**knowledge)**. In the second step, **persuasion**, the teacher forms an attitude towards IBL. **Decision** is the stage, in which the teacher makes the choice, whether to adopt or to reject IBL. In order to take on a new viewpoint, one must decide to let go of an old one. A good reason needs to be given for one to decide to make a shift in thinking (Shapiro, 1994). In the following step, **implementation,** IBL is put into use. The outcomes of the implementation are considered within the **confirmation** step, in which the teacher seeks reasons to continue/discontinue practicing IBL in classroom. The theoretical framework of the process of knowledge acquisition provides important information for the organisers of supporting actions for teachers. They should take potential hindrances within this process into account and be aware of the stages their participants are situated at. This information makes teacher events easier to plan.

3.3. The importance of the contextual factors

As mentioned earlier, the implementation of innovative teaching does not only depend on the teachers themselves but is also influenced by a number of contextual/**environmental** factors (Tirosh & Graeber, 2003). The PRIMAS project analysis of needs (Dorier/PRIMAS, 2010) defined several key **contextual factors** that are closely related to policy and the education system within each country. Important contextual factors in relation to IBL are:

- presence of inquiry-based learning issues in the **curriculum**
- **time** in the curriculum scheduled for carrying out inquiry-based learning
- **materials** for inquiry-based learning present on the market
- presence of IBL tasks in **textbooks**
- presence of inquiry-based learning tasks in **assessment** of **students' knowledge** of IBL
- appreciation of IBL by students' **parents, reforms or new policies** etc., which have an impact on day-to-day teaching
- the support of the head of school
- students' appreciation of IBL: students have their own beliefs and concepts about a subject. They may initially decline changes to these and their reaction may be quite strong and emotional (Lester, 2002).

We recommend to the organisers of supporting actions for teachers to attend the contextual factors, which may influence their activity. The organisers should be prepared to make use of contextual factors' positive effects or to minimize their negative impacts.

3.4. The appropriate way of communication

There are different communication channels, which can be used to inform the target groups, such as teachers, heads of school, teacher trainers, representatives of school authorities etc. Three important channels are characterised in the following:

Interpersonal channels involve a face-to-face exchange between two or more individuals (Rogers, 1995). These include training, lectures, one-day courses, information events, workshops, discussions, personal contacts, consultancy, and collaborative programmes. Interpersonal channels are very important at the persuasion stage by forming and changing attitudes towards IBL and thus influencing the decisions to adopt or reject it.

Mass-media channels are means of transporting messages that enable a source of one or few individuals to reach an audience of many (Rogers, 1995). They include radio, television, print communications, communication through websites and social networks, but also policies, administrative arrangements or events with participation of decision-making structures (committees, principals, etc.). Small promotional materials, such as informative posters and brochures, which catch attention, can effectively support dissemination activities or raise people's interest. They need to be specifically developed for different target groups.

Publishing research results in journals does not constitute a sufficient dissemination process (King et al., 1998) but it can be a possibility to inform the wide public about IBL and to give them some ideas about it. By communicating on this channel, it is possible to reach a large number of people within a particular group, most probably individuals interested in our subject.

It is important to evaluate the options of communication one has to hand and then selectively choose one or more channels to get the message out to the right target groups and in the right wording.

3.5. Different speed and willingness of teachers to adopt IBL

Interaction between individuals on the same or on similar levels of beliefs, education or social status usually leads to more effective communication (Rogers, 1995). Thus, the role of colleagues, who have already trialled IBL, has to be stressed in the dissemination process. Colleagues with positive experiences are very good motivation and convincing sources of information for other teachers, thus their input and representation in the dissemination process should be an integral part.

Some individual teachers have the ability to shape their schools, just as schools and organisations shape the behaviour of individual teachers; others need colleagues as examples to follow them.

There are many characteristics involved in the individual decision to adopt or reject inquiry-based learning. Most of these are related to teachers' values, interests and beliefs. There is growing evidence that teachers' beliefs about their field and how it should be taught play a significant role in shaping their classroom behaviours (Chapman, 1997; da Ponte, 1994; Thompson, 1984) and the consequences of following these behaviours influence their beliefs (Sargent & Fearon, 2011).

Thus, as Ernest (1989) argued, significant and meaningful teaching reforms are unlikely to take place, unless teachers' deeply held beliefs about mathematics/science and its teaching and learning change. This means, a teacher will only change his way of teaching, if he is really convinced about the new method and their positive effects.

Moreover, change at an affective level is a long-lasting process. All knowledge is constructed and these constructions are influenced by the prior beliefs, knowledge and experiences of the "knower" (Smith, 1993). Consequently, different people experiencing the same intervention will have different constructions of the experience (Lachance & Confrey, 2003). According to Dobbins et al. (Dobbins et al, 2002) teachers attending conferences, participating in research projects or with access to a research consultant, are more willing to adopt IBL.

Rogers (1995) categorised people into five categories with regards to their tendency to adopt innovation: Innovators, Early Adopters, Early Majority, Late Majority and finally Laggards (cf. fig. 6). In the following reference is made to the categories. Further reference is made to their relevance in the planning of supporting actions for teachers.

Innovators and **early adopters** do not need much convincing. Some of them will try IBL just because it is new. They are leaders, who prefer to be among the first trialling new things. Usually teachers willing to be early adopters are those with greater empathy, less dogmatism, a greater ability to deal with abstractions, to cope with uncertainty and risk, higher self-efficacy and higher aspiration for formal education. They also differ in their communication behaviour: they attend more conferences, are more active in teachers' associations, have more contact with researchers and have a higher degree of opinion leadership. Age is not a significant characteristic to predict whether a teacher is an early adopter or not. In relation to sustainability, this group will leave IBL as soon as they find something else interesting to try. To be successful in the dissemination of IBL, the **early majority** and **late majority** should be attracted, but these two groups behave differently from groups on the ends of the bell curve. Members of these two groups are followers, doing things when they see somebody else doing it.

The **early majority** needs special care and effort to implement IBL. They are followers in nature, but the only people they follow are each other. They watch each other, waiting for somebody else to make the first move. On the other hand, they are quite loyal once they establish a positive attitude to IBL.

There is no smooth or logical transition between early adopters and the early majority. The key is to find members of the early majority group having a problem and offer IBL a solution. The problem can be a new curriculum, a new form of assessment, etc. Early adopters trust only well-established institutions and colleagues. Actions for this group should contain examples of good practice and/or contributions from early adopters satisfied with IBL.

The late majority is quite easy to pursue. They watch the early majority very closely, they will start practicing IBL when they see that the early majority is satisfied with it.

Laggards are stuck to traditions, they are proud that they do not do anything new or in a new way. They will use IBL only when it is widely used in schools. They may never even try to use IBL in classrooms.

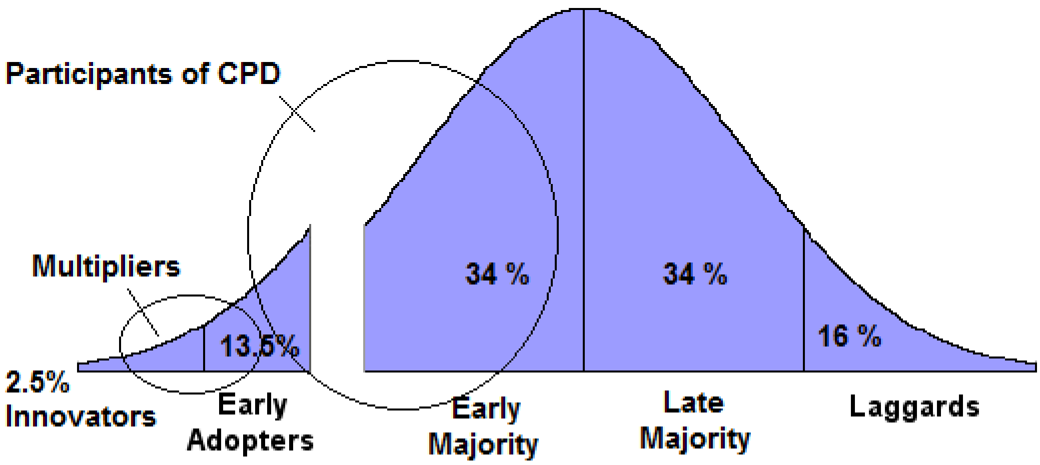


Figure 3. Adopter Categorisation on the Basis of Innovativeness (Rogers, 1995)

By planning supporting actions for teachers, it is important to consider the different categories in order to cope with participant requirements. It’s essential to reflect on which category the participants fit in and how the event should be organised in order to achieve as much profit as possible.

4. PLANNING SUPPORTING ACTIONS FOR TEACHERS

Planning a dissemination activity requires quite a bit of work. In order to develop a successful activity, it is necessary to consider the following aspects.

- What is the aim of the activity? What are the target groups?
- How can we acquire our target groups?
- What should be the content of the event?
- How can we set the right frame and create the appropriate setting for the event, making attendees feel appreciated?

In the following the named aspects are summarised.

4.1. Aims and target groups

Before starting to plan an event, it is always very helpful to be clear about the focused target group and the aims of the event. Although, this sounds easy and trivial, experience shows that this aspect is neglected too often.

In order to clarify the ***aim*** of the event it is helpful to answer the following questions:

- Is the aim of the event informing a wider audience of teachers about IBL?
- Is the aim of the event motivating teachers to participate in professional development courses?
- Is there another aim of the event? Which one?

The clarification of the aims of the activity is a milestone in the context of the preparation of an event. Therefore, take your time defining the purposes. Setting targets is an important condition for a successful supporting action for teachers.

Besides defining the aims of the activity there is a need to consider, which target group the activity aims to reach. On the basis of Rogers' five categories it is also crucial to identify the participant's tendency to adopt IBL (cf. chapter 2.1 to 2.5):

- Is the event directed to teachers or to 'supportive groups' for teachers, such as head teachers, assessment development or teacher educators?
- Which category of adopter may the participants belong to? (Fig. 6). Do they already have experience with inquiry-based learning and want to know more? Do they have no experience or knowledge at all?
- Which social background does each participant have?
- Which are the proximal systems of the participant?
- In which schools and which subject do participants teach?
- What are the contextual factors under which teachers work?

Each of these questions has its own requirements, which have to be taken into account: for example, some of the participants might not teach the subjects (in the PRIMAS project case) maths and science. Further, the role of participants at their schools must be clear: How can they, as head teachers or support teachers in their school include inquiry-based learning? The reader can find examples for this in the case studies from Germany and Malta (see Case Study Description here).

We can also try to consider the activity from the participants' point of view and answer the following questions, which help us to explore the **teachers' perspective and their needs.**

- Why does a teacher participate in the event? What participants' questions could be expected?
- What kind of guidance does a participant need?
- What kind of information is a participant not interested in?
- What are participant's expectations about the activity?
- What is the attitude of a participant concerning the event? Are there some fears expected?
- Does a participant have some previous experience with IBL pedagogies?

4.2. How can a focused target group be acquired?

If the aims and target group are already clarified, the strategy of reaching the focused participants can be considered. Teachers, as well as head teachers, teacher educators etc. often suffer from an overload of work. Furthermore, if a whole day activity is planned, teachers need permission to attend the event instead of being at school. As a consequence, there is a need to carefully reflect on how to attract teachers. They must be convinced that coming to the particular event offers support for their day-to-day teaching. It is important and useful to be aware of the contextual factors, which can influence the planned activity. The following questions may help the organisers of supporting actions to clarify teachers' interests concerning the event and to point out potential hindrances:

- Is there a new curriculum which teachers need support to deal with?
- Is there a new form of assessment which teachers are not familiar with?
- Are schools assessed by external evaluators and do they need help in this respect?
- Is there already a planned event for teachers, which we can join?

Another important question is, how teachers can best be informed about the activity. Careful reflection will lead to ideas on how to advertise the upcoming event. At this level of preparation the consideration of the channels of communication can be very helpful. The use of existing networks seems to be a profitable possibility to inform potential participants about the event. It can be supportive to contact the school authorities or a teacher association which would be willing to distribute the information about the planned activity.

Another way of reaching teachers and other target groups could be using other events to spread information on inquiry-based learning. Sometimes there is a possibility to 'attach' the event to a larger conference, which attracts the same target group.

All these aspects are illustrated in the case studies of Spain, Switzerland, Slovakia, Cyprus and Germany (see Case Study Description here).

4.3. What should be the content of the event?

Having informed the target group about the event, it is now important to carefully plan and structure it. Again, the content and the structure of the event are dependent on the target group and its interests. However, there are some aspects that are useful to issue in almost every event for IBL dissemination. In the following, we mention some possible topics you may wish to consider - bearing in mind that they are just meant to be ideas or suggestions.

4.3.1. Introduction to IBL pedagogy

To start with, a brief introduction to IBL pedagogy should be given to the participants in every event. Depending on the type of event as well as on the previous knowledge the attendees probably have, this introduction might be more or less detailed. However, it is referred to the fact that IBL is an innovative way of learning and teaching with the aim to develop 'inquiring minds and attitudes' of young people. This is also the reason why the tasks ought to have a relevance to the students' everyday life. Moreover, it is important to mention the new role of teachers and students in IBL classrooms. While the teachers are proactive, support struggling and challenge stronger students, the students work more independently, pose their own questions, explore and evaluate. Furthermore, open tasks lead to the fact that pupils can use different solution strategies. Besides, the different IBL processes play an important role and are supposed to be mentioned briefly at the beginning of an event. The following figure shows the most important IBL processes in a clearly arranged diagram. Experimenting, Communicating, Measuring and Predicting are only some of them and become clearer when dealing with the features of IBL tasks.

Figure 4. Activities inquiry-based learning includes

4.3.2. Information on the PRIMAS project

Depending on the type of the event and the target group, you may wish to talk about the PRIMAS project itself. The participants could be informed about PRIMAS as an international project that aims to effect a change in the teaching and learning of mathematics and science across Europe. It may be explained that the PRIMAS project brings together experienced experts from different countries and different backgrounds, such as teachers, head teachers, researchers, university professors, teacher educators and more. The PRIMAS partners together do not only work at IBL Modules which are meant to be used for teacher training and professional development, but also at IBL tasks that are directly tested in schools and improved afterwards.

4.3.3. IBL Modules

As there are different IBL Modules that the participants of the event usually do not know yet, a short introduction is helpful to give a better insight into the concrete work of the PRIMAS project. The following modules are available on the PRIMAS website at http://www.primas-project.eu and are expected to be mentioned:

PD Module 1: Student-led inquiry

PD Module 2: Tackling unstructured problems

PD Module 3: Learning concepts through IBL

PD Module 4: Asking questions that promote reasoning

PD Module 5: Students working collaboratively

PD Module 6: Building on what students already know

PD Module 7: Self and peer assessment

All modules were developed to support teachers with using inquiry - based learning approaches in their classrooms. Every module deals with a certain topic within IBL pedagogy. While the second PD module is about how to handle open tasks, the fifth module deals with students working cooperatively in groups and the seventh is about innovative assessment methods. It ought to be explained that the modules are independent from each other and do not have to be worked at in this sequence.

4.3.4. Tasks

Besides the PD modules, the PRIMAS project partners have developed a wide range of IBL tasks that can be presented exemplarily when running an event. All of them have in common that they are rather unusual mathematical and science tasks. "*You are planning a trip through the desert. Your jeep can carry fuel for only 1000 km, and the next petrol station is 3000 km ahead. What is the best way to get across?"* - This is just one example of an open task developed by PRIMAS. Often, it is useful to try out an open task like this with the participants of the event to involve them and to underline the different approach to mathematics and science.

Afterwards, it is suggested that you point out the features of IBL tasks as they become clearer when having dealt with a specific task before. Depending on the group of participants and on the type of event, these features can be worked out together or just be presented by one of the leaders of the event.

Anyway, IBL tasks are characterised by their openness, the multiple solution strategies and the relevance to the students` lives. Moreover, the students can usually work on IBL tasks on different levels which means, that IBL tasks support the idea of natural differentiation. Also, many IBL tasks include collecting data, designing experiments and working with diagrams. Consequently, IBL tasks are often worked at in groups, which is another feature of this kind of tasks.

Last, but not least, it is often meaningful to mention and discuss the chances and difficulties of IBL lessons. If this is not taken into account by the speaker himself, it might come up in a discussion afterwards.

Further aspects

You may also decide to run workshops on specific topics, such as IBL and assessment; Dealing with heterogeneity by using IBL; Finding IBL tasks for a specific topic; Dealing with parents.

Depending on what is going to be the main area of content, different frameworks may be suitable to inform the participants best. In the following chapter, some types of events are described and discussed.

4.4. What is an appropriate framework for our supporting action for teachers?

There is a large number of possible frameworks, of course, but not all of them are equally suitable for supporting actions for teachers. As mentioned above, the setting has to be chosen carefully in addition to the target group, the content of the event and more. Consequently, it is necessary to consider the strengths and weaknesses of the different frameworks. Based on the experience of several PRIMAS project partners, the following types of frameworks might work well:

A **conference** is an appropriate framework if the main aim of the event is to reach a wide audience and to give an initial insight into a general topic. The participants do not need to have much previous knowledge as the experts will inform their audience about everything they need to know. Also, the listeners can address their questions directly to the experts as well as discuss their ideas in groups later on. Besides, a conference is usually a single event which is scheduled to last about two to six hours. Consequently, the listeners might find it easier to take one day off at school to attend the conference than to participate in seminars on a regular basis. However, a conference is less useful if a rather specific or limited topic is discussed as there is little interaction. All in all, the case studies from our PRIMAS partners in Switzerland, Germany and Cyprus (for more detailed information see Case Studies Description here) support the idea that conferences are quite effective, especially to give an overview of a certain topic as well as to inform the whole target group.

In contrast to a conference, **workshops and seminars** are more interactive events that allow room for discussions in smaller groups. They usually take place at universities, schools or educational centres - either on their own or as a part of a conference or another event. Usually, the participants are already well-informed about the corresponding topic. Often, they work on a concrete purpose.

In the workshops, the participants are directly involved and touched by IBL pedagogies, deepen their knowledge and initial understanding and benefit from the face- to- face exchange. Case studies in Norway and Slovakia (see Case Study Description here) have shown that seminars are useful to better understand and reflect on one`s own beliefs as well as try out new ideas in a less formal environment. Workshops and seminars support the idea of cooperation and collaboration; however, the group consists of a limited number of participants who might focus only on their own topics instead of dealing with new questions and ideas.

Summer schools open up new possibilities as the participants work intensively together for several days. Not only are the attendees submerge into a certain topic, but also summer schools provide a wide range of activities within themselves, such as lectures, discussions, workshops and more. However, the problem is that most of the interested teachers, head teachers, and others suffer from an overload of work and just cannot take part in an event lasting several days. Still, the case study in Romania has shown that summer schools motivate and encourage the participants a lot as they feel really involved and actively try out the things they learn.

Another possible way to disseminate the idea of IBL is so- called **open lessons** as well as **competitions**. Both activities directly involve students so that teachers, school authorities and other interested individuals get to know IBL tasks and methods in practice. This type of event offers a concrete and initial insight into IBL and can help to encourage teachers. Later on, they can put their new gained knowledge into practice themselves, following the principle “learning by doing”. Nevertheless, it is difficult to communicate an idea only by demonstrating it in practice as a theoretical background is important as well. Anyway, the case study about a maths competition in the Netherlands (see Case Study Description here) underlines the importance of events demonstrating the idea of IBL in practice.

A rather different way to disseminate IBL pedagogy is to establish a teacher network on the **internet**. The Case Study about the teacher website in Spain (see Case Study Description here) demonstrates that new information on IBL tasks are spread effectively and that websites are a helpful way to reduce the gap between projects and teachers. Of course, this kind of framework is different from the others as there is no personal contact at all. Therefore, it is rather useful to attract attention, inform and exchange first ideas via the internet. Later on, face- to- face interactions should probably take place as well, always depending on the aim of the participants.

In summary, it should have become clear that every type of event has its strengths and weaknesses. Therefore, it is even better to disseminate an idea by using different strategies and planning several kinds of events.

In the following we will illustrate these aspects with the help of interesting cases of dissemination activities which may inspire you to run similar events.

5. EXAMPLES OF SUCCESSFUL DISSEMINATION ACTIVITIES

5.1. Case Study/ Dissemination activity Switzerland: Crossed overview on scientific approach in mathematics, physics, chemistry and biology

Context

In Geneva, a new "*plan d'études*", valid for all French speaking Switzerland (PER: Plan d'études Romand), will be introduced in September 2011, for all sorts of compulsory education (ages 4 to 15).

With regards to mathematics and sciences this new PER is divided into five major branches, one being mathematics and the natural sciences. This is a novelty since mathematics and the sciences have traditionally been taught as different school subjects. On the other hand, this novelty is not completely radical since even if they appear in the same branch, mathematics and sciences are still taught separately. However, placement in one branch aims at making the two subjects closer. In particular, in the text of the plan d'études, a common introduction has been written that presents what a scientific approach should entail, referring both to mathematics and the sciences.

This new situation required some discussion between science teachers. This was also a good opportunity to introduce the PRIMAS project to a large audience, not only superficially but in relation to a major real-life issue in Geneva.

In coordination with the Presidents of Group[1] (PG) in mathematics, we set up a one-day training course that any teacher could voluntarily attend. It had been announced in a formal offer at the end of school year 2009/2010. It took place on 18 November, 2010, at a school in Geneva. Around 50 teachers, mostly of lower secondary education, but also of upper secondary, in mathematics physics/chemistry and biology[2] signed up for it.

[1] At the level of lower secondary education (Cycle d'Orientation, CO) in Geneva, there are elected representative teachers of each school subject: two in mathematics, two in physics/chemistry and one in biology.

[2] It would be difficult to give an overview of the division between disciplines since, due to a lack of mathematics teachers, many physics and biology teachers actually also teach mathematics.

Event

Date: 28 November 2010

Target Group(s): Secondary school teachers

Participants: 50

After several discussions between the PG and PRIMAS team, we set up the following schema for the training course (see annexe for a precise programme of the day).

We started with a joint presentation between the PG and PRIMAS team, in order to summarise what the aims of the PER are, and how PRIMAS and, more generally, promoting IBL in the teaching of mathematics and sciences could help better implementation of the new ideas in the PER.

Then, three specialists presented, over half-an-hour, what a scientific approach could represent in their field. A condition we set them was not to limit their talk to teaching but actually to the larger issue of the epistemology of each scientific subject.

More than an hour of discussion was planned after the three presentations.

In the afternoon the participants were divided into small groups (of four or five) containing at least one teacher of each subject and one PG or PRIMAS team person. They were given four questions and asked to choose two in each group and tackle them from the standpoint of their own background and culture.

<u>Here are four questions - each group should choose two to work on:</u>

You must tackle the questions from your own field of expertise, which may be complementary.

The goal is not to arrive at a definitive answer, but to employ your diverse opinions and scientific backgrounds to tackle these questions and to come to an agreement within the group.

In each group, for each chosen question, you will have to give an account of the debate in the group (use transparencies or a power-point presentation for five minutes).

1) What is the best way to heat up one litre of water: resistance, a micro-wave oven, electrical hotplates, a kettle, etc.?
2) How can one determine the average yearly temperature of the Earth?
3) It is commonly said that forests, especially the Amazon, are the lungs of the Earth. What does this mean? Is this arguable?
4) Two identical glasses are filled with the same quantity of wine and water respectively. With a spoon, one takes some wine from the first glass and pours it into the glass of water and mixes it with the spoon. Then, with the same spoon, one takes exactly the same quantity as before from the glass containing the mixture of wine and water and pours it into the glass of wine, then mixes it. Which has the most? The wine in the glass of water or the water in the glass of wine?

The explicit idea (see how we formulate the question in the annexe) was not that they reach a definitive answer but rather that they put forward their similarities and differences in opinion in a way that made it possible to tackle the questions despite their different scientific backgrounds.

At the end of the day each group presented, the results of their discussions on one transparency sheet. The presentations were made grouped by questions.

The main ideas that guided our organisational decisions were:

- We wanted teachers to be fed with some information about the scientific approach in each subject by specialists, with some opportunity to respond (morning).
- It was a great opportunity to have teachers of different disciplines gathered for a training course; we had to give them the opportunity to work together. We wanted to disseminate PRIMSAS ideas without losing focus of the aim of the day. It was in this spirit that we set up the afternoon programme. At the end of the day we presented PRIMAS in more detail, gave a flyer to each participant and advertised events to come.

Analysis

The morning was quite interesting. The three presentations contrasted quite significantly, but were universally appreciated. The timing was just right and the discussion was rich, with many participants asking questions and discussing issues. Rapidly, some distinction between scientific approaches appeared, mostly between mathematics and the other sciences, but also between biology and physics, especially concerning the role of experiments. We used the entry of a glossary given in the PER defining words like hypotheses, experiment, etc., in order to structure the debate.

The group-work in the afternoon was usually very interesting even if, as is usual, some groups worked together better than others. Here again, the mathematics way of thinking appeared very specific compared to other sciences. However, mathematics teachers were quite puzzled by questions like the one about forests being the lungs of the Earth and realised that this could actually lead to some scientific debate in which they could be involved.

The presentations at the end of the day were a bit too long. This could have been predicted and is actually always a pitfall in this kind of event. We have to think of a new way of closing a session, when a long time has already been spent in group work!

Conclusions and recommendations

Overall, we have several reasons to be quite satisfied with what happened during this day. First of all, we had quite a few teachers (even if 50 does not seem a lot it is when one takes into account that Geneva is quite small and that attendance was voluntary). Secondly, the format of the day, and the fact that we had taken a long time to prepare, produced consistent and productive results.   We only have to revise the way we organised the end of the day.

Teachers were universally happy, and the fact that they got to meet teachers from other subjects and exchange ideas with them seemed like the main source of satisfaction.

Finally, the consistency of PRIMAS objectives with the theme of the day was genuine and it was a great opportunity to present our project in a situation that made sense in a local curriculum context.

Programme of the training course

Crossed overview on the scientific approach in mathematics, physics, chemistry and biology

(CO-00121) – 18th November 2010

8h30 -9h00 Presentation of the day. Context PER and PRIMAS

(Bernd Hatlanek, Christian Colongo and Jean-Luc Dorier)

9h00 – 9h25 Scientific approach in biology

Christian Orange

9h25 – 9h50 Scientific approach in physics

Guy Robardet

9h50 – 10h15 *Coffee break*

10h15 – 10h40 Scientific approach in mathematics

Pierre-Alain Cherix

10h40 – 12h00 Discussion

12h00 – 13h30 *Lunch*

13h30 – 15h00

Group work

15h00 – 16h00 Presentation of the groups' work

16h00 – 16h30 Conclusion

5.2. Case Study/ Dissemination activity Romania: PRIMAS piloting Action

Context

This case study describes a series of piloting events in which teachers were involved in practising IBL methods with students at different locations (Gherla, Sanmartin, Odorheiu Secuiesc, Hodod, Beltiug, Batanii Mari, Estelnic, Cluj Napoca, Miercurea Ciuc, Târgu Mures, Satu Mare). A group of 14 teachers was selected at previous ("inform them" type) dissemination events. After an initial workshop each of them prepared a teaching unit (2-3 lessons), which was carried out with students, attended by 1-3 colleagues, videotaped, analysed in group and then used with another group of students. At the end of the activity the participating teachers formulated their concerns, remarks, positive and negative insights about IBL methods in general and about the analysed teaching activities in particular. The whole activity was carried out in April and May 2011 and it was intended to exemplify a basic cycle of a PD course. At the dissemination activities the participants were informed about the existing European context, about IBL and about the PRIMAS project. At the initial workshop they had an IBL task and a group session where they had to develop a common structure for their activities based on the IBL definition formulated by the PRIMAS project. At the dissemination activities there were more than 200 participants, but only 14 wanted to work in this experimental group. The aim of this group was to gain some authentic experience with IBL in the Romanian context, where students are not familiar with open-ended questions, or with group work at mathematics or science lessons; they do not usually use scientific calculators or computers at mathematics and science lessons, and they have a centralised and overloaded curriculum and a well-contoured traditional assessment system. In this way, the participants got fully involved in practising IBL methods and through them the project had a good dissemination in their schools (for students, teachers and parents) and the experience of this group can constitute a strong basis for the future CPD courses. Due to a strong collaboration with some regional and local associations (the Hungarian Teachers' Association, the Farkas Gyula Association and the SimpleX Association) only the coordinators and their expenses were paid from the PRIMAS budget.

Activity

Date: April/May 2011

Target Group(s): Maths and physics teachers

Participants: 14

As a result of participation in the event "School Days in Harghita County", where the PRIMAS team made presentations and held four different workshops in different locations (Odorheiu Secuiesc, Toplita, Gheorgheni, Miercurea Ciuc) for more than 200 mathematics teachers, the necessity of a deeper insight arose. As a consequence, we organised an experimental study group with 14 teachers. The action plan had three phases. The first phase consisted of a workshop on 10 April, where they had the opportunity to work on an IBL task as teachers. They had to develop a teaching unit for understanding the arithmetic-geometric mean inequality based on the comparison of different interest schemes (3x1.5 hours). After this they had to adopt a common strategy they would use in their future lessons and in developing future teaching/learning tasks. In the last part of this phase each participant chose a teaching unit he was going to detail and transform to fit the IBL strategy (for a list of these units see Appendix 1). In the second phase each participant developed his own teaching unit and after several discussions with the coordinators and colleagues he/she implemented it with his own students. Each activity was videotaped and attended by a few members of the group to obtain a more personal insight and to have a better opportunity to observe students' actions/reactions. In the next phase these activities were discussed in the group and the improved versions were implemented with other students. In the last phase the group had to analyse the improved version of the activities and to evaluate the progress. In almost all schools we organised Puzzle Houses after the regular activities, where the students and colleagues from the school (and occasionally from the neighbourhood) were invited to play with Happy Cube puzzles, Impuzzable cubes, a collection of more than 100 wire puzzles and other IQ games. At the end of these activities a short workshop was performed using the Happy Cube study.

Results: six members of the group decided to support the PRIMAS team and to act as multipliers in future PD courses; another three members chose IBL as the main topic of their degree thesis (this is required in the Romanian system to obtain the highest level in undergraduate education). Two members had the idea of making a virtual environment for some teaching modules (the elementary operations) in order to offer a supporting tool for students and teachers. Three members renounced further developments - they will use IBL only if they obtain already-developed teaching materials. The accumulated experience and know-how can constitute a strong basis for a future CPD programme. The development of the teaching materials will be continued and most teaching units will be published not only on the website of the project, but also in some local journals, or possibly in a Romanian PRIMAS publication. An overview of this activity, some units, comments, and conclusions will be published in Romanian journals with a wide readership (over 3000 readers). From the next academic year a new course for pre-service teachers will be introduced at the Babeş-Bolyai University. This will focus on practical aspects of teaching mathematics with IBL methods. The Romanian PRIMAS team was invited to give lectures on IBL (a one-week PD programme in July) in the framework of the "Bolyai Summer Academy", organised by the Hungarian Teachers' Association in Romania.

Conclusions and Recommendations

1. Regarding the dissemination:

a. Concrete, relevant and detailed examples and cases are needed (especially for attracting people to CPD activities). All activities have to be prepared in detail and in advance, so this requires a well-organised team.
b. There are some typical negative reactions (time-related, assessment-related and students' behaviour-related). To overcome these, some longitudinal studies would be necessary, or the absence of these studies has to be compensated for somehow (by presenting student/teacher interviews).
c. The efficiency of "inform them" type dissemination events is very low in comparison with an "involve them" type event, but both are necessary. A half-day workshop is sufficient to illustrate some IBL principles and to co-opt people into a short-term CPD activity, but a deeper exercise (one PD cycle) is useful in co-opting colleagues in longer PD programmes. (In Romania the majority of PD courses are not practice-oriented and they are usually very short – some colleagues refused to participate in a longer CPD).
d. Some participants appreciated the personal outcomes of this activity as enlightening not only for the aspects of IBL but also for some difficulties from their previous teaching practice; but they formulated a lot of concerns regarding a long-term use of the IBL methods. Most of these concerns were related to the huge amount of background work in preparing these activities.

2. Regarding the teaching activities:

a. A major difficulty (especially with high-school students) is that if students are not familiar with group work or with making inquiries, time-control needs to be very efficient (at the beginning), otherwise they may waste their time.
b. The teacher's role has to be understood via the classroom processes and in concordance with some long-term development processes. It is not sufficient to support classroom processes, they have to be integrated consciously into a long-term learning process.

Annex: Teaching units (brief description):

- Teaching centroids – the main aim of this unit is to understand the notion of the centroid for polygonal domains and for an arbitrary system of points and to understand the principle of decomposition. A basic problem is to determine (calculate and construct) the centroid of a homogeneous polygonal object (a piece of wood).
- Colouring problems – the aim of this unit is to understand the usefulness of colouring in some covering problems and to construct non-standard colouring starting from a given situation. A basic problem is to determine the maximum number of $1\times n$ pieces that can be placed on a rectangular board with given dimensions ($a\times b$) without overlapping.
- Logical puzzles (following Raymond Smullyan: *What Is the Name of This Book?*) – The aim of this unit is to develop a bridge between formal mathematical logic and some logical puzzles.
- Operations and algorithms with natural numbers – This unit is developed to understand the properties of the elementary operations on an operational level and to understand the algorithms we use for calculations (addition, subtraction, multiplication, division)
- Operations and algorithms with integer numbers – This unit is developed to understand the elementary operations with integer numbers.
- Operations and algorithms with rational numbers – This unit is developed to understand at an operational level the elementary operations by rational numbers (how can you calculate the ratio of two rational numbers, etc.)
- Extracting square-root – Discover an algorithm for square root extraction using visualisation
- Visual representations of algebraic formulas (proofs without words) – Discover algebraic formulas using visualisations
- The concept of the area and The Bolyai-Gerwin theorem – Introducing the concept of the area by decomposition and understanding the Bolyai-Gerwin theorem.
- Teaching divisibility properties using rectangular grids – The aim of this unit is to give a visual interpretation on rectangular grids for a series of number theoretic notions (lcm, gcd, etc.) and to understand some properties of these using the properties of the grid.
- Combinatorial proofs for number theoretic theorems (Little Fermat, Wilson) – Studying combinatorial problems that imply number theoretic properties and obtain generalisations for the number theoretic properties by generalising the combinatorial setting.
- Graph representations and probability – The main aim of this unit is to detail elementary problems of probability in a unitary manner using graph representations (how to discover the product rule for conditional probabilities using non conditional probabilities in a classical framework)
- Puzzle making and classification
- Puzzles and combinatorial problems

5.3. Case Study/ Dissemination activity United Kingdom: Introducing Inquiry-based Learning to trainee mathematics teachers in England

Context

Initial Teacher Education

There is a range of different routes in Initial Teacher Education in England (ITE) in preparation for teaching. However, because teaching is a graduate profession, potential teachers in general either study initially for a first degree in a specific discipline such as mathematics or science, or follow a degree course that is situated in education as a discipline itself. The preparation of secondary teachers is predominantly of the former type, with over 90 per cent following this route, which in most cases is an additional year of university-based study leading to a Postgraduate Certificate in Education (PGCE), whereas in the primary sector over 40 per cent of entrants follow the latter route, which provides a broader range of subject knowledge appropriate to teaching as well as study related to teaching, and learning more broadly. These courses are predominantly based in Higher Education Institutions (HEIs) although a small number of entrants to teaching each year follow courses that are school-based (about five per cent of post-graduates in both secondary and primary sectors). Although the design of the training/education in HEIs of those following courses towards teaching is in the hands of university lecturers and tutors, all courses lead towards Qualified Teacher Status (QTS) and to achieve this students must have met a range of statements of competence defined nationally. These "standards" are organised around three themes: (1) Professional attributes, (2) Professional knowledge and understanding and (3) Professional skills. Many of these are school-focused and assessment is carried out by teachers in schools working in partnership with university-based tutors. As part of the one-year HEI ITE courses students spend at least 18 weeks in schools that work closely in partnership with a local HEI, practising teaching under the guidance of a school-based mentor.

Consequently for "trainee teachers" the focus is very much on day-to-day classroom practice and the school as a work place. In an ethnographic study Hodkinson and Hodkinson (1999, 275) found that the predominant focus of school experience for trainee teachers concerned the pragmatics of 'teaching and implementation of national policies rather than those aspects of pedagogy, reflection and critical analysis' traditionally encouraged by the HEIs. The different priorities are perhaps encapsulated in the tension often experienced in the use of the words "education" and "training" which are often used interchangeably in this context but with very different underlying philosophies. In general one would expect to find that trainee teachers are exposed to a narrow range of pedagogies in their placement schools with teachers very much focused on 'teaching to the test' that often focuses on routine application of rules and procedures rather than deeper understanding of a relational nature.

This case study describes a one-day event for PGCE secondary mathematics trainees in the final 'enrichment' period of their course during which the PRIMAS partner explored some of the ways of working, both mathematically and pedagogically, that mathematical modelling and inquiry-based learning promote. Prior to the day those attending were sent preparatory work (see below) to do; they brought their responses to the day and used them to stimulate discussion.

An inquiry-based episode:

Before the day please reflect on an episode (maximum size – a lesson) that encapsulates for you what might be thought of as "inquiry-based learning". On a single side of A4 report very briefly what you - as teacher – and your pupils did and your thoughts as to why this encapsulates inquiry-based learning for you.

Event

Date: 08 June 2011

Target Group(s): Trainee secondary mathematics teachers

Participants: 40

Forty trainee teachers in the final weeks of their initial training for teaching mathematics in secondary schools attended the day which was organised around a theme of considering the mathematical activity of mathematics learners. This was to raise general concerns of the experience of the learner in the mathematics classroom, which government inspectors characterise as being passive and leading to surface learning rather than deep understanding.

"*Pupils rarely investigate open-ended problems which might offer them opportunities to choose which approach to adopt or to reason and generalise. Most lessons do not emphasise mathematical talk enough; as a result, pupils struggle to express and develop their thinking.*"

(Understanding the Score, Ofsted, 2008a)

The day was organised so that the trainee teachers would have opportunities to consider both mathematical activity for themselves and to consider issues in relation to pedagogies that might support such activity for pupils in their classrooms. An introduction to the trainees informed them of the curriculum development projects LEMA (Learning and Education in and through Modelling and Applications[3]) and PRIMAS (Promoting Inquiry in Mathematics and Science Education across Europe[4]). Working in groups of four, they were then asked to complete one of nine different modelling tasks that come from the LEMA professional development materials with the intention that these would immerse them in a

[3] http://www.lema-project.org/web.lemaproject/web/eu/tout.php

[4] www.primas-project.eu/

new type of mathematical activity rarely found in schools. In addition to being asked to work on the modelling task trainees were asked to produce a poster of their work and were expected to make a presentation of this to the rest of the group.

Following this immersion in mathematical activity each group was asked to consider this activity and how they might summarise it in schematic form for their school students.

Revolving door

At what speed should a constantly revolving door rotate?

.... at the entrance to a hotel?
.... at the entrance to a supermarket?....

Race

In a school playground there are two trees: one is small and one is large.

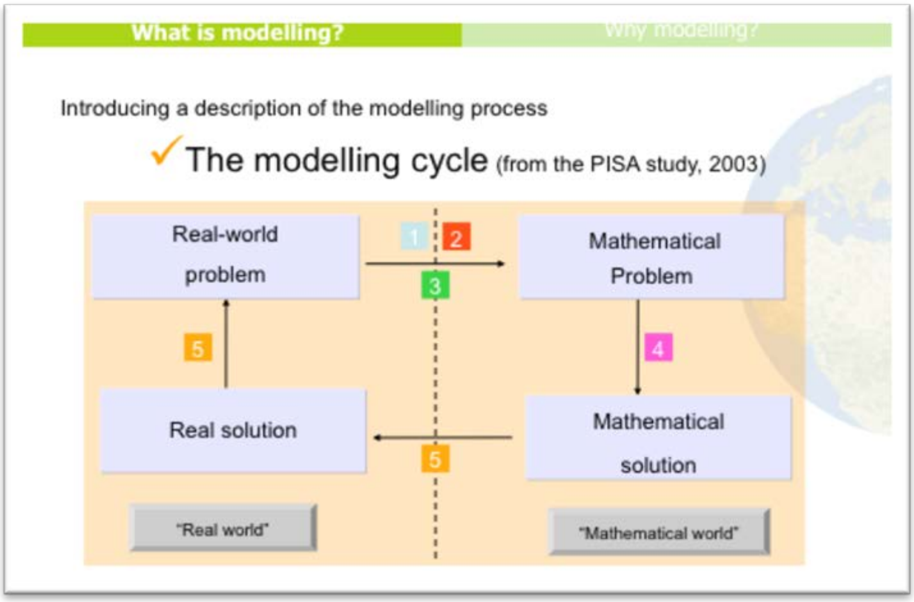
There is also a straight fence.

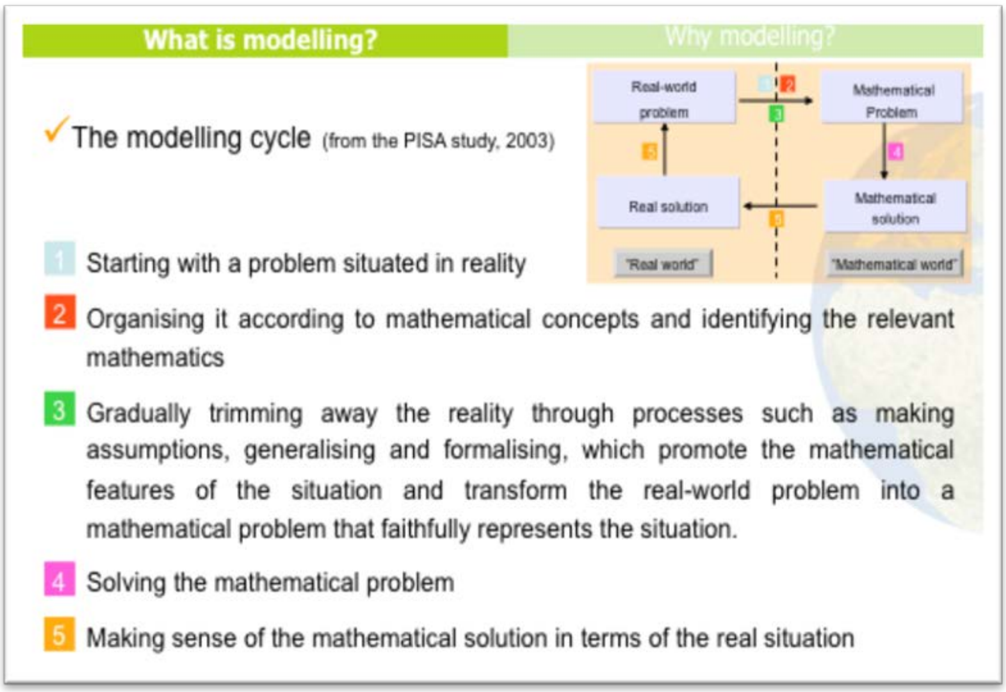
A group of pupils organise a race: each pupil starts at the small tree then has to touch the fence before running to the large tree to complete the race.

Where is the best place for a pupil to touch the fence?

The groups worked on their tasks with many feeling unsure of how to start, but after some advice felt secure enough to proceed. In many cases the groups worked with similar levels of mathematics as has been observed with students in lower secondary schools. The group working on the task “Race”, for example, felt unsure about how to proceed at the outset and eventually simplified the situation to consider the case of a straight-line fence, with both trees standing in the same distance from the fence. They proceeded by making scale drawings of the situation, and by pooling resources they concluded that the best place for a pupil to touch the fence would lie at the point which is mid-way between the two tress. Time prevented them from making much progress with a situation where the trees were at different distances from the fence. In contrast, pupils have been observed taking a more geometrical view of the situation and realising that the place to touch the fence is such that a straight line drawn from one tree as object and the other as image gives a solution for all cases.

Group feedback highlighted the need for pupils to make assumptions and to ask pertinent questions prior to getting started on any of the tasks. In terms of their developing pedagogy this raised lots of questions, and for most groups this was a prominent part of their schema of the modelling process. Having considered their own understanding of modelling as a meta-competency the modelling cycle as introduced in the PISA assessment framework for mathematics (OECD, 2003) was introduced and discussed (see below).





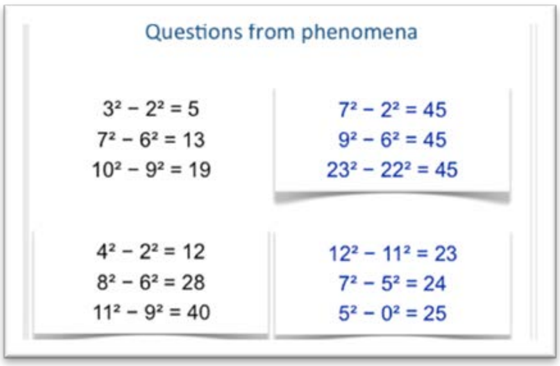
Pedagogic issues were discussed prompted by use of video sequences of French primary school pupils working on a modelling task. In particular, this demonstrated how pupils of all ages can engage with modelling tasks – the same task, perhaps worked on at a more detailed and complex level could be used by older pupils.

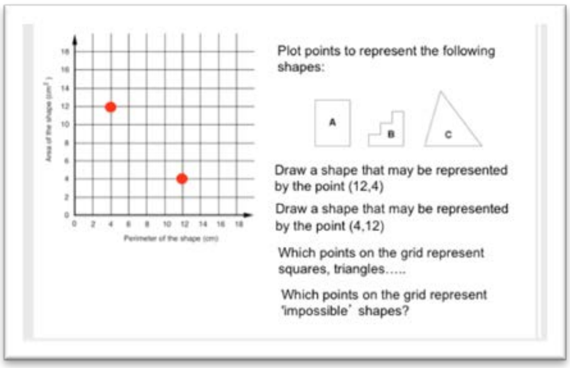
Following this, the trainees were asked to share their initial understanding of inquiry-based learning using their preparatory work and to write down some of their initial conclusions as to the nature of inquiry-based learning. This resulted in a discussion about whether inquiry-based learning in mathematics is closely aligned with mathematical investigations (briefly these might be considered as open-ended problems in mathematics in which students seek to explore mathematical structure in situations that are often situated in the world of mathematics itself).

Morgan (2006, 230) points to the different discourses and values surrounding the use of coursework in mathematics at school, and the tensions that exist among them:

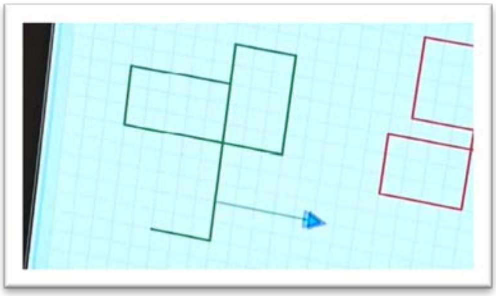
“The discourse surrounding the notion of ‘investigation’ in school mathematics in England introduces values related to, among others, exploration, creativity, originality and the nature of mathematical activity that are at times in tension with the values of the dominant assessment discourse, including reliability and comparability.”

As earlier in the day, the trainee teachers again were asked to explore some open-ended tasks that might be used to instigate inquiry-based learning in mathematics.





Finally, inquiry-based learning pedagogies were again discussed prompted by use of the PRIMAS study modules on student-led inquiry with the group watching a video sequence from a lesson in which pupils used the ‘spirolaterals’ software.



Pirolaterals software from PRIMAS resource bank

Video of a lesson with pupils working on the spirolaterals task.

The ensuing discussion focused around needs in relation to teacher needs in the areas of questioning, working with groups, and resources.

Analysis

The session raised many developmental needs of this group of new entrants to the teaching profession. Notable among those were these new entrants to the profession:

- Had little or no experience of mathematical activity of this type during their own education.
- Were not always comfortable with how to proceed in open-ended tasks that support IBL – particularly in mathematical modelling tasks.
- Would like to implement IBL approaches in their future mathematics lessons.
- Believe that IBL can support the development of pupils' problem-solving competencies, can be used with students of all abilities, and it is not necessary for the pupils to have extensive subject knowledge before they tackle problems.
- Consider that the curriculum does not encourage IBL approaches and that text books that they use do not support such approaches.
- Do not know how to assess pupils' work in IBL.
- Perhaps most important of these was the lack of confidence of the beginning teachers in tackling some of the tasks.

Finally, it should be noted that general satisfaction with the day was summed up in two emailed comments:

"All of us found the workshop the other day very useful and will definitely try using some of those scenarios for investigation/inquiry/enquiry in lessons! Open-ended tasks and modelling are useful for making pupils think more creatively and realistically."

And, "There were some really rather fun and thought-provoking activities in the work the other day! Many thanks!"

Conclusions

This one-off event introducing some of the issues surrounding IBL was facilitated by a PRIMAS partner who had worked with the group previously: this is clearly advantageous in getting down to some serious discussions relatively quickly. Also, because the session was run by a PRIMAS partner who had also worked on LEMA, they were able to draw from the wide range of available resources with relative ease.

Overall, it appears that an important part of the day was the dual focus on mathematical activity and pedagogies related to this. In particular, it was important that the participants were given enough time to work on some of the tasks to some depth and to consider the competencies and meta-competencies that these required. This reflection on mathematical activity was encouraged by the requirement of the groups to report their thinking back to the whole group.

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