DA2205 Introduction to the Philosophy of Science and Research Methodology 7.5 credits

(also called Theory and Methodology of Science – TaMoS)

4.5 Credits part - course memo period 2, 2024

Contents

Introduction

A warm welcome to the second part of the course! In this part you will learn about the theory and methodology of science through a series of online lectures, seminars, and quizzes. The course ends with an exam. A 4.5 credits course represents 12 hours of study each week, including scheduled hours.

Advice from previous students

In course evaluations for previous periods, students wanted to pass on the following advice.

- This course is different from many other courses in an engineering degree, and often requires a slightly different approach.
- It is a good idea to follow along with the course structure, such as watching lectures when they are scheduled and completing the quizzes.
- It is useful to take careful notes during the lectures. However, this increases the viewing time of the videos, so you need to plan for that.
- Taking time to prepare for the seminars and actively engaging in the seminars makes it much easier to understand the course concepts and pass the exam.

Intended learning outcomes

This part of the course is examined through four seminars (1.5 credits) and an exam (3 credits). Students demonstrate their skills orally in the seminars and in writing in the exam.

After having completed the course, the student should, with regards to the theory and methodology of science, both orally as well as in writing, be able to:

1. Identify definitions and descriptions of concepts, theories, and problem areas, as well as identify the correct application of these concepts and theories.
2. Account for concepts, theories, and general problem areas, as well as apply concepts and theories to specific cases.
3. Critically discuss the definitions and applications of concepts and theories as they apply to specific cases of scientific research.

Disability – Support via Funka

If you have a disability, you may receive support from Funka. More information at: https://www.kth.se/en/student/studentliv/funktionsnedsattning. We recommend you inform us regarding any need you may have since Funka does not automatically inform the teacher.

Contact information

Any kind of questions can be e-mailed to Henrik Lundvall (course contact): henrik12@kth.se (make sure to always include your course code). Do not use the Canvas messaging system, as we cannot track which questions have been answered or not. We currently have no office hours, but you are welcome to schedule a meeting by sending us an e-mail.

Examiner: Arvind Kumar, arvkumar@kth.se
Course contact: Henrik Lundvall, henrik12@kth.se

Schedule

You find the course schedule on www.kth.se/schema, by searching for your course code.

You can find due dates for the assignments and quizzes on Canvas, under assignments.

Course literature

There is one main course text:

- *Justified Method Choice - Scientific Methodology for Scientists and Engineers* by Till Grüne-Yanoff.

In addition, there are three supplemental texts:

- *The Art of Doing Science* by Sven Ove Hansson.
- *Algorithmic Reasoning and its Limitations* by Tor Sandqvist.
- *On Being a Scientist: Responsible Conduct in Research,* which is an excerpt from a text by the National Academy of Sciences.
- *Ethical Thinking* by Jesper Ahlin.

All are available in the file format pdf from the Canvas pages. They cannot be bought as physical books, but you are welcome to print them. On the Canvas page “Reading instructions” you can see which sections to read for the lectures. There are also texts for the seminars, see the document “Seminar information” on Canvas.

Lectures

This course includes the following eleven lectures. Most of them are available as videos on Canvas to watch whenever you want. Their place in the schedule is a suggestion of when you might view them. The exceptions are the lectures “Introduction and scientific knowledge” and “Algorithmic reasoning and its limitations” which are given as campus lectures.

1. Introduction and scientific knowledge (at campus)
2. Scientific inferences (59 minutes)
3. Observation and measurement (76 minutes)
4. Experiments (49 minutes)
5. Models (62 minutes)
6. Statistics (62 minutes)
7. Explanations and causes (81 minutes)
8. Algorithmic Reasoning and its Limitations design (at campus)
9. Qualitative methods (93 minutes)
10. Research Ethics (103 minutes)
11. Anticipating Risk in Science and Engineering (84 minutes)

From the second lecture onward, there is an associated quiz of 15 questions. If you complete the quiz with at least 14 points, you will get 0.5 bonus points. You can attempt to complete the quiz as many times as you like until it closes. This quiz closes at the end of the week where the lecture is scheduled (Sunday, 23:59, of each week). This is to incentivise studying throughout the course, rather than only at the end.

In addition to the quizzes, there are two flipped classrooms. During these hours, the lecturer answers your questions. You must ask the question on a discussion forum (link available on Canvas) and you will be able to “like” other people’s questions. During the two flipped classroom sessions, students can collect 0.5 bonus points per session. The bonus points from quizzes and flipped classrooms are then scaled to fit the exam format and added to the part 1 exam score, capped at the maximum for that part. Bonus points are valid for the exam and re-exam belonging to the period and year when they were collected.

Seminars, 1.5 credits

The course includes a mandatory seminar series comprised of four seminars. Each seminar covers selected course contents from the video lectures and course readings, and following the first seminar, each subsequent seminar connects to the previous seminars. Seminars are intended as a collaborative learning activity where you practice critically discussing course contents and practice applying course contents to cases, with instruction and support from teaching staff. The overall topics covered during the seminar series are as follows:

- Definitions, operationalizations and hypotheses (course week 3)
- Designing a scientific study (course week 4)
- Interpretation, analysis and evidence (course week 6)
- Risk and research ethics (course week 7).

Since completion of the seminar series yields course credits, the seminars feature mandatory activities: (1) preparing and passing a seminar quiz, and (2) actively participating on the seminar. Missing activities result in seminar incompletion and thus no seminar course credits.

Before each seminar, you read the assigned readings (reading instructions available on Canvas). Before attending each seminar, you must also pass a mandatory seminar preparation quiz (See section on Schedule and see Canvas for deadlines). There is no limit on number of quiz attempts up until the quiz deadline. You must complete the quiz with a passing score of 14 points before the deadline (indicated in Canvas as “Passed”).

The preparation quizzes are intended to ensure that all participants come prepared to the seminar for a more rewarding seminar learning experience. If you attend the seminar without completing the preparation quiz beforehand, you will not be marked as attending.

On the seminar, you will be working together with other students on exercises as per instructed by the teacher. The exercises are formulated in such a way as to promote critical reflection and discussion, as well as to practice application of course concepts to case scenarios.

You are expected to engage actively with the course contents and work on the exercises during the seminar. Passive attendance on the seminar will be marked as not attending. Active participation on the seminar does not mean that you are expected to demonstrate full proficiency of course contents. Rather, it means that you are expected to have properly engaged with the relevant course material beforehand and made an honest attempt at understanding it. Arisen questions and reflections can be addressed on the seminar.

For information on what to do if you have not completed a preparation quiz or actively attended on a seminar, see the section on Examination and completion.

Note that the TimeEdit course schedule shows multiple seminar slots for every seminar week. The different slots correspond to different seminar groups. You will join only one seminar group upon course start and your group takes only one seminar per seminar week. Instructions on how to join a seminar group as well as a seminar group schedule will be available on Canvas after the course starts and before the start of the seminar series.

Seminar contents and reading instructions. All the texts can be found on Canvas.

Seminar 1 – Definitions, operationalizations and hypotheses.

Texts:

- Grüne-Yanoff, Till – Justified Method Choice, chapters 1, 2, 3, 13
- Optional reading: Hansson, Sven Ove – Art of Doing Science: sections 2.2-2.8, 3.1-3.2, 5.0-5.1, and 5.8

Topics relevant for the seminar:

- Stipulative and lexical definitions
- Narrowness and broadness (as applied to definitions)
- Vagueness
- Hypotheses (and their quality criteria)
- Direct, aided and indirect observation
- Operationalization
- Accuracy and precision (as qualities of observations and measurements)
- Measurement error (random and systematic error)
- Convergent validity and divergent validity

Seminar 2 – Designing a scientific study.

Texts:

- Grüne-Yanoff, Till – Justified Method Choice, chapters 4, 5.
- Optional reading: Hansson, Sven Ove – Art of Doing Science: sections 3.7, 4.2-4, and 5.1-3.

Topics relevant for the seminar:

- Experiment, observational studies and model studies
- Mill's method of difference
- Internal validity and external validity
- Experimental control
- Constancy, elimination and effect separation

- Randomization
- Control group and treatment group
- Observer influence
- Confirmation bias
- Blinding
- Epistemic virtues of models (Parameter precision, Similarity, Robustness, Simplicity, Tractability, Transparency)
- Analogies (positive, negative, neutral)

Seminar 3: Interpretation, analysis and evidence.

Texts:

- Grüne-Yanoff, Till – Justified Method Choice: chapters 2, 6, 7.
- Optional reading: Hansson, Sven Ove – Art of Doing Science: sections 1.6-7, 3.7, 3.9, 5.3-5, 5.7, 7, 8 and the box on p. 24.

Topics relevant for the seminar:

- Repeatability, reproducibility and replicability
- Statistical evaluation
- Statistical significance
- Correlation and causality
- Explanatory virtues (Accuracy [of explanations], Non-sensitivity, Precision in the explanans, Precision of the explanandum, Cognitive salience)
- Duhem-Quine thesis
- Ad-hoc hypothesis
- Falsificationism (Popper)
- Inductive and deductive inferences

Seminar 4: Risk and research ethics.

Texts:

- Grüne-Yanoff, Till – Justified Method Choice, chapters 11, 12.
- "On Being a Scientist: Responsible Conduct in Research", National academy of Sciences.
- Ahlin, Jesper, "Ethical Thinking".
- Optional reading: Hansson, Sven Ove - Art of Doing Science: Section 9.

Topics relevant for the seminar:

- Gift authorship and ghost authorship
- Scientific misconduct (falsification, fabrication and plagiarism)
- Informed consent
- Deontology, consequentialism and virtue ethics
- Precautionary principle
- Decision making (under certainty/risk/ignorance/deep uncertainty)

Exam, 3 credits

There is an exam at the end of the course. To take this exam you need to register for it on kth.se during the exam registration period.

The exam consists of three parts. Part 1 is a multiple-choice part, primarily examining the first learning outcome. For each question there can be 1-4 correct options and you need to select all correct options and only the correct options to get 1 point. Partial points are not given. The bonus points collected during the period are then applied to the score on part 1 in 0.5 increments up to a score of 15.

Part 2 consists of two essay questions. You are here asked to explain and discuss, in your own words, the meaning of some of the course concepts and apply them to specific situations. This part tests the

second and third learning outcome, up to grade level C. Each question is graded between 0-5 points, in 0.5-points increments.

Part 3 tests learning outcome two and three, on the grade level between C and A. Here you are asked to explain and critically discuss the course terminology in an independent way. You do not have to complete part 3 to pass the exam, but the maximum grade is then C. Completing part 3 cannot increase your grade from below C. This part is graded C, B and A without the use of points, and bonus point cannot increase the grade above C. You have three hours to complete parts 2 and 3.

During the exam you are allowed to access the course material. Each submission will be reviewed for plagiarism. Note that you will not have enough time to complete the exam unless you have studied during the course. You can give your answers in English or Swedish.

Grading criteria

The grading criteria for the parts of the course graded pass or fail are the same as the fulfilment of the course learning outcomes, in the way stated above. Below are the grading criteria for the exam, in Swedish, with English translation. The letter grade is determined by the fulfilment of all required criteria for each grade. Grading tables will be available a couple of weeks after the course starts. The letter grade is based on the exam.

Grading criteria can be found on the following pages.

	Lärandemål 1: Identifiera definitioner och beskrivningar av begrepp, teorier och problemområden, samt identifiera den korrekta applikationen av dessa begrepp och teorier. ***Learning outcome 1:*** *Identify definitions and descriptions of concepts, theories and problem areas, as well as identify the correct application of these concepts and theories.*	**Lärandemål 2:** Redogöra för begrepp, teorier och generella problemområden, samt tillämpa begrepp och teorier på specifika fall. ***Learning outcome 2:*** *Account for concepts, theories and general problem areas, as well as apply concepts and theories to specific cases*	**Lärandemål 3:** Kritiskt diskutera definitionerna och tillämpningarna av begrepp och teorier med avseende på specifika fall av vetenskaplig forskning. ***Learning outcome 3:*** *Critically discuss the definitions and applications of concepts and theories as they apply to specific cases of scientific research.*
A	Studenten identifierar **ett flertal** av definitioner och beskrivningar av begrepp, teorier och problemområden korrekt samt identifierar den korrekta tillämpningen av dessa begrepp och teorier. *The student identifies **multiple** definitions and descriptions of concepts, theories and problem areas, and identifies the correct*	Studenten redogör korrekt, samt med **stor utförlighet** och precision för kursbegrepp, teorier och problemområden samt gör rimliga tillämpningar av dessa begrepp och teorier på ett **mycket övertygande sätt**. *The student provides correct, **extensive** and precise accounts for concepts, theories and general problem areas, and provides **very convincing** applications of those concepts and theories to specific cases.*	Studenten framställer en **välargumenterad** diskussion av definitionerna och tillämpningarna av begrepp och teorier med avseende på vetenskaplig forskning på ett utförligt, **självständigt** och **mycket precist** sätt. *The student presents a **well-argued, independent,** extensive and **very precise** discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research.*

B	*application of these concepts and theories.*	Studenten redogör korrekt och med **precision** för kursbegrepp, teorier och problemområden samt gör rimliga tillämpningar av dessa begrepp och teorier på ett **övertygande sätt**. *The student provides correct and **precise** accounts for concepts, theories and general problem areas, and provides **convincing** applications of those concepts and theories to specific cases.*	Studenten framställer en **huvudsakligen välargumenterad** diskussion av definitionerna och tillämpningarna av begrepp och teorier med avseende på vetenskaplig forskning på ett **utförligt** och precist sätt samt med **viss självständighet** i framställningen. *The student presents an **extensive,** precise**, mostly well-argued**, and **somewhat independent** discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research.*
C		Studenten redogör **korrekt och tydligt** för kursbegrepp, teorier och problemområden samt gör **rimliga tillämpningar** av dessa begrepp och teorier på specifika fall. *The student accounts, **correctly and clearly** for concepts, theories and general problem areas, and provides **reasonable applications** of these concepts and theories to specific cases.*	Studenten framställer en diskussion av definitionerna och tillämpningar av begrepp och teorier med avseende på vetenskaplig forskning på ett **precist** sätt med **ansats till argumentation och självständighet**. *The student presents a discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research in a **precise way** with an **attempt at independent and argumentative** reasoning.*
D		Studenten redogör **i huvudsak korrekt** och med **tillräckliga beskrivningar** av kursbegrepp, teorier och problemområden och gör acceptabla tillämpningar av dessa begrepp och teorier på specifika fall. *The student provides mostly correct and **sufficiently satisfactory** accounts of concepts, theories and general problem areas, and provides acceptable applications of these concepts and theories to specific cases.*	Studenten framställer en diskussion av definitionerna och tillämpningarna av begrepp och teorier med avseende på vetenskaplig forskning **utan större felaktigheter eller motsägelser**. *The student presents a discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research **without substantial errors or contradictions**.*
E		Studenten redogör **med knapphändiga beskrivningar i huvudsak korrekt** för kursbegrepp, teorier och problemområden och gör **acceptabla tillämpningar** av begrepp och teorier på specifika fall. *The student provides **sparse, but mostly correct** accounts of concepts, theories and general problem areas and provides **acceptable** applications of those concepts and theories to specific cases.*	Studenten framställer en diskussion av definitionerna och tillämpningarna av begrepp och teorier med avseende på vetenskaplig forskning **som knapphändig, eller i enstaka fall felaktig eller motsägelsefull.** *The student presents a **sparse** discussion of the definitions and applications of concepts and theories, as they apply to specific cases of scientific research, with **some notable errors or contradictions**.*

FX		Studentens redogörelser av kursbegrepp, teorier och problemområden **är markant inkorrekta eller mycket knapphändiga**. Studentens tillämpningar av begrepp och teorier på specifika fall är **delvis inkorrekta.** *The student's accounts of concepts, theories and general problem areas are **very sparse or contains substantial errors**. The student's applications of those concepts and theories are **partially incorrect**.*	Studenten gör en **ansats** till att diskutera definitionerna och tillämpningarna av begrepp och teorier med avseende på vetenskaplig forskning, men framställningen är **markant otydlig, felaktig eller motsägelsefull**. *The student presents an **attempt** at a discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research, but the discussion is **substantially unclear, wrong or contradictory**.*
F	Studenten identifierar som mest **enstaka** definitioner och beskrivningar av begrepp, teorier och problemområden korrekt eller identifierar inte den korrekta tillämpningen av dessa begrepp och teorier. *The student identifies at most a few definitions and descriptions of concepts, theories and problem areas, or does not identify the correct application of these concepts and theories.*	Studentens redogörelser av kursbegrepp, teorier och problemområden **saknas eller är** (mestadels eller helt) **inkorrekta** och tillämpningarna av begrepp och teorier på specifika fall **saknas eller är i stor utsträckning felaktiga**. *The student's accounts of concepts, theories and general problem areas are (substantially or completely) **incorrect or missing**. The student's applications of those concepts and theories are **largely incorrect or missing**.*	Studenten **genomför inte** en diskussion av definitionerna eller inte av tillämpningen av kursbegreppen, eller så är dennes diskussion **otydlig, felaktig eller motsägelsefull**. *The student **does not present** a discussion of the definitions and applications of concepts and theories as they apply to specific cases of scientific research, or their discussion is **unclear, wrong or contradictory**.*