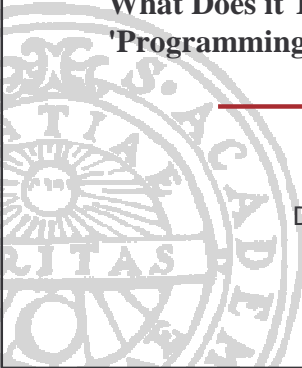


What Does it Take to Learn 'Programming Thinking'?



Anna Eckerdal,
Anders Berglund
Dept. of Information
Technology
Uppsala University
Sweden

... 'Programming Thinking'?

Student D: I've taken many math courses but math is kind of logical and you understand it but this is... no I don't know. No but I kind of think *it's easier to study math*. Then you often have something creative to base it on, or you don't, but *you learn more methods* and kind of, there is some theory behind. [...]

Yes, I think it has been difficult with concepts and stuff, as to understand how to use different, how one should use different things in a program. And I actually think that most of it has been difficult, but *this very thought behind*, it feels as some people just understand programming [...] But I still think the course, *it's difficult for a novice to sort of get a grip of how to study*

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... 'Programming Thinking'?

Student C: I don't know... I guess it's actually to solve a certain type of problem, *it's rather like the math courses*. Then *learning different methods* to solve them in different ways. Much like that, if you look back at the course it's not much actually but very, very fundamental. So to... get an overview and a basic idea of what it's about and that you can read on your own whenever you need.

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What Does it Take to Learn 'Programming Thinking'?

- Phenomenography
- The study
- Results
- Insights from Mathematics Education Research
 - Process-object duality
- Comparison
- Conclusions and Implications for education

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Phenomenography

(Marton & Booth, 1997)

- § Aims at analysing and describing the variation in students' understanding of phenomena/concepts
- § Takes the learners' perspective
- § The researcher formulates a limited number of qualitatively different categories of description
- § Qualitative empirical research approach
- § Analysis on a group level

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The study

- § 14 first year undergraduate students in the study program Aquatic and Environmental Engineering.
- § First programming course, using Java. Giving 4 Swedish credit points.
- § One hour individual semi-open interview

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The interview

§ Questions on understanding of what learning to program means

- What do you think learning means in this course?
- What do you experience the course to be about?
- What has been most important to you in this course?
- What do you think was the aim for you when learning to program?
- What has been difficult in the course?

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Excerpts from the interviews

"What does it mean to learn in this course?"

Student N: I think it is all about learning, partly the commands, fundamental commands I use, I have to remember them

Student E: Well it's like thinking programming I think. Understanding things, putting together and how you make things work sort of and accomplishing what you want yourself.

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Excerpts from the interviews

"What does it mean to learn in this course?"

Student D: You just think of things like when you withdraw money from a cash point, kind of, then you start to think, okay, it's these steps, figures and the sum and kind of [...] No but those things that one starts to think a little about how certain things are built

Student G: To get to try, like, you learn to think in a special way, you learn problem solving. [...] It's problem solving.

Student K: You know, it's good to have this kind of courses because you get to kind of exercise problem solving. [...] You have a problem that you solve in different ways and then you perhaps find the best way. That's one of the central parts I think. Then that you must write in some programming language, that you can perhaps do in any language.

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Excerpts from the interviews

"What does it mean to learn in this course?"

Student E: Yes but it's that the more you know about computers the less dependent on others you'll be, sort of.

I: I see.

E: I don't know, if you work somewhere later and have some insight into things, then I think it'll open a window so that you know what it's about at least even if you don't, I mean, it's the pros that will deal with the real things.

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Learning to program is experienced as...

1. To understand some programming language, and to use it for writing program texts.
2. As above, and in addition learning a way of thinking, which is experienced to be difficult to capture, and which is understood to be aligned with the programming language.
3. As above, and in addition to gain understanding of computer programs as they appear in everyday life.
4. As above, with the difference: learning a way of thinking which enables problem solving, and which is experienced as a "method" of thinking.
5. As above, and in addition learning a skill that can be used outside the programming course.

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Process-object duality

§ Discusses the idea of reducing abstraction

§ *Process conception*: is regarded "as a potential rather than an actual entity, which comes into existence upon request in a sequence of actions."

§ *Object conception*: this notation is captured as one 'solid' entity.

Process conception of a concept precedes, and is less abstract than the *object conception*

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Process-object duality, cont.

Process conception is expressed as “canonical procedures”:

- § A procedure that is more or less automatically triggered by a given problem.
- § It enables students to obtain a solution without worrying too much about the mathematical properties of the concepts involved.
- § It gives students the assurance of following a well-known, step-by-step procedure, where each step has a clear outcome.
- § Reduces abstraction level

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Process-object duality, cont

Category 1-3:

1. To understand and use some programming language.
2. A way of thinking which is experienced to be difficult to capture and which is aligned with the language.
3. To gain understanding of programs in everyday life.

Category 4-5:

4. A way of thinking which enables problem solving, and which is experienced as a “method” of thinking.
5. A skill that can be used outside the programming

course

Students have not even reached process conception. They do not discern the canonical procedures

Students have at least reached process conception

↓ Canonical procedures

Possibilities for object conception

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Summary

- Students need “canonical procedures” as a vehicle to reach object conception.
- There are students who fail to perceive “canonical procedures”. These students do not even reach process conception - there is a level *beneath* process conception when learning OOP.
- Minimum requirements in the course is that students reach process conception
- How can we help beginning programming students to discern “canonical procedure” when learning object-oriented programming?

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Implications for teaching

Canonical procedures in OOP, tentative list:

- § To know standard approaches for simple OOA
- § Given an UML diagram, transfer to skeleton code
- § Given an algorithm in pseudo-code, transfer to code
- § To get a repertoire of (simple) standard algorithms for (simple) standard problems
- § ...

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