Translated outline & lesson plans

Pre-service biology and chemistry teachers in upper secondary school (15-18 year olds)

These materials are based on the work within the project Promoting Attainment of Responsible Research & Innovation in Science Education (PARRISE).
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Course outline and lesson plans
SSIBL teacher professional development (TPD) sessions

Utrecht University, Freudenthal Institute, The Netherlands

Pre-service biology and chemistry teachers in upper secondary school (15-18 year olds)

Overview course outline

Duration	Two 1.5 hour face-to-face meetings and 3h independent assignment , in the context of the regular 20 weeks pre-service teacher course (one semester).
Short summary	This teacher professional development (TPD) programme adopts an inductive approach in which teachers get acquainted with the SSIBL pedagogy through several experiential activities. First, teachers explore SSIs, after which they collaborate in designing and reflecting on SSIBL learning and teaching activities. This pre-service teacher programme has been implemented with different groups of biology-, chemistry- and science student teachers. The programme is designed to develop student teacher's understanding of, and skills and competence in, teaching and learning through socio-scientific inquiry-based learning (SSIBL). The goal is to support teachers in designing SSIBL lessons and to contribute to their teaching repertoire by providing them with the means to foster scientific literacy and reflective citizenship in science education.
Intended learning objectives of the TPD	The student (pre-service teachers) can : • State characteristics and examples of SSIs, in which knowledge of school subjects (chemistry or biology) is involved and develop arguments about why SSIs should be integrated in biology/ chemistry education • Map a controversy / SSI (including different stakeholders' viewpoints and values that are at stake) • Identify learning and teaching activities to introduce and discuss SSIs in classroom settings • Link inquiry-based learning to students' questions (SSIs) • Link SSIBL to the science curriculum (e.g. new science modules, Concept-Context approach) • Develop a SSIBL lesson (or school work plan) for science classrooms drawing both on existing and novel SSIs and inquiry contexts • Reflect on PSTs' SSIBL lesson designs and be able to identify strong and weak elements • Recognise and state different learning and teaching activities that can be

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	used in classroom practice in the context of SSIBL, as well as their pros and cons • recognise opportunities for teaching school students about aspects of citizenship in SSIBL

Session no.	Duration	Main Activity /objective	Approach: Inductive
1	1.5 h	• Get acquainted with characteristics of SSIs • Learn how to raise meaningful students' questions, a 'need to know' • Scaffolding student's inquiry	Teachers as learners
Homework assignment	3 h	• Design SSIBL lesson plans linked to the science curriculum	Teachers as developers
2	1.5 h	• Present SSIBL lesson plans and discuss • Reflect upon different learning and teaching activities that can be implemented in classrooms in the context of SSIBL, as well as the required teacher skills	Teachers as learners Teachers as developers

Lesson plans

Session 1 (1.5 hours)

Introduction to SSIBL and take home assignment

Learning goals

The student (pre-service teachers) can:

- State characteristics and examples of SSIs, in which knowledge of school subjects (chemistry or biology) is involved and develop arguments about why SSIs should be integrated in biology/ chemistry education
- Map a controversy / SSI (including different stakeholders' viewpoints and values that are at stake)
- Identify learning and teaching activities to introduce and discuss SSIs in classroom settings
- Link inquiry-based learning to students' questions (SSIs)
- Link SSIBL to the science curriculum (e.g. new science modules, Concept-Context approach)
- Develop a SSIBL lesson for science classrooms
- Develop a school work plan in relation to the examination requirements, based on SSIBL elements

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Before the session

As an optional preparation activity, ask your student teachers to read several documents before the SSIBL sessions. Documents can include (parts of) the SSIBL framework (Levinson, 2017), a scientific article on SSIs in science education, and a YouTube video from the PARRISE website (available as resource, www.parrise.eu).
e.g.:
https://www.youtube.com/watch?v=BKobYuVLNVA
https://www.youtube.com/watch?v=j167asjZv_g
https://www.youtube.com/watch?v=fhQ8ZrklAQc&t=242s

Introduction [10']

Start the session by connecting it to prior sessions, e.g.

- Refreshing a prior session on IBL
- Connecting to curriculum innovation in The Netherlands (concept-context approach, introducing SSIs as a context)

First, discuss the reasons for exploring SSIs in science education. They are linked to innovations in science and technology that have impacts on society, as well as educational aims such as critical citizenship. Additionally, discuss links between SSIBL and the national Dutch curriculum specifications.

Optional first activity:
You also might opt to choose to start the session by enacting an SSI activity, for instance, introducing a dilemma and asking the student teachers to ''take a position on the line''.

- *Statement: We should intervene when animals in the 'Oostvaardersplassen' (a nature reserve in the Netherlands) are threatened by starvation' [see PowerPoint in **Presentations_UU**]*
- *Students think for a minute about the statement and choose their position on the line (from 'agree' to 'disagree').*
- *Discuss with neighbours on the line: arguments for where you are, questions for the others (this activity can be enhanced by replacing it with 'beweegredeneren', see opinion-forming phase and **Handouts_UU**.*

What and why? [25']

The PSTs are **introduced to multiple SSI-cases**, like genetic testing, nanotechnology, waste plastics, climate change. They discuss these controversies in a 'carousel assignment' (worksheet available in ***Handouts_UU***, example SSIs can be found in the 'SSI cases' document in the Resources, in Dutch), based on questions like:

- What is the case about, what is the controversy?
- Which stakeholders are involved, which societal values are associated with this?
- What content knowledge is relevant?
- Which questions does the issue raise that your students could investigate?

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Optional second activities:
You could also ask your teachers to bring their own SSIs to the session. Give them a task to bring a news article (from a paper or from online sources) to the session, which represents their subject (biology, chemistry, mathematics, or physics) in the news. Another option is to map out one SSI extensively, writing down opinions of teachers on the dilemma, what kinds of opinion these are (based on science, economics, ethics, intuition etc).

What and why? [20']
Based on teachers' findings, the teachers **reflect on the SSI-cases** in a plenary discussion, from a SSIBL perspective (socio-scientific issues (SSIs), inquiry-based learning (IBL), and citizenship education (CE))

- Identify and discuss characteristics of these controversies and how to address them in classroom settings
- Develop arguments about whether and why SSIs should be included in the science curriculum.

Box 1 lists some answers provided by the UU pre-service teachers to give you an idea of what to expect from these activities.

Box 1 – UU outcomes of the carousel activity

During reflection on SSI articles in the UU TPD sessions, these characteristics were often mentioned by PSTs:

- Dilemma, controversial issue, societal issue
- Linked to science, developments in science
- Usually interdisciplinary in nature
- No simple or clear-cut answer or solution
- Involves making a choice/decision
- Both scientific content knowledge & emotions play a role (different kinds of knowledge)

PSTs often mentioned that incorporating SSIs in science education is important because it:

- Promotes scientific literacy
- Includes citizenship education
- Asks for scientific and moral reasoning concerning authentic problems (societal issues)
- Is present in national curriculum aims of The Netherlands
- Connects their science subject to student's daily life

Discuss types of question (content related, societal, nature of science, ethical, etc; see examples of these questions in ***Presentations_UU*** in 'resources').

Arguments are developed about whether and why SSIs should be included in the science curriculum. Link the exemplars in the discussion to important aspects of the SSIBL framework by means of reflective questions from teachers' perspectives e.g.:

- Why would you teach these kinds of activities? (related to importance of CE and RRI in their teaching)

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- What specific student learning goals do you consider important as a science teacher (educational vision); content, affective- and cognitive learning goals.
- What challenges do these activities present for you as a teacher?
- Which knowledge and skills do you need as a teacher?
- How are these activities related to the national curriculum?

How? [25']
Next, **discuss ways to encourage students asking questions** (IBL), and give examples of how social and scientific inquiry can be integrated to explore these students' questions:

- e.g. mapping controversies, scaffolding inquiry, data sources & reliability, social inquiry, experiments.
- Dialogue and decision-making: a dialogue tool for teachers can be presented and examples like '*beweegredeneren*' (''Arguments in motion'', van der Zande, 2011) can be shown and/or practiced (see 'opinion-forming phase' below, and see ***Handouts_UU***).

PSTs could ask their students questions like:

- Do you think that this is a trustworthy authority? Why/why not?
- What is the evidence for that claim?
- Can you explain the logic for your statement?
- This makes logical [or intuitive] sense to me but I don't have much evidence. Can someone suggest some evidence to support this?

The following activity, Mepham's Ethical Matrix, is a possible way to perform inquiry on the social aspects of the case. The assignment 'Ethical Matrix' of Mepham (Mepham, 2000) is done in small groups of PSTs (worksheet available in Resources: ***Handouts_UU***) as an example of inquiry into different stakeholders' perspectives. This can be done as a plenary discussion, in small groups or individually (or with post-its on the board, to give an insight in which 'cells' are still empty, for instance). The pre-service teachers list stakeholders and fill in the table/ matrix. The assignment can be discussed and reflected upon in a plenary discussion.
Mepham's Ethical Matrix can also serve as a tool for teachers during classroom discussions; the teacher is able to keep track of the different stakeholders' perspectives. It can also show which elements are under-represented in the discussion.

Opinion-forming phase [15']
Discuss examples of teaching and learning activities which show how to implement the opinion-forming phase.

Give tips for using dialogue in the classroom. Enact the example of '*beweegredeneren*' ('Arguments in motion', Van der Zande, 2011) (see also ***Handouts_UU***).
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, introduce a statement (for example: 'Everyone should automatically be registered as an

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organ donor at birth'). Participants stand on a line continuum in the classroom, 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 formed their opinions, using mostly feelings/emotions (the 'heart') or rationale thinking (the 'brain').
The teacher (educator) is the mediator during the whole activity. They ask participants questions, illustrating as many different sides and opinions as possible. If participants change their opinion regarding a statement, they are able to move to a new location in the classroom. Remind students that there are no 'winners', and answers are not 'right' or 'wrong'.
After this, present the tool 'Dialogue and decision-making: a dialogue tool for teachers' (and hand a copy; tool present in ***Handouts_UU*** in 'Resources'). This tool lists possible teacher roles in classroom dialogue and shows how suitable these roles are for different learning goals. Additionally, it provides questioning techniques and frames.

Homework [10']
Teachers receive a **take-home group or individual assignment to design a SSIBL lesson**. Teachers develop a design for a SSIBL lesson in small groups or individually, with the help of a worksheet (available in ***Handouts_UU*** in 'Resources').
The pre-service teachers (PSTs) do not have to trial this lesson in their classroom practice (since training schools do not (always) offer this freedom/opportunity to PSTs), and the assignment is not graded. However, the PSTs know that they have to present their work during the final session. This assignment helps the PSTs to integrate SSIBL in their future lessons.

The different elements of session 1 are sometimes explicitly and sometimes implicitly linked to the six educational phases described by Knippels & de Bakker (2016; translated version in ***Presentations_UU***).

In the PowerPoint, a homework assignment is provided for the chemistry and biology cohorts.

Session 2 (1.5 hours)
Presenting the SSIBL lesson
(Preferably a week or two later)

Learning goals

The student (pre-service teachers) can:

- Link SSIBL to the science curriculum (e.g. new science modules, Concept-Context approach)
- Develop a SSIBL lesson (or school work plan) for science classrooms drawing both on existing and new SSIs and inquiry contexts
- Reflect on PSTs' SSIBL lesson designs and be able to identify strong and weak elements
- Recognise and identify different learning and teaching activities that can be used in classroom practice in the context of SSIBL, as well as their pros and cons

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- Recognise opportunities for teaching school students about aspects of citizenship in SSIBL;

The **pre-service teachers present the SSIBL lessons** they have designed to the other teachers and teacher educator, and receive feedback. In a plenary, discuss the lessons and the developmental process. Discuss and reflect upon the following aspects, for example:

- ways to introduce an SSI in the classroom
- ways to scaffold students raising questions about the SSI and defining research questions
- different elements of the inquiry: scientific, social and global aspects
- ways to integrate action
- different learning and teaching activities to foster the above mentioned elements
- the pros and cons of different learning and teaching activities that the PSTs have included in their SSIBL lesson designs
- how the SSIBL lessons are linked to the science curriculum
- the challenges and opportunities PSTs foresee in enacting SSIBL in their classroom practice

This session helps teachers to analyse different teaching SSIBL scenarios and to reflect on their own skills. Product and process reflection is standard in all activities during the TPD course.

References

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