STEM and Diversity

MaSDiV PD course manual

MaSDiV

Supporting Mathematics and Science Teachers in
addressing Diversity and promoting fundamental Values

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Co-funded by the
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of the European Union

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Introduction

This MaSDiV professional development course aims to support the teaching of science and mathematics in diverse and multicultural contexts for the benefit of all students, regardless of their cultural or socioeconomic background.

A novelty in this program is the use of science learning to enhance the social and civic dimensions of education promoting values that are cornerstones of modern democratic and multicultural societies. The main target group is **lower secondary school teachers teaching students aged 11-16**.

The PD course features three modules presenting inquiry-based learning (IBL):

- as an approach for addressing achievement-related diversity;
- in real-life, relevant contexts so as to promote fundamental values of our societies;
- as a tool for intercultural learning.

We call this teaching approach "inclusive science education".

Rationale for a teacher education program that promotes inclusive STEM education

Science is a vital prerequisite for active participation in society and belongs to the eight key competences outlined in the EU framework for key competences (EC 2007). However, across the EU, 17% of 15-year-olds underachieve in science. In mathematics, that figure rises to 22%, and can be as high as 36.6% among students with low socioeconomic backgrounds (ET 2020). Changing societies, increased migration and changes in students' needs together with changes in the aims of science, technology, engineering & mathematics (STEM) education resulted in an urgent need for inclusive education that promotes learning in groups with different competence levels and cultural backgrounds.

This PD course provides an evidence-based approach to tackle current challenges in STEM education: the underachievement of particular student populations; linking science competences with social and civic competences and effectively supporting teachers as they face increasing social, cultural and competence-related diversity in their classrooms.

The PD course will be translated and adapted to fit into current innovations to the national curricula.

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Aims and objectives

General Objectives

- To strengthen *beliefs* and self-efficacy about using inquiry based learning (IBL) to address diversity; showing the relevance and implications of mathematics and science and promoting fundamental values and taking into account cultural differences
- To enrich *knowledge* focused on ethical and cultural dimensions of mathematics and science to promote fundamental learning
- To acquire *knowledge* and understanding of the main challenges related with teaching in multicultural science and mathematics classrooms, such as dealing with controversial issues
- To gain *skills* to apply the course knowledge into a practical knowledge related to interventions in multicultural science and mathematics classrooms
- To develop teachers' self-reflection on their classroom teaching as regards *inclusive science education* (thereby indicating their knowledge of science education and their skills).

Specific aims per module

Module 1 - Achievement

- The ability to make explicit and enrich beliefs and practices for addressing diversity in science and mathematics classrooms
- The ability to prepare a lesson plan with teaching methods that take the opportunity of diversity in achievement in the classroom
- The ability to re-design classroom materials into resources with IBL characteristics to create learning environments to be used for including all students and addressing diverse achievement levels
- Provide experience with purposefully chosen teaching methods and resources for science or mathematics that take the opportunity of diversity in achievement among students

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Module 2 - Contexts

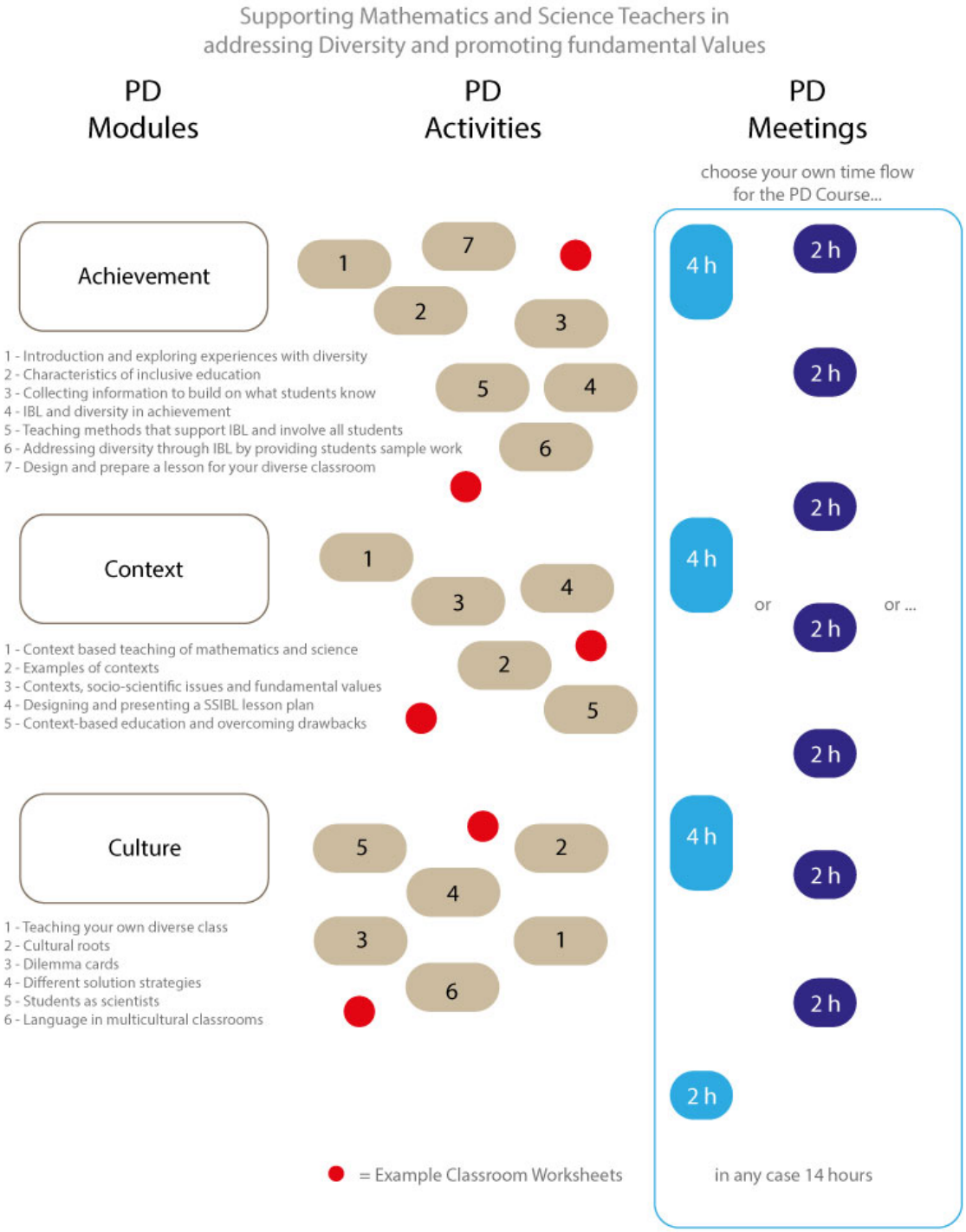
- Understanding the value of using contexts in IBL tasks in science and mathematics to support the learning process by making connections between context and concepts and apply this in classroom teaching
- Being able to find and use real-life, relevant contexts for IBL in daily science and mathematics teaching
- Enabling students to apply science and mathematics in real life contexts.
- Understanding how real-life relevant contexts (e.g. genetic engineering, climate change, oil drilling) and scientific and moral reasoning can promote fundamental values of our societies and apply this in classroom teaching
- Understanding how the use of contexts in science and mathematics IBL tasks can support inclusive education and intercultural learning and apply this in classroom teaching
- Understanding the nature, applications and implications of science and mathematics for societies
- Making students understand that scientific decisions based on science /mathematics are also influenced by moral, ethical and social reasons.

Module 3 – Intercultural learning

- To acquire knowledge and understanding of cultural diversity and social inclusion in science and mathematics education, focusing on schools and the classroom.
- To acquire knowledge and understanding of the main challenges related to teaching in multicultural classrooms, such as creating an inclusive classroom culture.
- To be able to recognize and use opportunities to include culture-related aspects in science and mathematics teaching and dealing with controversial issues (dilemma's).
- To gain skills to apply the course knowledge into a practical knowledge related to interventions in multicultural classrooms
- To become reflexive of one's own normative position and values in relation to cultural diversity
- To learn how IBL can support students by taking into account their various cultural backgrounds
- To learn how to use IBL to promote students' intercultural competences by using realistic relevant contexts situated in different cultures.

Structure of the course

The course is structured in three modules. Each module has a set of activities.



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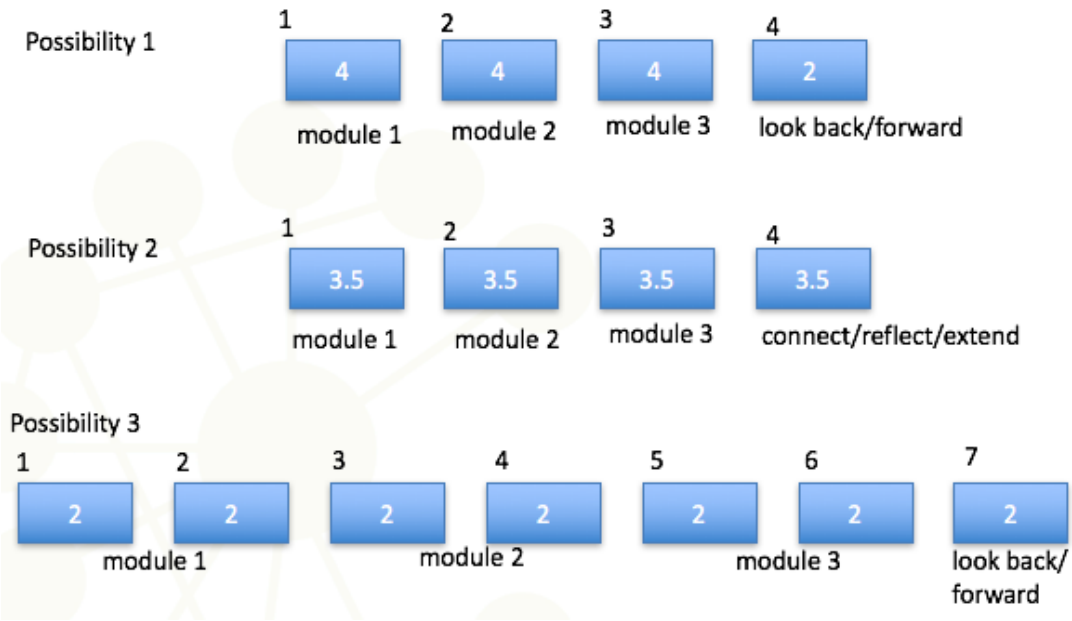
The PD course covers the three modules in a **connected** way. The order of the modules is fixed, so that activities can be followed up on in the next sessions and participants can build on the work they have done so far. The first module covers IBL as an approach to dealing with performance related diversity. Participants design a teaching activity for this. Building on this exemplary teaching activity in module 2 the use of (real-life, relevant) contexts is addressed as a way for taking into account other aspects of diversity, focusing on cultural diversity and fundamental values. Participant either adjust their teaching activity to employ contexts for these aims or design a new activity. In the last module the focus in on approaches and tools for intercultural teaching and learning in diverse classrooms. Participants finish the teaching activity and lessons plan to incorporate this aspect as well.

For each **module** an outline is available for the educator. It includes the specific aims, a description of the activities and homework and a list with references to literature. Presentation (ppt) and worksheets for participants are provided separately. We suggest a teaching method for each activity, but these can be replaced by others. It is important that collaborative work and active learning are promoted in the activities. Participants will be inspired to use these methods with their students.

Student	The student in lower secondary school, aged 11-15
Participant	The teacher who participates in the PD course
Educator	The teacher-trainer who runs the course

The 14 hours of the course can be **organised** in several ways. We provide three examples.
In all models the ratio 2:1 for contact-time versus homework (try-out/reading/research) should be taken into account.



Degrees of freedom

We designed the PD course in a way that the course leader(s) have some degrees of freedom. This is important because the target groups can differ (math/science teachers, etc.). You can vary in:

- the order of the activities (and sometimes even the preferred length)
- the examples (maths, science, or a mix)
- the homework (this depends on the number of meetings)

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The **target group** of the PD-course is teachers of STEM in lower secondary education. In the modules we use examples from both science and mathematics. Most examples can be exchanged for others. The way the group of participants is composed may influence your choice of content. If for example all participants teach the same subject, let's say 'physics', you may want to use only examples from Physics class. The same is true for making small groups in the sessions: you can vary these if your group is diverse with respect to the subjects they teach.

The **ways of working** with participants in the course reflects the 'values' and practices addressed in the course: Inquiring and collaborating are important. The ways of working include:

- Reflecting on existing beliefs and practices regarding addressing diversity and IBL
- Providing and discussing concrete subject-specific examples
- Developing and reflecting on important principles for addressing diversity in science and mathematics classrooms
- Experimenting with and reflecting on teaching methods for diversity

Example classroom worksheets

Alongside the PD materials there are example classroom worksheets. These worksheets can be used within the PD course, but also in the classroom (by the teachers). The following examples are available on the MaSDiV website (masdiv-project.eu):

- Fishery
- A healthy multicultural meal
- Rope
- Chocolade
- Escape the classroom
- Can the earth feed us

Each example starts with an overview of the content of the classroom activity.

Title	Rope
Subject(s)	Mathematics
Learning goal(s)	• Understand how variables refer to varying unknowns; • Construct and use expressions with variables to solve problems.
Time	One lesson (circa 30 minutes)
IBL	The activity asks for IBL: The task doesn't prescribe a solution procedure and invites students to reason geometrically or algebraically for finding unknowns and to critically reflect on the generalizability of their solution strategies. As a teacher you will need to decide how organize the collaborative work, and how to share/communicate the various strategies and whether to offer more structure, guidance and help.
Achievement	Collaborating on an open task allows for diversity in chosen strategy as well as in the level of achievement. Students can discuss and support each other. Classroom discussion of strategies is needed to share strategies and to provide focus to generalizing (based on students' contributions).
Context	The context is rather artificial, but very concrete and allows all students to start reasoning about the problem.
Culture	Encourage students to find their ow solution strategies. Appreciate and acknowledge diverse solutions and take that opportunity to discuss characteristics of the solutions to afford whole class progress.
Fundamental Values	Collaborative work, valuing each other's reasoning in group work, feel part of an inquiring community (belonging).
SSI/RRI	NA

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And every classroom worksheet also has a lesson plan.

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Quality

The **quality** of the course is ensured by meeting the criteria in the following ways:

10. Literature supports topics and ways of working in the modules
    - Literature references are provided in each Module
11. PD modules are based on research findings about effective PD.
    - In the last decades, PD research has led to the development of PD itself and related quality criteria. It is now commonly accepted that PD courses should (cf. Barzel & Selter, 2015):
      - take teachers' needs into account (Guskey, 2000)
      - combine seminar phases with learning on-job at school (Lipowsky & Rzejak, 2012);
      - be long-term (Tirosh & Graeber, 2003);
      - stimulate cooperation between teachers (Barzel & Selter, 2015);
      - be relevant to teaching practice (Barzel & Selter, 2015); and
      - foster teachers' reflection on their beliefs about mathematics teaching (cf. Tirosh & Graeber, 2003), Barzel & Selter, 2015).
      - See also: Maass, Swan, Aldorf 2017
12. Partners are actively involved in the development of the PD concept
    - this is ensured during the project meetings
13. Examples (contexts) from each partner become part of the PD materials.
    - in the modules examples from partners are included. While translating the module local examples can be added by partners as well.
14. There is 'evidence' in every partner country that the MaSDIV teacher training approach is fitting in the national 'tradition' of teacher training
    - This is ensured during the project meetings
15. National agencies/partners are involved in disseminating the final (translated) PD materials
    - This is ensured by each partner

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