The Fibonacci Project

DISSEMINATING INQUIRY-BASED SCIENCE AND MATHEMATICS EDUCATION IN EUROPE

STARTING PACKAGE

Support Handbook for Establishing a Reference Centre for Science and Mathematics Education

Strategies, Objectives, Examples and Recommendations

WWW.FIBONACCI-PROJECT.EU

WITH THE SUPPORT OF

EUROPEAN COMMISSION

SEVENTH FRAMEWORK PROGRAMME

What is
the Fibonacci Project ?

The ambition of the Fibonacci project is to contribute to the dissemination of Inquiry-Based Science and Mathematics Education (IBSME) throughout the European Union, in a way that fits with national or local specificities.

This project defines a dissemination process from 12 Reference Centres to 24 Twin Centres based on quality and a global approach. This is done through the pairing of the Reference Centres selected for their large school-coverage and capacities for transfer of IBSME with 12 Twin Centres 1 and 12 Twin Centres 2, considered as Reference Centres-in-progress.

A scientific committee of acknowledged experts in science and mathematics education supervises the work. An external evaluation is also included to check the achievement and impact of the project.

The Fibonacci project will lead to the blueprint of a transfer methodology valid for further Reference Centres building in Europe.

The project, started on January 1, 2010 for a duration of 3 years, is coordinated by the French *La main à la pâte* programme (*Académie des sciences*, *Institut National de Recherche Pédagogique*, *École normale supérieure* – the latter being the legal entity in charge of Fibonacci), with a shared scientific coordination with Bayreuth University (Germany).

The Consortium includes 25 members from 21 countries with endorsement from major scientific institutions such as Academies of Sciences. It will be subsidized up to 4.78 million euros by the European Commission 7th Framework Programme.

Fibonacci has received endorsement or manifestation of interest from the following prestigious scientific bodies:

The Academy of Athens • The Berlin-Brandeburg Academy of Sciences • The Bulgarian Academy of Sciences • The Finnish Academies of Sciences and Letters • The French Academy of Sciences • The Romanian Academy • The Royal Academy (UK) • The Royal Irish Academy • The Royal Netherlands Academy of Arts and Sciences • The Royal Swedish Academy of Sciences • The Serbian Academy of Sciences and Arts • The European Science Education Research Association (ESERA) • The European Space Agency (ESA) • The International Research Group on Physics Teaching (GIREP) • The InterAcademy Panel on International issues (IAP)

Preamble

This booklet provides an organisational framework for a Fibonacci Reference or Twin centre who would like to establish and coordinate a structured and ongoing initiative in schools at a city, district, county, or regional level.

This framework offers perspectives and recommended best practices for the following seven strategies:

- professional development and support
- establishing a training network
- giving teachers access to resources
- assessment
- coordinating a local support network
- mobilising decision-makers
- project management

Each of them is explained in detail below in an overview document containing objectives, real-life examples, links to annexes and recommendations. This is not intended to be a turnkey template. Rather, it provides examples of actions that, most importantly, should be adapted to local contexts, needs, and resources.

Since the ultimate goal of this type of project is to engage a large portion of teachers, plans must be made for a preparation phase that may last an entire year. This provides an opportunity to mobilise local actors and partners and to get them involved in developing the project. More specifically, the viability and success of the project depend upon the following conditions:

- a shared belief in the project's long-term challenges and outlooks
- willingness from political institutions, including vital support from the local and national education system
- effective mobilisation of local actors (local authorities, scientists, parents, associations, etc.) united around a single project
- a clear commitment from all partners to allocate the necessary human and financial resources to support the project throughout its life (at least three years)
- institutional support for the teachers: trust, academic oversight, scientific guidance, training
- a development plan that combines the project's strategic aspects and their subsequent actions and sets a timetable
- an official agreement contracting all the partners' commitments for the duration of the project (at least three years)

By combining this partnership framework with the set of actions **prescribed by the project's development plan (see Strategic Plan section in the starting package)**, academic teams will achieve both significant quantitative and qualitative levels of IBSME.

Reference centres and Twin centres : the Fibonacci network

The dissemination strategy of Fibonacci is based on a network of 12 Reference centres throughout Europe which all have a recognized expertise for sustainable Inquiry-Based Scientific Education implementation at local or regional level in natural sciences or mathematics. The Reference centre is usually mainly working with the classes around in association with other local partners of interest (scientists, municipalities, museums…). Local partners provide support and contribute to opening the school to its environment, by linking science and mathematics activities with daily life situations and professional contexts (scientific careers).

In the frame of the project, each Reference centre is in charge of spreading IBSME to at least 2 new European cities or regions (Twin centres). A quality and sustainable tranfer will be guaranteed by field visits,professional development and tutoring. An important aspect is that the twinning strategy must not be a one-to-one relationship,with simple cross-exchange, but a cumulative process where a Reference centre's main objective is to develop the potential of the Twin centre so that the latter can become itself a Reference centre on a short term basis (2 to 3 years).

Qualification of a Reference centre :

- Recognition and expertise in inquiry-based scientific education approach
- Systemic approach to implement IBSME at local level
- Availability of pedagogical resources and scientific material for schools
- Outstanding experience in teachers and professional development
- Competence to involve a local network of key players and to create locally a consensus with these actors to the benefit of primary science and mathematics education at school
- Connections with institutions and universities regarding research in scientific education

Main actions of a Reference center :

In the frame of the project, the Reference centres will implement the following actions :

- Working locally with at least high quality IBSME classes, providing professional development and materials for teachers and ensuring follow-up and quality assessment
- Organizing field visits for other centres
- Twinning and tutoring two centres during two years
- Disseminating locally and broadly the Fibonacci project
- Contributing to common European activities in the frame of Fibonacci
- Organizing and participating in European training sessions
- Organizing and participating in European conferences and seminars

Establishing a Reference centre to Develop Science and/or Mathematics in Schools

Strategies to Apply

Mobilising Decision-Makers

Obtain support from authorities and decision-makers to ensure the project's viability.

Possible actions

Ongoing discussions, institutional meetings (steering committee, etc.), contract initiatives, informational campaigns, etc.

Assessment

Offer formative assessment tools:

- for teaching practice
- for student learning.

Measure the project's impact on classroom practice.

Possible actions

Diagnostic assessment, description of teaching practice, formative assessment, etc.

Professional development and Support

Develop and improve teachers' skills in teaching science and/or maths using inquiry-based methods by helping them overcome their apprehensions.

Possible actions

CPD sessions focused both on specific content and scientific teaching, pedagogy, academic guidance, scientific guidance...

Objectives

- **To implement inquiry-based science and mathematics education in the classroom.**
- **To help pupils improve their knowledge and develop scientific, social and language skills.**

Coordinating a Local Support Network

Link and systematize the competences of the local community that support the work done in classrooms and schools.

Possible actions

Guidance from scientists, parent participation, partnership with cultural or scientific organisations (museum, planetarium, etc.), companies, associations, etc.

Creating Teachers Networks

Motivate and mobilise teachers to work together (and with other professionals) to build collective expertise in science and/or mathematics education.

Possible actions

Collaborative projects to develop resources, assessment of practice, joint initiatives between schools, forums, etc. Support of School Principals is key to success of this element.

Giving Teachers Access to Resources

Offer all teachers logistical, scientific and educational support.

Possible actions

Develop a curriculum aligned with the national curriculum; provide materials and lesson plans, etc.
Provide an online forum for teachers to network and share ideas during and after the project.

Project Management

Duties of the coordinating committee: Assign a main contact person, serve as an intermediary between schools, institutions and partners, manage the budget, supervise planning, implement and assess the program's actions, provide a contact person for the Reference centre's events...

Mobilising Decision-Makers

Introduction

An innovative project intending to make substantial changes in classroom practice must have ongoing support from local community members, which implies informing community representatives who may have an interest in the project and bringing them together. They could be academic or municipal authorities, the pupils' parents, academic and scientific organisations, museums, companies, associations, cultural centres, etc. It is important to link in, wherever possible, to synergistic organisations and networks doing similar work, so as not to push the project in as something totally «new», but as something that links in effectively with their infrastructure. Getting inputs from such groups early on in the project will ensure they take ownership of the project objectives. This is vital to ensure longer term sustainability of the project and embedding of its actions into the larger education system long after the project is complete.

Objectives

Obtain support from authorities, decision-makers and community representatives to ensure the project's viability and have the means to effectively change classroom practice towards an inquiry-based educational approach.

Example of actions

- Have regular discussions with all the local actors.
- Create a community board in order to involve community representatives and decision-makers in the project's orientations.
- Identify the local entities and people involved with/dedicated to science education.
- Hold institutional meetings.
- Contract the commitments and duties of the partners through agreements.
- Promote the program (develop a brochure describing the project, etc.).
- Invite decision-makers into the classrooms.

Recommendations

- As soon as the project starts, it is important to identify and inform local organisations that are likely to directly or indirectly contribute to the project. This means analysing each actor's interests and the role they could play in the project, as well as understanding how the project can meet each of their needs and interests.
- Make the project's objectives clear to the interested parties, as well as the problems it poses for the school.
- Make it clear that when implementing this type of project, it may take some time before results can be noticed and measured.

Professional Development and Support

Introduction

Teachers professional development (PD) training and support are vital tools in changing teaching practice.

PD at the beginning of the project, even a short course (two or three days) will provide the educational and scientific support needed to understand inquiry-based science and mathematics education. Strong justification for IBSME and concrete examples of its benefits will help in convincing teachers that they have made the right decision to engage in, and commit to, changing their teaching practice. Then, support in the classroom and regular exchanges will help teachers to get started with the activities, to solve the problems that arise when implementing this new strategy, and to consolidate certain scientific concepts. Teachers gradually gain self-confidence and greater autonomy in their jobs while acquiring a deeper understanding of the content and thought process through their classroom practice.

Example of actions

▶ a three-day "basic" training session could have the following objectives:

- simulate an inquiry-based science class (raise a question, challenge teachers to solve it in a way that takes into account their expected scientific culture, etc.)
- provide teaching tools on topics to be studied during the school year (materials, modules, learning sequences...)
- begin a thought process on IBSME practice and work on the scientific, social and language skills it requires in the classroom

▶ scientific support from trained and coordinated students, researchers or engineers. This guidance could have the following objectives:

- help teachers overcome their apprehensions about science
- help them understand the scientific content
- offer them support in preparing, implementing, and assessing the sessions - especially during the experimental phases

Recommendations

- Working to change IBSME practice requires time and ongoing activities in teacher professional development training and support for a minimum period of three years. Thus, scheduling time for training over several years is an important part of the project's success and quality.
- During the Pollen and the Sinus projects, experience showed that peer-to-peer collaboration was a very effective educational support to teachers, particularly during the second year of training. It helped improve active collaboration among teachers and communication between schools, and favoured the expansion of the project.
- In addition to this, scientific guidance from science and engineering students helps relieve teachers' apprehensions and gradually confirm their command of the scientific approaches and content.
- These support methods have to be planned, prepared, coordinated and monitored. They do not replace training; rather, they provide additional support.

Establishing a Teachers Network

Introduction

A qualitative change in teaching practice requires time and depends on a group effort. Support and exchange systems enable teachers to share and compare their practice, their thoughts, and their individual skills. Instilling these dynamic and multi-school training networks can be a determining factor in a lasting change in teacher practice. Thus, teachers remain the primary drivers of their own careers[1].

Objectives

Motivate and mobilise teachers to work together (and with other professionals) to build collective expertise in science education.

Example of actions

- Organise discussions
- Produce tools, classroom resources or collaborate on revising these resources (courses, lessons, etc.)
- Participate in joint projects or theme-based projects
- Write learning activities for science and/or maths classes in groups, teach classes in pairs, assess them in groups
- Encourage descriptions and analyses of classroom practice as an exercise in formative assessment, and produce feedback reports on what happened in class
- Analyse the methods used in class and their effect on how the pupils learned (for example, make a recording of discussions between pupils to assess their comprehension of the concepts being worked on)
- Provide assessment frameworks to overcome any problems teachers encounter and to uphold the project's dynamic
- Give teachers access to a system of material and educational resources
- Value teachers' and pupils' initiatives to promote public events in schools (expositions, forums, school newspapers, articles, blogs, etc.)

Recommendations

- Success of development processes depends upon teachers' mid-term and long-term will and capacity of conscious engagement in the transformation process[2]. It has been observed that training, support and resources are not enough to make substantial, lasting changes. Therefore, an atmosphere of trust, teacher autonomy, time for group reflection and professional collaboration must be sought. Peer support from other teachers and the school principal are vital to long term success in sustaining change in the classroom. It is important to constantly engage with school principals so they support the project ideals.
- In a Fibonacci centre, it is possible as well as desirable to create a teachers network, which will help advance science and/or maths education by building collective expertise. Ideally it would be optimal to link in to an existing training network with established infrastructure.

[1] M.Gather Thurler, J.P. Bronckart, Transformer l'école (Changing Schools), De Boeck, 2004. In this book, the author discusses the "learning organisation"

[2] M.Gather Thurler, J.P Bronckart, Transformer l'école (Changing Schools), De Boeck, 2004.

Giving Teachers Access to Resources

Introduction

IBSME can be more easily implemented when teachers are given access to lesson plans that explain the different stages of learning on a subject, and when materials necessary for the development of every class session are provided. This requires planning and adapting the course curricula.

Objectives

Offer all teachers educational, scientific and logistical support.

Example of actions

- Create a study schedule for every academic year. Scheduling should meet the following criteria:

    - the themes chosen should refer to the regional and national curricula

    - every year is composed of periods of about seven weeks between each school holiday; this provides an opportunity to identify major scientific and/or mathematics themes per year throughout the pupils' education.

- Lesson plans are chosen by the coordination team and teachers and/or schools.
- Provide teachers with resource kits for the courses and the materials they require.
- Encourage teachers to use everyday materials with low capital cost that are highly accessible to children at school and at home.
- Organize material maintenance and delivery. The annual refurbishing budget for the kits should be about 10% of the total cost of the materials.

Recommendations

- Teachers must be involved in the curriculum development and course selection processes.
- It is important to consider teachers' comments concerning the use of materials so that they can be improved.
- To fully optimise loaning of the kits to schools, a rotation schedule can be established and sent to teachers at the beginning of the year. The schedule indicates the period at which every subject can be tackled, and specifies the dates during which materials can be borrowed and returned. Also, to help track when materials need to be restocked between periods, each kit may have a tracking sheet that teachers use at the end of every period to mark materials that are missing and to write their comments concerning their use, so that the kit contents can be improved.
- Make sure to anticipate and plan for the time needed to put the teaching kits together. It is difficult to gauge how much time is required because there are several tasks to do.
- Whenever possible try to use materials already in a school and work with a teacher to adapt them.

Project Assessment

Introduction

The purpose of assessment is to measure results. It is crucial because it helps improve the project's organisation and further the knowledge acquired by teachers and pupils. In an IBSME project, at least three dimensions must be assessed:

- the processes put into place to reach an objective
- the actual changes in teaching practices
- student learning

Thus, assessing teaching practices or student learning pertains to different assessment methods, objectives and tools.

Moreover, two types of assessment - formative and summative - should be considered for each of these dimensions. They also have different purposes and implementation methods. For example, when evaluating teaching practices, either a formative or a summative rubric can be used to observe classes.

Objectives

Measure the project's impact on classroom practice

Offer formative assessment tools :

- for teaching practices
- for pupils' learning

Example of actions

- Provide access to lesson plans[3] that have clear teaching objectives aligned with the curricula and resources for student formative assessment.
- Put teaching self-assessment practices into place by providing teachers with a formative chart.
- Define teaching practice using summative charts to measure differences between actual and recommended practices.
- Offer evaluation activities at the beginning and end of courses to assess pupils' knowledge acquisition.
- Encourage teachers to keep a portfolio throughout the project which will be very beneficial to them and to the project coordinators in assessing a shift in their teaching practice.

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[3] A lesson plan is a teaching document that contains a series of activities to progressively teach a science subject.

Recommendations

- Before proceeding to measure the project's impact, for example, on the pupils' understanding, you must know whether the project's implementation complies with the accepted model. In the first stages of the project, therefore, evaluation is based on data mainly collected by observing the teachers' and pupils' activities, interviews with teachers, administrators and pupils, the teacher's preparatory classroom activities, and the pupils' science notebook[4].
- "Only after it becomes apparent that IBSME has been an integral part of the pupils' practice for a sufficient amount of time can you assess the outcome of what they have learned. Otherwise, you run the risk of drawing the wrong empirical conclusions, which can lead to faulty decision-making."[5]
- Formative student assessment requires a clear definition of the teaching objectives ultimately being sought in terms of knowledge and skills. Consequently, it is of the utmost importance to help teachers determine and adopt these objectives.
- Formative and summative assessments not only differ in terms of their objectives, but also in terms of when they should be used and the tools they require. Mixing them together compromises their objectives.
- Any sort of evaluation must strictly define the following four aspects[6]:

  - A conceptual framework (for example, what is being defined as "knowledge", "skill" or "IBSME")

  - Objectives to evaluate (for example, the knowledge acquisition that has to be functionally explained and verified or the accepted definition of Inquiry-Based Science and Mathematics Education)

  - A selection of data sources (an activity, questions, the experiment notebook, an observation, etc.) and tools to organise the data (a chart, a form, etc.)

  - Interpretation of the results of the evaluation to draw conclusions from it (define the level expected, parts to improve, etc.)

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[4] IAP, «Report of working group on international collaboration in the evaluation of Inquiry Based Science Education (IBSE) programs,» 2006.

[5] Idem

[6] R. Shavelson, M. A. Ruiz-Primo, M. Li, and C. Cuauhtemoc, «Evaluating new approaches to assessing learning,» National Center for Research on Evaluation, Standard and Student testing, California University, Los Angeles CSE-R-604, 2003. And NRC, «Knowing what students know: the science and design of educational assessment,» Washington D.C.: NAP, 2001

Coordinating a Local Support Network

Introduction

An educational project such as establishing a Fibonacci center necessarily becomes part of a specific local context (city, district...). Therefore, this context must be carefully examined and associated with the Fibonacci project, for example, through a number of community partnerships.

Objectives

Articulate and systematize the competences of the local community that support work done in classrooms and schools.

Example of actions

- Set up a community board and invite representatives of the interested organisations to inform them of and mobilise them around school initiatives
- Get science and mathematics higher-learning institutions involved in the classroom support activities
- Organise cultural activities related to the subject of the lesson being taught in class (for example, plan a visit to a mill during the lesson on gears)
- Encourage parents to participate in the activities and share their know-how
- Organise actions between the partners
- Promote the project within the community
- Organize meetings with local companies to determine the results they expect from the program
- Talk to the national science promotional organization and ask for their support, particularly in promoting the project and disseminating its findings

Recommendations

- As soon as the project begins, local scientific and cultural organisations that may potentially become involved in the project should be associated.
- In order for potential partners to be receptive to requests, the project has to be sufficiently clear and complete. Otherwise, potential partners may not clearly perceive how they can get involved in the project and what role they can assume.
- It is recommended that partnerships with scientific institutions be part of project. More information on scientific partnership can be found at : **<www.astep.fr>**

Project Management

Introduction

Given the number and variety of the project's participants and the range of resources at play, a clearly identified coordination system must be put in place to manage the project and determine its priorities.

Objectives

- To determine and implement the priorities for the project established by the steering committee.
- To plan, develop, evaluate, and adapt the project's actions within its different dimensions.
- To make sure the project runs well on a day to day basis and is coordinated with all its partners.

Example of actions

- Steering the Project

Many bodies can steer the project:

- The core steering committee, or community board
Contains representatives from the main participants in the field. It has decision-making power and control over setting up the project, monitoring it and steering it (number of classes, geographic areas, budget, etc.). It meets on a regular basis. This board will represent the community involvement in the project and serve as the meeting place for all the local actors (teachers, parents, educational authorities, museums, scientific community...)

- Local coordinating team
It contains a coordinator, the main contact for all the partners, schools and teachers involved in the project, and a trainer from the national education administration whose primary role is to train the teachers and monitor the classes participating in the project.

- Day-to-day Project Coordination

- plan meetings (coordination, informational, institutional meetings)
- write "required" documents (activity reports, emails to schools, meeting preparation, minutes, etc.)
- manage educational materials (ordering, restocking, etc.)
- manage the teams (partners, apprentices, guides, pupils, etc.)
- participate in professional development: design, preparation and implementation
- help produce resources
- support teachers in classrooms
- organise communication campaigns (newspaper, science fairs, brochure, website, planning classroom visits, welcoming delegations, etc.)

Recommendations

- Beginning of the project: quite often, a project results from an idea or initiative of a small group of people who have discussed it and had a chance to:

  - visit another Fibonacci centre, see how it works, understand how it is implemented locally;

  - meet and talk with teachers (locally and elsewhere), visit classrooms (attend classes);

  - conduct a local assessment, find key actors in science education, identify prior actions undertaken in this area, identify the teachers' needs: what they lack, their problems, how to solve them.

- Structuring the project: a Fibonacci centre project depends on structural elements such as materials, course activities, training, scientific partnerships, etc.

As the ideas develop, the project should be designed with the help and contribution of all the partners that will be involved, beyond the original group that initiates the proposal. Therefore, it is important to:

- explain the project's objectives to the partners

- establish the limits of the area in which the project will be implemented, and how it will be implemented (corps of volunteers, sector, etc.)

- schedule the project's rollout phases depending on how long it is and on the local limitations, and draw up a timetable for actions

- determine a list of actions to carry out and their content

- plan for locations to store the materials, train the instructors

- forecast the project budget (number of positions, operating costs, spending for materials, travel, etc.)

- define each person's duties and commitments

- draw up a collective agreement that will contract the project in terms of objectives, implementation methods, resources allocated and partners commitments.

consortium members

Credits

Graphic design:
www.lezard-graphique.net - 2010

Flags icons:
www.IconDrawer.com

Fibonacci Picture:
Stefano Bolognini

Partners

European coordination

France - *La main à la pâte* (French Academy of sciences, INRP, École normale supérieure Paris). For the purpose of Fibonacci, the École normale supérieure is the legal entity coordinating the project.

Scientific coordination

Science: **France** – *La main à la pâte* Mathematics: **Germany** – University of Bayreuth

Reference centres

Austria – University of Klagenfurt **Denmark** – University College South Denmark **France** – ARMINES/ Graduate School of Engineering of St Etienne **France** – Graduate School of Engineering of Nantes **Germany** – Free University of Berlin **Germany** – University of Augsburg **Germany** – University of Bayreuth **Netherlands** – University of Amsterdam **Slovakia** – University of Trnava **Slovenia** – University of Ljubljana **Sweden** – Royal Swedish Academy of sciences **United Kingdom** – University of Leicester

Twin centres 1

Belgium – Free University of Brussels **Bulgaria** – Institute of mathematics and informatics of the Bulgarian Academy of sciences **Estonia** – University of Tartu **Finland** – University of Helsinki **Greece** – University of Patras **Ireland** – St Patrick's College **Portugal** – Ciencia Viva, National Agency for Scientific and Technological Culture **Luxemburg** – University of Luxemburg **Romania** – National Institute for Lasers, Plasma and Radiation **Serbia** – Vinca Institute for Nuclear Sciences **Spain** – University of Cantabria **Switzerland** – University of Zurich.

Associated partner for the Greenwave project

Ireland – Discover Science and Engineering - Discover Primary Science.

Twin centres 2

Austria – generation innovation ForschungsScheck **Belgium** – Dienst Katholiek Onderwijs **Denmark** – NAVIMAT, Danish National Centre for Mathematics Education **Denmark** – VIA University College **France** – University of Nancy **Germany** – Cologne & Bonn Chambers of Commerce and Industry **Germany** – Thuringer Institut fur Lehrerfortbildung **Italy** – National Association of Science Teachers **Poland** – Jagiellonian University **Spain** – University of Alicante **Turkia** – Academy of sciences/TUBA **UK/ Scotland** – University of Glasgow **UK / Northern Ireland** – Queens University.

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