

# SOCIO-SCIENTIFIC ISSUES AND ASSESSMENT

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**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?

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## 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?

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## 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?

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## 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.