Inquiry-Based Science Education
IBSE
Some Perspectives from EU and Ireland

Marie Walsh
Limerick Institute of Technology
Limerick, Ireland
Marie.Walsh@lit.ie
Good Morning

Dia duit

Dobré ráno

MWalsh ICT Prague 2014
Structure of Presentation

**Part 1**

- Ideas and perspectives on Inquiry-Based Science Education (IBSE)

**Part 2**

- Some suggestions for implementation of IBSE
Spelling 😊

Inquiry:
A formal investigation

The prefix “in” comes from Latin

Enquiry:
Asking a question

The prefix “en” comes from French
Rocard Report 2007

- A renewed pedagogy for the FUTURE of EUROPE

The intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments.

(Linn, Davis, & Bell, 2004).
Rocard report and IBSE

• A reversal of school science-teaching pedagogy from mainly deductive to inductive, inquiry-based methods provides the means to increase interest in science.
Out with the old and in with the new??
Rocard report and IBSE

• IBSE has proved its efficacy at both primary and secondary levels in increasing children’s and students’ interest and attainments levels

• while at the same time stimulating teacher motivation.

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Rocard report and IBSE

• IBSE is effective with all kinds of students from the weakest to the most able and is fully compatible with the ambition of excellence.

? Management
Rocard report and IBSE

- IBSE is beneficial to promoting girls’ interest and participation in science activities.

e.g. Scifest Ireland 2014:
60% female 40% male
Rocard Report: Inductive Approach

• Gives more space to observation, experimentation and the teacher-guided construction by the child of his/her own knowledge.

• Also described as a ‘bottom-up’ approach.

• Today the Inductive Approach is most often referred to as Inquiry-Based Science Education (IBSE)
Rocard report and IBSE

IBSE and traditional deductive approaches are not mutually exclusive and they should be combined in any science classroom to accommodate different mind-sets and age-group preferences.
When should we use IBSE?

BIG IDEAS - what robust concepts drive this inquiry?

System level Curriculum what connections can be made (does the context lead itself to standards)

Context for inquiry: project, problem, event essential question Is it worthwhile?

FRAMING THE INQUIRY

initial student input...
What do we know students are interested in learning about and doing? What does THIS group of students need?

Learning intentions what do we want students to understand? (How do these understandings link to the 'big idea'...) to be able to do? and to be? How might we know they have learned these things?

Murdoch 2010
# Levels of Inquiry

<table>
<thead>
<tr>
<th>Basic enquiry model</th>
<th>Main responsibility for:</th>
<th>Procedure</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of enquiry</td>
<td>Problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 3 Open enquiry</td>
<td>Student</td>
<td>Student</td>
<td>Student</td>
</tr>
<tr>
<td>Level 2 Guided enquiry</td>
<td>(teacher)</td>
<td>Student</td>
<td>Student</td>
</tr>
<tr>
<td>Level 1 Structured enquiry</td>
<td>(teacher)</td>
<td>(teacher)</td>
<td>Student</td>
</tr>
<tr>
<td>Level 0 Confirmation/verification</td>
<td>(teacher)</td>
<td>(teacher)</td>
<td>(teacher)</td>
</tr>
</tbody>
</table>
# Inquiry Types for IBSE

(Pathway adapted from National Research Council, USA, 2000)

<table>
<thead>
<tr>
<th>LEVEL 0</th>
<th>Confirmation or Verification</th>
<th>Completely teacher-directed.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>‘Read it in the book’</td>
</tr>
</tbody>
</table>

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### Inquiry Types for IBSE
(Pathway adapted from National Research Council, USA, 2000)

<table>
<thead>
<tr>
<th>LEVEL 1</th>
<th>Structured</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strongly teacher-directed.</strong> Students follow their teacher’s direction in pursuing a scientific investigation to produce some form of prescribed product, e.g. they investigate a question provided by the teacher through procedures that the teacher determines, and receive detailed step-by-step instructions for each stage of their investigation.</td>
<td></td>
</tr>
</tbody>
</table>

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Inquiry Types for IBSE
(Pathway adapted from National Research Council, USA, 2000)

LEVEL 2
Guided

More loosely scaffolded. Students take some responsibility for establishing the direction and methods of their inquiry. The teacher helps students to develop investigations, for example offering a pool of possible inquiry questions from which students select, and proposing guidelines on methods.
**Inquiry Types for IBSE**
(Pathway adapted from National Research Council, USA, 2000)

| LEVEL 3 Open | Strongly student-directed. Students take the lead in establishing the inquiry question and methods, while benefiting from teacher support. For example, students initiate the inquiry process by generating scientific questions and take their own decisions about the design and conduct of the inquiry and the communication of results. |

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<table>
<thead>
<tr>
<th><strong>Diversification</strong></th>
<th>A combination of two types of inquiry, for example a guided inquiry phase followed by an open inquiry phase.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coupled</strong></td>
<td></td>
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</tbody>
</table>
Herron Scale of evaluation of level of inquiry

<table>
<thead>
<tr>
<th>Level</th>
<th>Problem</th>
<th>Procedure</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: An "x" indicates that students are provided with the information or steps necessary to complete the designated component.
Continuum of IBSE

After Levy et al 2011
5 E’s

Engage

Evaluate

Explore

Elaborate

Explain

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Teachers with specific change management competences required to operate successfully as change agents in their schools will facilitate the implementation of inquiry based methods.
Why is Inquiry Based Education especially important when teaching STEM subjects?

• IBSE is a very flexible approach, in terms of implementation.

• The teacher’s choice of topics and activities to perform through an IBSE approach will depend on a particular national context.

• **BUT** Many teachers do not have a lot of experience when teaching through an IBSE approach.
Why is Inquiry Based Education especially important when teaching STEM subjects?

• A number of EC-FP7 projects promote an IBSE approach

• PROFILES, SAILS, Pathway, PRIMAS or Fibonacci, ESTABLISH, TEMI, CHAIN REACTION, etc.

• IBSE education provides a window to engage in relationships with stakeholders of formal and informal education such as researchers and scientists, firms, parents associations etc.
Projects with elements of IBSE

[Logos of various projects]

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What is Inquiry?

Inquiry is...
- forming coherent arguments
- critiquing experiments
- distinguishing alternatives
- searching for information
- researching conjectures
- planning investigations
- diagnosing problems
- debating with peers

European Science and Technology in Action: Building Links with Industry, Schools and Home

Definition of Inquiry from: Linn, Davis and Bell, 2004
‘The best way to learn is to do - to ask, and to do. The best way to teach is to make students ask, and do. Don’t preach facts - stimulate acts’

Paul HALMOS, Hungarian-born American mathematician.
Pathway Supporting Action

• Proposes a standard-based approach to teaching science by inquiry that outlines instructional models that will help teachers to organise effectively their instruction.

• Deploys a series of methods to motivate teachers to adopt inquiry based techniques and activities in their classrooms
Pathway Supporting Action

• Offers access to a unique collection of open educational resources and teaching practices (linked with the science curricula) that have proven their efficiency and efficacy in promoting inquiry based education and that are expanding the limitations of classroom instruction.
TEMl
Teaching Enquiry With Mysteries Incorporated

• Working with teacher training institutions and teacher networks across Europe to implement innovative training programmes called ‘enquiry labs’.
• Based around the core scientific concepts and emotionally engaging activity of solving mysteries, i.e. exploring the unknown.
• Enquiry labs use scientists and communication professionals (e.g. actors, motivational speakers, etc.) to mentor teachers through the transition to use enquiry to teach science.
TEMI
Teaching Enquiry With Mysteries Incorporated

• Adopts a clear definition of enquiry in terms of a cognitive skillset, and sets out a stepwise progression to push students towards becoming confident enquirers.

• The project pays equal attention to the affective side of learning.

• We will help teachers foster a deep motivation to learn, by bringing to the fore the sense of mystery, exploration and discovery that is at the core of all scientific practice.
TEMI
Teaching Enquiry With Mysteries Incorporated

MYSTERY OF THE MONTH

GENIE IN THE BOTTLE

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Opening a bottle, which contains hydrogen peroxide solution, a mysterious genie appears.
TEMİ
Teaching Enquiry With Mysteries Incorporated

• For this experiment you will need
• Hydrogen peroxide solution
  • (H₂O₂, 30%, 40ml)
• Manganese dioxide (MnO₂, powder)
• Erlenmeyer flask (1000ml)
• thread
• empty tea bag
• aluminium foil
• stopper with one bore hole
What state of matter is the "genie" in before opening the bottle?
Right! Because the stopper has a bore hole, the "genie" cannot be gaseous. When you open the bottle, a tea bag with manganese dioxide drops into the hydrogen peroxide solution. What does the manganese dioxide trigger?
Correct! Manganese dioxide is a catalyst and starts the strongly exothermic reaction:
hydrogen peroxide $\rightarrow$ water + oxygen
$2 \text{H}_2\text{O}_2 (\text{aq}) \rightarrow 2 \text{H}_2\text{O} (\text{l}) + \text{O}_2 (\text{g})$
Is the produced oxygen the mysterious "genie"?
Perfect! The "genie" is not made of oxygen, because gaseous oxygen is not visible. Thus, only the water can cause the effect. How is that to be explained?
Chain Reaction

• training teachers to approach inquiry by providing exemplars of the inquiry approach in a typical classroom setting
• providing on-going support to the teachers as they develop the practice of scientific inquiry in their classroom.
Chain Reaction

- Resources used in the Chain Reaction project are based on Pupil Research Briefs (PRBs) which are problem solving and inquiry based classroom resources developed in the successful UK project Pupil Researcher Initiative.

- PRBs which are based around "The Earth and the Universe" areas covering topics from space science to environmental education for developing countries, to the impacts of climate change.
PRB on Green Heating

Teachers' Notes

• Knowledge and understanding
• All types of electronic radiation form a continuous spectrum
• When radiation is absorbed the energy it carries makes the substance which absorbs it hotter
• Infrared radiation is absorbed by the skin and is felt as heat
• Different wavelengths of electromagnetic radiation are reflected, absorbed or transmitted differently by different substances and types of surface
• Dark, matt surfaces are good absorbers of radiation
• Light, shiny surfaces are good reflectors of radiation
• Thermal energy is the transfer of energy by waves, and particles of matter are not involved.
PRB on Green Heating

Route through this Brief

- Green Heating 1
- Green Heating 2
- Green Heating 3
  - Green Heating 4
  - Investigation
  - Investigation
  - Investigation
  - Report
- Green Heating 5
  - Investigation
PRB on Green Heating

• **IBSE links**
  • Using scientific ideas and models to explain phenomena and developing them creatively to generate and test theories
  • Critically analysing and evaluating evidence from observations and experiments
  • Using a range of scientific methods and techniques to develop and test ideas and explanations
  • Assessing risk and working safely in the laboratory
  • Planning and carrying out practical and investigative activities
Evaluation and Assessment

• IBSE in the curriculum should also lend itself to evaluation and assessment.

• Effectively planned evaluation and assessment informs the didactic process and enhances the development and consolidation of instructional methods.

• It should design performance tasks for students that align with curricular outcomes. It might also involve students in determining how their learning might be demonstrated.
# Assessment and Evaluation Phases

<table>
<thead>
<tr>
<th>Phases of Assessment and Evaluation</th>
<th>Purpose</th>
<th>Also Called</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment for learning (before)</td>
<td>To determine students’ prior knowledge and skills.</td>
<td>Diagnostic assessment</td>
</tr>
<tr>
<td>Assessment for and as learning (during)</td>
<td>To determine the next steps in learning</td>
<td>Formative assessment</td>
</tr>
<tr>
<td>Assessment of learning (after)</td>
<td>To judge what students have learned based on data obtained through several recent and varied assessment techniques.</td>
<td>Summative assessment and evaluation</td>
</tr>
</tbody>
</table>
“SAILS aims to prepare teachers, not only to be able to teach through Inquiry Based Science methods but also to be confident and competent in the assessment of their students’ learning.”
A Community of practice

- Online community is open to teachers, educators and others interested in IBSE and assessment; willing to learn and propagate new practices and methods.
- A source of knowledge and provide access to the resources of the SAILS project and other related IBSE projects and other research all aggregated in one place (stored, linked and referenced).
- A place for teachers to share their experiences, practices and reflections with similarly experienced educators at national and European levels.
STUDENTS and IBSE

• Learner engages in scientifically oriented questions.
• Learner gives priority to evidence in responding to questions.
• Learner formulates explanations from evidence.
• Learner connects explanations to scientific knowledge.
• Learner communicates and justifies explanations.
Levels of student engagement

- **Open Inquiry**: No predetermined question: Students propose and pursue their own questions.
- **Guided Inquiry**: No predetermined method: students must determine how to investigate the problem.
- **Structured Inquiry**: No predetermined answer: conclusions based solely on student investigation.
- **Limited Inquiry**: "Traditional" labs: students follow the directions and make sure their results match those given in the text.
Some Interpretations of Basic Principles of IBSE from POLLEN

• The need to take ownership of the initial question.
• The need for individual experimentation.
• You can see only what you strive to see.
• A great deal of information can be found in documentation, but it can be found even more easily by those who know what they are looking for.
• Learning is not only acting on and with objects, it is also talking with other children and writing both for oneself and for others.
In a more inquiry-oriented classroom

• Learner engages in scientifically oriented questions.
• Learner gives priority to evidence in responding to questions.
• Learner formulates explanations from evidence.
• Learner connects explanations to scientific knowledge.
• Learner communicates and justifies explanations.
Benefits of IBSE include:

- Improved experience of discipline-based learning
- Development of **transferable skills** for employability and **lifelong learning** such as:
  - Autonomous learning
  - Critical thinking
  - Team-work
  - Information literacy
  - Student enthusiasm and motivation for learning

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21st Century Competencies

Core Values

- Self-Awareness
- Self-Management
- Social Awareness
- Critical and Inventive Thinking
- Relationship Management
- Decision-Making
- Information and Communication Skills
- Confident Person
- Civic Literacy, Global Awareness, and Cross-cultural Skills
- Self-directed Learner
- Active Contributor
- Concerned Citizen
Time for a break!
Inquiry in Science Education: skillsets
## Inquiry approaches

<table>
<thead>
<tr>
<th>Essential features of science as inquiry</th>
<th>More</th>
<th>Amount of Student Self-Direction</th>
<th>Less</th>
<th>Amount of Guidance from Teacher or Material</th>
<th>More</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students engage with an event, phenomenon or problem when they ...</td>
<td>More</td>
<td>pose a question</td>
<td>Less</td>
<td>select among questions</td>
<td>More</td>
</tr>
<tr>
<td></td>
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<tr>
<td><strong>Evidence</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students give priority to evidence when they ...</td>
<td>More</td>
<td>determine what constitutes evidence and collects it</td>
<td>Less</td>
<td>are directed to collect certain data</td>
<td>More</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Essential features of science as inquiry</td>
<td>Amount of Student Self-Direction</td>
<td>Amount of Guidance from Teacher or Material</td>
<td></td>
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<tr>
<td>----------------------------------------</td>
<td>---------------------------------</td>
<td>------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Explanation</strong></td>
<td>More</td>
<td>Less</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students construct explanations when they ...</td>
<td>formulate their own explanation after summarising evidence</td>
<td>are guided in process of formulating explanation from evidence</td>
<td>are given possible ways to use evidence to formulate explanation</td>
<td>are provided with evidence</td>
<td></td>
</tr>
<tr>
<td><strong>Connections</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students evaluate their explanations when they ...</td>
<td>examine other resources and form links to explanations</td>
<td>are directed toward sources of knowledge</td>
<td>are given possible connections</td>
<td>are provided with connections</td>
<td></td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students communicate and justify their explanations when they ...</td>
<td>form reasonable and logical argument to communicate explanations</td>
<td>are coached in development of communication</td>
<td>are provided guidelines for communication</td>
<td>are given steps and procedures for communication</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from *Inquiry and the National Science Education Standards*, National Research Council (2000).
Do YOU want to be an IBSE teacher?

- Are you optimistic?
- Are you open?
- Are you appreciative?
- Are you flexible?
- Are you purposeful?
The importance of questioning?

• Write down one question you might ask students about this:

Nappy absorbed 793g of tap water

Nappy absorbed 286g of saline
5 Simple Questions

“What do you think?”

“How do you know this?”

“What questions do you still have?”

“Why do you think that?”

“Can you tell me more?”
Early childhood themes, primary priorities, junior cycle key skills and senior cycle key skills

<table>
<thead>
<tr>
<th>Early childhood themes</th>
<th>Primary priorities</th>
<th>Junior cycle key skills</th>
<th>Senior cycle key skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploring and thinking</td>
<td>Develop learning, thinking and life skills</td>
<td>Managing information and thinking</td>
<td>Information processing</td>
</tr>
<tr>
<td>Communicating</td>
<td>Communicate well</td>
<td>Communicating</td>
<td>Communicating</td>
</tr>
<tr>
<td>Well being</td>
<td>Be well</td>
<td>Staying well</td>
<td>Being personally effective</td>
</tr>
<tr>
<td>Identity and belonging</td>
<td>Have a strong sense of identity and belonging</td>
<td>Working with others</td>
<td>Working with others</td>
</tr>
<tr>
<td></td>
<td>Engage in learning</td>
<td>Managing myself</td>
<td>Critical and creative thinking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Being creative</td>
<td></td>
</tr>
</tbody>
</table>

Where could IBSE aid development?

*Source: Junior Certificate Science Consultation document*
Adopting IBSE into the Irish Science Education Curriculum

• For the past ten years Science has been part of the Primary Curriculum and IBSE has become quite common at primary level.
• However, IBSE is not the usual approach taken by second level teachers.
• In an examination driven system the concept of inquiry is not always given the attention it deserves.
• Need for professional development in the use of IBSE approaches to support the Science curriculum.
Continuous Professional Development: Teachers and IBSE - guidelines

• take into account the teachers’ existing beliefs and practical knowledge
• enhance teachers’ Content Knowledge, Pedagogical Skills, and knowledge about inquiry
• be consistent with school’s practices and general reforms of science education
• provide opportunities for designing new activities or adapting existing ones
• provide opportunities for testing the activities with students and for peer collaboration
• provide long-term support with the use of new technology
Continuous Professional Development: Teachers and IBSE - PDST

In Ireland teachers are supported through new initiatives for teaching and learning through the PDST.
Supporting the Practising Teacher

Continuing Professional Development

• PDST links to Scientix - promotes and supports a Europe-wide collaboration among STEM teachers, education researchers, policymakers and other STEM education professionals.
Supporting the Practising Teacher

Science on Stage

• A European initiative designed to encourage teachers from across Europe to share best practice in science teaching.

• The overall aims of Science on Stage are to:
  • Provide a forum for teachers to exchange teaching ideas for the sciences
  • Inspire and re-enthuse science teachers
  • Provide teachers with access to quality science teaching resources and ideas
  • Inform teachers about wider science research
  • Raise the profile of science teaching with education ministers in the countries involved
Supporting the Practising Teacher

Science on Stage

http://www.scienceonstage.ie/videos.html
Adopting IBSE into the Science Education Curriculum at Primary level

• Discover Primary Science
Local Initiatives

• Limerick Education Centre in association with the PDST (Professional Development Service for Teachers) has in 2014 endeavoured to foster teacher capacity at primary level to encourage greater focus on scientific experimentation in the classroom.

• The teachers from 4 primary schools have engaged in an initiative called LEC Junior Scientist which comprised of a series of professional development opportunities facilitating them to transfer the acquired skills to their classrooms.

• Almost 200 hundred primary school children from junior infants to sixth class have been engaged in a range of scientific experiments since the start of this school year.
Inquiry leads to exhibition

The programme culminated in an exposition of the children engaged in a range of experiments in March in Limerick Institute of Technology

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Inquiry leads to exhibition
Inquiry leads to exhibition
Adopting IBSE into the Irish Science Education Curriculum – Secondary level

• Aspects of IBSE are already inherent in the Science curriculum of the post-primary Junior Cycle as planning, investigations, critiquing experiments, searching for information, debating with peers and forming coherent arguments are all part of the Junior Science Syllabus.

• However, only planning investigations and forming coherent arguments are assessed.
Adopting IBSE into the Science Education Curriculum

• At Junior Cycle, the practical nature of the curriculum and the method of assessment allow space for IBSE to be incorporated into the curriculum.

• Coursework A (10%) is a record of completion of prescribed practical investigations and Coursework B (25%) is a report on two specified investigations undertaken in the third year.

• Students also are given the option of submitting a report on an investigation of their own choice that meets the criteria.
Inquiry in the current curriculum

- Lower secondary Junior Certificate Science marks are distributed as follows:

- Coursework A – 10%
  (Experiments and investigations specified in the syllabus)

- Coursework B – 25%
  (2 from choice of 3 specified investigations)
  (or student may choose one ‘Own Investigation’)

- Terminal examination – 65%
  (Section 1 – Biology / Section 2 – Chemistry / Section 3 – Physics)
Biology

- **Investigate** and compare the quantitative effects of changing (a) wavelength of illumination and (b) either intensity or duration of illumination on the phototropic growth response of recently germinated plant shoots/seedlings.

Chemistry

- **Investigate** and compare the quantitative effects of changing (a) metal types and (b) fruit/vegetable type on the emf (voltage) produced across two different metals, when the electrolytes take the form of fruits and/or vegetables.

Physics

- **Investigate** and compare the quantitative effects of changing (a) material type and (b) material thickness on the level of sound insulation provided by a range of materials.
Indication given by teachers of the amount of help given to students carrying out Coursework B

Source: Declan Kennedy, IBSE in Ireland

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Proposed new Junior Certificate

Rationale – summary

- Inquiry based learning – enable students to ask more questions, develop and evaluate explanations
- Build on primary school science
- Enhance scientific literacy
- Social development – meet challenges of senior cycle sciences, employment, further education and life
- Promote problem solving, reasoning and decision making
- Collaborative approach - working in groups
- Develop key skills of Junior Cycle
Learning to Inquire

• http://vimeo.com/41853131
A Conceptual Model for Improving Science Comprehension

Inquiry-based Learning/Experiential Education

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Strategies for IBSE teaching and learning

- Brainstorming
- Case studies
- Concept cartoons
- Concept mapping
- Model building
- Games
- Field trips and investigations

Thinking About Science

What Do You Think?

Written by Sharon Peppett
© Millgate House Education Ltd
www.millgatehouse.co.uk

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Strategies for IBSE teaching and learning

- Projects
- Drama and role play
- Questioning
- Stories
- Mysteries or discrepant events
- ICTs

- Underpinned by Ethics and Attitudes
The skills most developed by students after applying an IBSE approach:

• Observation skills,
• posing of investigation questions,
• planning and designing investigations,
• reviewing evidence,
• developing conclusions,
• discussion of results....
Students also learn to use secondary sources

• Books
• Experts
• Internet

• Students find needed information in this way
• They learn how and where to look
• They learn the need to consider with a critical eye.
Comparing Inquiry and Traditional Classrooms

<table>
<thead>
<tr>
<th>Traditional</th>
<th>Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students often work alone</td>
<td>Students often work in groups</td>
</tr>
<tr>
<td>Emphasis on mastery of facts</td>
<td>Emphasis on understanding of key concepts</td>
</tr>
<tr>
<td>Follows a fixed curriculum closely</td>
<td>Allows for pursuit of student questions</td>
</tr>
<tr>
<td>Activities rely mainly on textbooks and workbook materials</td>
<td>Activities rely on primary sources</td>
</tr>
<tr>
<td>Students are viewed as “blank slates”</td>
<td>Students are viewed as thinkers with their own theories about the world</td>
</tr>
<tr>
<td>Teachers tend to disseminate information to students</td>
<td>Teachers facilitate an interactive learning environment</td>
</tr>
<tr>
<td>Teachers tend to seek correct answers</td>
<td>Teachers seek to understand student learning</td>
</tr>
<tr>
<td>Assessment tends to be separate from teaching</td>
<td>Assessment is interwoven with teaching</td>
</tr>
</tbody>
</table>

Adapted from *In search of understanding: the case for constructivist classrooms*, Brooks & Brooks (1993).
Organising the classroom for IBSE

The Physical Environment

*Practical suggestions:*

- Space for materials,
- works in progress,
- displays.
- Building up a supply of equipment.
- Access to ICT and library.
The classroom culture

• For IBSE to be effective there needs to be a classroom culture where all students feel comfortable

• And all have the opportunity to participate in all aspects of the science work: the hands-on, thinking, talking and writing.

TEAMs work best if they are small – 4 is usually ideal
Co-operative learning: The Jigsaw Method

Home group

Expert group

Expert group

Expert group

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The Jigsaw Method

Mimics teams of scientists working towards a common goal

How does it work?
How can you gauge activity?

- Randomisers
- Response cubes
- Wipe clean boards
Inquiry also develops reporting and presentation skills – links to ICT

How should students present their findings?

• Presentations
• Models
• Reports/Project folders/Portfolios
• Video clips/ YouTube
• Posters
• Blogs
• Wikis
• Websites
Stop motion animation

- A method of facilitating discussion
- Students use camera phones to collect images and then import and edit in Windows movie maker
Modelling

Source: Majella Dempsey NUIM

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Modelling

Source: Majella Dempsey NUIM
Modelling

Source: Majella Dempsey NUIM

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• Effective ways to present a lot of information about inquiry in a short space of time.
Websites

Incorporating development of ICT skills

www.weebly.com

Students can develop their own website to present their findings.

Free if not published.
Wikis

• A method of collaboration which can be monitored and moderated by the teacher if intervention is necessary.
• Allows tracking of contributions within a group.
• www.pbworks.com
It is really important that you do not circulate any surveys until you have had them approved. There is an ethical aspect to this - if you were doing research you would have to have any survey approved.

If you are putting together an electronic survey please send to me before you circulate.

This workspace is the forum through which you are to communicate the development of the second mini project.

Sample wiki for Project
Science Fairs: examples of collaboration

• In most countries, science-related extracurricular activities at school are related to better student performance, a stronger belief by students in their abilities to handle science-related tasks, and greater enjoyment of learning science.

• And, in many countries, this is true even after accounting for the socio-economic background of both students and schools.......
• SciFest@School
• SciFest@College
• SciFest Final
• The projects are evaluated by an expert panel of judges from academia, enterprise and government. One project is selected to represent Ireland at the Intel International Science and Engineering Fair (ISEF) which is held annually in May in the USA.
SciFest

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Google Science Fair

“I would promote practical, active learning, and try to make it a bit more fun...The day of doing ‘textbook, textbook’ is going out.”

Shaun Holly, Teacher
Summary related to the Rocard Report

- Renewed school’s science-teaching pedagogy based on IBSE provides increased opportunities for cooperation between actors in the formal and informal arenas.
- Due to the nature of its practices, IBSE pedagogy is more likely to encourage relationships between the stakeholders of both formal and informal education.
- It creates opportunities for involving firms, scientists, researchers, engineers, universities, local actors such as cities, associations, parents and other kinds of local resources.
Learning Inquiry
References


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http://www.scientix.eu/web/scientix-cop-02/ibse/-/message_boards/message/182615
http://www.slideshare.net/EilishMcLoughlin1/esof2012-ibse-14jul2012
www.pdst.ie
www.scifest.ie
www.btyse.ie

Levels of enquiry http://astroedu.iau.org/ebl_old/


Amgen Teach https://www.youtube.com/watch?v=Geb5XlZ6IqU

file:///C:/Users/Marie/Downloads/Amgen%20Teach%20Workshop%20120%20(1).pdf


http://www.scienceonstage.ie/videos.html

MWalsh ICT Prague 2014


TEMI Project http://teachingmysteries.eu/en/

www.pbworks.com

www.weebly.com

www.pdst.ie
Děkuji
to PDST Ireland, especially Maria Sheehan
to JCT Science Miriam Hamilton

and to VSCHT Prague:
Marcela, Zdenek, Hana, Anna
Any Enquiries?

Marie Walsh
Limerick Institute of Technology
Limerick, Ireland

Marie.Walsh@lit.ie