Researching students' learning of computer science - Different research approaches / methodologies

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Coming lectures and lab

24/9 Qualitative and quantatative research
28/9 Understanding teaching of CS
30/9, 15.15 - 18.00 Lab on qualitative research approach: How do students understand 'object' and 'class'
4/10 Understanding learning of Computer Science
6/10 Quantitative Research methods

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Researching students' learning of computer science - Different research approaches/methodologies

Shows the students' perspective

Today

- Different ways to perform research into learning
  - Quantitative and qualitative research approaches

Shows learning as a part of being in the world

Examples

1. Statistical project - quantitative
   - How should recursion be taught
2. Phenomenography – qualitative
   - Grading in a project course in computer systems?
3. Socio-cultural research perspective - qualitative
   - Why do teams of students produce so different results?

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Have you

- Joined the yahoo group http://groups.yahoo.com/group/CERcourse_Uppsala?
- Read all papers on distributed on http://www.it.uu.se/edu/course/homepage/datadidaktik/ht10/teaching?
- Noted that the lab is at Blåsenhus, Uppsala Learning lab 30 sept until 18.00?

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Lab

- Lab "Understanding object and class"
- Qualitative research, phenomenography

- Preparation (will be available on the web)
  - Where: http://groups.yahoo.com/group/CERcourse_Uppsala/ Click Files
  - File-name: *Interview excerpts for the lab Sept 2010*
  - Read transcripts on the web (31 interview excerpts).
  - Follow instructions in the yahoo group

- After lab
  - Write a report
    - Telling about your results.
    - Discussing your results. Give the reason that you can see to why they are trustworthy and to why they are not.
    - Comment the insights that can be gained from this kind of research.

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Why focus on "learning" in Computing Education Research?

We remember

- How do our students understand and learn computer science concepts?

- How to teach computer science?
- Learning and researchability are closed connected in this context

A research approach = A research methodology = A research framework

We remember

- Offers a way to perform research in learning.
- Organizes "ways to see things".
- A lens with a certain focus.
- With a specific research approach: Some issues get clearer, others blurred.

A research approach

We remember

- The approach determines the nature of the results that you can get.
- You have to select an appropriate research approach!

An "simple" distinction

- Quantitative research approaches (in the natural science tradition)
- Qualitative research approaches (in the social science tradition)

Quantitative approaches

Numbers

Observable variables, "hard" evidence

Experiments

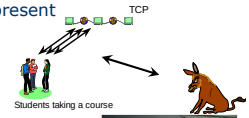
Experiments with students

Fragmented view

Qualitative approaches

Descriptions

Interpretations, researcher is present

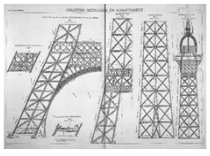


Studies in real settings

Broad understanding

Quantitative and Qualitative

Fragmented view



Broad view

Which perspective is inviting to

A) measure and study details?

B) describe the full setting?

Quantitative/Qualitative research

- Quantitative research is grounded on
  - "… the assumption that features of the social environment constitute an objective reality … collecting numerical data on observable variables"
- Qualitative research is grounded on
  - "… the assumption that individuals construct a social reality in the form of meanings and interpretations. … studying … intensively in natural settings"

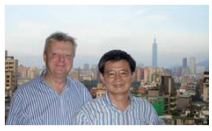
Implications for the role of the researcher, the concept of evidence, trustworthiness, interpretation etc.

(Gall, Borg & Gall, 1996)

Example 1:
Conceptual Models and Cognitive Learning Styles in Teaching Recursion

Alternative title

How shall we teach recursion?



- Statistical study, quantitative

(Wu, Dale & Bethel, 1998)

Example 1:
How shall we teach recursion?

- Research questions:
  1. Are ***concrete* models** of teaching recursion better than ***abstract* mdels**?
  2. Do students with an ***abstract* learning style** (as measured by Kolb's test) do better than students with a ***concrete* learning style**, when learning recursion?
  3. Do students with a *concrete* learning style learn better when provided with a *concrete* model?
  4. Do students with an *abstract* learning style learn better when provided with a *abstract* model?

Draws pictures of memory etc.

Mathematicall y inspired

A test that checks of someone is an abstract or a concrete thinker

Kolb's claim: Some students think abstract, others think concrete

How would you do?

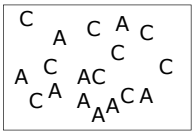
Talk to a friend for 3 minutes

Example 1:
How shall we teach recursion?

- How Wu, Dale and Bethel did:
  1. Let 237 students make a Kolb test (Result: 76 concrete learners, 161 abstract learners)
  2. Split the students into two groups. Teach one group in a concrete way, the other one in an abstract way.
  3. Compare results:
     - test: after end of lecture (indicating understanding)
     - test: after two and six weeks (indicating retention)

Example 1:
How shall we teach recursion?

- Learners: Concrete and abstract
- Teaching: Concrete and abstract



Classroom 1. Concrete teaching

Classroom 2. Abstract teaching

- Tests after: 5 minutes, 2 weeks, 6 weeks

Example 1:
How shall we teach recursion?

- They found that
  1. Abstract learners do better than concrete learners
  2. Concrete models are better for understanding
  3. Concrete models are somewhat better for retention
  4. No correlation between concrete/abstract learners and the concrete/abstract teaching

What does this tell us?

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Example 2:
Grading in a project course

- Qualitative and quantitative project

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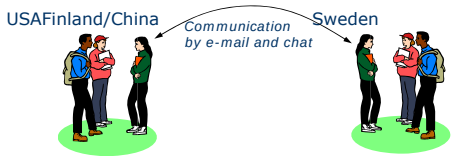
Example 2:
Grading in a project course



- 3 + 3 advanced CS students per team
- 16 teams in total
- No lectures
- Tutoring by e-mail and chat

(Berglund, 2005; Daniels, Berglund, Pears & Fincher, 2004)

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Example 2:
The Runestone course
The student project

- The task:
  Write a software system that could control a motorized Brio labyrinth from any Web browser.
- Instructions to students:
  1. **Input:** A path for a steel ball on a web-browser (in a purpose-made software) from the end-user.
  2. **Process:** The ball should move according to the path (very hard to succeed– poor hardware)
  3. **Result:** The resulting path should be visible on the screen

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Example 2:
Hardware and software

Hardware was given to the students

A camera is placed over the surface

The nobs were replaced by step engines

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Example 2:
The Runestone course
Why?

- International collaboration for students who do not go on exchanges.
- Students get different aspects on CS, by working with different students.
- Experience of collaboration over ICT tools.
- Experience of projects.

The Runestone course will appear (with different hardware) spring 2011

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Example 2:
Grading in a project course

- Both process and product are graded
- Team members are graded by "their" instructor
- Process grade is based on weekly meetings
- Components of the Runestone grading scale:
  - Team performance
  - Individual contribution
  - Peer evaluation
  - The instructor's decision.
- Different grading schemes in Sweden and US
  - Sweden: pass/fail
  - US: A to E

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Problematic???

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Example 2:
Grading in a project course

- Teachers' distribution of grades
  (quantitative)
- Peer evaluation
  The students' evaluation of each others' contributions
  (quantitative)
- Students' experienced purpose of being graded
  (qualitative)

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Example 2: Grades

- Grades awarded by the instructors, according to the Runestone scheme (Max = 100, Pass ≈ 60)

To all students	83,61
To Americans	81,55
To Swedes	85,05

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Example 2 Peer evaluation

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- Each student awarded USD 120.- to his team-mates

From Swede to Swede	22,25
From Swede to American	18,79
From American to American	20,07
From American to Swede	20,07

Then, what is the driving force?

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Example 2: What is phenomenography?

- Describes learning and understanding from the **students' perspective**
- Discusses **learning in a collective**.
- Outcome: A **few qualitatively different ways** to understand something

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Phenomenography

We remember

Example:
Phenomenography.
How do students understand "object"?
(Eckerdal & Thuné, 2005)

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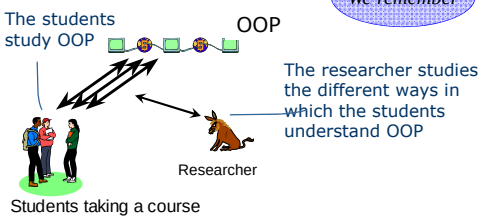
Example 2: Phenomenography

We remember



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Example 2: The experienced purpose of being graded

Cat	Getting a good grade …	Focus is on
1.	… has a value on its own	The grade *per se*
2.	… is a tool to reach other aims	The benefits of a good grade
3.	… is sub-ordinated to other aims	Me and the team My team and other teams

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Example 2: Results on grading

- Getting a good grade is not the driving force for most students in this project.
- "Me in the team" or "My team in front of other teams" is often important.

- How generalizable are these results?
- How can we use this in our teaching?

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Example 2: Why the learners' perspective in phenomenographic research?

- An understanding of how students learn about something (CS concepts) is a good tool to improving teaching.
- A change that is not perceived as "good" by the students does not improve learning.
  - Example: Grades are not the driving force for most students in Runestone.

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Example 3: Why do teams of students interpret a programming task so differently?

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Example 3: Socio-cultural theory

- Describes learning as a part of the situation.
- Focus is on social interaction, the use of language and tools.
- Language and tools contain in themselves a social interaction and a history.
  - Example: C++, Linux

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Example 3: Why do teams of students interpret a programming task so differently?

- Three teams of students (in the US) followed a project course.
- Task: Write a program for a "client".
- For the three teams: Same setting, similar task, similar students.

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Why were they different?

- The results of the three teams were completely different.
  - Team A: Excellent code, not necessarily solving the right problem
  - Team B: Fulfilled all formal requirements.
  - Team C: Poor result, mainly internal problems.

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Example 3: Why do teams of students interpret a programming task so differently?

- We know:
  - The university sets the task, the rules and the learning environment.
  - Something differs.

- Data collection:
  - Observation (to see how the teams collaborated)
  - Interviews

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Example 3:
Why do teams of students interpret a programming task so differently?

- The different teams negotiated between the members to work for a different aim/object.
- Each team selected tools, rules etc in relation to their aim.
- Team C failed this negotiation.

Team A: Excellent code, not necessarily solving the right problem
Team B: Fulfilled all formal requirements.
Team C: Poor result, mainly internal problems.

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The examples

1. Conceptual Models and Cognitive Learning Styles in Teaching Recursion
2. Grading in a project course
3. Why do teams of students interpret a programming task so differently?

For each of them:

a) What kind of results can the approach offer?
b) To what is the approach useful?
c) To what degree are the results trustworthy?
d) To what degree are they generalizable?
e) To what degree are they transferable?

The author says for which problems the results can be applied

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The reader says for which problems it cn be applied

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Summary

- Different methodologies get different kind of results
- Certain methodologies are not generally better than others
- Select a methodology from your research question.
- Make sure that there is one (or several) methodology/ies that can address your question. If not, change question.

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Assignment

- Comment on the questions at the previous slides (example).
  - Select two papers presented in this or previous lectures. Refer to and compare these papers.
  - Work individually and follow good practice for academic honesty.
  - Write one or two papers.
  - Dead-line: Oct 6, 10.00