The PRIMAS project: Promoting inquiry-based learning (IBL) in mathematics and science education across Europe

PRIMAS materials – IBL teaching and professional development materials (final collection)

PRIMAS is developing a high-quality collection of IBL classroom materials and IBL professional development materials for teachers in Europe.

This report shows our approach and is a reference to the revised, extended and improved collection of such materials that is available at the project website.

www.primas-project.eu

The project PRIMAS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 244380.

PROMOTING INQUIRY IN MATHEMATICS AND SCIENCE EDUCATION ACROSS EUROPE

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Teaching and professional development materials for IBL (version 3 – final)

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TABLE OF CONTENTS

The project PRIMAS has received funding from the European Union
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1. EXECUTIVE SUMMARY

i) Background

The project PRIMAS regroups 14 teams from 12 different countries. It aims to effect a change across Europe in the teaching and learning of mathematics and science with teachers supported to develop inquiry-based learning (IBL) pedagogies so that students gain experience of IBL approaches. Ultimately, our objective is a greater number of students with more positive dispositions towards further study of these subjects and the desire to be employed in related fields. Work package 3 (WP3) of the project is carried out in a close cooperation between Prof. Malcolm Swan, University of Nottingham and Dr. Michiel Doorman of Utrecht University.

ii) Aims and purpose

The main aim of WP3 'Materials' is to assemble a rich collection of teaching materials and resources for professional development which encourage and support teachers to implement inquiry-based learning (with attention for interdisciplinary teaching) in science and mathematics at secondary and primary level.

iii) Theoretical background

The Rocard-Report (2007) draws a distinction between two approaches to teaching: a deductive, teacher-centred, transmission approach in which students are recipients of information, and an inductive, student-centred, collaborative approach, referred to as inquiry-based education. The prevalent lack of enthusiasm for mathematics and science in schools is mainly due, the report asserts, to the prevalence of transmission methods. Although our model of inquiry-based learning is student-centred, the learning process is guided and scaffolded by teachers and materials (Hmelo-Silver, Duncan & Chinn, 2007). Our model should not be confused with that of minimal guided discovery methods, where the teacher simply presents tasks and expects learners to explore and discover ideas for themselves (Kirschner, Sweller & Clark, 2006). While 'discovery' teaching is still inquiry-based, it appears less effective than the challenging, collaborative teaching that we envision. Fundamentally, inquiry-based learning is based on students adopting an active, questioning approach.

Although many teachers would like to have more inquiry-based learning going on in their classrooms, it can be quite hard to get started. Successful inquiry requires new learning tasks, new teaching repertoires and changing roles for both teachers and pupils. Teacher development does not come about through repeated attempts to persuade but through opportunities for individual teachers 'to doubt, reflect and reconstruct' in unhurried, 'safe' environments (Wilson & Cooney, 2002). We do not seek to change teachers' beliefs so that they behave differently, but rather offer opportunities to behave differently so that their experiences may give them cause to reflect on and modify their beliefs (Fullan, 1991).

iv) Methods

In a first phase (6 first months), every country involved has selected teaching materials and materials for professional development (PD). The selection of the materials was based on an initial analysis of processes that are involved in IBL. In addition, the selected materials had

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Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 244380.

already proven their efficacy and efficiency in at least one country. The selected materials were discussed during two project meetings.

In the first project meeting we agreed upon a general structure for a cover sheet that contains a short introduction to the material, metadata and information about the relation with IBL and possible use in professional development courses. The cover sheet also provides links to the actual resources. This structure is used for the presentation of the materials on the PRIMAS website, ensuring easy guidance, accessibility and assessment of the materials and their contents.

The content of the materials was further discussed in detail during a second project meeting. Initially, the differences between teaching practices in the involved countries provided a challenge in relation to usability, conceptualization of IBL and emphasis on different IBL processes. We therefore identified key characteristics of classroom activities that support IBL and pedagogical implications for teachers as guiding principles to organize our content. These key pedagogical implications were further elaborated and condensed into a limited number of issues for teachers that now form the backbone of our PD package for IBL.

The character of the first set of materials varied in length, quality/depth and in IBL character. The latter was the result of the different cultures with respect to IBL in all partner countries. We decided to define a grain size for all materials and to differentiate between materials that are closely connected to the core PD modules, that envision the project's interpretation of IBL, and materials that might be useful for first steps towards IBL but not closely connected to the topics addressed in the core modules. A review-committee was responsible for the quality control. They reviewed all materials upon criteria like layout, content, the connectedness to the core modules and whether the articles are of sufficient quality for publication on the Primas website.

Finally, all partners used our PD modules (they are translated in all partner languages) and other resources for their professional development courses on IBL. In close connection with WP4 (work package for professional development) this resulted in additional materials for our collection, feedback on the database and an optimization of the PD modules and the web-interface.

v) Outcomes

The current – and final – PRIMAS collection of materials for IBL is a rich, robust and flexible package of teaching materials and resources for professional development. It is the result of almost four years of international cooperation and professional development events in 12 different countries. The resources encompass primary and secondary education and cover the subjects mathematics and the sciences.

The extensive discussions of materials resulted in a shared understanding of processes related to our model of IBL (exploring situations, planning investigations, experimenting systematically, interpreting and evaluating, and communicating results) and in a shared understanding of the main issues for teachers in a PD program (organising student-led inquiry, using unstructured problems, developing concepts, asking questions, managing classroom interaction, supporting collaborative work, and using assessment to promote learning).

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2. THE COLLECTION OF MATERIALS

2.1 The aim

The PRIMAS project has the overall objective of promoting a more widespread uptake of inquiry-based learning in mathematics and science at both primary and secondary levels across Europe. Across Europe there are calls to attract more students to mathematics and science: this is acknowledged as being of importance to national economies and the position of the EU in relation to the rest of the world. However, there is evidence that although young people understand the importance of science and mathematics they see careers in other sectors as being more attractive. As the rate of development of technology appears to be ever increasing it seems essential that we are not only able to provide adequately prepared workers but also citizens that are equipped with knowledge and skills that allow them to understand critically the world in which they live.

The PRIMAS partners seek to support teachers develop pedagogies that will allow them to work with students to develop inquiry skills in mathematics and science through dissemination of "what works" in classrooms. We will therefore provide professional development materials and a range of professional development courses and other opportunities for teachers to explore effective teaching methods and classroom materials for direct use by students. We seek to ensure that teachers are also supported indirectly through our work with a wide range of stakeholders such as parents and policy makers that will attempt to ensure that changes in learning experiences do not meet with opposition.

The project will work to achieve its aims over four years (2010-2013) bringing together educational expertise from 14 institutions across 12 European nations. Jointly as a group we have a vision of young people who are excited by their developing knowledge of mathematics and science which they approach with enquiring minds. We look forward to providing a range of resources and activities that will support teachers who wish to join our mission to ensure that experiences in learning mathematics and science reflect the exciting world that young people live in and which has been developed by application of these subjects.

The website www.primas-project.eu is used to present the PRIMAS resources and activities about inquiry-based learning (IBL). The site is used to collect, publish and relate teaching materials and materials used for professional development on IBL in science and mathematics in primary and secondary education. The site will also include language switches for offering all partner countries the possibility to use the website as a tool for professional development and to offer visitors from all partner countries the opportunity to find resources or activities for their classroom practice.

2.2 IBL and key characteristics of materials

A list of processes that characterize inquiry-based learning and related pedagogical issues for teachers has been identified to characterize our materials (see Figure 1). We summarized and listed these characterizations in a table and used this table as information data to explicitly link these characteristics to the materials in our collection (see Table 1).

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The information in an article ('cover sheets') that accompanies each material item on the website, frames how the item illustrates IBL and how it can be used in a professional development activity that will encourage teachers to implement IBL in science and mathematics. This includes boxes for information about aims, discipline, age group and pedagogical issues.

In this way the identified processes and issues for teachers function as a guide for developing a coherent and research-based collection of classroom and PD materials.

Figure 1: The IBL cycle with related processes

Figure 1 illustrates processes related to IBL (Klahr, 2000). We distinguish between characteristics of processes of inquiry (student practices) and issues for teachers (teacher competencies related to pedagogies for IBL) needed for implementing these processes. These issues will eventually structure our PD package.

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From this outline the following categories can be recognized:

Processes of inquiry	**Issues for teachers**
Exploring situations and formulating problems	Organising student-led inquiry
Planning investigations, selecting or constructing representations and tools	Helping students to tackle unstructured problems
Systematically collecting, documenting and analyzing data	Promoting concept development through inquiry
Interpreting and evaluating findings	Asking questions
Communicating results and reflecting	Creating and managing classroom interaction that encourages IBL
	Supporting collaborative work
	Using assessment to promote learning

Table 1: Key characteristics of processes of inquiry and issues for teachers

2.3 An initial collection

The first year of the project resulted in a collection of 40 resources on IBL in science and mathematics education as best practices in the partner countries. The focus was on collecting rich, collaborative tasks (Swan, 2008) that require non-routine problem solving strategies (Doorman et al., 2007).

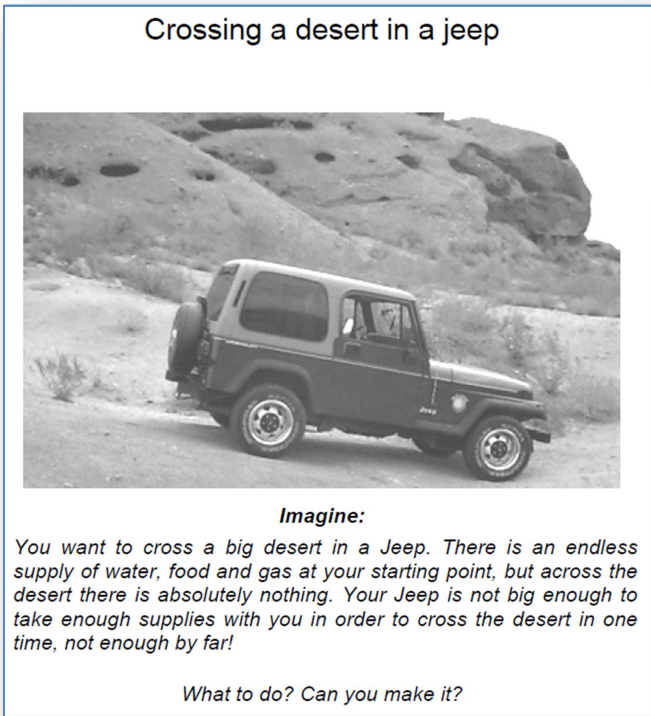

Figure 2: Crossing a Desert – example of an inquiry-based mathematics task

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The collection was published on the PRIMAS website (by 2010). Each article either contained teaching material or material for professional development. The materials could be filtered and searched with metadata that are related to key characteristics of IBL processes and to related issues for teachers. Cover sheets of materials guide visitors in a practical sense (e.g. by providing links to related articles, documents and to external websites), but also by pointing out important pedagogical issues lying behind a specific IBL task at hand at the time of the first presentation.

The first year (2010) underlined differences in classroom practices and in differences between opportunities for professional development in the partner countries. It showed that the PD package to be assembled with the materials should have the flexibility to be used in these various national contexts.

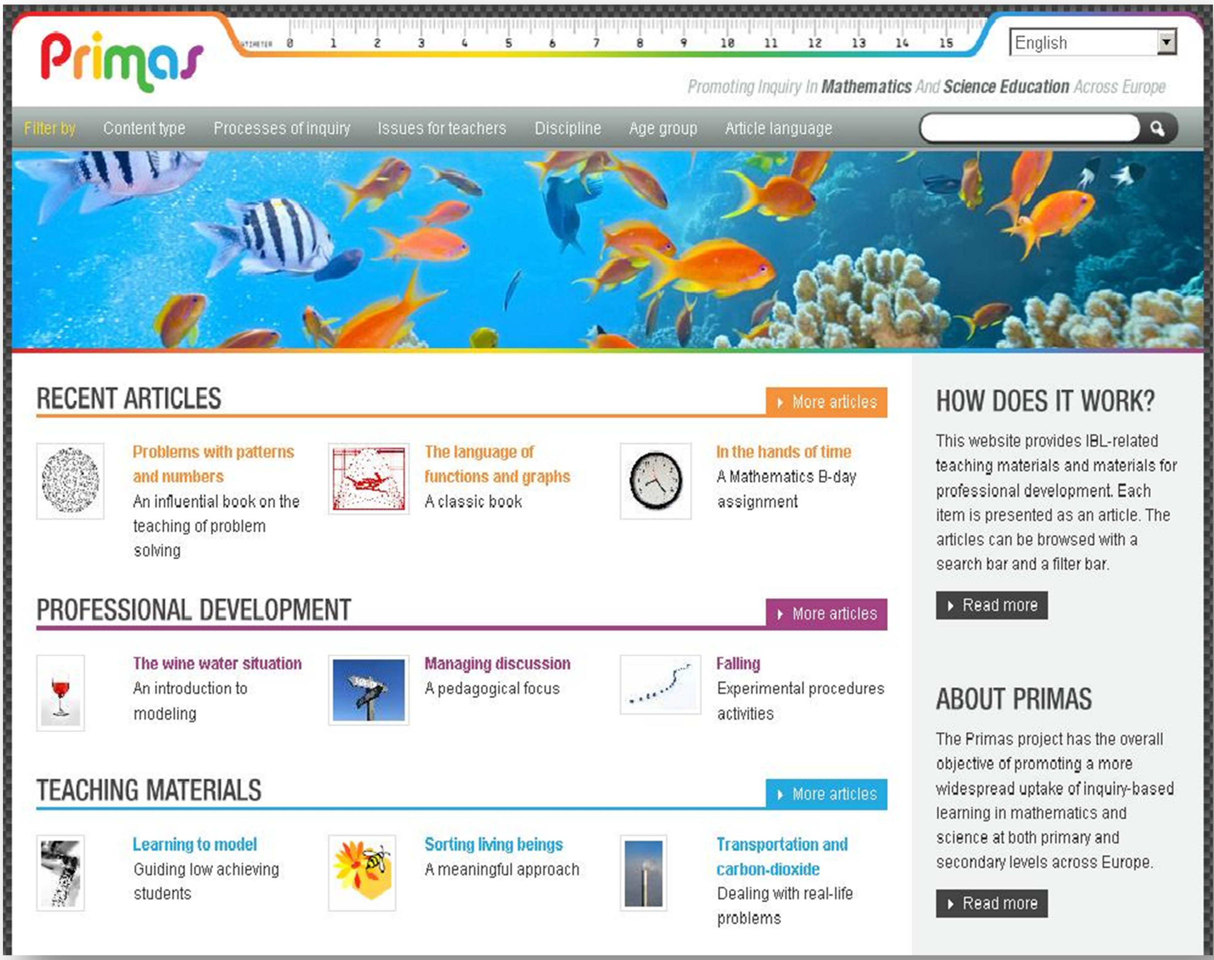

Figure 3: The first front page of the PRIMAS website.

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The first website with the material collection displayed on its front page, showed the most recently contributed articles, materials for professional development and teaching materials. The filter bar for browsing the collection would unfold itself at the top of the page by moving the mouse over the bar (see Figure 4).

Figure 4: The first filter bar with key words for selection

Main comments on the first collection and the website were:

- The ‘hidden’ filter menu is unclear,
- The request for a more prominent presentation of the aims of PRIMAS related to IBL, contexts for professional development, and professional development strategies, and a clearer embedding of the materials collection within these aims,
- A better connection between teaching materials and PD modules, and
- The request for more materials for science.

2.4 Towards an improved and extended collection

The first collection of materials was discussed and we decided upon an improvement of the classification and the search criteria of the resource collection for purposes of usability and clarity. The aims of the improvement were (1) a more clear distinction between teaching materials and resources that are specifically designed for adapting PD modules for your target group (e.g. science teachers or teachers from primary education), and (2) a better connection between the resources and the elaborated definition of IBL.

We also agreed upon common quality criteria for the materials. A review committee was established to propose criteria and review all materials in order to come to a second, improved collection of materials.

Finally, we started to design science alternatives for the math examples in the PD modules and created subtitles with the PD videos to enable partner countries for creating their subtitles in the partner language and using the videos in their context.

General extensions of the collection led to a more balanced coverage.

PROFESSIONAL DEVELOPMENT MODULES

The first collection of resources needed to become better balanced with a more clear connection to a common definition of IBL and integrated in a core program for continuous professional development. An important milestone was the decision to proceed with a PD

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package on IBL with concrete teacher activities, supported with videos of lessons and take home activities for teachers to experience and develop IBL competencies in their practice.

The PD package is piloted in all partner countries. The piloting and extending of the modules led to an ongoing process of refinement of the package and all resources, and thus again to important decisions about material quality and suitability. These decisions led to new versions of the material collection that fits the PD possibilities for implementing IBL in all partner countries. Making these original materials usable for a Europe-wide audience required substantial modification of the original materials and the creation of a facility for adding multilingual subtitles to the video elements.

Demarcation of IBL

In the majority of day-to-day teaching teachers and students usually favour routine technical tasks, with which they feel secure but which lack demand for students. Initiating a real debate in the class based on a sufficiently rich problem needs a lot of work and practice from a teacher and necessitates a new type of contract with students. Teachers may therefore be reluctant to adapt their teaching in this way. In order to develop students' abilities to perform such processes teachers also need to use different kinds of tasks to those commonly presented in textbooks, where the recall of basic knowledge and practising of routine procedures dominate. The teacher has to propose sufficiently rich situations, with authentic questions that have to be accessible to students, but yet not too easy. A priori analysis of tasks and national contexts suggested us tools to make the right choices in this direction. Second, pedagogies must make a shift away from a 'transmission' orientation in which teacher explanations, illustrative examples and exercises dominate, towards a more collaborative orientation in which students work together on 'interconnected', 'challenging' tasks. Here, the teacher’s role is completely different and includes (Brousseau, & Gibel, 2005; Swan, 2006) making constructive use of students’ prior knowledge, challenging students through effective, probing questions; managing small group and whole class discussions; encouraging the discussion of alternative viewpoints and helping students to make connections between their ideas.

Inquiry-based learning provides not only a new way of involving learners in doing science at school but also a way of improving science education at both primary and secondary level (Rocard, 2007). A common misunderstanding is to confuse IBL with doing experiments or some practical work in the classroom. If the knowledge needed to conduct the experiment is provided by the teacher or by the task as a kind of cookbook recipe, the experiment can hardly be called inquiry based. The degree of inquiry depends on the openness of the situation as well as on the distribution of responsibilities between the teacher and the students. Different authors have developed different classifications of inquiry-based learning situations (e.g. Walker, 2007; Tafoya et al.,1980; Fradd et al., 2001). In the PRIMAS guide for professional development providers[1] these classifications are elaborated.

We elaborated the initial characterization of IBL into a cloud of five perspectives from which IBL can be viewed with specific characteristics related to each perspective (Figure 5).

After identifying all these aspects, we agreed upon the Primas focus in the area of the teacher: extending his or her repertoire for fostering IBL in day-to-day practice. The main message sent to teachers would be: we don’t need to change everything. IBL is not a completely different educational practice, but an essential ingredient of good education.

[1] http://www.primas-project.eu/artikel/en/1247/Reports+and+deliverables/

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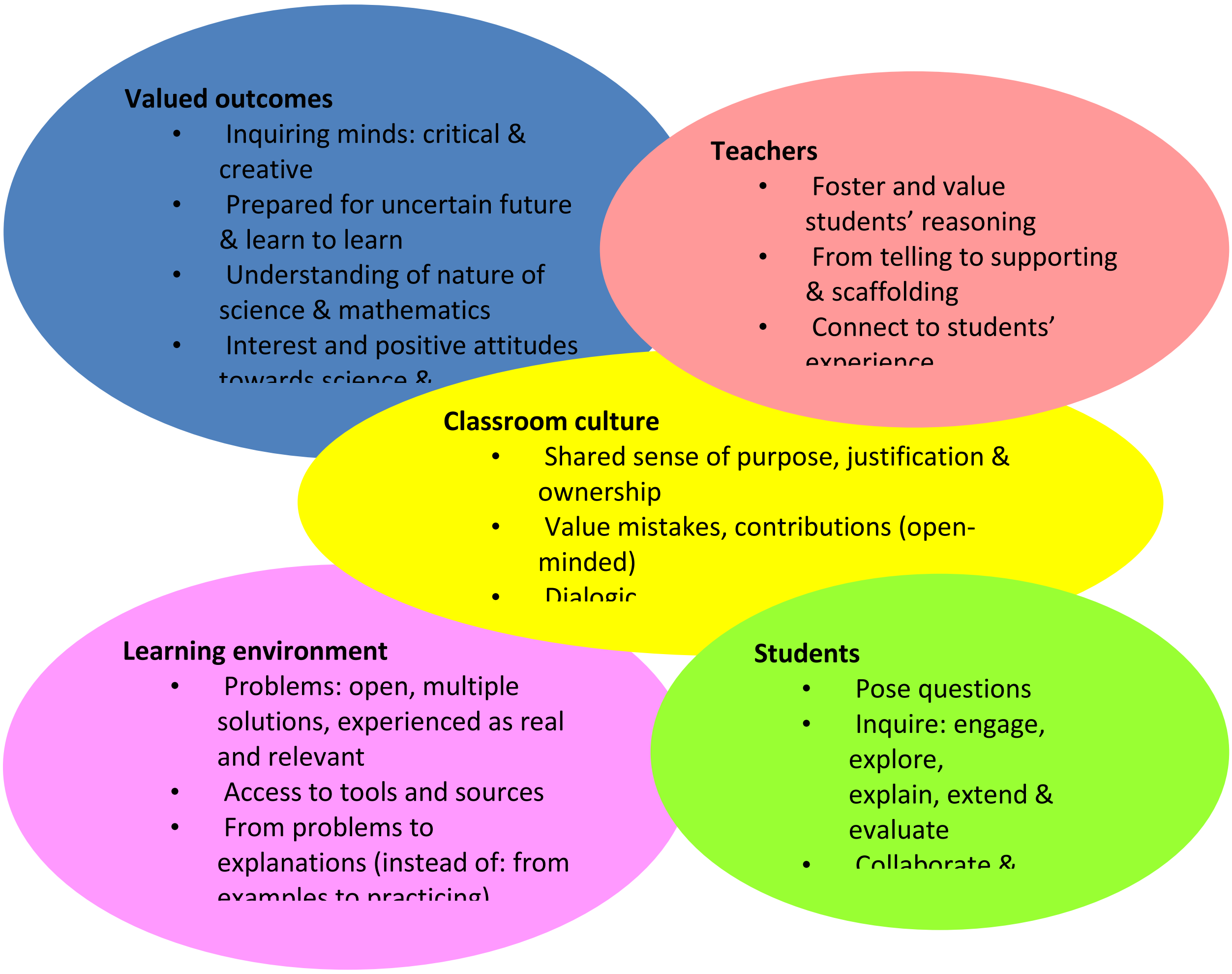

Figure 5: Five perspectives clarifying IBL

THE REVIEW PROCEDURE

The review committee started in 2011 for organizing quality control and improving the material collection. During a project meeting (Egmond, 2011) all partner countries joined small group discussions about an initial judgement of all materials. This judgement contained a qualification (good, useful, needs improvement, should be deleted) and a positioning of each item in a hierarchy (close to the core PD modules <> far from the PD modules). All consortium members/academic teams were invited to comment on the classification and the hierarchy.

Further inputs of the group discussions were the request for more science activities, for more activities for primary education and for criteria describing implementation-related aspects like required pre-knowledge of students and teaching preparation requirements. In addition, we should be careful dealing with IBL characteristics as if they are objective criteria. National and school context determine also to what extent an activity is (a first step towards) IBL.

After discussing these findings we agreed upon a a more coherent presentation and online organization of the material collection, involving a showroom that starts with PD modules and

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Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 244380.

continues with structured guidance. In addition, it was agreed that those partners best able to do so would contribute additional science and additional materials for primary education.

Furthermore, a review committee was established consisting of 10 partners from 8 partner countries, representing north, south, east and west Europe and mathematics as well as science, in order to adequately take into account different cultures and practices. Couples of reviewers from different countries and from different disciplines were created. All items in the materials were distributed among the couples (with distinct reviewer and author countries). The criteria for which they were asked to review all materials were:

- Suggestions for improving connections with IBL
- Suggestions for improving layout
- Suggestions for the content
- Intro on website: clear how to use it? (equipment needed; pre-knowledge; what they learn besides IBL?)
- Publication on website: A – project (e.g. Lema); B – PD course (e.g. Bowland modules); C – PD session (connected to a module; e.g. Questioning a bag of apples); D – all other items (materials); E – delete from website.

The review process resulted in a list of recommendations for all materials. Some of the materials were deleted, because they were only available in a foreign language. The majority of the initial materials collection were adapted according to the recommendations of the review panel. Some sample recommendations:

- *Item: Learning to model* – Very structured (link to PD module 'Tackling unstructured problems' and suggest to open-up some of the activities). Some tasks have the potential to offer opportunities for students to do science.
- *Item: Falling, modeling, and being smart* – Rewrite the website text to clarify that the document mainly contains organizational information and use better IBL language (e.g. see: Transportation and carbon dioxide). PD module 'Asking questions' (activity E) gives clear suggestions for content-related questions for the teacher.
- *Item: Discuss, estimate, calculate, measure, assess!* The activity needs a better layout. The text on the website needs rewriting. It could be related to the PD module: 'Tackling unstructured problems'.
- *Item: Construct you own mathematical morning* – Connect to the PD module 'Tackling unstructured problems' as a nice example.
- *Item: Language of functions and graphs* – Tasks are not explicitly designed for IBL. Make that clear on the site. Connect it to PD module 'Learning concepts…' as an inspiration source for teachers that can use them to write their lesson plans.
- *Item: Sorting living beings* – Connect to PD module 'Learning concepts…' Improve introduction on Primas site (see review). Mention that more useful material is available at the Pollen site.
- *Item: Create the most airy "troll" cream* – Add to the website text that the task needs a fair amount of work by teachers before they can use it in their classroom.
- *Item: Division of Fractions* – The website text should judge the material as well suited for contexts that afford only small & first steps. And make clear that the tasks are close-ended and structured, but still what happens in class can have an IBL flavor.

The review procedure resulted in an extensive, work-intensive and substantial quality improvement of the materials collection providing the major step towards the final collection.

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2.5 The resources for PD

In this section, the current organization of the materials (hierarchy, additions) and their presentation (on the website) and quantitative description will be presented in detail. We start with an outline of the seven extended professional development modules as the core set of the materials collection (Table 2).

Module	Description
Student-led inquiry	Students' curiosity to answer their own questions can be a very powerful drive to engage in high quality inquiry. This professional development module considers how students might be encouraged to ask productive questions for learning. Teachers will be encouraged to experience what it feels like to think like a mathematician or scientist, and reflect on the role shifts that are necessary for students to share this experience in the classroom. Concrete examples being addressed in this module include: • predicting the trajectory of a paper cup rolling over the floor; • inducing rules that govern the walking behaviour of a 'turtle' in a computer animation; • analysing and reflecting on a lessons structure in which students are provoked to generate questions and to answer them.
Tackling Unstructured Problems	In the classroom, most tasks are highly structured, and students are told which techniques to deploy. By contrast, in real-world problems people often need to make simplifications, construct models, choose an approach, and evaluate outcomes by their own criteria. This module supports teachers to present classroom problems in a less structured fashion. The structure of the module is that, first, teachers will observe successful classroom practices, and teachers discussing the issues they encounter on video. Next, they will create more open versions of the tasks they use, they will try out these materials in their own classrooms, and get feedback on that.
Learning Concepts Through IBL	A teacher can be greatly in favour of doing inquiry, but there is always the curriculum pressures. If IBL is to find its way into the classroom, it has to make strong contributions towards content learning aims as well. This module considers how inquiry based learning may be integrated into the process of teaching content. This unit has many activities within it - too many for one session. Concrete examples being addressed in this module include exploring structures, classifying and defining (sets of animals, functions, shapes, …) and connecting and translating types of growth, graphs, tables and formulas.
Asking Questions that Promote	Many good teachers will ask questions throughout their lessons, in order to keep the students involved. But not all questions are equally good to promote IBL. This module supports teachers to

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Reasoning	develop questioning strategies that are effective for IBL. The module contains a selection of professional activities that are designed to help teachers to reflect on: • characteristics of their questioning that encourage students to reflect, think and reason; • ways in which teachers might encourage students to provide extended, thoughtful answers, without being afraid of making mistakes.
Students Working Collaboratively	If students are to make sense of scientific and mathematical concepts, then they will need opportunities to share, discuss and work together. However, just having the students work and talk together may not be enough to evoke student interactions that will be beneficial for learning. This module considers how teachers could promote cooperative work in their classrooms. The module offers the professional development provider resources that will help teachers to: • consider the characteristics of student-student discussion that benefit learning; • recognize and face their own worries about introducing collaborative discussion; • explore techniques for promoting effective student-student discussion; • consider their own role in managing student-student discussion; • plan discussion based lessons.
Building on what students already know	Mathematics teaching assumes that students do not arrive at sessions as 'blank slates', but as actively thinking people with a wide variety of skills and conceptions. Research shows that teaching is more effective when it assesses and uses prior learning so that the teaching may be adapted to the needs of students. Prior learning may be uncovered through any activity that offers students opportunities to express their understanding and reasoning. This process is often referred to as formative assessment. This module considers the different ways this can be done and focuses on the following questions: • How can problems be used to assess performance? • How can this assessment be used to promote learning? • What kinds of feedback are most helpful for students and which are unhelpful? • How can students become engaged in the assessment process?

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Self and peer assessment	"... self-assessment by students (…) is in fact an essential component of formative assessment. Where anyone is trying to learn, feedback about their efforts has three elements – the desired goal, the evidence about their present position, and some understanding of a way to close the gap between the two. All three must to a degree be understood by anyone before they can take action to improve their learning" (Black & Wiliam, 1998). This is particularly true when the focus of the assessment is on the processes involved in IBL. Many students do not understand their nature and importance in mathematics. This module encourages discussion of the following issues: • How can we help students to become more aware of IBL processes, and their importance in problem solving? • How we can encourage students to take more responsibility for their own learning of IBL processes?

Table 2: The content of the 7 Primas PD modules

Doing each module with teachers will take a session of about three hours, a week (or more) in between for the teachers to try out a lesson in their own classroom, and another half hour or so in a second session.

ACTIVITY B: WHAT KINDS OF QUESTIONS PROMOTE INQUIRY?

Time needed: 20 minutes.

Give teachers time to discuss the following issues.
Ask them to record their collective ideas on a copy of Handout 2 shown.

- What types of questions promote inquiry-based learning?
- Give some examples that you have recently used.
- Handout 3 describes some characteristics of effective questioning. Reflect on the implications of these ideas for your own practice.

Afterwards give them copies of Handout 3. This contains a summary of some research findings into questioning. This shows that effective questioning displays the five characteristics:

- The teacher plans questions that encourage thinking and reasoning.
- Everyone is included.
- Students are given time to think.
- The teacher avoids judging students' responses.
- Students' responses are followed up in ways that encourage deeper thinking.

Invite teachers to discuss the research findings in small groups.

- Which of these principles do you usually implement in your own teaching?
- Which principles do you find it most difficult to implement? Why is this?

Figure 6: Example activity from PD module "Asking questions that Promote Reasoning"

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The topics of the PD modules have been carefully chosen to highlight key aspects of successful IBL which apply to both mathematics and science across a range of ages. Each module contains a collection of classroom activities combined with detailed suggested lesson plans, integrated into a program of discussion-based teacher development activities. Teachers are expected to try some of the materials in their own classrooms as part of these activities – one aim is to introduce an element of Inquiry-based teacher development rather than lecturing teachers on how to do IBL, and to create a bridge between classroom materials and pedagogical theory. This is supported by videos showing the materials in use and of teachers reflecting on their lessons. Our aim is that these modules will develop into a “framework” into which a wider variety of Mathematics and Science teaching materials from the PRIMAS collection can be incorporated. We are working closely with WP4 to ensure that this is in harmony with their work.

In addition to the activities in the modules we designed supplementary materials. In addition, we connected the modules to other materials in the database that are closely related to the activities. This makes it possible for professional development providers to tailor the module to their audience. For instance, it might be the case that their PD course is attended by only science teachers. In such cases the they can use the supplementary materials for science for module *Student-led inquiry*:

- Activity A: Asking questions - Handout 1: Dissolving sugar lumps
- Activity A: Asking questions - Handout 2: Modelling and experimenting cycles in science and in mathematics (a comparison)
- Activity B: Making observations from photographs - Handout 3: Photographs to explore with science
- Activity D: Plan a lesson, teach it and reflect on the outcomes - Handout 6: A sample lesson plan for dissolving sugar lumps and the use of science concept cartoons.

Rolling cups

Look at these two paper cups.

Imagine that they are going to roll across the floor.

- List some possible questions that occur to you.
  "Will the cups roll in a ...?"
  "How can I predict ...?"
  "What would happen if....?"
- Make up some conjectures. These might start like this:
  " When you use this shape of cup then this is what will happen ..."
  " If you roll the cup too hard, then ..."
- Now carry out an experiment and collect some data.
  Can you *explain* and *prove* your conjectures?

Figure 7a: A mathematics version of PD-activity A

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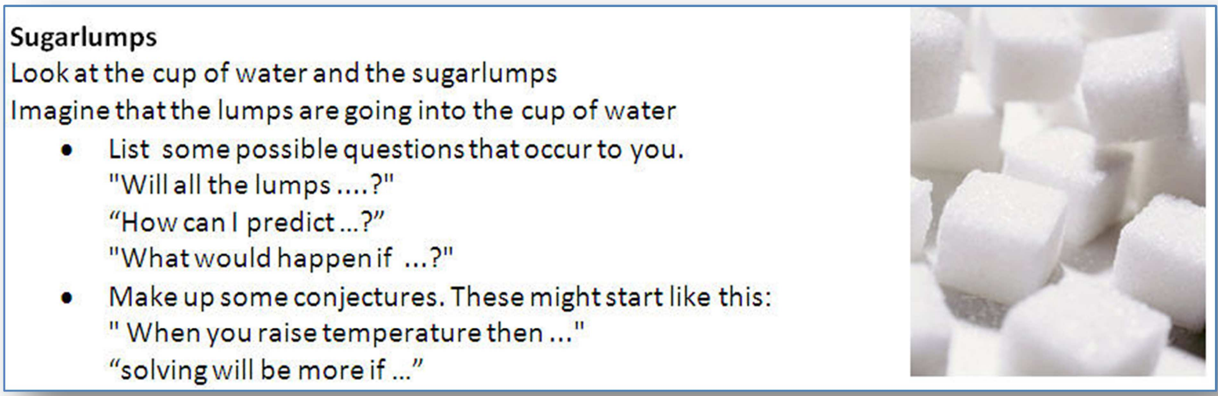

Figure 7b: A science version of PD-activity A

The presentation of all materials on the website is framed by the hierarchy as described above (PD module, supplement, further suggestions and other materials) and by grain size varying from suggestion for one lesson to large projects (Figure 8).

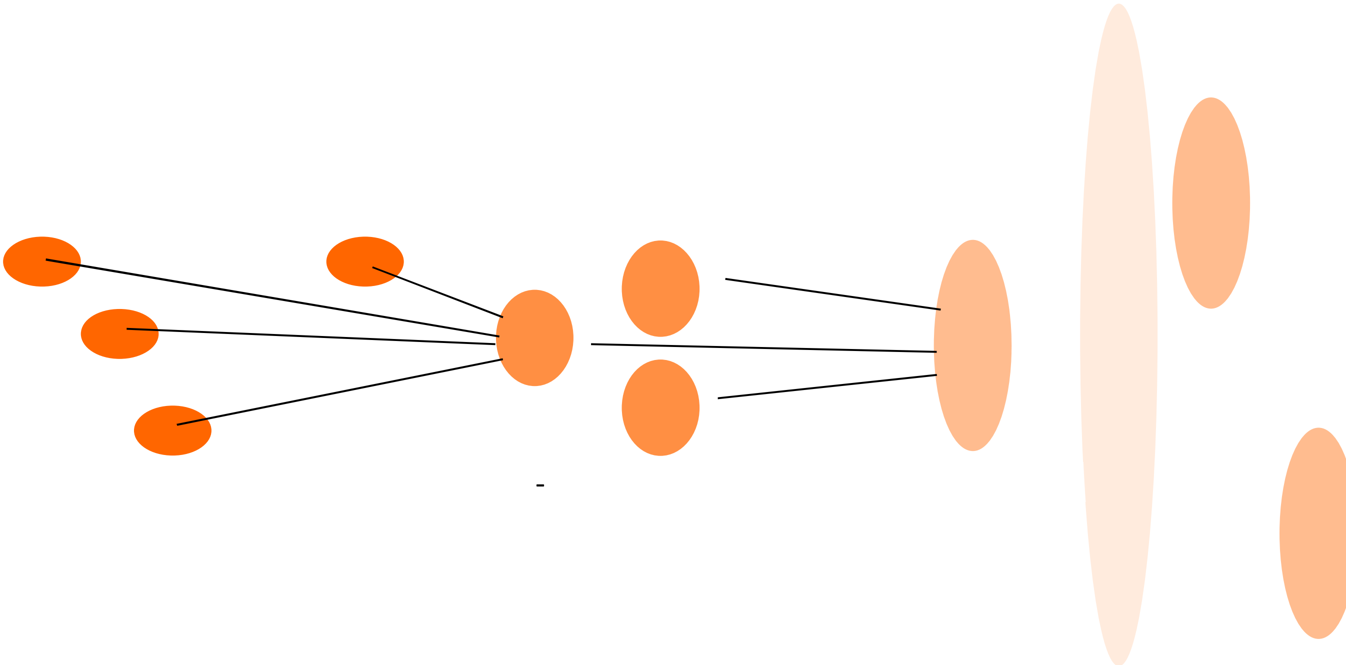

Figure 8: Grain size of materials in the collection

The entire collection of materials can be found and browsed on the Primas site by using free search or filters (www.primas-project.eu). More specifically, keywords in the filters are used for IBL-related characteristics of the articles. We distinguish between characteristics of student materials (processes of inquiry) and of professional development modules (issues for teachers).

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AN IMPROVED SEARCH INTERFACE

Instead of the hidden search bar that unfolds after mouse over, we designed a search interface that is familiar for current standards in interface design (see Appendix).

EMBEDDING OF MATERIALS COLLECTION

With an extensive update of the PRIMAS website the materials collection was better embedded in the overall context of the project, one of its main strands – the professional development (i.e. the PD modules), and framed by general introductions to teachers and other about IBL, what it is, why it improves education and why it needs support (see Appendix).

2.6 The final collection

QUANTITATIVE SUMMARY OF THE FINAL COLLECTION

All materials are published as articles. Each article has a cover sheet with links to underlying documents and/or websites. In addition, some articles have links to related PRIMAS articles.

Total number of articles	127	
Mathematics / science	79 / 67	[some are interdisciplinary]
Teaching material / material for PD	91 / 45	[some are resources for teaching and PD]
Core set of PD modules	7	

www.primas-project.eu

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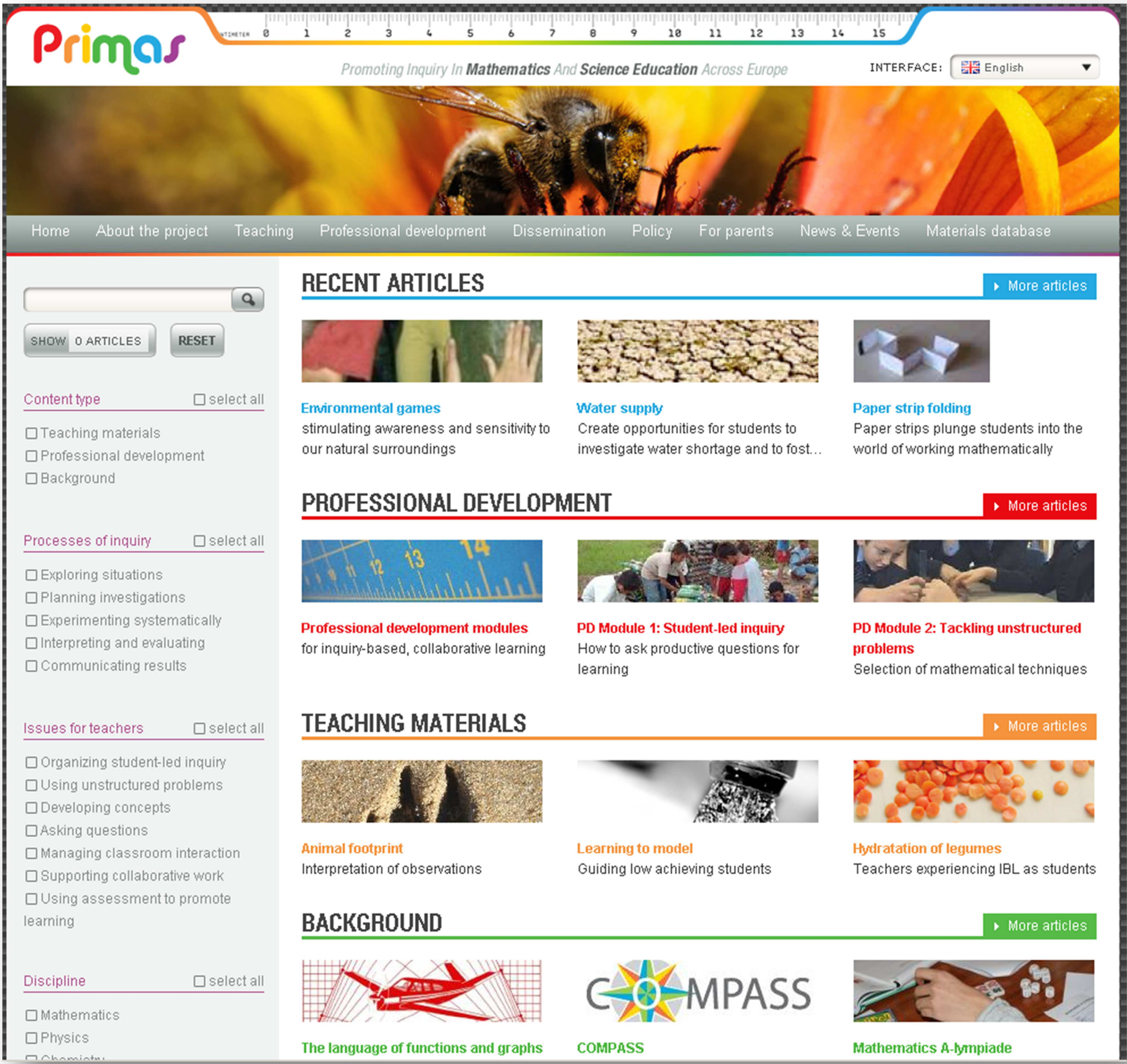
APPENDIX

Screenshots of www.primas-project.eu

The first screenshot in this appendix shows the starting page of the Materials database, the second illustrates IBL-related content of the front-page of the PRIMAS-site, and the third illustrates a search in the database.



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to promote inquiry-based learning in mathematics and science at both primary and secondary levels across Europe

The European Project PRIMAS
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 implementation and use of inquiry-based learning in mathematics and science. PRIMAS provides materials for direct use in class and for professional development. Further, we run professional development activities and support professional networks in each of the partner countries. Additionally, PRIMAS works with stakeholders such as policymakers, school leaders and parents to create a supportive environment for inquiry-based learning.
Read more about the project

What is inquiry-based learning?
Inquiry-based learning involves exploring the world, asking questions, making discoveries, and rigorously testing those discoveries in search for new understanding. Inquiry-based learning can have many faces, dependent on context, target group and learning aims. However, inquiry-based learning approaches all have the shared characteristics of aiming to promote curiosity, engagement and in-depth learning.
Read more in Primas reports

Why inquiry-based learning?
In our dynamic knowledge-based society, pupils must develop the ability to attain knowledge and competencies as well as problem-solving skills. Knowledge of facts alone is not enough in the 21st century. Pupils should develop competencies to apply their knowledge in realistic, problem-solving situations. They also need to develop competencies for self-directed learning and to explore new knowledge areas. Inquiry-based learning can support the development of such competencies.
Read more about what you can do with IBL

Why does inquiry-based learning need support?
Although many teachers would like to have more inquiry-based learning going on in their classrooms, it can be quite hard to get started. Successful inquiry requires new learning tasks, new teaching repertoires and changing roles for both teachers and pupils.

- Learn more about the project
- Teaching inquiry-based
- Running professional development courses
- Spreading the idea of inquiry-based learning to various target groups (Dissemination)
- Policy issues
- How my child profits from inquiry-based learning (For parents)
- News & Events
- Go directly to the materials database

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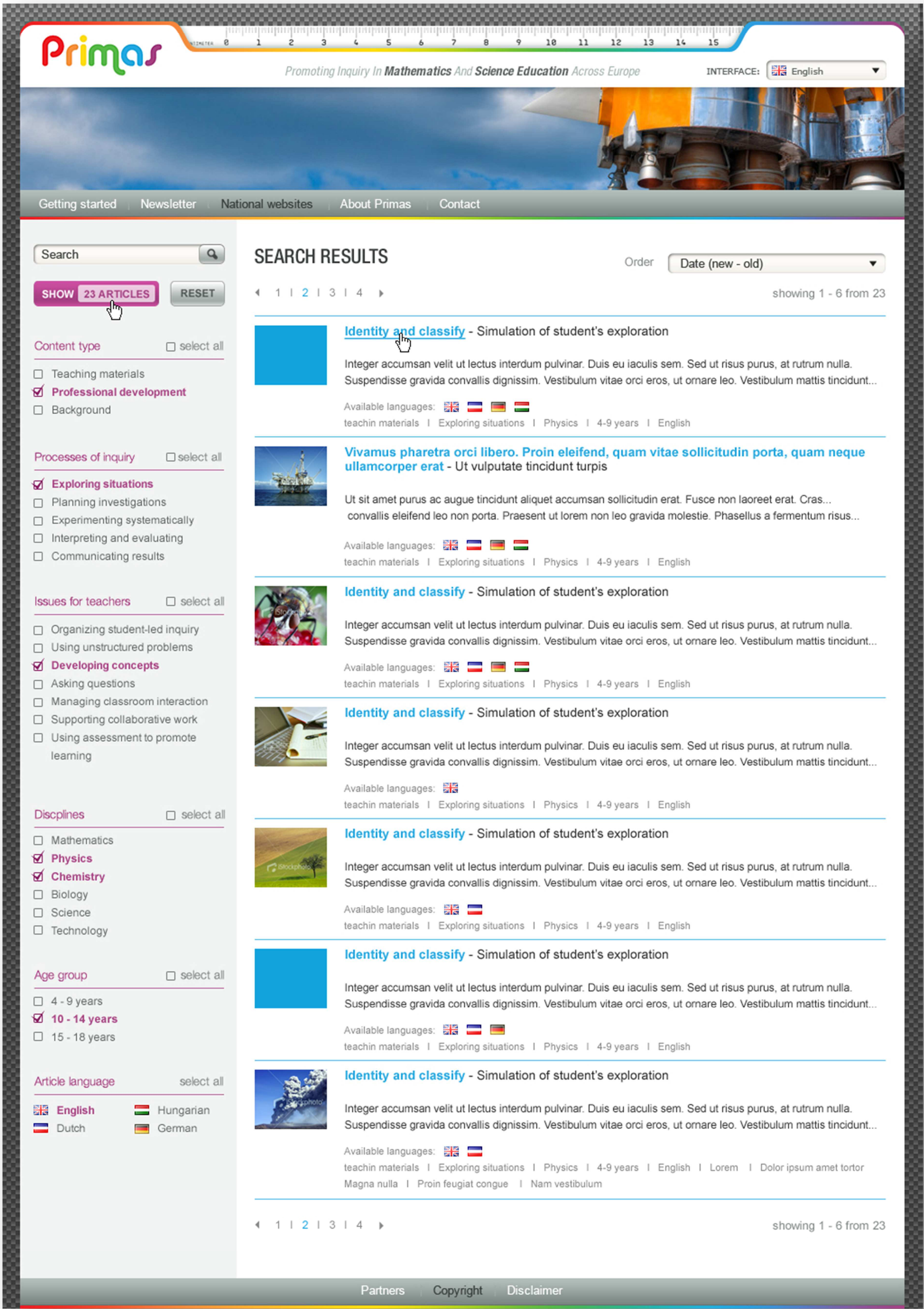

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