

Outline & Lesson plan SSIBL TPD Course on ‘Genetically Modified Food’ for pre-service biology teachers in upper-secondary education¹

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Summary & objectives

<p>Short summary</p>	<p>In our TPD course, we chose the socio-scientific issue (SSI) ‘genetically modified food’ in order to introduce the SSIBL approach to our pre-service biology teachers at the University of Vienna. The teachers are engaged as learners, as developers and as reflective practitioners in our course. First they experience a SSIBL environment on ‘genetically modified food’ as learners and then get acquainted with the theoretical rationale underlying the SSIBL approach. Afterwards they design SSIBL environments themselves, which they carry out in school. Finally, the pre-service teachers reflect on their SSIBL teaching experiences.</p>
<p>Intended learning objectives of the TPD</p>	<p>At the end of our TPD course on ‘genetically modified food’ the teachers should be able to:</p> <ul style="list-style-type: none"> O1. Describe and explain typical controversies over genetically modified organisms (GMOs) in food (inc. which GMOs are in use; risks and opportunities in relation to the environment, our health, our societies and the economy; risk assessment in the field of green gene technology; stakeholders involved and their differing interests regarding the use of the GMOs in food; political regulations in Austria, the EU and internationally; consumer behaviour regarding GMOs in Austria, the EU and internationally etc). O2. Characterize a SSIBL approach regarding its general learning objectives (e.g. scientific literacy, citizenship education) and establish links to the Austrian national curriculum for biology education. O3. Develop and implement a SSIBL unit in class (choosing an interesting and captivating starting point for students, involving purposeful, research-driven learning through collaboration, critical examination of evidence, using tools for carrying out stakeholder analysis and mapping the controversy, conduct an in-depth debate on the topic). O4. Reflect on teacher’s teaching in a SSIBL environment and reflect on student’s learning in terms of argumentation.

¹ The following additional material for this TPD course is available on the [PARRISE website](#): *Handouts_UNIVIE* & *Presentations_UNIVIE*.

Overview course outline

Session	Duration	Objectives & main activities	TPD model approach
1	3 hours	The pre-service teachers (PSTs) get to know the SSIBL approach: Theoretical introduction to the educational objectives of the SSIBL approach and the links to the national curriculum for biology education. PSTs are presented with a starting point for the SSI-topic 'food quality: genetically modified food' and they carry out a literature research on self-initiated questions in the field of 'genetically modified food'.	Teachers as learners & teachers as experiential learners
2	3 hours	PSTs get to know the SSIBL approach: They work on mapping the controversy based on the knowledge they gathered during their literature research on the topic.	Teachers as experiential learners
3	3 hours	Theoretical introduction to SSIBL regarding its central teaching approaches (e.g. entry into a SSI topic; IBSE, stakeholder analysis, mapping the controversies) and presentation of practical examples of SSIBL learning environments. PSTs get to know students' subject specific learning difficulties and teaching approaches to support students learning 'genetics and genetic engineering'.	Teachers as learners
4	2 hours	Expert lecture: PSTs learn about risk assessment of GMOs from an expert in the field.	Teachers as learners
5	4 hours	The PSTs learn to plan and prepare a SSIBL project (including an interesting and captivating starting point for students, raising authentic questions, doing self-directed research on the topic, taking action).	Teachers as developers
PSTs implement their SSIBL projects in participating in-service teachers' biology classes.			Teachers as teachers

6	2 hours	The PSTs reflect on their teaching experiences.	Teachers as reflective practitioners & teachers as learners
7	3 hours	PSTs learn about the nature of argumentation (scientific as well as ethical) and how to foster student's argumentation in SSIBL learning environments.	Teachers as learners and as educational researchers
8	2 hours	The PSTs transfer their knowledge about SSIBL to another SSI. PSTs reflect on their teaching experiences with SSIBL and their learning experiences on the TPD course.	Teachers as developers & teachers as reflective practitioners

Lesson plan

Session 1 (3 hours)

Introduction to SSIBL as (experiential) learners and take home assignment

Learning Goals:

- The pre-service teachers (PSTs) are introduced to the SSIBL approach as learners: Theoretical introduction to the educational objectives of a SSIBL approach and links to the national curriculum for biology education.
- The PSTs get to know the SSIBL approach as experiential learners: They are presented with a meaningful way into the SSI topic 'Genetically Modified Food' and they carry out a literature research on self-initiated questions through a take home assignment.

Description of Activities:

Introduction (30')

In the first session, the PSTs get an overview of the TPD course and its objectives. The teacher educators (TEs) briefly introduce the teachers to the specific teaching and learning approach in the TPD course (SSIBL) and link its educational objectives to the national curriculum for biology education. The EU goal of "Responsible Research and Innovation" is also introduced, as well as the EU PARRISE project (objectives, actions ...).

Organizational issues (60')

A team-creating process then takes place between pairs of PSTs who will undertake a SSIBL project in school together. The teams link up with an in-service teacher who is willing to invite them to their biology class and allow them to teach approx. 6 lessons in the course of the semester.

SSIBL introductory unit on "Raising authentic questions" (90')

In the second part of the session, the TEs lead the PSTs through a SSIBL introductory unit, which aims to raise authentic questions on the socio-scientific topic 'Genetically Modified Food'. The TEs present teachers with different food products (cheese, flour, soya drink, milk, yoghurt, polenta ...) bought from a supermarket. A seal of quality proclaims that the products are produced without the use of

genetic engineering. In groups of 4-5, PSTs discuss what comes to mind when they are confronted with the seals of quality on these products (see fig. 1).



Figure 1: SSIBL entry unit on „Genetically Modified Food“

Afterwards, each group presents their ideas in a plenary and, together with the TEs, important questions/topics are identified and grouped:

Here are some examples of “big questions”, which may arise during this introductory unit:

- How are the terms “GMOs”, “gene technology” etc defined?
- What are the legal rules regarding cultivation of GMOs and labelling in our country, the EU and the USA?
- What are the pros and cons of genetic engineering? What are the risks and opportunities in relation to the environment, our health, our societies and the economy?
- Which GMOs are in use?
- What is consumer’s behaviour regarding GMOs in Austria? What beliefs do people have about GMOs? What is the media’s role in people’s opinion-making?

SSIBL unit on “Researching self-initiated questions” (home assignment)

At the end of this session, teachers select a question which is of particular interest to them. Their take home assignment is to carry out a literature research on the question and write a short

summary (2-6 pages) of their findings. These summaries serve as the subject-specific knowledge base for all the PSTs. Before the next session, each teacher also reads their colleagues' summaries.

Session 2 (3 hours)

Introduction to SSIBL as experiential learners

Learning Goals:

- The PSTs get to know the SSIBL approach as experiential learners. The PSTs work on the SSIBL method "Mapping the Controversy" using the knowledge they gathered during their literature research.

Description of Activities:

SSIBL unit on "Mapping the Controversy" (180')

The PSTs are asked to create a 'map of the controversy' that surrounds the topic 'Genetically Modified Food' as it currently presents itself to them.

Guiding Questions for this task:

- Who are the actors (human and non-human – e.g. bees etc)? How do they act? What interests do they pursue?
- How (and why) are some actors related?
- Where do conflicts exist? What are the conflicts about?
- Which contradicting values, ideologies become apparent in the conflicts?

PSTs are asked to display the information from their literature research in the map in an aggregated manner, but to take care not to oversimplify and thereby distort the information. They can choose the mode of presentation (e.g. role play, flip chart, etc). PSTs work in groups of 4-5 and have plenty of time to fulfil the task (90').

Afterwards the PSTs present their map in a plenary (see fig. 2 & fig. 3). The maps are compared and discussed.



Figure 2: Example of mapping controversy created by the PSTs in the TPD course



Figure 3: Another example for mapping controversy

Session 3 (3 hours)

Introduction to SSIBL as learners & as developers

Learning Goals:

- The PSTs get to know the SSIBL approach as learners through a theoretical introduction regarding its central phases and practical examples of SSIBL environments.

Description of Activities:

Reflection on the experiential learning experience & introduction to the main phases of a SSIBL project (90')

Over the past two sessions, teachers have experienced three key phases in a SSIBL project: “Raising authentic questions”, “Researching self-initiated questions”, “Mapping the Controversy”. In the third unit, these experiences are first reflected upon using the following questions:

- How did I experience these SSIBL units?
- What was new for me/what was not?
- What did I like/what did I not like?
- What was difficult/challenging?
- Where would I have wished for more support/clearer instructions/more direct input?

Afterwards, experiences are exchanged in a plenary. The TEs introduce the main phases of a SSIBL project from an educational perspective (see handout A in **Handouts_UNIVIE**):

1. SSIBL initial phase: Choosing an interesting and captivating starting point for students & raising authentic questions.
2. SSIBL enaction-phase:
 - a. Involving students in purposeful, research-driven learning through collaboration and critical examination of evidence.
 - b. Using tools for carrying out stakeholder analysis and mapping the controversy with students.
 - c. Conduct an in-depth debate with students on the topic.
3. SSIBL action phase: Taking meaningful action.

The TEs give more examples of possible implementation of the different SSIBL phases regarding different SSIs, taken from their teaching experiences in school and from other PARRISE partners.

Clarification of open questions regarding subject knowledge & its teaching (90')

In the second part of this session, open questions regarding the subject content “genetics and genetic engineering” are discussed with the PSTs. As preparation for this unit, the TEs analyse the summaries written by PSTs after the first session concerning PSTs’ difficulties with subject knowledge. The TEs try to help clarify difficult subject matter by giving short explanations about the issues.

The TEs also describe typical learning challenges students in school face with the subject content and how to help them overcome these difficulties.

Session 4 (2 hours)

Expert lecture & introduction to SSIBL as developers

Learning Goals:

- Expert lecture: PSTs learn about risk assessment of GMOs from an expert in the field.
- PSTs learn to develop a SSIBL project for upper secondary education.

Description of Activities:

Expert lecture & discussion (120')

In this session an expert talk is organized. We invited the molecular biologist Martin Moder (IMBA - Institute of Molecular Biotechnology; <https://www.imba.oeaw.ac.at/>) who gave a lecture about myths in the risk evaluation of GMOs. He introduced our PSTs to the central scientific publications in the field of risk assessment of GMOs and explained how risk assessment is carried out in this research field.

His talk is available on Youtube: <https://www.youtube.com/watch?v=DqMlUmQw1lk> [German]

Important literature he draws on in this talk:

- Séralini, G.-E. et al. (2012). RETRACTED: Long term toxicity of a herbicide 'Roundup' and Roundup-tolerant genetically modified maize. *Food and Chemical Toxicology*, 50 (11), pp. 4221-4231. Open access: <http://www.sciencedirect.com/science/article/pii/S0278691512005637>
- Carpenter, J. E. (2011). Impact of GM crops on biodiversity. *GM Crops*, 2(1), 7-23. Open access: <http://www.tandfonline.com/doi/abs/10.4161/gmcr.2.1.15086>

After the talk, the PSTs were invited to discuss their point of views with the expert. Here are some examples of our PSTs' questions:

- How easy is it to fake scientific findings in the field of molecular biology?
- How do you judge the reliability of a scientific study on the risk assessment of genetically modified food?
- Isn't it unethical to alter the genetic code of an animal like in the case of the AquAdvantage salmon?
- What do you think of CRISPR/Cas 9?

Development of a SSIBL project for upper secondary education (Take home assignment)

Before the next TPD session, PSTs have to design a SSIBL project in pairs for upper secondary education. They are guided by the following list of tasks:

1. Choose a specific GMO: e.g. Bt corn, Roundup-Ready soya, AquAdvantage salmon, Golden Rice
2. Research the following topics:
 - a. Genetic engineering method used in this GMO
 - b. Purpose of manipulation
 - c. Legal situation (national/EU/international): cultivation regulations/breeding regulations, production, import, labelling
 - d. Possible risks for humans and nature (underlying biological mechanisms, scientific risk studies)

- e. Economic factors: worldwide cultivation, GMO producing companies, agriculture
 - f. Illustrating the controversy in the media & advertising
 - g. Positions of NGOs, the public and other stakeholders
3. Design a SSIBL project based on their researched knowledge, with its main phases (including an interesting and captivating starting point for students, raising authentic questions, doing self-directed research on the topic, taking action).
 4. Prepare a lesson plan for the SSIBL project which can be presented in the plenary in the next TPD session.

Session 5 (4 hours)

Introduction to SSIBL as developers

Learning Goals:

- PSTs learn to develop a SSIBL project for upper secondary education.

Description of Activities:

Presentation of lesson plans and giving feedback (240')

Each pair of PSTs present their lesson plans to peers and the TEs (10-15') and receive feedback (15-20'). In their feedback, the TEs mainly focus on whether the essence of a SSIBL environment (student-directedness, multi-perspectivity, promotion of democratic values, etc) is captured in the teachers' projects and help the teachers to put SSIBL features into practice.

After this session the PSTs start to carry out their SSIBL projects in the participating in-service teachers' biology classes. Each project lasts 6 lessons, preferably organized in 3 double lessons. PSTs are requested to collect students' artefacts during their teaching in class (e.g. authentic questions, student's written argumentation, maps of controversies etc).

Session 6 (2 hours)

PSTs as teachers in a SSIBL project and as reflective practitioners

Learning Goals:

- PSTs learn to carry out a SSIBL project in school and to reflect on their teaching experiences.

Description of Activities:

Reflection of the SSIBL teaching experiences (120')

The TEs lead a coaching session for the PSTs. PSTs are free to talk about their first experiences with teaching using the SSIBL approach in their classes. The focus of the session is providing support in cases where it is needed and to point out links to the SSIBL framework in order to foster a deeper understanding of the underlying educational rationale.

The following reflection method is used. The PSTs are asked to reflect on their past teaching experiences and to think about future teaching experiences in their SSIBL projects (PSTs may not have finished their teaching in class when the 5th TPD session takes place). The teachers are presented with a poster full of emotion words. These should help to remind them of past teaching experiences and to visualize future teaching situations.

First, each teacher reflects individually; then they exchange experiences and thoughts in a plenary.

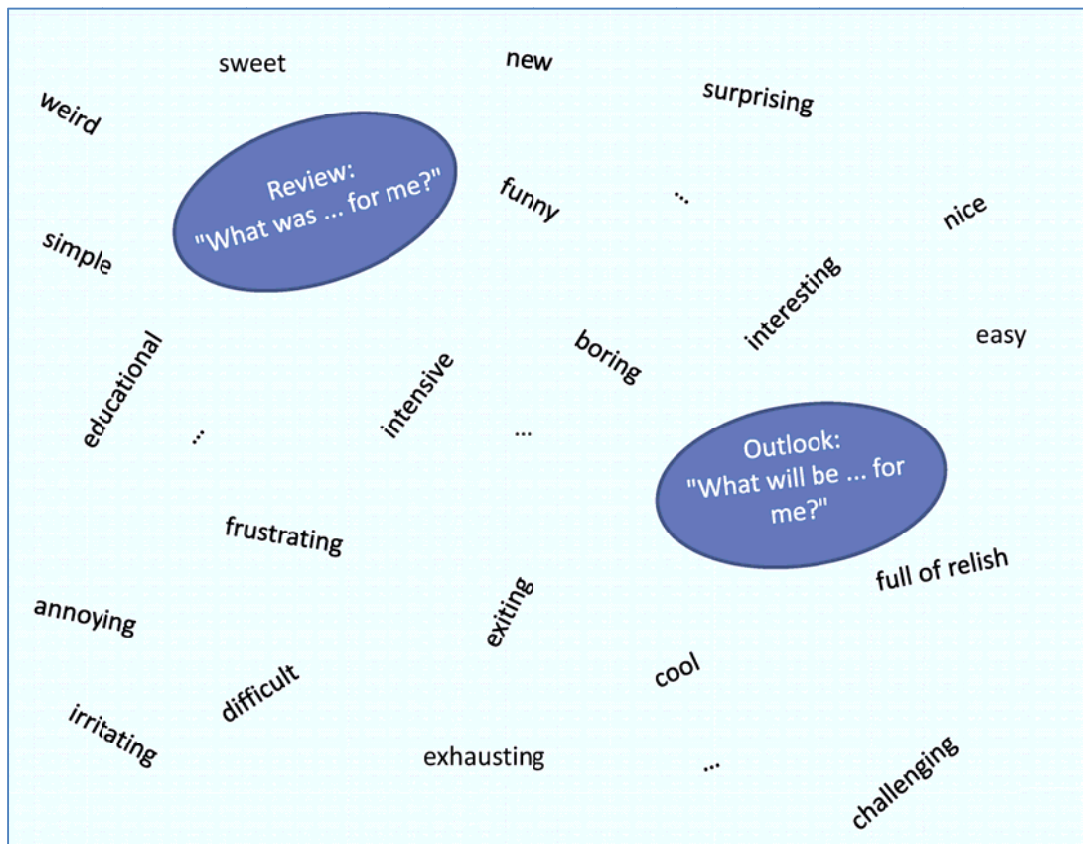


Figure 4: Reflection method based on emotions as reminders of experiences

Session 7 (3 hours)

PSTs as learners & as educational researchers

Learning Goals:

- PSTs learn about the nature of argumentation (scientific as well as ethical) and how to foster students' argumentation in SSIBL environments.

Description of Activities:

Interactive lecture on the nature of argumentation (60')

In this session, the TEs introduce PSTs to the nature of scientific and ethical argumentation (based on Toulmin's model of argumentation). The presentation is also based on the following paper: Bayertz, K., & Kompa, N. (2016). *Moralisches Argumentieren [Ethical argumentation]*. WWU Münster. Open access [German]: https://www.uni-muenster.de/imperia/md/content/kfg-normenbegrueundung/intern/publikationen/bayertz/84_bayertz.kompa_-_moralisches_argumentieren.pdf

Analysis of student's argumentation (120')

Toulmin's model is used afterwards to analyse students' written arguments on "Genetically Modified Food". The arguments were collected by the PSTs while teaching in class. The teachers are asked to analyse 3 students' arguments exploring the following sub-tasks:

1. Analyse the elements of the students' arguments
Which are explicit and which are implicit?
2. Represent the basic structure of the argument:
What is argued for?
Which reasons (descriptive & normative) are provided for the claim?
3. What else is noticeable?

PSTs work in groups of 4-5 (60'). Afterwards, they present their findings in a plenary and methods to foster student's argumentation in SSIBL environments are discussed at the end of the session (60').

Session 8 (2 hours)

PSTs as developers of SSIBL projects & reflective practitioners

Learning Goals:

- PSTs transfer their knowledge about the development of a SSIBL environment to another SSI.
- PSTs reflect on their teaching experiences with SSIBL and their learning experiences on the TPD course.

Description of Activities:

Transfer unit: Developing another SSIBL project on a different SSI (120')

PSTs are challenged to apply the knowledge they have gained during the TPD course as well as during their teaching in class to another SSI. In groups, they work on a lesson plan for a SSIBL learning environment on a self-selected SSI (60'). Afterwards, the groups present their lesson plans in a plenary (60').

Revision of the lesson plan, reflections on teaching and learning experiences (Take home assignment)

As part of their seminar paper, the PSTs have to hand in a detailed description of their lesson plan. This should be a revision of their initial lesson plans, based on their teaching experience and reflections. PSTs are also asked to reflect on their SSIBL teaching experiences as well as their learning experiences on the TPD course (see handout B in **Handouts_UNIVIE**).