






MODELLING IN MATHEMATICS AND OTHER DISCIPLINES

<https://identitiesproject.eu/modelling/>
















Modular blocks	Goals of the block	Activities	IDENTITIES approach to interdisciplinarity			Role of participants	Mode of interaction	Suggested digital tools	Workload time	Non-editable format	Editable format	Hints for implementation
Introduction	Gaining confidence with the main general themes of the project while making people act by themselves	Ice-breaking and boundary activities.						Forum	2 h	https://identitiesproject.eu/wp-content/uploads/2022/12/ICE-BREAKING-activity-and-tools-for-collecting-data.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/ICE-BREAKING-activity-and-tools-for-collecting-data.pdf	
		The IDENTITIES project (disciplines, interdisciplinarity, and key questions)						Assignment		https://identitiesproject.eu/wp-content/uploads/2022/12/INTRO.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/INTRO.pdf	
		Introduction to curricular and S-T-E-M advanced interdisciplinarity						Assignment		https://youtu.be/7C8wQlnd-4		
		Interdisciplinary images activity						Word Cloud		https://identitiesproject.eu/wp-content/uploads/2022/12/images-activity.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/images-activity.pdf	
		The taxonomy of interdisciplinarity						Assignment		https://www.youtube.com/watch?v=63KeevmdKis&list=PLWp28C6uXyOvCwGpG5CA6Dop7H8&index=2		
Modelling the growth of trees	Pre-questionnaire	Preliminary ideas about modelling in mathematics and physics						Assignment	4 h	https://identitiesproject.eu/wp-content/uploads/2022/12/Modelling-in-interdisciplinary-education-Pre-Question.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/Modelling-in-interdisciplinary-education-Pre-Question.pdf	The students are asked to express their initial ideas about modelling in mathematics and physics.
	Experiencing horizontal mathematics in a realistic fiction.	A-didactical situation about the growth of trees						Assignment		https://identitiesproject.eu/wp-content/uploads/2022/12/The-growth-of-trees.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/The-growth-of-trees.pdf	The students are asked to face a problem individually and in small groups. The intent is to evidence how mathematical modelling in extra-mathematical situations involves boundary objects and lexicons belonging to many fields. It is important to clarify to the students that the focus is the explicit mathematization of a problem by asking questions about it and reflecting on the process of addressing it from a mathematical perspective.
		Simulation of a teaching situation and solution of the re-launched realistic fiction						Assignment		https://identitiesproject.eu/wp-content/uploads/2022/12/Belaunched-realistic-fiction-The-growth-of-trees.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/Belaunched-realistic-fiction-The-growth-of-trees.pdf	The students reformulate the mathematical version of the problem and propose a solution. In this activity, the disciplinization is explicit and scaffolded by the model of horizontal and vertical mathematization. The reformulation leading from the original version of the text to the mathematized one is relevant and should be stressed by the teacher. We suggest organising a brief discussion to compare the different problems and approaches.
		Vertical and horizontal mathematization and their relationships						Assignment		https://identitiesproject.eu/wp-content/uploads/2022/12/PLATEAU-S-CIRQUE-13_Proceedings_CARM-Special_Issue-7_Yvain_Prebiski.pdf	not editable	The teacher can read this document and prepare a lesson about the model of horizontal and vertical mathematization and re-analyse, together with the students, their own processes with the lens. Another option is to only assign to the students the reading of this article and then analyse it with them.
	Showing the feasibility of this activity in secondary school ordinary settings with a community of practice supporting teachers (BeSci).	Reflection about implementations in secondary school						Padlet		https://identitiesproject.eu/wp-content/uploads/2022/12/FTES-Yvain-Cherrier-2019-CIRM11-TW006_28.pdf	not editable	The students are asked to read the paper about the same teaching experiment in France and post their personal reflections about their experience as students and the fictive experience as teacher in a Padlet.
	Evaluating tool	Home report						Journal				The students are asked to produce a report about their experience as students and the fictive experience as teacher, reflecting on the relevance and feasibility of such activities in a maths class in high school, with particular attention to linguistic and epistemological aspects.
Modelling in science: the case of the greenhouse effect	Discussing epistemological issues that can represent a demanding challenge for students, and more generally for citizens, related to climate science.	Modelling in science: questionnaires about the Cartographer and Palomar and about their own conceptions about modelling in science						Assignment	6 h	https://identitiesproject.eu/wp-content/uploads/2022/12/Questionnaire-Palomar-Cartographer.docx.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/Questionnaire-Palomar-Cartographer.docx.pdf	Ask the students to answer individually and send the questionnaire.
		The interaction between matter and radiation: heat and temperature.						Assignment		https://identitiesproject.eu/wp-content/uploads/2022/12/Experiment-cylinders.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/Experiment-cylinders.pdf	Following the guide for implementation of the same activity in the PhD dissertation by Tasquier (2015) prepare a lesson using the slides. Ask the students to foresee the graphs before showing them.
		Experiments and empirical data about the interaction between matter and radiation						Assignment		https://identitiesproject.eu/wp-content/uploads/2022/12/Guide_experiment_cylinders.docx.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/Guide_experiment_cylinders.docx.pdf	Ask the students to answer the questions in small groups.
		Modelling and interpretation of empirical data related to the interaction between matter and radiation						Assignment		https://identitiesproject.eu/wp-content/uploads/2022/12/greenhouse-experiment.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/greenhouse-experiment.pdf	Following the guide for implementation of the same activity in the PhD dissertation by Tasquier (2015) prepare a lesson using the slides. Ask the students to foresee the graphs before showing them.
Boundary objects and boundary crossing	Modelling in science education: data from students' answers	Modelling in science education: data from students' answers						Assignment	3 h	https://identitiesproject.eu/wp-content/uploads/2022/12/Analysing-students-epistemological-knowledge-of-models-and-modelling-in-science-results-from-a-teaching-learning-experience-on-climate-change.pdf	not editable	Use the presentation to make comments about secondary school students' interpretation and use of the term model in science education, and discuss about the epistemological issues following the paper by Tasquier and colleagues.
		Introducing boundary objects and boundary-crossing mechanisms						Assignment		https://youtu.be/80V9vEo-U		
		Discussing experiences as boundary people						Jamboard				Write in a jamboard in groups your personal positive and negative feelings and comments about the previous experiences, expressing opinions about the process of modelling you feel more comfortable with. Discuss with your colleagues and, if they have a different background, organize the post in order to make visible to common and different aspects of people with different backgrounds.
		Identification of mathematical and physical processes of modelling						Padlet				Collect individual reflections about modelling in physics and analogies and differences with the modelling activity in a extramathematical fictive situation.
Interdisciplinary analysis of modelling processes	Discussing the boundary crossing mechanisms triggered by the reflection about modelling as boundary object	Analysis of coordination in interdisciplinary modelling: boundary crossing mechanisms in the activity about modelling of the interaction matter-radiation and horizontal mathematization in the activity about modelling of the interaction matter-radiation.						Assignment	3 h	https://identitiesproject.eu/wp-content/uploads/2022/12/Analys-questionnaire.docx.pdf	https://identitiesproject.eu/wp-content/uploads/2022/12/Analys-questionnaire.docx.pdf	Following the questions, the students are asked to adapt the scheme of mathematical modelling to include elements that is necessary to include in a physics modelling process, recalling the discussion about the Greenhouse effect.
Wrap-up	Evaluating tool	Participants' presentations						Assignment				In presence ask the students in groups to prepare a presentation about their modelling activity and a reflection about modelling in physics making a comparison with their answers to the questionnaires at the beginning of this phase; then they present it to the classmates and the teacher. Online, ask the students prepare a video of their presentation.
		The contribution of modelling to the development of interdisciplinarity at school: final discussion						Padlet	4h			Discuss their presentations to find common aspects and to institutionalise analogies and differences between mathematical and physical modelling, reaching an agreement about modelling in physics, including mathematical modelling phases as an interdisciplinary practice in the case of the Greenhouse effect. In the case of distance learning, use a Padlet to collect ideas, organise them in topics, and prepare a video including final feedback by the trainers.

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		Final report	    			Assignment				Ask the students to produce a final report of the whole activity with personal reflections but showing that they learnt how to use the scaffolding concepts introduced to highlight and make emerge the disciplinary identities and interdisciplinary aspects of modelling (boundary objects, boundary-crossing mechanisms, horizontal and vertical mathematization, physical and mathematical model, interpretation and predictions, etc.).

Legend

Keywords for the IDENTITIES approach to interdisciplinarity	Keywords for the participants' roles in the module	Keywords for the type of participants' engagement in the activities
   Identities of the disciplines ● mathematics ■ physics ▲ computer science  Interdisciplinarity zone  Boundary objects  Boundary-crossing mechanisms  Epistemological activators  Linguistic activators	 Role of explorer  Role of student  Role of analyst  Role of teacher-designer	 Individual activity  Group activity  Interactive activity trainer-trainees