Translated handouts

This document provides an overview of all handouts used during the UU Teacher Professional Development programme for Socio-scientific Inquiry-based learning.

Contents:

- Carousel assignment: studying several SSI examples
- Mepham's Ethical Matrix
- Table for facilitating SSIBL-lesson design
- 'Arguments in motion' – classroom lay out and short summary
- Characteristics of a lesson using SSIBL – Socio-scientific inquiry-based learning
- Examples of SSIBL subjects
- Teacher tool for having a whole-class dialogue

Authors (unless noted otherwise)

Marie-Christine Knippels	Freudenthal Institute, Utrecht University
Michiel van Harskamp	Freudenthal Institute, Utrecht University
Roald Verhoeff	Freudenthal Institute, Utrecht University

Developed by the Freudenthal Institute, Utrecht University, The Netherlands
(see https://www.uu.nl/en/research/freudenthal-institute)

Carousel assignment: Studying several SSI examples

Questions	Case A	Case B	Case C
What is the case about, what is the controversy?			
Which stakeholders are involved, what are their interests, which societal values are associated with the case?			
What science content knowledge is relevant?			
Which questions does the issue raise that your students could investigate?			

Mepham's Ethical Matrix (the columns 'do no harm' and 'Positive effects' can be merged to one: 'wellbeing')

Respect for:	Fairness	Autonomy	Do no harm	Positive effects
Stakeholders involved:				

Characteristics	Content of the learning activities/ lesson(s)	Educational approach	Materials
1)* & 2) Subject (Socio-scientific Controversy) What makes it a controversial issue? (relevant and conflicting interests/ values/ knowledge)			
3) Doing inquiry What is the central question? Which (different types of) sources do we use to answer the question?			
4) Dialogue/communication Which activities do I use to support student's dialogue and opinion-forming?			
5) Taking action Which action perspective for students can I identify?			
6) Reflection What do I reflect upon at the end?			

*These numbers refer to the 6 educational phases of Knippels, M.C. & de Bakker, E. (2016) Eerste hulp bij het starten van een dialoog tijdens de bèta-les, *Didactief*, 46(10), 12-13. [*First aid in initiating a dialogue in science classes*]

'Arguments in motion' – classroom lay out and short summary

'Arguments in motion' (Dutch= beweegredeneren) is a teaching strategy developed by Paul van der Zande (for more information, please see also http://www.ecent.nl/artikel/2599/Beweegredeneren/view.do in Dutch).

During 'Arguments in motion', participants (teachers, students, etc) think about a statement, their own opinions, and whether these opinions were formed based on their feelings (heart) or thoughts (brain).

First, a statement is introduced (for example: 'Everyone should automatically be registered as organ donor at birth'). Participants place themselves on a line in the room, showing whether they are ´for´ or 'against' this statement.

Subsequently, the teacher (educator) introduces the 'heart-brain-axis' by placing the heart and brain pictures with captions 'for' and 'against' in the four corners of the classroom.

Participants now have to position themselves according to how they reached their opinions, using mostly feelings/emotions (the 'heart') or rational thinking (the 'brain').

A possible lay out of the classroom during 'arguments in motion'.
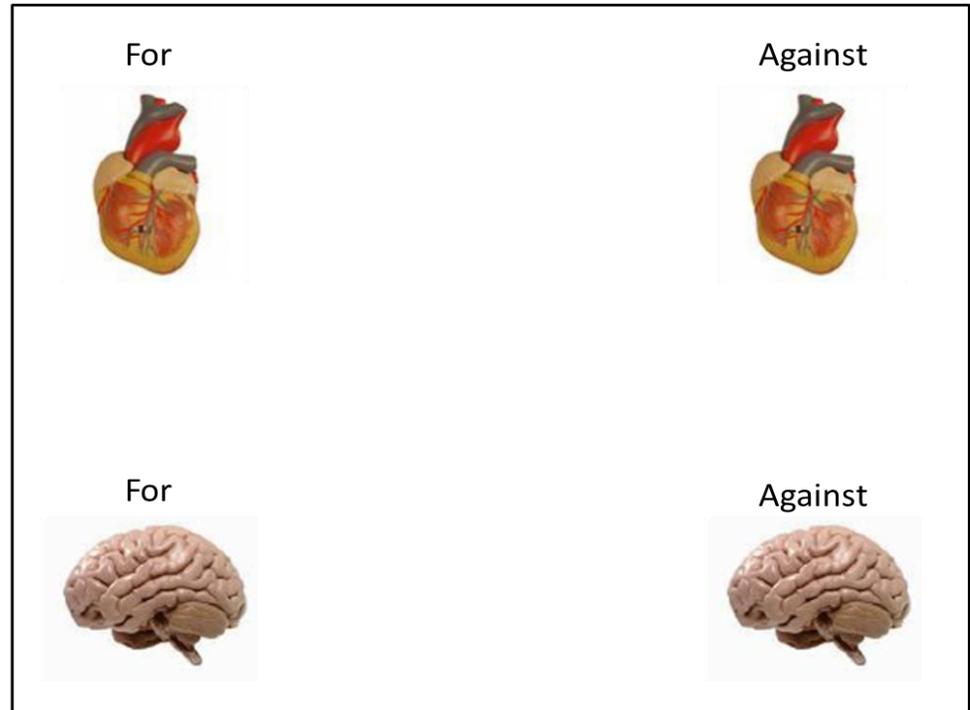
The teacher (educator) is the mediator during the whole activity. They ask the participants questions, illustrating as many different sides and opinions as possible. If participants change their opinions regarding the statement, they are able to move to a new location in the classroom.

Remind them that there are no 'winners', and answers are not 'right' or 'wrong'.

Utrecht University

PAR!SE | Promoting Attainment of Responsible Research & Innovation in Science Education

Characteristics	
Controversial subject	Developments in scientific research often influence our society. These innovations can lead to both personal and societal dilemmas, called **Socio-Scientific Issues** (SSIs). A SSIBL lesson uses an SSI as a starting-point. The SSI is a dilemma; people have different opinions about the issue and there is no clear answer to it. Think for example about the use of biotechnology. The extent to which biotechnology can be integrated in our society is a societal issue raised by scientific research and innovations in life sciences. In order to set up a good SSIBL lesson, you clearly need knowledge not only about your own discipline, but also about, for example, social sciences and ethics. More examples from SSIBL subjects are included in this document.
Perform research using different types of resource	Let pupils set up and investigate their own research questions about the subject. Here the **Inquiry Based Learning (IBL)** part of SSIBL is covered. The pupils perform their SSIBL research using not only the scientific method; other methods from social sciences should be incorporated. Think about holding interviews with important stakeholders or giving out questionnaires to investigate opinions. Society often attaches great importance to the results of scientific research, when forming their own opinions about SSIs. Therefore discuss the influence of scientific results on society with your pupils. Tell them that researchers have responsibility to perform objective and reliable research, as the results can be the basis for the opinions of many individuals.
Dialogue / communication	Plan a phase in your lesson for pupils to discuss their results. A classical dialogue is a suitable method but also think about communication via different kinds of (new) media. Support pupils in choosing their communication method.
Action	SSIBL research ideally leads to concrete action. Support the pupils in taking action based on their SSIBL research. Let them make their own choices about the most appropriate action to take, and let them organize and do it. Afterwards, make sure the pupils reflect on the changes that occurred because of their action. If there is no immediate action possible, be explicit about why this is the case. Discuss potential future action potential with the pupils.

Examples of SSIBL subjects

Subject	Socio-Scientific Issue - dilemma	Knowledge	Dialogue/communication	Action
Sun tanning parlours	Should sun tanning parlours be banned for younger people under the age of 18?	**Scientific:** Radiation Structure of the skin **Other:** Risk and uncertainty Human Rights Freedom of choice Decision-making	Dialogue on research outcomes: e.g. how important is freedom of choice in this issue, to what extent can governments force this restriction on society?	Set up an educational campaign at school and/or on social media.
Antibiotic resistance	Is a uniform policy for the prescription of antibiotics needed, to prevent global resistance?	**Scientific:** Bacteria Antibiotics Infectious diseases **Other:** Policies in different countries Risk and uncertainty Legalisation Decision-making	Dialogue on research outcomes; e.g. reasons for the differences in antibiotic policy between countries, how different policies influence resistance of bacteria.	Write a message to the Ministry of Public Health in your own or another country.
Recycling paper	Should we stop recycling paper, because the recycle process costs money and effort and also burdens the environment?	**Scientific:** Chemical structure of paper Manufacture of paper Environmental burden **Other:** Cost-benefit analysis Decision-making	Dialogue on research outcomes; e.g. how much attention should be paid to costs and environmental burden in this issue, what comes out of the comparison between costs and environmental issues?	Make your own decision regarding paper recycling: do you decide to stop or continue?

Teacher tool for supporting whole-class dialogue

By: Miranda Overbeek, Marie-Christine Knippels and Arend Jan Waarlo (Freudenthal Institute, 2014)

Science and technology are constantly developing; how do you prepare pupils for decision-making about *socio-scientific issues* (SSIs), i.e. complex problems as a result of scientific/technological developments that influence society? One way to do this is through whole-class dialogue. But how do you do that? This tool gives some hints on values, since SSIs consist of knowledge and values components. This tool targets the values component and considers:

- Why dialogue?
- Roles of the teacher
- Techniques for asking questions
- Frames (of reference)

Why dialogue[1]?

The goal of dialogue is to think about a problem together and to understand each other. So dialogue is cooperative in character[1]. In dialogue, pupils aren't made to defend a position, so that there is opportunity to learn something from the perspectives of the other pupils[2].

In a discussion or a debate, the goal is to resolve a difference of opinion, so that there will eventually be a winner, and to establish whether, for example, more points of view are possible. So a discussion or a debate is competitive in character[1]. In a discussion or a debate people tend to dig in on their own position and no longer listen to others with an open mind, so they will not learn about other perspectives as quickly[2].

Therefore, we opted for dialogue as a method: dialogue is more suitable to clarify the pupils' values that are often implicitly present.

In dialogue, the following are important:

- Equality: all pupils have the same rights to say or ask something.
- Mutual trust, respect, openness and understanding.
- Basing opinions on arguments and discovering the validity of the argumentation together.
- Listening to each other and trying to understand what the other is saying.
- Reflecting on what is said.
- Thinking with each other about the topic.

The roles of the teacher[4]

Depending on your goal i.e. development of values through transmission (transferring certain values), through clarification (letting pupils discover their own values) or through communication (teaching pupils to communicate values)[3] – there are different roles you can fulfil as a teacher in dialogue. The chart below gives an overview of these different roles and the degree to which they are suitable for developing values through transmission, clarification or communication. ++ is very suitable, + is suitable and – is unsuitable.

Role teacher	Role description	Development of values through:		
		Transmission	**Clarification**	**Communication**
Participant	You are free to express ideas, opinions and emotions, like the pupils. This can be confusing for pupils, since teachers are the professionals.	+	+	+
Dedicated teacher	You disseminate your own opinions about the topic. This can lead to indoctrination.	++	-	-
Observer	You do not interfere in the dialogue.	-	+	++
Instructor	You clarify relevant information, concepts and ideas. You ask questions to assess the level of understanding. And you give positive or negative feedback on input from pupils.	-	+	+
Devil's advocate	You propose contradictory points of view to stimulate the dialogue.	-	+	++
Advocate	You present all possible points of view and conclude with your own opinion, supported by arguments.	+	-	+
Neutral chair/ Neutral facilitator	You encourage pupils to contribute to dialogue and keep an eye on the rules of dialogue, but do not give your own opinion or positive/negative feedback on the input of pupils.	-	++	++
Declared stakeholder	At the start of dialogue, you give your own point of view so that pupils will be able to assess teacher bias later on.	-	+	+

Which roles do you usually take on? And would you do so after reading the descriptions of these different roles?

The premise of this tool is development of values through clarification and communication. The role of the teacher as neutral chair/ neutral facilitator in whole-class dialogue is useful for that. Development of values through clarification and communication requires the following from a teacher:

- Ensure an open, inviting and safe atmosphere.
- Be neutral.
- Adapt questioning techniques (described below).
- Establish the results of reasoning processes by pupils.

Questioning techniques[5]

In whole-class dialogue, it is important that:

- It is clear to everybody what a pupil is trying to say (**clarity**).
- The foundation for pupils' opinions emerges, this can be both rational and emotional/intuitive (**arguments**).
  - And examine their validity.
- There remains a focus on the original question (**structure**).

Clarity: Which questions can you ask when …

… it is unclear what a pupil is trying to say?

- "Can you explain this?"
- "Can you give an example?"
- "What do you mean by …?"

… you are not sure that you or the rest of the class understand correctly what a pupil is trying to say?

- "Do you mean … when you say that …?"
- "Do I understand correctly when you say that …?"

… it is unclear that something a pupil says has to do with the topic of the dialogue?

- "What does this have to do with …?"
- "How does this correspond to …?"
- "Does this help us with … in the dialogue?"

Arguments: Which questions can you ask when …

… a pupil doesn't support his/her point of view?

- "Why do you think that?"
- "What did you base that on?"
- "Can you prove this?"

… a pupil gives an incorrect argument?

- Ask the whole class: "Does anyone have a different idea about that?" And subsequently ask them to justify their opinions (as described above).
- Ask the whole class: "If what X says is true, what could be the result of that?"
- "What did you base that on?"
- "Could the opposite be true?"
- "How does this match with what you just said?"
- Introduce your own opinion as a hypothesis: "Suppose that … what might we be able to say about that?"

… a pupil uses a discussion breaker [6]?

- When a pupil uses a discussion breaker like "It's everybody's own decision whether or not to use the technology" or "You cannot stop/influence technological progress", explain that society and technology/science are intertwined and influence each other: society influences science and science influences society. Two examples:
    o Society influences science: society is in fact able to influence, for example, the use of technological innovations. When for example the company Myriad Genetics filed a patent on all medical treatments that are developed based on mutations in BRCA-1 that they discover, breast cancer patient associations cooperated internationally to stop this.
    o Science influences society: one thing science can do is to change society's values. For example, the invention of the contraceptive pill caused homosexuality to be more acceptable, because heterosexuals could now also have sex without procreation as its goal.

… a pupil gives an emotional argument?

- Encourage pupils to look at the values behind their emotions[7]. Ask further questions / reflect on the emotion!
    o *Example of asking further questions:* A pupil says "I'm afraid of it." Ask another question: "What is it you're afraid of?" [8].
    o When reflecting on emotions it is important to include both your own emotions and those of others. *Example of reflecting on emotions:* A pupils says: "I'm afraid of the technology." To find out whether the pupil is really afraid of the technology as such (i.e. consequences for society), you can invite the pupil to take a broader perspective regarding emotions, for example: put yourself in the place of people who benefit from or are damaged by the technology. Is the technology socially acceptable or not in that case[9]?
    o Sometimes emotions are based on wrong factual information. In that case it is important to correct these at a factual level[8]. Emotions can also make us blind to quantitative considerations: for instance, plane crashes are rare, but people with fear of flying focus on them. Also, try to ease these emotions with factual information. You should do so subtly, by acknowledging/going along with, for example: "Yes, that is terrible, but luckily it doesn't happen often." The chance that something that someone is afraid of may actually happen is small does not necessarily mean that the emotion 'fear' is irrational. Consider, for example, nuclear energy: the chance of a nuclear disaster may be small, but the consequences are disastrous. Besides, there are alternatives for nuclear energy[9].

… a pupil gives a general argument[10]?

- Ask the pupil to be more specific. For example: a pupil says "We must respect autonomy." Ask for example: "What does that mean here in this situation?"

… pupils do not (want to) understand each other's opinions/argumentation

- Invite them to take the other's perspective; let them put themselves in the other's place through emotion[3].
- Pupils can use different patterns of arguments / ways of thinking. If this is the cause of them opposing each other, make it clear to them that they are both using different patterns of argument / ways of thinking. There are three patterns of argument/ ways of thinking[4]:
  - *Pragmatic argumentation:* Action X may (not) be performed, because X leads to the (un)desirable consequence Y.
  - *Deontological argumentation:* Action X may (not) be performed, because X is (not) in agreement with moral principle Y.
  - *Argumentation based on justice:* Action X may (not) be performed, because action X itself or the consequences of X are (un)just.

Structure: What questions can you ask when …

… you want to wind up the dialogue?

- "Do we have a better understanding of the situation?" / "Do you have a clearer view of the situation?"
- "Have some of you changed your mind from before?"

… you want to reflect on the dialogue?

- "Have we looked at all possible options?"
- "Is this dialogue complete?"

… the topic of the dialogue has moved away too far from the original question?

- "What does this have to do with what we discussed first?"
- "How did we get from … to …?"

Frames (of reference)[11]

Frames are cognitive shortcuts, or rather frames of reference, that people use (subconsciously) to be able to understand complex information. Frames are based on someone's convictions, values and experiences. Frames help you to interpret and

organize information. They provide a simplification of the information, by (subconsciously) filtering it: you will consider some aspects of the information as important and others you leave out of consideration because they appear irrelevant or go against your intuition. Because different people have different frames, they can interpret the same situation differently. As a result, frames can interfere with dialogue[12]. When there is a difference of opinion in dialogue, it is therefore important to discover how pupils frame the dialogue/what the underlying frames are. To find out, it is necessary to ask questions about underlying convictions/values and then consider the point from the other's perspective (described under questioning techniques).

In addition to the above mentioned *personal frames*, there are also *media frames*. Media frames concern the way that information is presented in the media: aspects may be over- or underexposed (subconsciously)[13]. As a teacher, there are two ways you can use media frames in dialogue:
- Make sure that you are not subconsciously framing dialogue, for example, by only looking at the topic from an economic perspective in the introduction.
- Considering the topic of the dialogue from various angles/ ontributing new perspectives to the dialogue. You can do so through the exemplary questions from the frame schematic below, or by asking for an example "But if you look at it from an economic perspective, what do you think of it then?"

Below you will find an overview of possible media frames in relation to technological innovations, with some possible questions that can be used in dialogue for each frame. Also, some possible questions from whole class dialogue on genetic manipulation are given (with the exception of the frame 'law and regulations' which was not considered in these whole class dialogues). Often you will have to point out the frames 'globalization' and 'law and regulations' yourself as a teacher, while other frames are more self-evident to pupils. The various frames are not mutually exclusive. Some frames are in fact closely related, this has been indicated with arrows in the overview.

Media frame	Description and possible questions	Example
Progress	What could the consequence of a technological innovation be, in terms of progress? Are there disadvantages to this progress? Progress here can take many forms, for instance: prosperity (related to economic frame), well-being (being happier is also a form of progress), doing good (related to ethical frame) or limiting/avoiding damage (related to risk frame).	"You can lessen people's suffering (for instance, if cancer no longer existed)."
Economic	What could the technological innovation yield, in terms of economic progress? And who would profit from that? Are there other ways to gain the same economic progress? Or will the economy suffer? And who would be disadvantaged by that? Or does it have no effect on the economy?	"It doesn't have a positive effect on the economic system, because there will be overpopulation when there are no diseases. The economic crisis will only be worse."
Ethical	Is the technological innovation ethically responsible: can you do this? What might be allowed or not allowed through the innovation, based on ethical principles? Where do we draw the line? Which of the innovation's risks are acceptable (from an ethical point of view)? Are there consequences if we are unable to introduce the innovation, because potential advantages can't be realized (*risk of inaction*)? The ethical frame also includes *soft impacts*[14]: the technological innovation influences values (*techno-moral change*). Example: the invention of the contraceptive pill caused homosexuality to become more acceptable, because heterosexuals could now also have sex without procreation as its goal.	"There have to be limits. For example, changing the way you look is less important than curing or preventing diseases."
Risk	The risk frame can be divided into soft impacts and hard impacts[14]. *Hard impacts* are quantifiable consequences of the technological innovation. Questions that might be asked are: What kind of risks might the innovation carry with it? What are the risks for man, animals and nature (*bio safety*)? Can we predict the risks at all (*unknown risk*)? And can we control the risks? Will the innovation not be put to harmful use (*bio security*)? *Soft impacts* are non-quantifiable consequences of the technological innovation on individuals and on society as a whole. Questions that might be asked are: How does a pupil see the innovation in relation to her/himself/ how does the innovation influence them? How would certain groups look at the innovation (stereotypes) / how does the innovation affect them? What is the effect of the innovation on people's norms and values?	"The long-term consequences are unclear; there are things that could go wrong."
Nature-nurture	Does the technological innovation influence nature/nurture? For example, are environmental influences lessened by the innovation? Will genes / genetic variation change as a result of the innovation? Two *control orientations* can be distinguished within nature-nurture: external (it is fate, this is uncontrollable = nature oriented) and internal (autonomy, you can influence it yourself = nurture oriented). In other words: is something a given or can it be controlled? Developments such as genetic testing change the external control orientation (fate becomes less uncontrollable). Synthetic biology, for example, results in more control, which means the internal control orientation is increased.	"It's natural that there are healthy and sick people, and that is what natural selection works with."
Law and regulation	Who controls the technological innovation: slow down if necessary, regulate? Should/could the populace be involved? Is society responsible? Are there different interests at personal and societal levels?	"The authorities were concerned that the therapy might be so effective that its widespread use might lead to overpopulation. That's why they limited its usage to those without children."
Globalization	What are the consequences of the technological innovation if you look at the global level? Does it improve our country's economic position? Do third-world countries gain anything from it?	"Third-world countries cannot afford it, so that the crops are only going to Europe, and third world countries don't gain from it, and differences only become worse."

Sources

1. Smaling, A. (2008). Dialoog en empathie in de methodologie. Amsterdam: SWP Humanistics University Press, 22-27
2. Zande, P.A.M. van der (2012). Beweegredeneren, een werkvorm bij dilemma's in de klas
3. Zande, P.A.M. van der (2011). Learners in dialogue: teacher expertise and learning in the context of genetic testing. Thesis.
4. Waarlo, A.J., (2014). Enhancing Socio-Scientific Issues-based Learning in Schools, D2.1 SYN-ENERGENE, co-funded by the European Commission under the 7th Framework Programme, Karlsruhe, Germany / Utrecht University, Freudenthal Institute for science and mathematics education (NL)
5. Anthone, R. & Mortier, F. (1997). Socrates op de speelplaats. Filosoferen met kinderen in de praktijk. Leuven / Amersfoort: Acco.
6. Boerwinkel, D.J., Swierstra, T. & Waarlo, A.J. (2012). Reframing and articulating socio-scientific classroom discourses on genetic testing from an STS perspective. Science & Education, 23:2, 485-507
7. Zande, P.A.M. van der, Brekelmans, M., Vermunt, J.D. & Waarlo, A.J. (2009). Moral reasoning in genetics education. JBE, 44, 31-36
8. Interview with Sabine Roeser by Arend Jan Waarlo on January 7 2014
9. Roeser, S. (2010). Emotional reflection about risks. The International Library of Ethics, Law and Technology, 5, 231-244
10. Handleiding moreel beraad
11. Nisbet, M.C. & Lewenstein, B.V. (2002). Biotechnology and the American media - The policy process and the elite press, 1970 to 1999. Science Communication, 23(4), 359-391
12. Kaufman, S., Elliott, M. & Shmueli, D. (2003). Frames, framing and reframing. Beyond Intractability. Eds. Burgess, G. & Burgess, H.. Conflict Information Consortium, University of Colorado: Boulder
13. Carver, R.B. (2012). Framing the Gene: A science communication study of how newspapers frame different meanings of the gene concept, with applications for science education. Thesis.
14. Boerwinkel, D.J., Swierstra, T.E. & Waarlo, A.J. (2012). Reframing and articulating socio-scientific classroom discourses on genetic testing from an STS perspective. Science & Education, 23(2), 485-507