

### 3.5 Science-Technology-Society (STS): Challenges and Chances

Peter Labudde – University of Applied Sciences,  
Northwestern Switzerland

In various countries, Science-Technology-Society (STS) is taught as a school subject. It is a so-called integrative, or interdisciplinary approach to teach biology, chemistry, earth sciences, and physics, not as separate subjects, but in ONE subject – including society and technology. What are the challenges and chances of such a subject? What are the characteristics of interdisciplinary teaching? How is STS related to inquiry-based science education? In the workshop we will discuss these and other questions on the basis of specific examples, i.e. of units like 'Petrol – and in the future?' or 'Blood pressure: relating the perspectives of medicine and physics'. Most of the examples and the underlying theory are part of the Swiss curricula. Switzerland, the home country of the presenter, has a long tradition of STS-teaching at all school levels, in particular in lower secondary school (grades 7-9). The following topics will be discussed in the workshop – always on the basis of providing concrete examples.

#### Arguments for a STS-approach

There are seven arguments and objectives of STS-Teaching and interdisciplinarity, respectively (Aikenhead, 1994; 2005; Bennett, Lubben & Hogarth, 2007; Labudde, 2008):

1. To integrate students' preconceptions and questions, i.e. to implement a constructivist oriented teaching style.
2. To motivate students and to increase their interest in science.
3. To prepare students for tackling complex problems, even – in the long term – key problems of mankind, like the ozone-problem, the change of gender roles, or the gap between poor and rich countries.
4. To prepare students for their professional live that has, in many cases, interdisciplinary characteristics.

5. To teach and cultivate interdisciplinary skills, like sophisticated and differentiated thinking, or tolerance of ambiguity.
6. To be able to gather and judge information in the age of ICT (information and communication technologies).
7. To teach science for both boys and girls, i.e. to reduce gender problems in particular in physics and chemistry.

#### Different categories of interdisciplinarity

Interdisciplinary has become a vogue word and a dazzling term. It is not a well-defined concept. The variety of words, like inter-, trans-, pluri-, multi-, and intradisciplinary leads to confusion. We try to systemize different forms of interdisciplinarity, used here as a generic term.

One can distinguish various categories of interdisciplinarity: on the one hand at the level of content and on the other hand, at the level of school subjects. The last includes two types of interdisciplinarity:

- I) an integrative school subject like STS;
- II) an additional subject like Problem Based Learning, or 'Interdisciplinary Themes, in addition to the separate subjects biology, chemistry, and physics.

Categories on the level of content include three types of interdisciplinary instruction (see Figure 1):

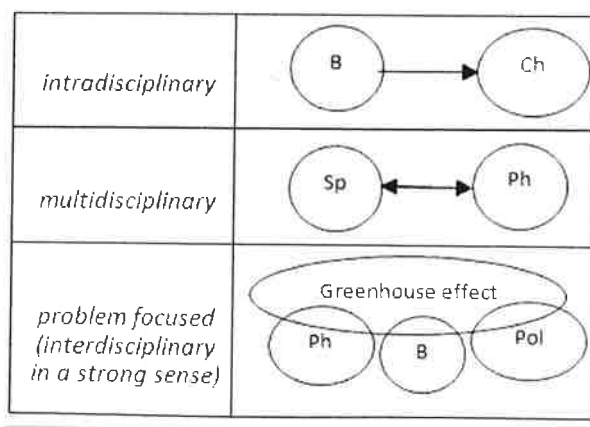


Figure 1. Three types of interdisciplinary instruction

- **Intradisciplinary:** Relating one subject, A to another subject, B (a one-directional link), i.e. when teaching drugs in biology, linking the topic with chemistry.
- **Multidisciplinary:** Linking two subjects, A and B (a bi-directional link), i.e. sports and physics within a teaching unit 'altius, citius, fortius: no limits?'
- **Interdisciplinary in a strong sense:** dealing with a problem like the greenhouse effect by including, among other subjects, physics, biology, and political science.

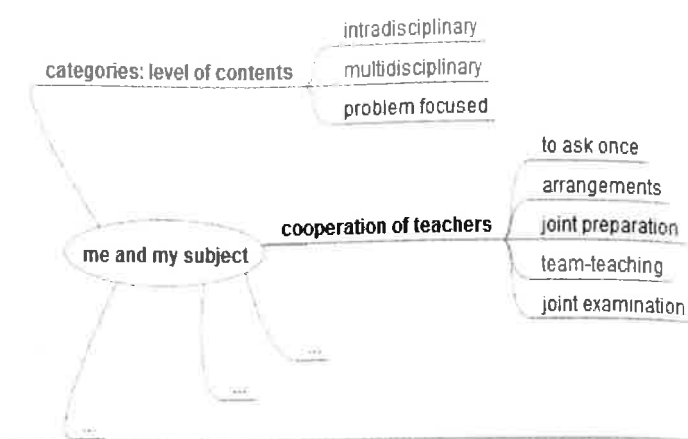


Figure 2. Two branches out of 16 of the mind-map on 'interdisciplinary teaching'

not ONE way to teach STS. Teachers find the mind-map extremely useful when preparing and analysing interdisciplinary (science) teaching units.

### **Inquiry-based science education and STS**

Some of the main objectives of inquiry-based science education (IBSE), as promoted by PROFILES, are that the students should be able (PROFILES, 2010, p. 11):

- To ask high-level questions (especially to initiate inquiry) and hypothesize solutions for tackling unsolved experimental problems.
- To solve scientific problems (experimentally using the range of process skills and/or using suitable secondary sources).
- To interact professionally, including collaboratively sharing knowledge with their peers, community members, or experts.

These features are part of the broader 5E model of Bybee et al. (2009), which includes: engagement, exploration, explanation, elaboration, and evaluation – so-called 21<sup>st</sup> century skills. The key idea of the 5E model is 'science education through inquiry'. Typical teaching units, based on the 5E model and on the IBSE-approach in PROFILES respectively are (PARSEL 2012):

- Champagne - how much can you afford?
- Lara is pregnant.
- Can I trust my Eyes? How do scientists observe.
- Chitosan - Fat Magnet?!

### **A mind-map 'interdisciplinary teaching'**

Does interdisciplinarity always mean team-teaching? Is project learning the main, or even the only teaching method in STS? Is the assessment in STS mainly formative and less summative than in traditional school subjects?

The answers to all are 'no'. Of course, it is possible, that interdisciplinary approaches include team-teaching, project learning and formative assessment – but it is not a necessity.

In order to illustrate the different kinds of interdisciplinary approaches, teachers and science educators can develop a mind map (Labudde, 2008; Labudde et al., 2004). In the centre of the map are 'Me and my subject.' From the centre, several branches are drawn, each of them belonging to one of seven dimensions:

1. categories (see above);
2. content;
3. skills;
4. role of the teacher;
5. teaching methods;
6. assessment;
7. open dimension.

Figure 2 illustrates two of the branches, 'categories: level of contents' (see above) and 'cooperation of the teachers. Thus the mind-map can illustrate and classify different kinds of interdisciplinary teaching. It can show that there is

Many of these and other IBSE examples show typical features of interdisciplinarity: the problem, or question can only be answered on the basis of two or more disciplines, e.g. biology, chemistry, political sciences, ethics. In order to reflect on the problem one has to gather and to combine information from different disciplines. It is necessary to put together factual and procedural knowledge from more than one discipline.

Within PROFILES, Inquiry-based Science Education (IBSE) and the STS-approach, as a paradigmatic example of an interdisciplinary science education, are strongly related. One determines and requires the other, and vice-versa.

## References

- Aikenhead, G. (1994). What is STS Science Teaching? In: J. Solomon and G. Aikenhead (eds.). *STS Education: International Perspectives on Reform*. Toronto, New York: John Wiley & Sons, p. 1-10.
- Aikenhead, G. S. (2005). Science-Based Occupations and the Science Curriculum: Concepts of Evidence. *International Journal of Science Education*, 89, 242-275.
- Bennett, J., Lubben, F. & Hogarth, S. (2007). Bringing Science to Life: A Synthesis of the Research Evidence on the Effects of Context-Based and STS Approaches to Science Teaching. *Science Education*, 91, 347-370.
- Bybee, R. (2009). The BSCS 5E instructional model and 21<sup>st</sup> century skills. Retrieved from: [http://www7.nationalacademies.org/bose/Bybee\\_21st%20Century\\_Paper.pdf](http://www7.nationalacademies.org/bose/Bybee_21st%20Century_Paper.pdf) (24.05.2012)
- Labudde, P. (2008). Naturwissenschaften vernetzen – Horizonte erweitern (*Linking sciences – broadening the horizon*). Seelze: Klett / Kallmeyer.
- Labudde, P.; Heitzmann, A.; Heiniger, P. & Widmer, I. (2005): Dimensionen und Facetten des fächerübergreifenden naturwissenschaftlichen Unterrichts: ein Modell (Dimensions and facets of interdisciplinary science education: a model). *Zeitschrift für Didaktik der Naturwissenschaften*, 11, 103-115.
- PARSEL (2008): Popularity and Relevance of Science Education for Scientific Literacy. Retrieved from: <http://www.parsel.eu/cms/index.php?id=53> (24.05.2012)
- PROFILES. (2010). Description of Work – annex 1 to the EC grant agreement. Brussels: European Commission, p. 11.