

NANO-THINK Course Structure and Learning Outcomes

The course is structured hierarchically into four modules that combine theoretical foundations with practical applications. Module 1 introduces the purpose and value of critical thinking in science, while Module 2 focuses on logic and argument, teaching students how to construct, analyze, and evaluate scientific reasoning. Building on this foundation, Module 3 connects critical thinking to research methods and scientific communication, highlighting the importance of sound design, source evaluation, and ethical practice. Module 4 offers practical application through individual projects and case studies, where students critically engage with scientific controversies, media representations, and discipline-specific challenges.

The content will be delivered using a combination of short video lectures, micro- and nano-lessons, readings, podcasts, videos, assignments, and interactive exercises in small, concise learning bits targeting main concepts. Each unit/topic ends with a short self-assessment of the topic, and a total module assessment before the next module can be started.

The assessment is incorporated within the lessons and will comprise a final online test as well, covering all four modules.

Learning Outcomes

On the background of the literature and the methods and materials prepared, the following ten learning outcomes (LOs) have been defined and agreed upon by the consortium.

These LOs cover the fundamental skills of Critical Thinking and therewith also the content of the curriculum.

Learning Outcomes

1. Define and explain the purpose, scope, and value of critical thinking in science.
2. Understand the difference between claims, evidence, arguments, and explanations, and analyze their role in scientific reasoning.
3. Evaluate arguments, identify premises, conclusions, and logical consistency.
4. Recognize and explain common fallacies and cognitive biases that distort reasoning in science and everyday contexts.
5. Assess basic elements of the credibility and relevance of scientific sources.
6. Demonstrate awareness of ethical issues in science, including transparency, attribution, data protection and biases in publishing.
7. Use basic skills to critically analyse representations of science in media, distinguishing reliable science from misinformation and pseudoscience.
8. Collaborate effectively in group projects to evaluate scientific controversies, formulate arguments, and present findings.
9. Demonstrate independent critical thinking through individual projects, reflection, and application of inquiry and scepticism to real-world problems.

The NANO-THINK course is shaped as a six-week online program. The total ECTS credit load is 2 which is equivalent to approximately 60 hours of the learner workload. The workload comprises the time for independent study, participation in online interactive activities (in the piloting year only), completion of interactive exercises, and engagement in the assessments after each lesson and at the end of the course. The online format is flexible and designed in such a way to allow participants to progress at their own pace while maintaining structured weekly objectives. The goal of the course is to ensure consistent learning and achievement of the defined learning outcomes.

Course Overview

Duration of the course: 6 weeks

ECTS load: 2 ECTS *

* 1 ECTS = 30 hours load

Format: Online course (asynchronous mode)

Assessments/Grading & Certification

- Modules can only be continued after a successful pass of the previous module.
- Assessment forms
- Automated tasks
- Quizzes: Short quizzes to test comprehension of key concepts/module content.
- Automated Case Study Analysis: assessments where students evaluate real-world scientific problems and present their analysis.

Module 1: Fundamentals of Critical Thinking

Goal: Understand the purpose, scope, and value of critical thinking in science. Introduce students to the core concepts, scope, and value of critical thinking with a special focus on its application in science and everyday reasoning.

Description: This module provides a foundational understanding of critical thinking by defining its purpose, importance, and role in both daily life and scientific contexts. Students will explore how claims and evidence are used in reasoning, learn to recognize common errors in thought, and practice applying critical thinking to short case studies in science. Module 1 also emphasizes creativity in problem solving, independent thinking, and the development of key inquiry skills such as asking good questions and evaluating information from multiple perspectives.

Learning Outcomes

By the end of this module, students will be able to:

- Describe what critical thinking is and why it matters in everyday life and science.
- Recognize the role of claims, evidence, and common reasoning errors.
- Outline how critical thinking supports good scientific practice.
- Identify the qualities of a critical thinker and ways to develop them.
- Apply relevant questions and creative thinking to approach problem

Module 2: Core of Critical Thinking – Argumentation & Logic

Goal: The goal of module 2 is to equip learners with foundational skills in logical reasoning and critical evaluation of arguments within scientific contexts, enabling them to distinguish sound reasoning from fallacious or biased claims.

Description: Module 2 introduces the basic concepts and tools of logic and argumentation as applied to science. Learners will explore the role of arguments in research, distinguish arguments from explanations, and analyse the structure and types of reasoning used in scientific discourse. The module also addresses common mistakes in reasoning, including formal and informal fallacies, cognitive biases, and hidden assumptions in scientific practice. Through case studies and exercises, learners will develop strategies for evaluating arguments, identifying fallacies, and fostering more rigorous and reflective scientific thinking.

Learning Outcomes

By the end of this module, learners will be able to:

- Differentiate between arguments and explanations and explain the role of arguments in scientific research and communication.
- Identify the structure of an argument (premises and conclusions) and classify arguments as deductive, inductive, or inference to the best explanation.
- Evaluate arguments for logical consistency.
- Recognize and explain common formal and informal fallacies in reasoning, particularly within scientific contexts.
- Analyze the influence of cognitive biases (e.g., confirmation bias, cherry-picking) and value assumptions on scientific reasoning.
- Apply strategies for addressing fallacious or biased reasoning in order to strengthen the quality of arguments in science.

Module 3: Critical Thinking in Science

Goal: Develop a strong knowledge foundation on the contemporary research method and discover how critical thinking has been developed in the past, how it drives the design, execution, and analysis of experiments in current science. Strengthen the ability to critically appraise scientific studies and data.

Description: Module 3 will provide students with a solid foundation in the contemporary research method while exploring the historical development of critical thinking. By understanding how critical thinking has shaped scientific inquiry over time, students will learn how it influences the design, execution, and analysis of modern experiments. A background to students will be provided to apply these principles to conduct rigorous, well-reasoned scientific research.

Learning Outcomes

By the end of this module, learners will be able to:

- Explain the historical development of the scientific method and its role in shaping modern scientific inquiry.
- Identify and describe the core components of the contemporary scientific method, including observation, hypothesis development, experimental design, data collection and analysis, interpretation, peer review, and dissemination.
- Critically evaluate the limitations of different research designs, including correlation studies, interventions, randomized controlled trials (RCTs), and blinded/double-blinded experiments.
- Apply principles of ethical research conduct, including proper citation, avoidance of plagiarism, transparency, and data protection in scientific studies.
- Understand the role of scientific language to accurately communicate research questions, methods, and findings effectively.
- Students will be able to design a simple scientific experiment using a structured study protocol and demonstrate how an AI tool can assist in planning and organizing their research process.

Module 4: Practical Application – Projects & Case Studies

Goal: Implement critical thinking skills in individual (and group) projects.

Description: Students will train critically evaluating scientific claims (in the media), distinguishing between reliable science and misinformation. Students will apply their acquired knowledge to real-world scientific cases.

Learning Outcomes

Upon successful completion of this module, students will be able to:

- Identify scientific and pseudoscientific claims in contemporary media and public discourse.
- Analyse arguments, evidence, and reasoning used in scientific communication and detect logical fallacies or biases.
- Evaluate the credibility and reliability of scientific sources, datasets, and media content using structured criteria.
- Apply principles of critical and scientific thinking to discipline-specific issues, demonstrating the ability to form independent, evidence-based judgments.
- Reflect on their own reasoning process and recognise personal cognitive biases influencing interpretation of scientific information.
- Demonstrate the ability to transfer critical thinking skills to professional or academic contexts through an individual project and self-assessment.