Indicators of teaching and learning science through inquiry in primary classroom

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Overview of workshop

- Part 1: Why IBSE? What do we want to achieve through it?
- Part 2: Thinking about how students learn and develop understanding
- Part 3: The learning activities of students
- Part 4: What IBSE means for the teacher
- Part 5: How do we know if IBSE is in operation?
- Part 6: Helping teachers become more effective in inquiry-based teaching

Part 1 Why IBSE

Some possible reasons:

- To provide more future students of science who will become scientists and technologists?
- To give provide scientific literacy for all students whether on not they will continue to study science?
- To develop skills of inquiry that can be used in other areas besides science?
- To give students sound understanding of scientific concepts?
- To ensure students know key scientific facts?
- To promote life-long learning?

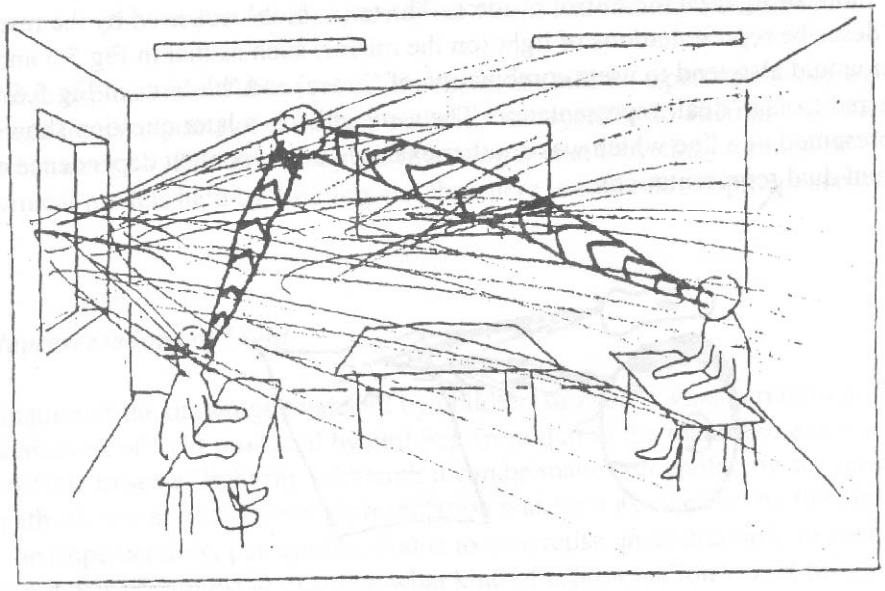
Scientific literacy

- Being comfortable and competent with broad scientific ideas, with the nature and limitations of science, with the processes of science and having the capacity to use these ideas in making decisions as an informed and concerned citizen.

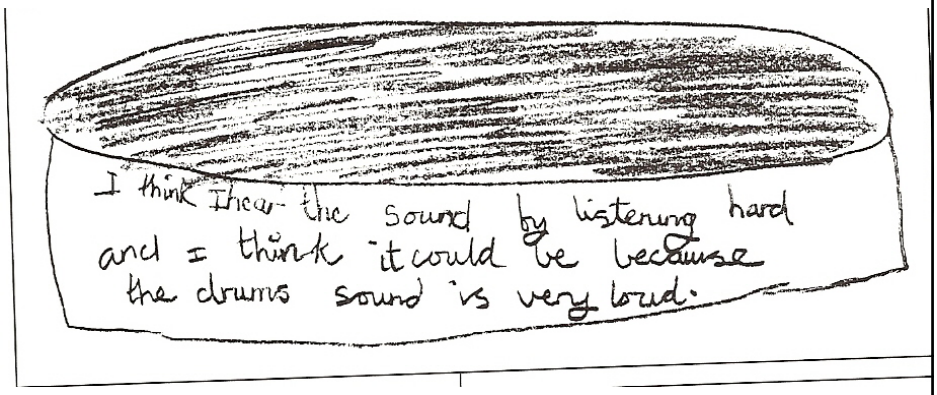
Part 2: How children learn

Evidence collected by Piaget and later by others

- children work things out for themselves from an early age – from repeated actions
- they often arrive at ideas that conflict with scientific ones because they are based on young children's necessarily limited experience and reasoning
- seen from the children's point of view they are reasonable



Age 11



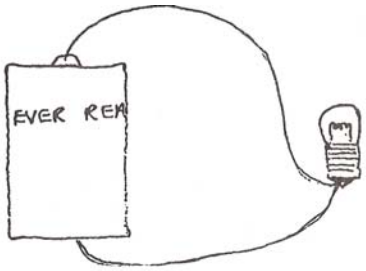


Fig 3: Julie Age 6.

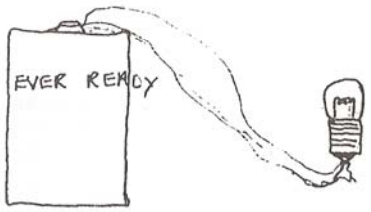
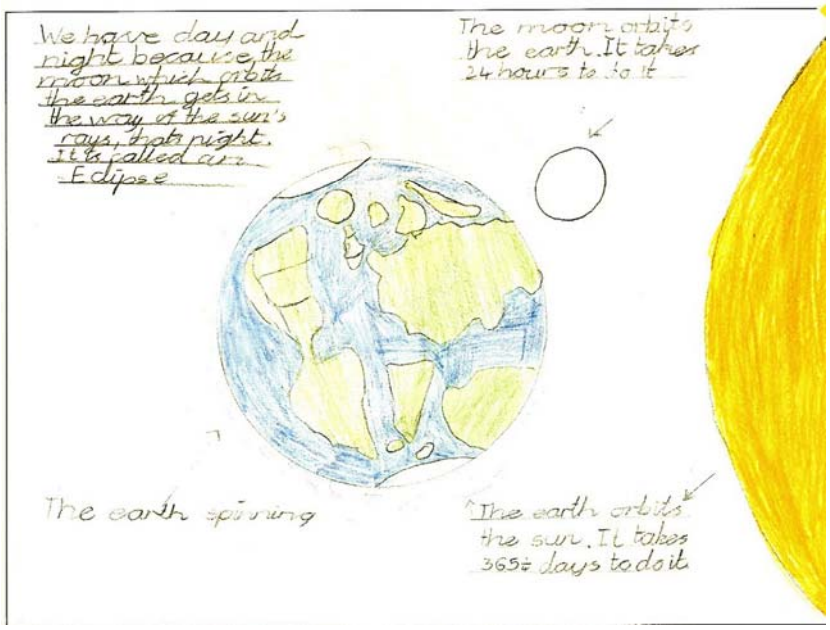


Fig 4: Makeda - Age 10



Taking students' ideas seriously: constructivism

- Constructivism is more than knowing students' ideas
- It means helping them to understand phenomena in a more scientific way
- It means enabling students to take an active part in creating scientific understanding by:
  - Collecting evidence to test their ideas
  - Linking ideas from one experience to a new one
  - Considering alternative ideas, with scaffolding
  - Using form scientific skills
  - etc

From individual constructivism to social constructivism

- Social constructivism means sharing, discussing defending ideas; dialogue, reflection
- Recognises the impact of others' ideas on the way learners make sense of things
  - sharing the understanding of events and phenomena through talk, dialogue
  - defending ideas through argumentation about evidence
  - finding words to communicate ideas
- Recognises the importance of language, particularly talk

The role of inquiry skills in developing ideas

- Using inquiry skills in developing and testing ideas by
  - observing, raising questions
  - using suggested explanations to make predictions
  - gathering, analysing, interpreting, communicating
  - refining ideas
  - moving from 'small' towards 'bigger' ideas
- If these skills are non-scientific, then we can expect non-scientific ideas to be formed

Inquiry

- A process in which learners build their understanding of fundamental scientific ideas through direct experience with materials, by consulting books, other resources, and experts, and through argument and debate among themselves. (NSF, 1997)

But:

- Not all learning in science involves inquiry
- Not all inquiry in science is scientific inquiry

Part 3: Learning activities of students

- Acumulando evidencias por la observación de eventos reales o de otras fuentes. (Gathering evidence by observing real events or using other sources)
- Siguiendo asuntos que han identificado como propios, aún habiendo sido inducidos por el profesor.(Pursuing questions which they have identified as their own even if introduced by the teacher)
- Haciendo preguntas adicionales que pueden llevar a otra investigación.(Raising further questions which can lead to investigations)
- Haciendo predicciones basadas en lo que ellos piensan o descubren (Making predictions based on what they think or find out)
- Conversando entre sí o con el profesor sobre lo que están observando o investigando.(Talking to each other and the teacher about what they are observing or investigating)

Learning activities of students contd

- Expresándose usando términos científicos apropiados con comprensión de la materia, tanto por escrito como oralmente.(Expressing themselves with understanding both in writing and talk)
- Sugiriendo formas de probar sus propias ideas o las de los demás para ver si existe evidencia para probar estas ideas.(Suggesting ways of testing their own or others' ideas to see if there is evidence to support these ideas)
- Tomando parte en la planificación de investigaciones con controles adecuados para contestar preguntas específicas.(Taking part in planning investigations with appropriate controls)

Learning activities of students contd

- Tratando de resolver problemas por si mismos.(Attempting to solve problems for themselves)
- Usando una variedad de fuentes de información para obtener datos que necesitan para su investigación.(Using a variety of sources of information for facts that they need for their investigation)
- Evaluando la validez y utilidad de distintas ideas en relación con la evidencia. (Assessing the validity and usefulness of different ideas in relation to evidence)
- Tomando en cuenta ideas que no son las propias.(Considering ideas other than their own)
- Reflexionando con autocrítica sobre los procesos y resultados de su indagación. (Reflecting self-critically about the processes and outcomes of their investigations.)

As a result of their experiences students will learn -

- Inquiry skills
  - Describe observations, make predictions, develop hypotheses,
  - Identify evidence needed and how to gather it
  - Critical thinking in analysing and interpreting evidence
  - Communication and reflection on procedures and findings
- Science concepts
  - About living things, materials, forces and energy, the Earth, solar system and universe, etc
- Attitudes and dispositions
  - Respect for evidence, willingness to consider alternative ideas, sensitivity towards people, other living things, etc.

Part 4: What IBSE means for the teacher

- What will the teacher have to do to give the students the opportunity to learn through IBSE?
- Consider (in groups) the list on the handout (Page 4)
  - What should be added?
  - What should be changed?

Part 5: How do we know if IBSE is in operation?

- Observe the class in action
- Ask the teachers (interview, questionnaire)
- Ask the students (interview , questionnaire)
- Study teachers' plans
- Review students' notebooks
- Talk to the students about observed events
- Talk to the teacher about observed events, their planning, their judgments of success
- Talk to parents, teaching assistants, school principals, etc

Ways and means

- Questionnaires to and/or interviews of teachers, children and others involved (head teachers, teaching assistants, parent helpers)
- Focusing questions for reviewing documents (eg nature of the written feedback on children's work; details of teachers' lesson plans)
- Observation procedures and schedules for observing teacher, children and classroom
- Photographs of events

How to interpret what you find?

Awkward questions:

- What is to be taken as satisfactory
  - what incidence of certain kinds of feedback is enough?
  - what expectations of how teachers use students' ideas?
  - what standards are to be applied in how students' work is displayed?
- Use of a comparison (control) group avoids some problems, but
- Value judgements are always involved and need to be made explicit

Using standards, or criteria, for evaluating classroom practice

- Agree the standards to apply
- Collect relevant evidence (more value judgments)
- Scan the evidence in relation to each standard statement and decide how good is the fit (more value judgments)
- Use the result to identify where there is need for further help

Some suggestions for standards

Teachers should be:

- Using a range of methods suited to the achievement of various goals of learning science
- Providing simple materials and equipment for students' first-hand exploration and inquiry
- Providing activities that are interesting, enjoyable and relevant to students
- Providing opportunities for inquiry relating to the *scientific phenomena* in their environment
- Regularly asking questions which invite students to express their ideas
- Knowing where students are in the development of ideas and inquiry skills

contd

Continued…

- Ensuring that students have evidence to back up their claims and ideas
- Including in lesson plans what students are intended to *learn* as well as what they will *do*
- Providing comments that help progress in oral or written feedback on students' work
- Ensuring that students regularly have chance to raise questions and that these are addressed
- Ensuring that students always know the purpose of their investigations and other science activities

Continued…

- Providing opportunities for students to discuss observations, plans, findings and conclusions in small groups and as a whole class
- Providing opportunities for students to obtain information from books, the Internet, visits out of school and visiting experts
- Discussing with students the qualities of good work so that they can assess and improve their work
- Providing time and encouraging students to reflect on how and what they have learned
- Keeping records of students' progress based on questioning, observation, discussion and study of products relevant to learning goals.

Evaluation of influences beyond the classroom and school

- Identify standards of practice for schools, for parental support, for advisers, for inspectors, for local or national government policy
- Involve those who are the subjects of the standards in the process and get their agreement
- Gather information and scan it to identify where practice matches expectations or where there is need for change.

Part 6: Helping teachers become more effective in IBSE

- Like students, teachers
  - have different starting points as learners
  - learn from first hand experience and examples
  - need to know what are their goals
  - need feedback to help them judge how well they are doing
  - need time to reflect
  - learn a great deal through discussion with peers.
- Provide opportunities for teachers
  - to experience inquiry at first hand
  - to try out strategies and see students' reactions
  - to take one step at a time!