Researching students' learning of computer science - Qualitative Research in Computing Education Research

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Today

- Research into students' learning of computing

- More precisely **qualitative research** in students' learning of computing.

- The nature of the results of different ways to perform research.

- Illustrates some ways to do research (selected for their relevance in CER) with their empirical results.

Researching students' learning of computer science - Qualitative Research in Computing Education Research

Today

- Different ways to perform research into learning
  - Quantitative and qualitative research approaches
- Phenomenography
  - Grading in a project course in computer systems?
  - What do students strive to learn in a project course in computer systems?
- Socio-cultural research perspective
  - Why do teams of students produce so different results?
- Constructivism
  - Smaller examples, conclusions for teaching.
- Summary

October 3 - 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.
  - Skim Berglund, 2006.
- After lab
  - Write a 1 -2 page reflection.
- (If you cannot attend, talk to Anders, well in advance)

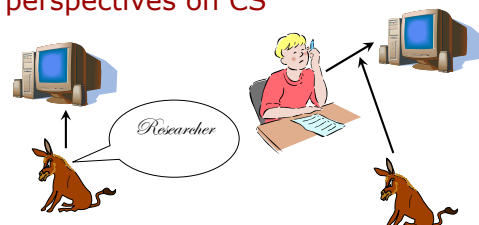## Why focus on "learning" in Computing Education Research?

- 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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CS Education is about research methodology and discusses different perspectives on CS

*In CS,
a researcher
studies computers*

*In CS Education,
a researcher
studies how students
understand computers.*

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A research approach/methodology/ framework

Informationsteknologi

- 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

Informationsteknologi

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

An "simple" distinction

Informationsteknologi

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

Quantitative/Qualitative research

Informationsteknologi

- 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)

Quantitative approaches / Qualitative approaches

Informationsteknologi

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

Qualitative Research in Computing Education Research

Informationsteknologi

Qualitative research approaches discussed:

- Phenomenography
- Socio-cultural studies
- Constructivism

Selected since they are frequently used in CS education research

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.

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

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So, what is phenomenography not ? And what is it?

- Phenomenography does not discuss the nature of the world, if something exist "in reality" or not.
- That is, phenomenography is not about *ontology*
- Instead, phenomenography is way to approach pedagogical research.
- That is, phenomenography is a methodology to gain knowledge about how students understand something

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Phenomenography

The students study OOP

OOP

The researcher studies the different ways in which the students understand OOP

Researcher

Students taking a course

The researcher is a learner in relation to his study object

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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.*

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Two larger phenomenographic examples

1. Grading in the Runestone course
2. What do students strive to learn in the Runestone course?

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Background

A project course in computer systems

USA

Communication by e-mail and chat

Sweden

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

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Student project

- 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 1: Grading in Runestone

- 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???

Analysing the grading in Runestone

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

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

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?

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

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?

Two larger phenomenographic examples

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1. Grading in the Runestone course
2. What do students strive to learn in the Runestone course?

Example 2
What do students in Runestone strive to learn?

"I guess I learned a lot, but what I learned wasn't what I expected to learn."

What do students in Runestone strive to learn?

- What do students, who participate in an internationally distributed project-based course, strive to learn?

What does it mean to learn something?
(from phenomenographic theory of learning)

The experience of learning something

Example TCP

This is an analytic separation. We "think apart".

What-aspect

How-aspect

Direct object

Example: Understanding TCP as communication between two computers

Act of learning

Example: Learning by memorizing

Motive

Example: Getting a grade

Why the learners' perspective?

- 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.

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.
- The separation between different entities is analytical and serve to build models

Empirical results from socio-cultural studies in CS Education

- *The* example: Open source community - Linux
- Why do our students hand in "incorrect" programs? (Ben-David Kolikant, 2002)
- Why do teams of students interpret a programming task so differently? (Holland & Reeves, 1996)

Example:
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 completly 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?

Why were the results of the three teams different?

- Initial assumption:
- The university sets the task, the rules and the learning environment.
- Still something differs.

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

Why were the results of the three teams different?

- Team A. Technically good solution
- Team B. Flashy
- Team C. Poor

Why were the results of the three teams different?

- 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.

Constructivism

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- Key idea:

  > Students construct their own understanding of what they learn

Value: Defines a pedagogy

- Extremely influential in school teaching.

Empirical results from constructivism in CS Education

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- Students construct rules for parameters. They are only sometimes successful. (Fleury, 1991)
- Students construct their own understanding of variables. (Paz, 1996; and others)
- Software visualization in itself does not help students understanding (Mulholland, 1997)

Results from constructivism in computing education research

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- Think twice before using visualizations
- Explicitly teach the model of the computer
- Don't start with abstractions
- Teach planning, teach to avoid "bricolage"
- Don't run to the computer
- Organize "closed labs"

(from Ben-Ari, 2001)

Qualitative research projects in CER A summary

Informationsteknologi

- The perspective of what reality is, what can be studied, what can be known, what the researcher's role is, how research is performed etc. varies.
- Qualitative research approaches in CER open new researchable questions.
- Different research approaches offer various contributions.
- Qualitative research projects often answers *why*-questions by offering discussions, perspectives and insights.