

DIVERSITY AND RELEVANT CONTEXTS IN SCIENCE AND MATHEMATICS CLASSROOMS

PD Module 2 of the MasDiV project

Aims of the session

- Learn how to use IBL tasks in science and mathematics
- How to make connections between context and concepts and apply this in classroom teaching
- Identify and use real-life, relevant contexts for IBL in daily science and mathematics teaching
- Discover how real-life relevant contexts (e.g. genetic engineering, climate change, oil drilling) and scientific and moral reasoning can promote fundamental values and inclusive teaching

Methods: Ways of Working

- Reflecting on existing beliefs and practices regarding addressing diversity and regarding IBL
- Providing and discussing concrete subject-specific examples
- Developing and reflecting on important principles for addressing diversity in science and mathematics classrooms
- Experimenting with and reflecting on using IBL for diversity

Connections

- Module 1 IBL & diversity in achievement
- Module 2 IBL, diversity and real-life relevant contexts

ACTIVITY 1

**Context based teaching of mathematics
and science (60 + 30 minutes)**

Exploring experiences with using contexts (act 1b & 1c)

Use the Homework you did on module 1 activity 6 (& 4)

- Did you use real-life contexts?
- Which contexts can you think of that will fit your lessonplan?
- In small groups discuss your reason(s) for using the specific context(s) you did. What are the benefits for your students?

Advantages/benefits of the use of contexts:

- They motivate students to learn
- They make it easier to remember concepts by providing more coherence, and making mathematics and science more concrete, less abstract
- Students learn to apply concepts in real-life situations
- Students learn about societal impact and experience the relevance of science and mathematics
- Students learn about how decisions based on science (scientific reasoning) are taken and on the influence of ethical, moral, social and cultural aspects on these decisions

Context-based approaches are approaches adopted in mathematics and science teaching where contexts and applications of mathematics and science are used as the starting point for the development of scientific ideas. This contrasts with more traditional approaches that cover scientific ideas first, before looking at applications.

source:

<http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=FB895DF1650B6C5755C6DFC1A77E3F0B?doi=10.1.1.433.6505&rep=rep1&type=pdf>

Optional extension 1 of the activity.

- Read and discuss one (or all) of the texts on worksheet 4 from research on the use of contexts.
- In small groups formulate a statement (or question) on context-based education.
- Discuss these statements in the way suggested by the course leader.

Optional extension 2: contexts in textbooks

- *A context is a practice or situation in which a concept is used and which is meaningful to students or can become meaningful to them by their activities. A practice is for instance: transportation, food preparing, medical services. A situation is for instance: the rainbow, vaccination, crystallization.*

Roles of contexts

Contexts can be

1. 'nice' dresses of traditional textbook tasks to give the impression that science is fun
2. related to an authentic practice for showing relevancy and applicability in future work
3. related to a socio-scientific issue for showing the importance of scientific knowledge in daily life

Activity in small groups

- look for contexts in your textbooks and identify the situation or practice and the incorporated concept (referring to the definitions above).
- Also identify the role in terms of the three roles numbered in the previous sheet.
- Formulate (based on the above and your experience in context-based education) one recommendation about the use of contexts in textbooks.
- Share these in the whole group

ACTIVITY 2

Examples of contexts (60 minutes)

Real-life relevant context: can the earth feed us?

Read the text below and answer the questions on the next sheet

Meat or vegetables

- Most people in the world are vegetarians. The main crops are wheat, rice, corn and potatoes. Eating meat is one of the rich Western diets, and this is questionable from an environmental perspective. Cattle herds in the world use larger and larger land-areas, more water and energy. An increasing proportion of the world's cereal production is used to feed animals. But the animals have a low efficiency. When the grain is passing through animals, 96% of the calories are 'lost' and only 10% of the protein from the grain remains in the animal. Conclusion: the more animal products mankind eats, the less people can be satisfied.

Source: Medan Jorden Snurrar, 2000, p.77

Real-life relevant context: can the earth feed us

In pairs discuss the context presented on the previous sheet:

- What subject-specific content and concepts (and questions and activities) can be related to this context?
- What role can the context have and what are benefits of the use of this context?
- Which opportunities and challenges does this context present for:
 - IBL?
 - Promoting scientific literacy?
 - Being relevant for society?
 - Addressing fundamental values?
 - Inclusive education? (see module 1 for a list of characteristics).

Real-life relevant contexts

In small groups look at worksheet 2a

- Analyze and discuss the contexts with respect to the questions on the worksheet
- Make a poster on a flip-over chart (see worksheet 2c) for each context.
- Prepare for a short presentations of the poster.

ACTIVITY 3

**Contexts, socio-scientific issues and
fundamental values (60 minutes)**

Study one of the worksheets

Classroom - worksheet - Fishery

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addressing Diversity and promoting fundamental Values

Fishery



The ocean is one of Earth's most valuable natural resources. It provides food in the form of fish and shellfish—about 200 billion pounds of fish are caught each year¹.

For millions of years the oceans serve as an important food source for all life on earth. By human kind the oceans have been fished for thousands of years and are an integral part of human society. Fish have been important to the world economy for all of these years, starting with the Viking trade of cod and then continuing with fisheries like those found in Lofoten, Europe, Italy, Portugal, Spain and India. Fisheries are still enormously important to the economy and wellbeing of communities.

The word fisheries refers to all of the fishing activities in the ocean, whether they are to obtain fish for the commercial fishing industry, for recreation or to obtain ornamental (aquarium) fish or even fish oil. Fisheries are usually designated to certain ecological distribution regions like the salmon fishery in Alaska, the Eastern Pacific tuna fishery or the Lofoten island cod fishery. Due to the relative abundance of fish on the continental shelf, fisheries are usually marine and not freshwater.

¹ <http://marinebio.org/oceans/ocean-resources/>

Can the Earth feed us? – Do we have enough food?¹



1948 the American ecologist William Vogt wrote the book: *Can the earth feed us?* The author was concerned that the global population was so big that they were right next to the border to have an adequate food supply. He argued that we need to stem population growth, otherwise there would be a disaster. It is 72 years ago William Vogt wrote this. At that time the world's population was about 2 billion. We are now 6.48 billion.

The question of human's food supply is still under discussion. In the textbook, *Medan Jorden Snurrar*, for Natural Science A is a chapter called: *Enough food?* When the textbook was written, the number of people on earth has passed 6 billion. Below is quoted a paragraph from the chapter.

**** Meat or vegetables***

Most people in the world are vegetarians. The main crops are wheat, rice, corn and potatoes. Eating meat is one of the rich Western diets, and this is questionable from an environmental perspective. Cattle herds in the world use larger and larger land-areas, more water and energy. An increasing proportion of the world's cereal production is used to feed animals. But the animals have a low efficiency. When the grain is passing pets, is 96% of the calories lost and only

¹ source: parrise project, <https://www.parrise.eu/>



Socio-scientific issues connected to contexts

Worksheets (Choose one)

- Can the earth feed us (biology and mathematics)
- Fishery (physics and chemistry)

In groups discuss what issues are at stake in this example.

- Try to focus on global issues, for example:
- the (un)fair distribution of the earth's resources and possible solution

Socio-scientific Issues (SSI)

SSI are controversial social issues which relate to science. They are ill-structured, open-ended problems which have multiple solutions.

See: Wikipedia

Supporters of SSI argue that it can:

- Cultivate a scientifically literate citizens who are able to apply evidence-based scientific content knowledge to real-world socio-scientific scenarios;
- Foster a collective social conscience whereby students consistently reflect upon the formation and implications of their own reasoning;
- Encourage argumentation skills that are essential for thinking and reasoning processes and mirror the types of discourse utilized in real-world scientific deliberations;
- Promote critical thinking skills, such as analysis, inference, explanation, evaluation, interpretation, and self-regulation^[5]
- Science educators often refer to all of these aspects together as, "functional scientific literacy."^[6]

Discussion

- To what extent do the two classroom examples have characteristics of SSI?
- To what extent can each of them contribute to each of the four goals?
- Would you use these (kind of) activities in your own classrooms? Why? Why not?

Connect to OECDs notion of global competency

- Individually select three topics from the list that you would teach.
- Small groups: discuss reasons for each person choices
- Whole group: discuss and categorize these reasons

Climate change and global warming

Global health (e.g. epidemics)

Population growth

Migration (movement of people)

Impacts of developments in the global economy

Air pollution

International conflicts

Hunger or malnutrition in different parts of the world

Causes of poverty

The pace of technological change in the world

The impact of ageing populations

Equality between men and women in different parts of the world

The consequences of clearing forests for other land use

ACTIVITY 4

Designing and presenting a SSIBL lesson plan (60 minutes)

Part a characteristics of a lessons using SSIBL

Worksheet 4

Discuss in small subjects-specific groups the feasibility of using this handout as a guide for designing a lesson/activity.

Part b Examples and ways to address SSIBL

- discuss the half worked out examples of SSIBL-lessons (dilemma's) on worksheet 5 and the suggestion to use topics from the news on worksheet 6.
- In the whole group ask if these examples and the ones used in the previous activities inspired them to develop a first version of an SSIBL example to use in their own teaching

Part c Design a first version of a SSIBL-lesson or activity

In subject-specific small groups start the design of a SSIBL-lesson or activity :

- identify the class, the topic and the elements you want to include (context, ssi, values...);
- formulate clear/SMART learning goals and make sure the activity and teaching methods fit the goals;
- use the handout on worksheet 4 as a guide for the design

Homework

- finalize the design of the SSIBL lesson (or activity) in the form of a lesson plan and teaching materials and try it out in their class before the next meeting and report on it the next time.

- Use the sample evaluation form to report on your experiences (see worksheet 7).

ACTIVITY 5

Context-based education and overcoming drawbacks (30 minutes)

Drawbacks of contextual teaching

- Which drawbacks/difficulties of teaching with contexts did you encounter?

Advantages and Drawbacks

| Advantages/benefits of contexts | Disadvantages/drawbacks of contexts |
|---|---|
| 1. Motivating to learn | 1. More language, concepts from the context |
| 2. Easier to remember, bring more coherence | 2. More time needed |
| 3. Student learns to apply concepts | 3. Concepts remain linked to the one context |
| 4. Students learn about societal impact and how decisions based on science are taken and can be influenced by moral ethical and cultural considerations | 4. Unclear what is learned |
| 5. Contexts indicate selection of concepts | 5. Realistic contexts sometimes too complex, not all scientific concepts fit to a context |

Drawbacks of contextual teaching

Discuss in small groups:

- How to overcome (or prevent) each of the listed drawbacks?

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