The Principles of Inquiry-Based Science Education

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Agenda

- Effective practice in science education
- Development of understanding through inquiry: a model
- Teaching and learning through inquiry in action
- Myths abut IBSE
- Obstacles to implementation
- Does it deliver?

The goals of science education

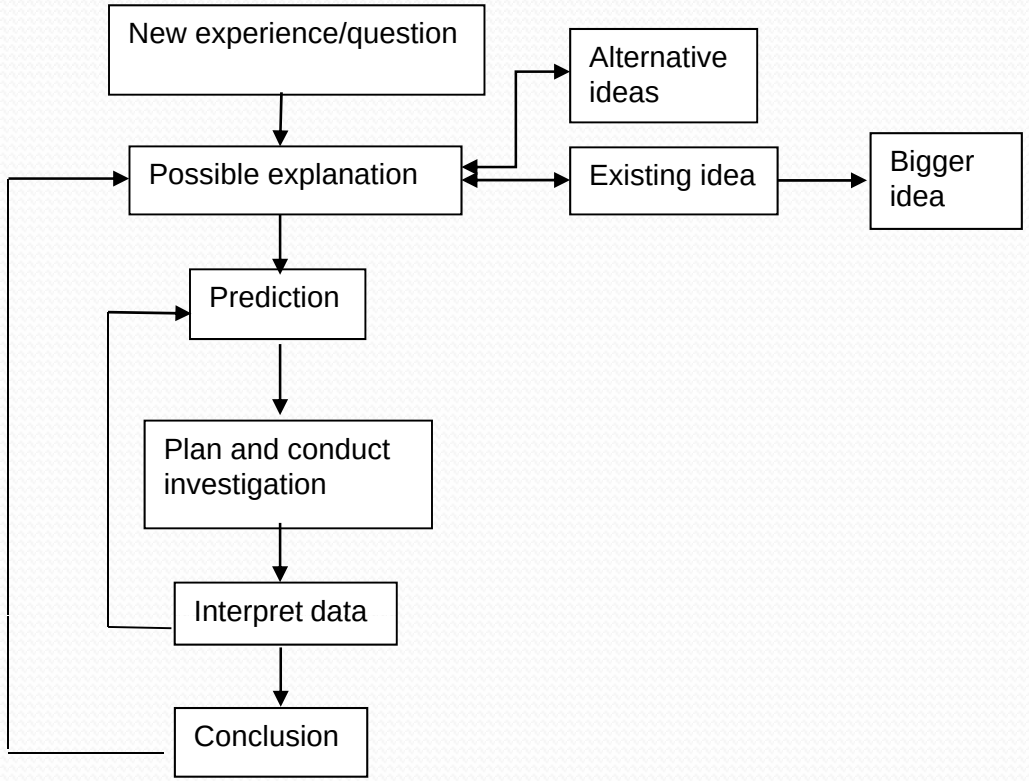
- Understanding of a set of big ideas in science which include ideas of science and ideas about science and its role in society
- Scientific capabilities concerned with gathering and using evidence
- Scientific attitudes.

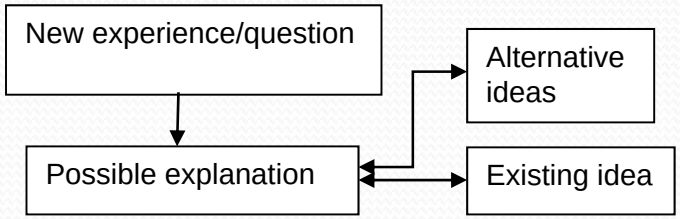
(Principles and big ideas of science education, p 8)

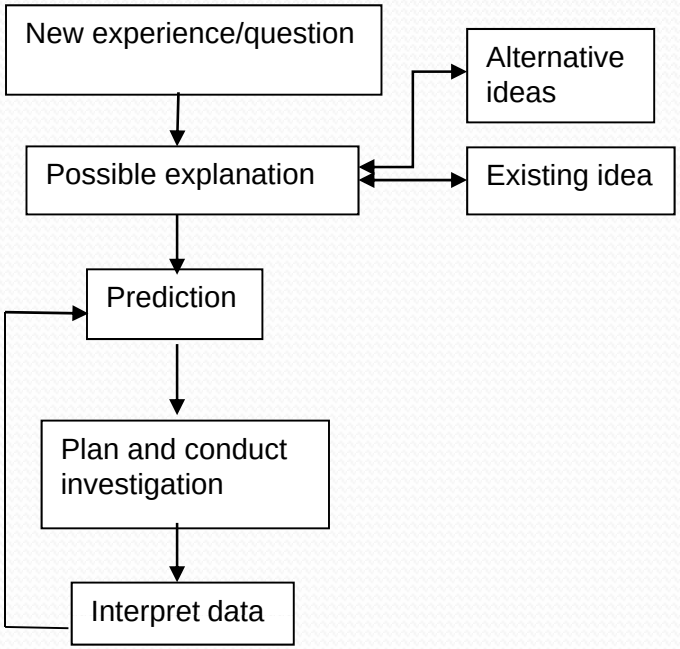
What do we know about effective practice in science education?

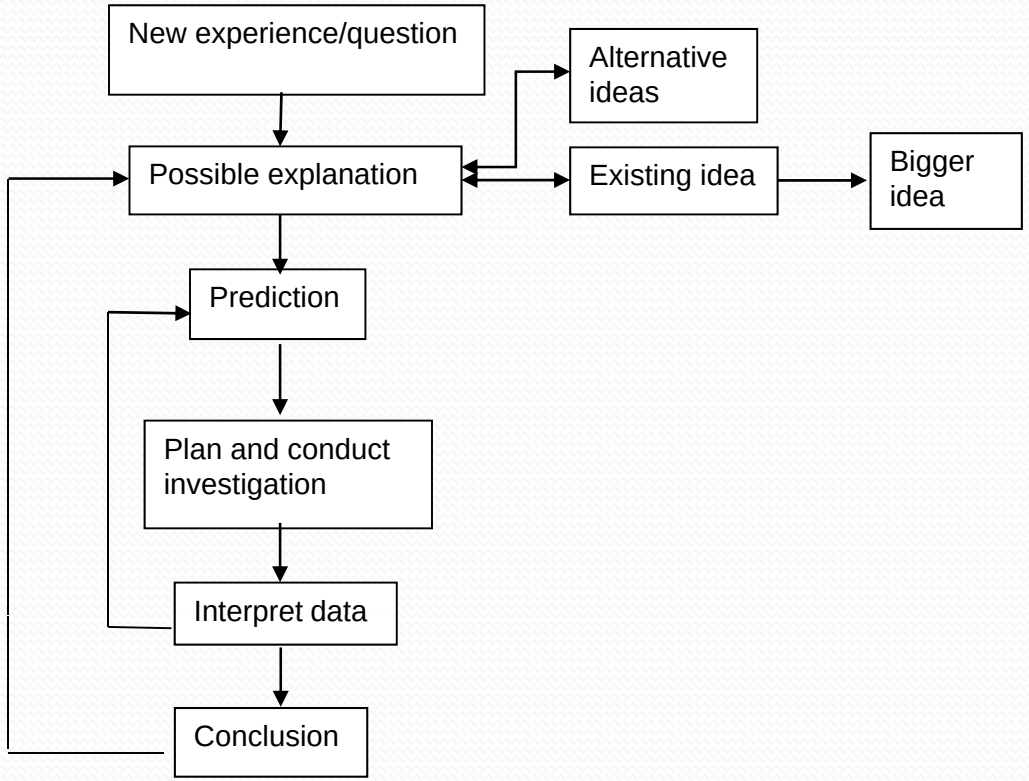
- Takes into account what students know already and what they believe about how things behave (constructivism)
- Exposes students to a range of ideas from various sources, including discussion among students
- Ensures that students face optimum challenge as their ideas and capabilities develop, through feedback from teachers, self-assessment by students (formative assessment)
- Learners have an active part; make sense of things for themselves; develop their understanding a capabilities
- **In addition,** in science education, students develop their understanding through gathering, interpreting and discussing evidence from the world around.

How does this development of understanding happen?




New experience/question
Possible explanation
Alternative ideas
Existing idea


New experience/question
Alternative ideas
Possible explanation
Existing idea
Prediction
Plan and conduct investigation
Interpret data



(Based on Harlen, 2006)

Defining inquiry-based science education

- IBSE means students progressively developing key scientific ideas through learning how to investigate and build their knowledge and understanding of the world around. They use skills employed by scientists such as raising questions, collecting data, reasoning and reviewing evidence in the light of what is already known, drawing conclusions and discussing results. This learning process is all supported by an inquiry-based pedagogy, where pedagogy is taken to mean not only the act of teaching but also its underpinning justifications.

  (IAP 2011)

Inquiry-based pedagogy

Teachers

- include plenty of hands-on (practical) work in the range of students' pedagogical practices used in science
- arrange group working, collaboration and discussion
- engage in dialogue with students and encourage use of scientific words
- promote the use of skills to collect and interpret relevant evidence
- use formative assessment strategies
- model scientific attitudes of respect for evidence, openmindedness, etc
- provide time for reflection.

Inquiry-based learning in action

Over a period of time, students will be

- Gathering evidence by observing real events or using other sources
- Pursuing questions which they have identified as their own even if introduced by the teacher
- Raising further questions which can lead to investigations
- Making predictions based on what they think or find out
- Suggesting ways of testing their own or others' ideas to see if there is evidence to support these ideas
- Using a variety of sources of information for facts that they need for their investigation
- Working collaboratively with others, communicating their own ideas and considering others' ideas
- Assessing the validity and usefulness of different ideas in relation to evidence
- Reflecting self-critically about the processes and outcomes of their investigations.

Myths about IBSE

- It is another name for practical work
- It is all about developing ideas *about* science and not *of* science
- It is about ‘discovery’
- It is appropriate only at the primary school level (up to age 11 or 12).

Obstacles to implementing IBSE

- Teachers' confidence in their grasp of the subject-matter
- External tests that require only factual knowledge
- Inadequate space and resources
- Shortage of time
- An over-crowded curriculum
- Large classes
- Lack of teaching assistants

(IAP 2009)

Does IBSE deliver?

- Need to have IBSE in operation before assessing outcomes
- No one research project has investigated the impact of having all aspects of IBSE in place (cf formative assessment research)
- Major review of research projects looking at outcomes of IBSE
  - found many deficiencies in the studies reviewed
  - but, a "positive trend favouring inquiry-based instructional practices, particularly instruction that emphasizes student active thinking and drawing conclusions from data."
  - and, that actively engaging students in learning through scientific investigations is more likely to increase conceptual understanding than strategies that rely on more passive techniques.

Minner et al 2010

Some references

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