

SOCIO-SCIENTIFIC ISSUES AND ASSESSMENT

How can assessment help in the development of competences required when dealing with SSIs?

Structure of the module

- What are the challenges associated with assessing skills and competences required in SSI lessons?
- What knowledge and competences do teachers need when assigning an inquiry dealing with environmental socio-scientific issues?
- How can formative assessment support students in the development of skills and competences required for dealing with SSIs?

1. What are the challenges associated with assessment of skills and competences required in SSI lessons?

Activity 1.1: Introduction



- SSIs are controversial topics with a scientific base which require people to engage in dialogue, discussion, and debate.
- For example building windfarms is an example of an environmental SSI.
- They are included in lessons to help students acquire reasoning skills and learn how to make decisions that include moral, ethical and social considerations.
- Through this module we will consider how we can use assessment during SSI lessons.

Activity 1.2: What outcomes are we after when we teach through SSI?



- Think-pair-share:



- What **learning outcomes** do we aim to achieve when teaching science and mathematics through SSIs?



- What possible **challenges** are involved (for the teacher and for students) when students learn science and mathematics through SSIs?



- What possible challenges related to **assessment** are there in relation to mathematics and science SSI-based lessons?



Activity 1.3: What challenges are involved in assessing these outcomes? Key findings from literature.

 In order to answer this question we need to consider why SSIs are included in mathematics/science and the outcomes that we wish to achieve.



- SSI contribute to scientific literacy
- Scientific literacy to include students:
 - familiarizing themselves with mathematics and science in action
 - developing their ability for evaluating the information made available to them on a daily basis
 - making decisions concerning controversial SSIs
 - taking part in debates and discussions on socioscientific controversies

Sadler and Zeidler(2009) based on Pouliot (2008)

Knowledge and skills involved when dealing with SSIs

- Knowledge about science
 - Collecting and assessing the quality of data
 - Interpreting data (correlation and causation, considering alternative explanations, integrating empirical data and non-empirical ideas)
 - Using scientific models
 - Appreciating uncertainty in science.
- (Sadler and Zeidler (2009) based on analysis of literature carried out by Ryder, 2001)
- Balancing the social complexities of SSI including economic, ethical and political effects of various courses of action (Sadler, Barab, & Scott, 2007);
 - Employing scientific habits of mind such as skepticism (Kolstø , 2001);
 - Engaging in argumentation in which ideas, data, and principles are examined, tested, and refuted (Driver, Newton, & Osborne, 2000);

Outcomes we are after when we teach through SSI

- Outcomes related to students' arguments (structural complexity) (Foong and Daniel, 2010)
 - Toulmin's (1958) six structural components of an argument (claim, data, warrant/s, backing/s, qualifier and rebuttal).
- Content knowledge in students' arguments (Foong and Daniel, 2010).
 - Is the knowledge applied relevant?
 - Is the knowledge specific to the case?
 - Is the knowledge valid to the argument?
- Outcomes related to skills involved when learning through SSIs (identified earlier).

Challenges involved in the assessment of SSI

- The kinds of practices encouraged through SSI involve complex reasoning, reflection, civic engagement and empowerment, none of which are easily captured in assessments of any kind. (Sadler and Zeidler, 2009)
- It is difficult to develop valid and reliable test items dealing with complex and controversial SSIs. (Sadler and Zeidler, 2009)
- SSI appear in some curricula but difficulty with developing valid and reliable test items often mean that dealing with SSIs is never part of high-stakes examinations. This includes international studies such as PISA. (Sadler and Zeidler, 2009)
- In countries where tests and examinations matter a lot, since SSIs do not appear in exams, they disappear from classrooms.

Implications

- SSIs help develop scientific literacy and prepare students for making decisions in every day life.
- Development of the skills involved requires time and also explicit teaching of certain skills.
- Teaching students the skills to argue must include the ability to differentiate between persuasive and weak arguments.
- So assessment that helps students and supports the development of these skills are more important than assessment that simply determines whether a skill is there or not.
- Hence the need for formative assessment practices that focus on improvement of student learning.

2. What knowledge and competences do teachers need when assigning an inquiry dealing with environmental socio-scientific issues?

Activity 2.1: Introducing a dilemma



- When was the last time that you watched a pyrotechnic display?
- Fireworks are often part of our celebrations, be it the New Year celebrations or a national event.
- They are used to light up and colour the evening sky in some theme parks.
- They are also used by the military for training purposes.
- But have you ever thought about the possible environmental impact of the use of fireworks in celebrations and festivities?



Case study

- In Malta, fireworks make up one of the characteristics of the warm summer nights and days!
- All towns and villages have their *Festa*, usually during one of the weekends between June and September.
- Fireworks enthusiasts work throughout the year to create these fireworks during their free time in specially constructed sites.
- Many consider it to be a tradition and part of the Maltese culture. The artistic displays attract many local people and tourists.
- However in recent years some concerns have emerged about the possible negative impact of pyrotechnics.
- Read the articles provided for some information about the matter.

Activity 2.2: Initial opinion forming



- On an individual basis, think about the dilemma presented in these articles, write down notes and form an opinion.
- Should the use of fireworks be controlled or even banned?



Activity 2.3: Take a position on a controversy line



- Imagine a line representing the level of agreement with the statement: **Fireworks should be banned.**
- Position yourself along the line depending on the extent of agreement.
- Explain and discuss your position with your neighbours on the line and ask questions.
- Some general discussion led by the educator.

Activity 2.4: Asking questions related to the controversy

-  • *On an individual basis think of questions that you would like to ask to help you understand better the dilemma.*
-  • *Share your questions in a small group. Which of these questions would you like to work on and investigate?*

Activity 2.5: Planning an inquiry related to the SSI



- Plan an inquiry related to the controversy to answer your chosen question/s and to obtain information that is not available regarding the issue.
- During the coming two weeks you will work on the inquiry and produce a short video in which you present your findings and your position as a group with respect to the dilemma.

Activity 2.6: Presenting results of the inquiry



- *Presentation of short videos of the inquiry.*



- *Discuss the inquiry, methods used, findings and their position with respect to the dilemma.*



Activity 2.7: Arriving at a decision



- In your group discuss and arrive at a decision with respect to the dilemma after considering different arguments, different interests, values, scientific ideas and scientific uncertainties.
- What action may be taken based on this decision (e.g. writing a letter to a fictitious newspaper or an authority and so on)? Plan the action.

3. How can formative assessment support students in the development of skills and competences required for dealing with SSIs?

Activity 3.1: Introducing the rubric



- The rubric (handout) may be used to evaluate competences demonstrated in the videos related to the SSI dilemma.
- What are the competences being assessed through the rubric?

Term	Description
Claims	*Assertions about what exists or values that people hold.
Data	*Statements that are used as evidence to support the claim.
Warrants	*Statements that explain the relationship of the data to the claim.
Qualifiers	*Special conditions under which the claim holds true.
Rebuttals	*Statements that contradict either the data, warrant or qualifier of an argument.

* From Simon, Erduran & Osborne, 2006

Term	Description
Counterclaim	An alternative to the claim or consideration of other standpoints.
Socio-scientific reasoning & awareness	Arguments and reasoning show awareness of multifaceted nature of the issue, considering multiple perspectives; employing scepticism.
Content	Knowledge such as scientific knowledge used in the argument.
Values and moral reasoning	Critical analysis of specific events/issues to determine what is right or wrong or what people ought to do in that situation. May involve thinking about needs, fairness, rights etc.

Example of an argument (from Schen, 2013)

“The new species evolved from species B [*claim*]. Both are red, close to the same size, and males create nests. The only difference is the beak size [*evidence*]. Since the new species evolved from B, the beak could gradually change, with behaviour of the male making the nest remaining [*reasoning*]. Evolution changes physical traits, opposed to behaviour [*rebuttal*], thus ruling out species D [*counterclaim*] as the new species ancestors.”

Activity 3.2: Reflection and Evaluation using self- and peer-assessment



- Use the rubric (handout) to evaluate competences demonstrated in the videos related to the SSI dilemma. You will evaluate your group's video and those of other groups.



- What are the benefits of self- and peer-assessment on further development of skills and competences related to dealing with SSI?

Activity 3.3: How can a rubric be used for formative assessment as part of SSI lessons?

- How may a rubric be used for formative assessment as part of mathematics and science SSI-based lessons to provide feedback to students?
- Work as a group to prepare a modified rubric with wording appropriate for use with mathematics/science students of a particular age.