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

Anders Berglund,
Dept of Information Technology
Uppsala University,
Uppsala,
Sweden

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

Today
- Discussing the large project
- The rest of the course

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

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?
- Summary

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Planning: Rest of the course

15/9 Discussion on project topics. Qualitative and quantatative research. Examples of CSEd Research.
16/9 Collaboration and plagiarism. Norms and rules.
16/9 15:15-17:00 How to write references. *Ivan Christoff*
18/9 Understanding teaching of CS. A lab on qualitative research approach: How do students understand 'object' and 'class'
23/9 Classifying CSEd Research. *Arnold Pears*
26/9 Critical research *Tony Clear, Auckland Univesity of Technology, New Zeeland*
10/10 Starting the project
14/10 + 15/10 Seminar, oral group discussion on earlier distributed papers. Half classes

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Sept 18 - LAB

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

- Preparation (will be available on the web)
  - Read transcripts on the web (31 interview excerpts).
  - Print them out, cut them into 31 pieces so that each interview section is on a seperate, small piece of paper.

- After lab
  - Write a report
    - Telling about your results.
    - Discuss 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.

- (If you cannot attend, talk to Anders, well in advance)

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Why focus on "learning" in Computing Education Research?

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

- How to teach computer science?

- Learning and researchability are closed connected in this context

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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.

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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!

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An "simple" distinction

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

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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, interpretation etc.

(Gall, Borg & Gall, 1996)

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Quantitative approaches	Qualitative approaches
Quantitative results	Descriptions
Observable variables, "hard" evidence	Interpretations, researcher is present
Social environment constitute an objective reality	Social environment is constructed
Experiments	Studies in naturalistic settings
Fragmented view	Broad understanding

(Berglund, Daniels & Pears, 2006)

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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)

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Example 1: How shall we teach recursion?

Draws pictures of memory etc.

Mathematically inspired

- 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?

How would you do?

Talk to a friend for 3 minutes

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

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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:
     - after end of lecture (indicating understanding)
     - after two and six weeks (indicating retention)

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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:
How do students experience grading in a project course?

- Qualitative project - phenomenography

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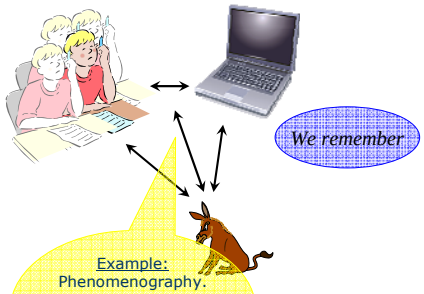
Example 2: Computing Education Research



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

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Example 2:
What is phenomenography?

- Describes learning and understanding from the learners' perspective
- Aims at analysing and describing the different ways in which students' understand something.
- Discusses learning in a collective.
- Outcome: A few qualitatively different ways, in which something is understood within a student cohort.

(Marton & Booth, 1997)

Example: The concepts of "class" and "object"; the role of the teacher

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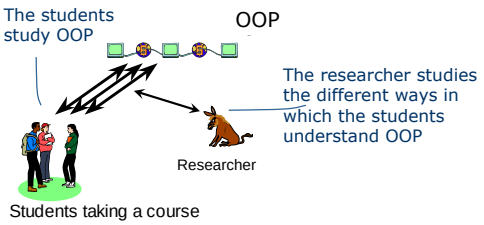
Example 2:
Phenomenography



The researcher is a learner in relation to his study object

Example 2:
Examples of phenomenographic results

- How do students go about programming? (Booth, 1992)
  - *Expedient.* Cut-and-paste
  - *Constructional.* Build from examples
  - *Operational.* "It works"
  - *Structural.* Underlying structure
- What is a computer network protocol? (Berglund, 2002)
  - *A way to communicate between two computers.*
  - *A method for communicating on an internet.*
  - *A set of rules.*
  - *A standard.*

Example 2:
How do students experience 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)

Example 2:
How do students experience grading in a project course?

- Student project: Produce a software system to control a (modified) Brio labyrinth from any Web-browser.
- The task demands computer communication solutions.
- The task requires collaboration within the team of 6.

Example 2:
How do students experience 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:
  - Team performance, in relation to the team's own plan
  - Individual contribution
  - Peer evaluation
  - The instructor's decision.
- Different grading schemes in Sweden and US
  - Sweden: pass/fail
  - US: A to E

Problematic???

Example 2:
How do students experience 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)

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

- 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:
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

- A framework for describing learning and/or development in a situation.
- Focus is on social interaction, the use of language and tools.
- Language and tools contain in themselves a social interaction and a history
- The result is a description in which some issues get clearer.

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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".
- Approx. size: One course module.
- For the three teams: Same setting, similar task, similar students.

- 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.

Why were they different?

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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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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 yout question. If not, change question.