Theory and Methodology of Science - TaMoS

Seminar instructions

AK2030, AK2036, DA2205, FAK3024, FAK3137

Contents

1. Introduction

There are four seminars, given over a period of five weeks. All seminars are mandatory. Each seminar will be given several times during its specific seminar week, but you must only attend each seminar once. You are not expected to attend all the sessions shown in the schedule.

Seminar 1 will be given on campus and seminars 2, 3 and 4 will be held over Zoom. Make sure you have installed Zoom and logged in with your KTH account. A microphone and a web camera are needed. Note that Zoom will also work on your mobile phone with the Zoom app. We will offer a Zoom-seminar group for seminar 1 as well, but only for students who are unable to join due to health reasons or because of immigration issues.

You join a seminar group under "People" in Canvas, and take all seminars with this group, on the same day of the week, at the same time. You can find a list with all seminar groups on the Canvas page Seminars. Here you will also find the Zoom-links for meeting 2 onwards.

The seminars target some of the topics introduced in the lectures. However, in the seminars you will practice at engaging with these topics independently and in-depth, working in smaller groups with tasks provided by the teacher. You and your peers will discuss your own and the other groups' solutions to the tasks.

2. Passing criteria

To pass each seminar, you must do the following things:

- Read the assigned material.
- Successfully complete the seminar preparation quiz by getting at least 14 points before your seminar.
    - If you attend the seminar without having passed the seminar quiz, your attendance will not be marked in Canvas.
    - The quizzes are open until Friday of each seminar week, but you need to do it before **your own** seminar.
- Actively participate in the seminar. Make sure you are prepared to answer questions and participate in discussions relating to the course concepts.

If you fail to do any of the above tasks, your attendance at the seminar will not be registered.

The "due date" of each quiz is set to Mondays at 15:15, the first seminar of each week, to help you remember that it needs to be done to pass the course. Canvas will indicate that your submission is "late" if you submit after this date, even though it is not. This "late" label does not mean anything for our purposes, and as long as you submit before your own seminar, you have done what you are supposed to.

The seminars are first and foremost intended to be a learning environment. However, since you are awarded with credits for passing the seminars, you are expected to be able to prepare before attending a seminar and participating actively. Do not worry if you think some part of the seminar contents (like a particular concept or theory) is complicated or difficult to understand. We primarily expect you to demonstrate that you have studied the material and tried to get a grasp of it.

3. Seminar contents and reading instructions

All the texts can be found in the Files-section on the Canvas course page.

Seminar 1 – Definitions, operationalizations and hypotheses

Texts

- Grüne-Yanoff, Till – Experiments, Models and Methodology: part 1, 2, 3, 12
- Hansson, Sven Ove – Art of Doing Science: sections 2.2-2.8, 3.1-3.2, 5.0-5.1, and 5.8

Concepts that you will be expected to be able to explain when you attend 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

Prepare answers for classroom discussion of these questions:

- What could be an operationalization for the concept of being financially successful?
- Suggest a good stipulative definition of "studied at KTH" given the purpose of investigating whether such people tend to earn more in their careers than others?

Seminar 2 – Designing a scientific study

Texts

- Grüne-Yanoff, Till - Experiments, Models and Methodology, part 4
- Hansson, Sven Ove – Art of Doing Science: sections 3.7, 4.2-4, and 5.1-3

Concepts that you will be expected to be able to explain when you attend the seminar:

- Experiment, observational studies, and simulations
- 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
- The interpretation problem
- Blinding

Prepare answers for classroom discussion of these questions:

- Consider the following hypotheses:
    1. Eco-friendly light bulbs cause skin cancer.
    2. Green roofs lead to heat reduction in urban areas.
    3. Eating red meat negatively affects memory.
- What type of study (observational study, experiment, simulation experiment) do you think would be the most suitable one for each of the hypotheses?
- For each of the three hypotheses, how would you implement control and treatment groups?

Seminar 3: Interpretation, analysis and evidence

Texts

- 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
- Grüne-Yanoff, Till - Experiments, Models and Methodology: part 6, 7
- "Seminar 3 Cases", see below.

Concepts that you should be able to explain:

- Repeatability, reproducibility, and replicability
- Statistical evaluation (p-value, significance level, control group)
- Causal explanation
- Deductive-Nomological account of explanation
- Correlation and causality
- Hypothetico-Deductive method for hypothesis testing
- Duhem-Quine thesis
- Ad hoc-hypothesis

- Falsificationism (Popper)

Prepare answers for classroom discussion of these questions:

- Formalize the experiment described in the case “Comprehension and digital note-taking applications” in the form of a hypothetico deductive test. Make sure to specify what the hypothesis is, what the auxiliary hypothesis are and what is the resulting conclusion.
- Explanandum: “Why did it take 3 seconds for the object to reach the ground, rather than 2 seconds?”. Law: Newtons 3rd law of motion. Try to come up with initial conditions (as many as needed) that together with the stated law would provide an explanation according the deductive nomological model of explanation. (If you find this hard, do the best you can and present what you came up with in the seminar.)

Seminar 4: Risk and research ethics

Texts

- ”On Being a Scientist: Responsible Conduct in Research“, National academy of Sciences
- Ahlin, Jesper, “Ethical Thinking”
- Grüne-Yanoff, Till - Experiments, Models and Methodology, part 11
- Hansson, Sven Ove - Art of Doing Science: Section 9

Concepts that you should be able to explain:

- Gift authorship and ghost authorship
- Informed consent
- Falsification, fabrication, and plagiarism
- Precautionary principle
- Descriptive/normative distinction
- Deontology, consequentialism, and virtue ethics

Prepare answers for classroom discussion of these questions:

- Imagine the following scenario. A research has been conducted with good intentions but the test subjects’ rights to their own bodies have been violated. What do you think the three different normative theories would say in this case?
- Consider the statement “I could never kill another person”. Is this a descriptive or a normative statement? Now, reformulate the statement so that it becomes normative or descriptive (depending on whether you think it is descriptive or normative to begin with).

4. Cases for seminar 3

Traffic Jams and Speed Limits on Inner-city Streets

Extended Abstract
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Traffic jams on highways are often caused by cars braking unexpectedly, causing other cars to brake and then having to accelerate again. The effects can continue to propagate to new cars for quite some time; hence, the effects of just one car braking for an obstacle can linger long after the actual obstacle is removed. It has previously been observed that this effect can be removed by lowering the speed limit. The causal model suggested to explain this states that

> *decreased speed limits reduce the need for sudden braking, and thus allows cars to keep a more constant speed.* (Andersson, Pettersson, & Lundström, 2018)

The aim of this study is to investigate whether this also holds true for inner-city streets; the hypothesis being that

> *a reduced speed limit decreases traffic jams on inner-city streets, and thus reduces the average time that cars spend on the street.*

The hypothesis above was tested on Markvardsgatan; a 250 m long one-way city street in Stockholm with street-side parking and one pedestrian crossing (see fig. 1). A camera was placed at the beginning of the street, identifying the license plate of each car that entered and making a time stamp. Another camera was placed at the end of the street, identifying exiting cars and making time stamps in the same way. The intervals between the two time stamps were used to calculate time spent on the street for each car. Data was collected over a period of two weeks. After this, on the first of July, the speed limit was changed from 40 to 30 km/h. After an additional two weeks of data retrieval the results were processed.

Our results show that the total time spent on the street per car decreased during the latter period. Additionally, during July, a larger number of registered cars did not exit the street as compared to June. We find it plausible that those cars have either taken a side road or been parked on the street. From this, we conclude that a decreased speed limit reduces traffic jams on inner-city streets. This means that the causal model of Andersson et al. (2018), explaining highway traffic jams, also holds true for inner city streets. We can also conclude that, somewhat counterintuitively, decreasing the speed limit on a city street actually *reduces* travel time.

Figure 1: Markvardsgatan, Stockholm

References:
Andersson, A., Pettersson, P. & Lundström, L. (2018). Higways and Sudden Braking: The Effects of Speed Limits on Traffic Jams. *TaMoS Road Research Quarterly*, 16-52.

Comprehension and digital note-taking applications

Extended Abstract
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Traditionally, students who attend lectures take notes using a pen and paper. Some studies show that taking lecture notes on digital devices negatively affect comprehension, compared to taking notes with pen and paper. Comprehension is here understood as ability to answer complex, analytical questions in relation to some material.

To mitigate this, PopUpNotes, an online note-taking application for mobile phones and computers, has been developed by T-Ten. The program features a text editor which prompts students to take notes in the program at certain intervals and popups with randomly chosen questions to answer in the program, such as "How does what is being said now relate to the topic?" and "Can you think of a counter-argument to point just made?". The notes are saved and can then be used for studying. To test if this application works the way it is claimed, we, a team of researchers from the Tamos Technical Institute, showed a 15-minute-long video on a big screen about the development of space flight to 20 students at Luleå Technical University. Students were given a computer and a log-in to the application. They chose to take part in the test in exchange for a lunch sandwich.

Immediately after having watched the video, each student was instructed to fill out a questionnaire on the computer. The students were asked to give essay answers to the following questions: "What was the main reason for the development of space flight?", "Which individual mentioned in the video was most important for the development of space flight? Explain your answer.", and "What was stated to be the next horizon for the development in spaceflight? Do you agree? Explain your reasoning." The answers were then discussed by the researchers, after which each researcher gave each and every survey a score between 1 and 100 on three qualities: accuracy, depth, and convincingness.

The results from Luleå was that the average score was very high for all three qualities. We hypothesized that this was due to the university's high profile as a space-related school, and that students might have known a lot about the development of space flight prior to watching the video. Additional research was therefore performed at Uppsala and Stockholm University in November, and again at Lund University in March. This was also done to ensure generalizability of the results to other contexts, such as other non-technical universities or so called University Colleges ("högskolor") and perhaps even high-schools ("gymnasier"). Such general applicability would make PopUpNotes in line with the digitalization in education program in Sweden.

	Luleå	Uppsala	Stockholm	Lund
Participants	10	47	16	18
Average accuracy	98	95	80	90
Average depth	97	80	75	90
Average convincingness	95	79	95	65
Total	290	254	250	245

Given that the total average is 259, a very good score since it is 86% of total possible score, we concluded that PopUpNotes is a good tool for note-taking on a digital device and that it mitigates the possible negative effects of using a digital device. Since all scores were high, and there was low variance between cities, this was a clear indication that this could be generalized to further targets, perhaps even high schools ("gymnasier").

References:
Johansson, K., & Schewens, C., (2016). Pop-Up knowledge - on improving note taking. *Education Research Quarterly*, 9-78.

Conflicting interests: none declared.