Didactics and didactic models in science education

Per-Olof Wickman
Department of Mathematics and Science Education, Stockholm University

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What is Didactics?

American Heritage Dictionary of the English Language

**di·dac·tic** (di-dăkˈtĭk) adj. Also **di·dac·ti·cal** (-tĭ-kəl).
1. Intended to instruct; expository. 2. Morally instructive. 3. Inclined to teach or moralize too much; pedantic. [Greek *didaktikos*, skillful in teaching, from *didaktos*, taught, from *didaskein*, to teach. See dens-1 in Appendix.*] — **di·dac´·ti·cal·ly** adv. — **di·dac´·ti·cism´** (-tə-sĭzˈəm) n.

**di·dac·tics** (di-dăkˈtĭks) n. Plural in form, used with a singular verb. The art or science of teaching or instruction; pedagogy.

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Clarke & Hollingsworth 2002
A model of teacher professional growth

Fig. 1. An implicit model of the purpose of teacher professional development.

Fig. 3. The interconnected model of professional growth.
What is didactics?

- Teachers’ science
- It is the professional science of teachers
- It is an academic discipline
- It is what teachers know (their collective knowing)
- It is the science unique for teacher education
- It is what teachers need specifically to learn to become teachers and to be able to teach students
- It is the development of this knowledge

- Cf. Physics, Economics, Medicine etc.
- Cf. Pedagogical Content Knowledge (PCK)
The centrality of the content for a specific group of students

Didactics is about how to create a situation (sequence, process) that establishes a fruitful relationship between:
Content

- Content covers not just subject content in a restricted sense
- The learning of skills, conduct and values (morals, aesthetics)
- Developing (formation of) the whole person (individual inclinations and as a citizen)
- Sub-disciplines of didactics
  - Subject didactics
  - For different ages
  - Interdisciplinary areas
  - ...

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Lee Schulman (1986, p. 13)

The professional holds knowledge, not only of how—the capacity for skilled performance—but of what and why. The teacher is not only a master of procedure but also of content and rationale, and capable of explaining why something is done.
Who is the knower in didactics?

- Who is the knower in physics, economics, medicine?
- Who is the teacher?
  - Only a teacher?
  - Also a teacher educator?
  - Also a researcher?
- Who is the researcher? Who is the teacher educator?
- Making the distinction between teacher, teacher educator and researcher more fuzzy in collective terms
  - We are all didactitioners, didacticists?
- A way to make PCK synonymous with the knowledge of a professional discipline of teachers, i.e. didactics
The questions

- Didactics is primarily driven by its questions, not by its theories (it is not a-theoretical, though)
- What questions do teachers need answers for?
- Schulman and traditionally in didactics:
  - What? (choosing content)
  - How? (choosing methods and processes)
  - Why? (analysis, consequence and rationale)
- Always with a specific group of students in mind
- How can I support a process in the classroom that establishes a didactic relationship between students and the content?
- Answer: Didactics needs to develop models for teachers
A didactic model

- A didactic model helps the teacher to answer the didactic questions what, how and why
- A didactic model helps the teacher to make decisions in planning, carrying out and evaluate teaching
- A didactic model helps the teacher to
  - analyse teaching (didactic analysis)
  - design teaching (didactic design)
- Practically useful theory and ethics
- A long tradition in Europe
- Johan Amos Comenius (Didactica Magna) 1592-1670
- Didactics tradition vs. the Curriculum tradition (Hudson 2002)
Didactic models

- Not one didactic model (not a grand theory)
- They have a restricted model capacity (Thalheim 2010)
- For different teachers, students, situations and content
- Models facilitates coping with complex decision processes
- Conceptual, analogies or symbols for the phenomena teachers handle
Some literature


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The production and use of didactic models

- Production of models (modelling) through studies of teaching-learning situations (synthesis)
- Use of models on teaching-learning
  - Didactic analysis
  - Didactic design (synthesis)

- Are entwined and intimately related
- Analysis and design are needed also for the production of models

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Use of didactic models

- Analysis and design
  - Analysis of how well certain teaching-learning sequences, situations and components fulfil certain aims, purposes or values
  - Models help teachers analyse how certain components or processes in teaching have certain observable consequences
  - Analysis supports the design of sequences, situations and components to fulfil certain aims, purposes or values in planning and carrying them out
  - Analysis supports the design of content for teaching and assessment of content learned.
The production of didactic models: didactic modelling

Three phases in direct interaction between practice and theory

1. Extracting
2. Mangling
3. Exemplifying
1. Extracting

- Didacticists study existing teaching and create a conceptual model of what teachers know and do
- Produce didactic principles that may ground teachers analyses for design choices
- Formulated in terms of what a teacher can observe in the classroom materially and in action (the teacher as a knower)
- Theory is transacted to make it didactically useful
- Grounded theory and design-based research useful for these aims
2. Mangling

- The Mangle of Practice (Pickering 1995)
- An extracted model is mangled with teachers to make it work more fruitfully
- The model is changed and complemented
- Gives evidence for how the model works and about its limitations
- So that the model becomes useful to teachers
- Domain of practice and consequences (Clarke & Hollingsworth, 2002)
- Elaborated beyond a method to a grounding giving rationales for teacher decisions
- Examine how the model may become useful for different content and situations
- Cyclic (cf. action research, lesson studies etc.)
3. Exemplifying

- Documentation of whole teaching sequences and of how the didactic model can be used to design and analyse it.
- The examples are part of the model
- Cyclic
- With different students, teachers, content, schools etc.
- A fully legitimate research field (not just making new models)
Some didactic models in science education

- Degrees of freedom (Schwab 1962)
- Curriculum emphases (Roberts 1982)
- Productive questions (Elstgeest 1985)
- Thematic patterns (Lemke 1990)
- Chemical triangle (Johnstone 1993)
- Companion meanings (Östman 1995)
- Communicative approaches (Mortimer & Scott 2003)
- Balance of agency in the science classroom (Arnold 2012)
- Framework of representational construction affordances (Prain & Tytler 2012)
- Abductive principles of discovery (Ferguson 2017)
Some didactic models

- Practical epistemology analysis (Wickman & Östman, 2002; Wickman, 2002)
- A conceptual apparatus to analyse what students are afforded to learn through a situation
- How can a teacher see what a students are learning from what they are saying and doing
- Dewey, Wittgenstein and socio-cultural theory: situated action, contingent
- Analysis of lab work in science
- A circuit, not linear
Practical Epistemology Analysis: imagine a conversation

Noticing a Gap

What Stands Fast

Yes

Construing Relations

Proceeding

Yes

A Gap is Filled

No

No

Encounters

In a situated activity with a Purpose

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What is learnt here? Purpose?

M: Really big eyes if you consider.
L: Let’s check then.
M: So, big compound eyes then.
L: Yes. (Laughs)
M: But perhaps they use vision very much when they look where they should land.
L: They have of course such, must have...
M: If you compare with this one (a beetle).
L: ... such ultraviolet vision.
M: This one is bigger, isn’t it, but has smaller eyes if you compare with the bumblebee.
L: Mmm.
Mangling

- Are there not always at least two different purposes?
- Organising purposes (Johansson & Wickman, 2011)
  - Proximate purpose
  - Ultimate purpose
- Examine:
  - Does the proximate purpose become an end in view? Can the students proceed according to purpose? Do they have an idea of what a completion of the task means?
  - Are the proximate and ultimate purposes continuous? Is the activity transformed to a more scientifically epistemic practice?
- Mangling further with teachers (Hamza et al. 2018)

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Summary: Why didactic models?

- Didactic models already have a well established although not always well defined function in educational (didactic) research
- Didactic models give teachers a professional language to share their educational (didactic) challenges
- Didactic models together with exemplifying documentation assure that teachers’ existing knowledge is preserved and possible to develop further
- Didactic models go beyond simplified ideas about “what works”, “best practice” and “evidence-based practice” by supporting teachers professional judgment and intelligence.
Summary: Why didactic models?

- Didactic models and their use give a theoretical and methodological openness which every discipline needs to develop.
- Didactic models enhance the agency of teachers by expanding the ways in which teaching and learning can be analysed (new conceptual distinctions).
- Didactic models bridge the gap between what it is to be a researcher, a teacher educator and a teacher.
Literature


