Improving conceptual understanding by inductive teaching:

An example of its success

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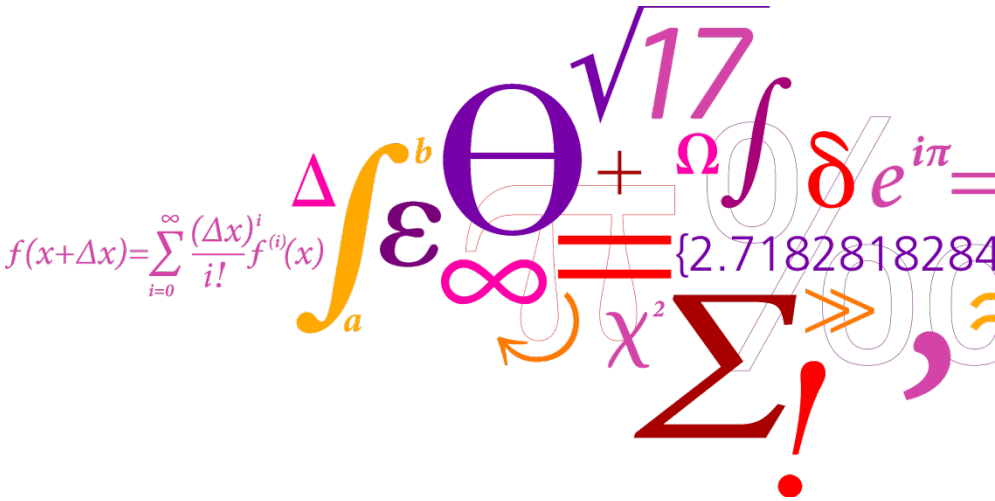


DTU Food
National Food Institute

Program

- My experience
- Discussion in groups
- Plenary

Introduction

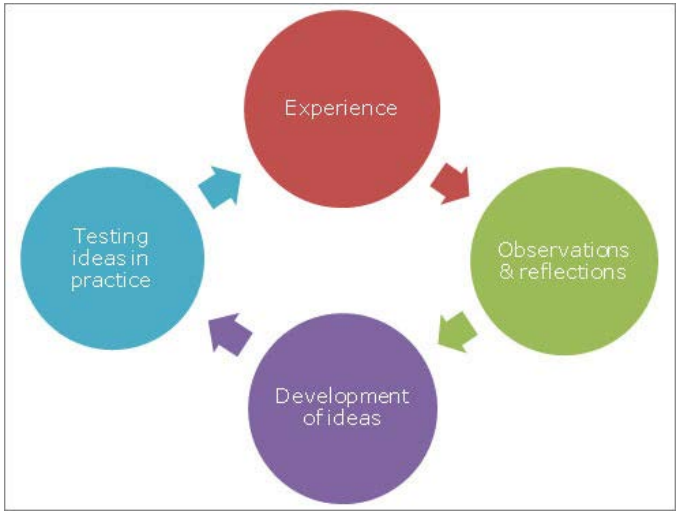
- My teaching: I learned by doing

- UDTU4 (2015):
  - Can I improve by changing the teaching method?
    - Without modifying a good course too much

- Use of inductive teaching

  - Learn by doing: Kolb's learning cycle (Experience, Reflection, Conceptualization and Practice)

  - Can I develop it?
  - Does it work?



Course

- ***Quantitative Microbiological Risk Assessment***

- ***3 wk 5 ECTS PhD course,***

  PhD students
  MSc students
  Post docs
  Food safety professionals

  International
  Variety of backgrounds

  Up to 20 students, 1 - 2 teachers

Relevant Learning Objectives

- *Understand why the variability in a stochastic model dissolves in the mean population risk estimate, and the uncertainty does not.*

- *Apply the separation of uncertainty and variability in a stochastic risk assessment model and explain why it is relevant.*

Challenge

- These LOs require new conceptual understanding, *accommodation* of new knowledge.
  - The intuitive solution to the problem is NOT correct
  - Students should change their way of thinking at a deep level
- How to make them realise this and understand the right solution?

Question

Does it facilitate accommodation of the concepts that

1) the population risk estimate is a single value when you use a stochastic model including variability
2) that you have to characterise the uncertainty of the risk estimate separately from the variability

if you apply inductive learning,

and:

Do I find the right balance between guidance and self-discovery?

Old, deductive appraoch

- Explain the theory
- Give an exercise (**X**) during the lecture
  - *Nobody is able to do it*
- Give an example
- Hope that they can now apply the knowledge
  - Examination by evaluation of a case study report:

  This is not really the case

New, inductive appraoch

- Explain the theory
- Give an exercise (**X**) during the lecture
  - *Nobody is able to do it*
- Give an example

1) Exercise **X** as pretest

2) Give a guided exercise
   - Discover that the intuitive solution is wrong
   - Discuss this with other students
   - Develop a correct solution to the exercise

3) Explain the theory

4) Give a new exercise,
   - Repeat the guided exercise, with an additional challenge

5) Evaluate whether they can now apply the knowledge
   - Use the old exercise (**X**)

Results (1)

1) Exercise **X** as pretest:

- *All students failed, as expected*

- *In the old approach they failed as well*
- *If they succeed later, they learned*.

1) Exercise **X** as pretest

2) Give a guided exercise

3) Explain the theory

4) Give a new exercise,

5) Evaluate whether they can now apply the knowledge

Results (2)

2) Give a guided exercise
   - Discover that the intuitive solution is wrong
   - Discuss this with other students
   - Develop a correct solution to the exercise

1) Exercise **X** as pretest

2) Give a guided exercise

3) Explain the theory

4) Give a new exercise,

5) Evaluate whether they can now apply the knowledge

Example guided exercise

3) Assume that 10,000 people digest a dose of 10 cfu

- How many people do you expect to get ill if r is fixed to 0.01?

- How many people do you expect to get ill if r varies according to a Beta distribution Beta(1,99)?

- Implement the model in @Risk and develop a method to assess the number of people that you expect to get ill.

- Repeat your simulations. What do you see?

- Can you think of another method to assess the number of people that you expect to get ill? How would that go?

- What difference would it make if the question was "How many people do get ill?" Can you answer this question anyway? How?

4) Compare your result of 3) with that of another group.

Did you apply the same method? If not, which one do you prefer?

What is the simplest way to estimate the number of cases?

Results (2)

2) Give a guided exercise

– Discover that the intuitive solution is wrong

They don't

– Discuss this with other students

There's little to discuss when you all make the same mistake

– Develop a correct solution to the exercise

You don't do that when you don't realise there is something wrong

Discussion between teacher and (groups of) students is needed to make them aware of the mistake they make. Thanks to that, some students managed to do it this year

Results (3)

3) Explain the theory

– *I could now refer to the exercise and the discussions the students had*

1) Exercise **X** as pretest

2) Give a guided exercise

3) Explain the theory

4) Give a new exercise,

5) Evaluate whether they can now apply the knowledge

Results(4)

4) Give a new exercise,
   - Repeat the guided exercise, with an additional challenge

   - *Most of the students were now able to do it ☺*
   - *I have achieved my objective*

How come?

- I expect that the exercise helped the students to understand the problem, and opened their minds for the solution.

- In the old approach they did solve it?

1) Exercise **X** as pretest

2) Give a guided exercise

3) Explain the theory

4) Give a new exercise,

5) Evaluate whether they can now apply the knowledge

Results (5)

5) Evaluate whether they can now apply the knowledge
   – Use the old exercise (**X**)

About 50% of the students can do it correctly, a clear improvement compared to the old approach and the pretest.

My new teaching method is more effective than the old one

1) Exercise **X** as pretest

2) Give a guided exercise

3) Explain the theory

4) Give a new exercise,

5) Evaluate whether they can now apply the knowledge

Conclusion

- The new, inductive approach improved the effectivity of the teaching

Theory → *Exercise* → *No Learning*

Exercise → *Theory* → *Learning*

- Even if the new concept doesn't get through in the students exercise, it facilitates accommodation

Discussion

- Is it the inductive approach or is it the guided exercise?
- Performances at exam are not explicitly compared
  - But seemed better for specific LOs
  - A student that missed the classes failed
- There's still 50% of the students who do NOT get it
- How to find the right balance between guidance and self-discovery?

Discussion in groups (3-4 pp.)

- A volunteer shares his/her experience with trying to explain a key concept of teaching that students find difficult to understand

- Volunteer explains what (s)he did to get the message true.
  - Did you change the explanation or the teaching method?
  - What method was used?
  - Did it work?

- Group discussion
  - Group members suggest alternative teaching methods

- Plenary