How can generative AI further students' modelling process?



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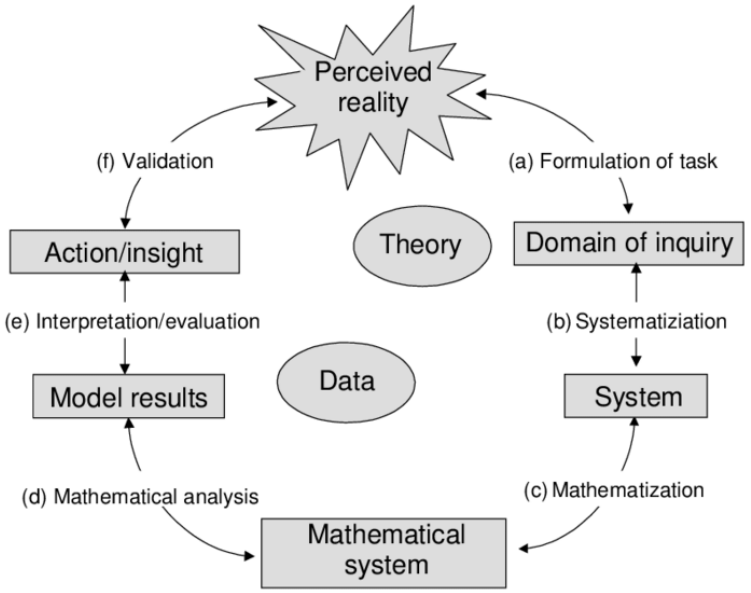
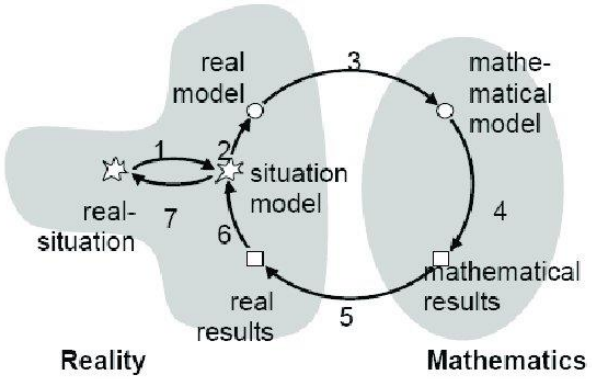
Agenda

1. Modelling and Frameworks
   - RQ
2. Designed Activity
3. A priori analysis
4. A posteriori analysis
   - The role of ChatGPT
5. Results

1: Modelling

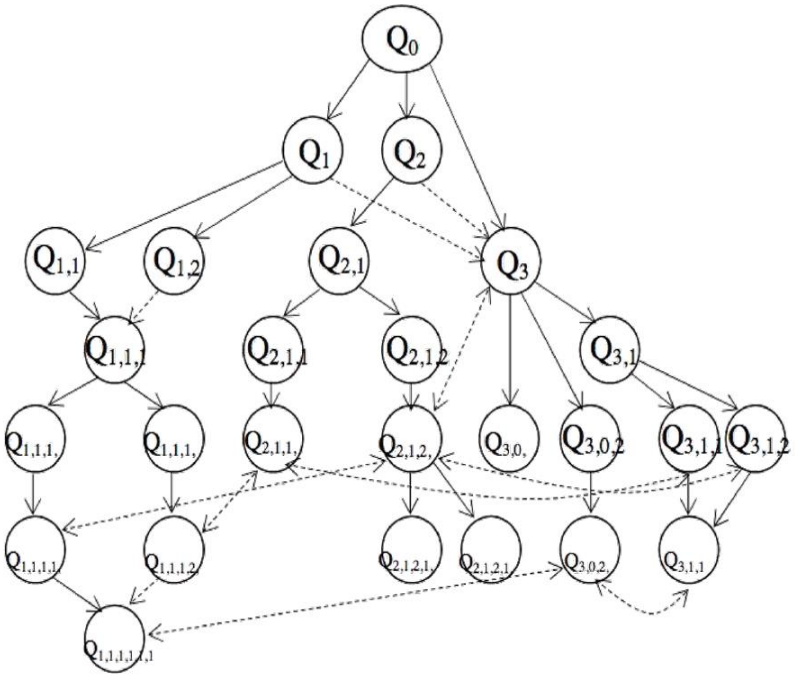


1. Understanding the task
2. Simplifying/structuring
3. Mathematising
4. Working mathematically
5. Interpretation
6. Validation
7. Presenting



Question-driven process, where we can analyse the role of generative AI and its support of students' inquiry

1: Modelling: Study and Research Process



Theory:
The Anthropological Theory of Didactic (ATD)

Framework:
Study and Research Paths (SRP)
&
Herbatian Schema

1: Modelling: Study and Research Process

Initiated by a *Generating Question*, Q_0

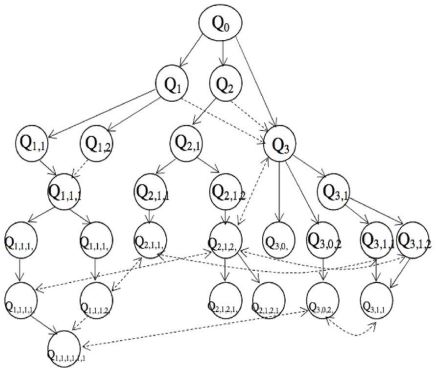
Study: acquire new knowledge from different sources i.e., textbooks, videos, existing models, etc.

Research: decompose and reconstruct the new knowledge to give partial answers to Q_0

Example:

Q_0: ”Are boys better at math than girls?”

Study: Study a model to analyse the data set, study how to apply the model, etc.



1: Modelling: The Herbartian Schema

[S(X;Y;Q)➡M]➥ A♥

S: the Didactical System
X: a group of learners
Y: someone to guide the process
M: Milieu
A♥: Personal answer

$A_i^{\Diamond}$: existing answers or knowledge
W_i: works
D_i : Data

$$M=\{A_1^{\Diamond},A_2^{\Diamond}\ldots,A_l^{\Diamond},W_1,W_2,\ldots,W_m,D_1,D_2\ldots,D_n\}$$

How does ChatGPT enrich the milieu?

2: Designed Activity

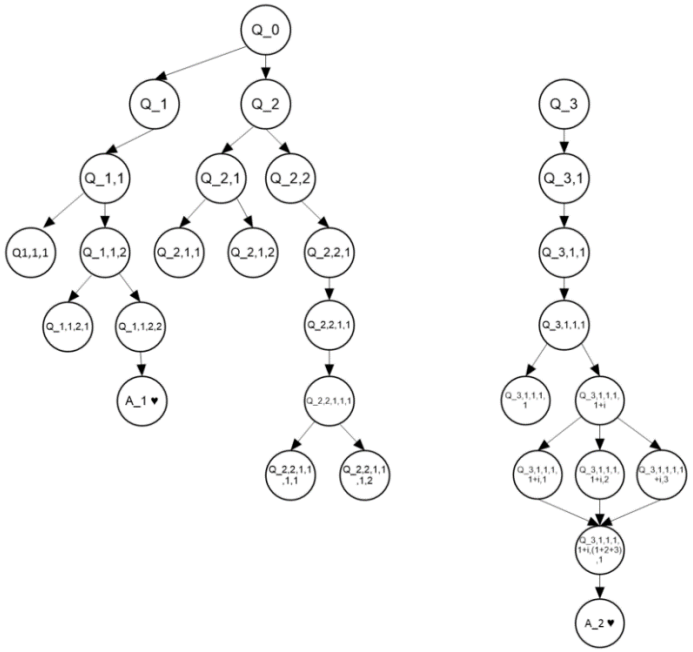
2’nd week in the course Applied Statistics (15 ECTS) for 2’nd semester data science bachelor students

Q_0: Design a study that aims at answering the question “Are boys better at math than girls?”

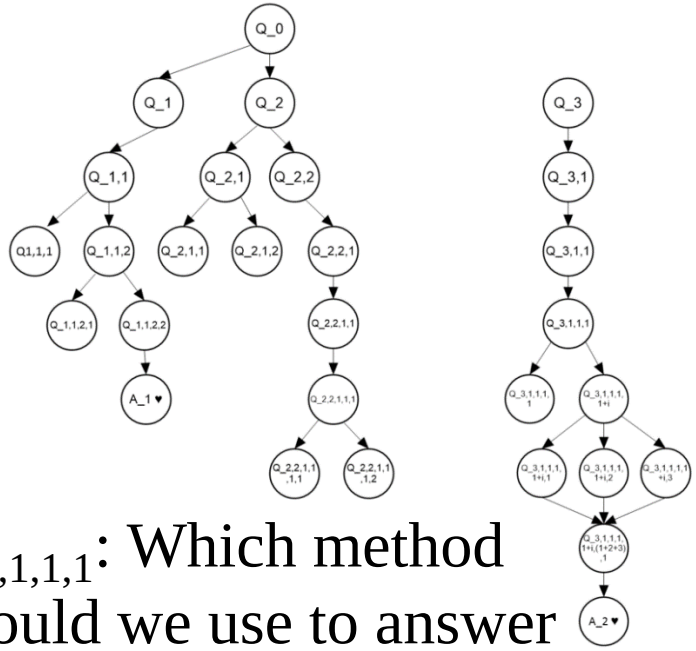
Hand in 5 pages + logbook of questions and resources

Q_3: What does the following data set say about “Are boys better at math than girls?”

Hand in 10 pages + logbook of questions and resources



3: A priori analysis



Data set: all given grades in written mathematics A-level, and the sex of the student in the year 2019. (10.000+ data points)

$Q_{3,1,1,1}$: Which method should we use to answer

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before applying a statistical
test assumptions must be met
and the research question as
well as context should be
considered
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$Q_{3,1,1,1,1}$: What is the distribution of our data set?

$Q_{3,1,1,1,1+i,1,3}$: Can the method answer $Q_{3,1,1}$

$Q_{3,1,1,1,1+i,2}$: Is the method appropriate for the context of our study

$Q_{3,1,1,1,1+i,1}$: Are the assumptions of the method fulfilled

3:Posteriori How does ChatGPT enrich the milieu?

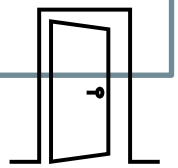
Q_1:"what kind of approaches are there to conduct a statistical analysis on a data set about grades?"

descriptive statistics, data visualisation, inferential statistics, regression analysis, multivariate analysis, longitudinal analysis, cluster analysis, machine learning, survival analysis and text analysis

works to be studied: W_1, W_2, W_3, ..., W_{10}

$Q_{1,1}$: "expand on inferential statistics",

hypothesis testing, confidence interval, sample distribution, central limit theorem, type I and type II errors, power analysis, effect size and assumptions



new works, W_{11}, ..., W_{20}

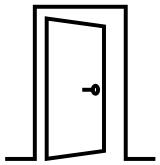
3: Posteriori How does ChatGPT enrich the milieu?

$Q_{1,1,1}$:"how do I go about hypothesis testing"

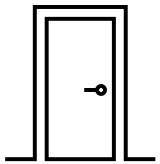
formulate hypotheses, select a significant level, choose test statistics, etc.

works to be studied: W_{21}, W_{22}, ..., W_{30}

W_23: "test statistic depends on the type of data and the hypothesis being tested. Common test statistics include t-test, z-test, χ^2-test, ANOVA, etc."



Null hypothesis: definition directly applicable to data set.



3: Posteriori

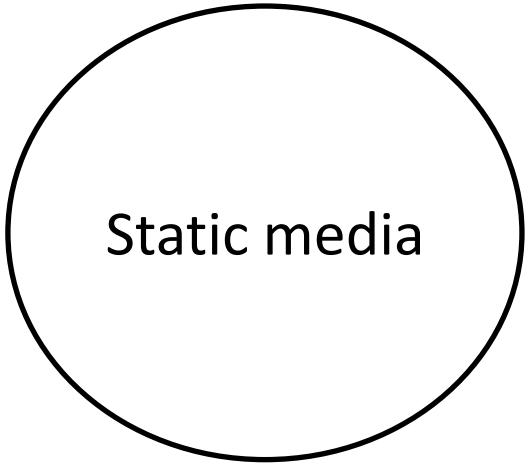
What did the students not use ChatGPT for?

Q_2 :"What can a bootstrap analysis be used for?

$Q_{2,1}$:How to perform it?"

$Q_{2,2}$: How to "conclude on bootstrap analysis, the importance of confidence intervals"

$Q_{2,3}$: "What are the shortcomings of a bootstrap analysis"



4: Result

ChatGPT is used for both broad domains to be studied but also provides definitions.

YouTube videos and webpages enrich the milieu with concrete techniques and methods to be used.

Nudging the continuous questioning done by students

Productive to engage university students in stochastic simulations

Some students were reluctant to go beyond their existing knowledge

Let us ask more complex questions to be studied by the students

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Our two papers are to appear in 2025.

Videos introducing the Anthropological Theory of Didactic
https://www.mathunion.org/icmi/awards/amor/yves-chevallard-unit

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