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Researching Lesson Study with The Anthropological Theory of the Didactic

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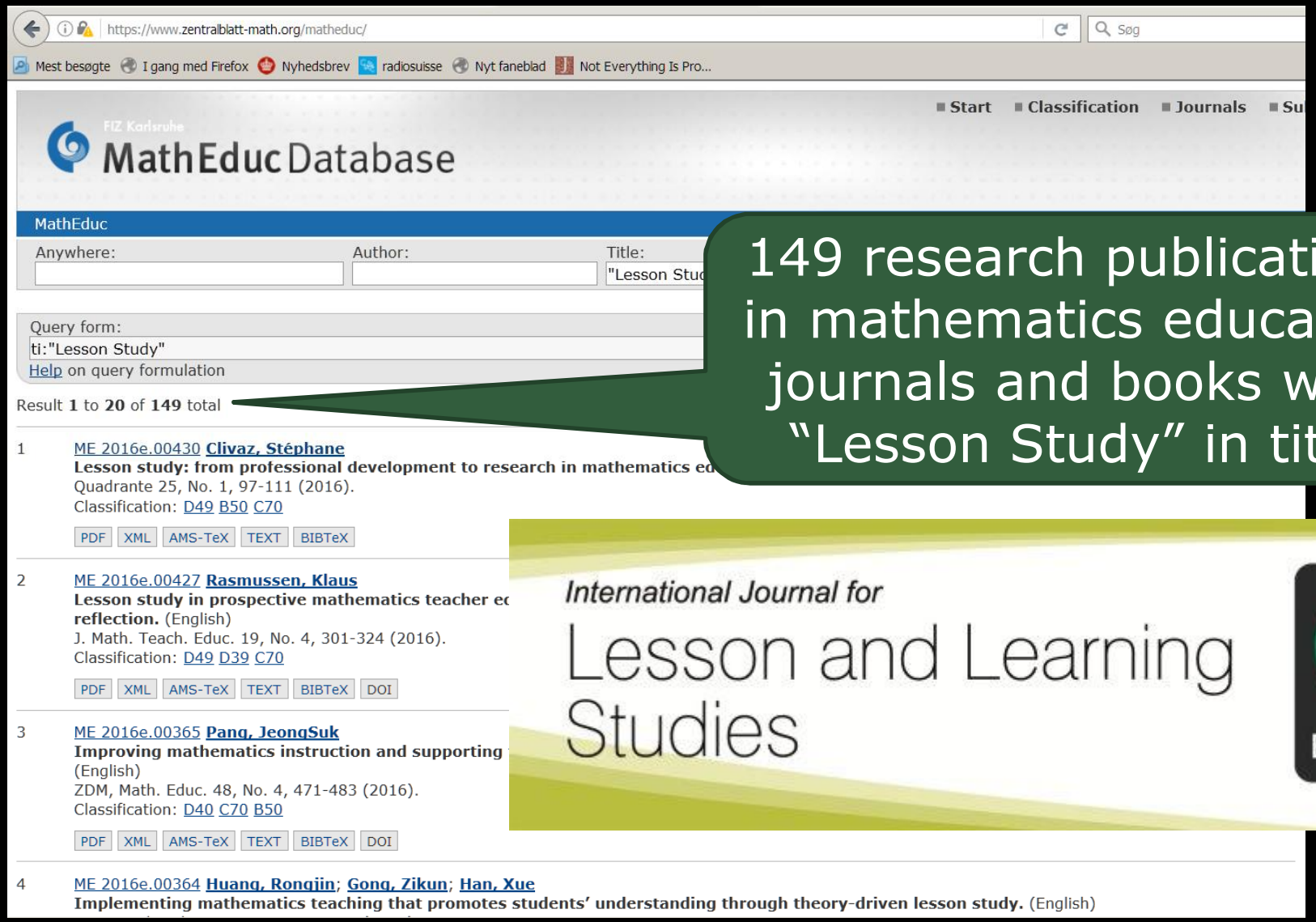
1. LS as a ”research topic”
   → Need for scientific models of LS
2. Model of ”what LS is about”
   → *mathematical and didactic praxeologies*
3. Model of ”what LS *is*”
   → *institutions and infrastructure*
4. Some results of ATD research on LS
5. The Anthropological Theory of the Didactic (ATD)
   → Outlook and invitation
6. Conclusion

1 – Lesson Study as Research topic



149 research publications in mathematics education journals and books with "Lesson Study" in title

International Journal for
Lesson and Learning Studies

Emerald

Some overall research directions pursued:

Examples of work	OBJECT: 授業研究 in Japan	OBJECT: Lesson study (…) abroad
Descriptive research: what is lesson study?	Lewis (1998): *A lesson is like a swiftly flowing river* Isoda, Stephens, Ohara, Miyakawa (2007): *Japanese Lesson Study in Mathematics*	Yoshida (2012): *Mathematics lesson study in the United States: Current status and ideas…* Hart, Alston, Murata (2011): *Lesson Study Research and Practice in Mathematics Education*
Interven-tion research: Results of specific LS, LS as method	授業研究 itself	Rasmussen (2016): *Lesson study in prospective mathematics teacher education: didactic and paradidactic technology in the post-lesson reflection.*

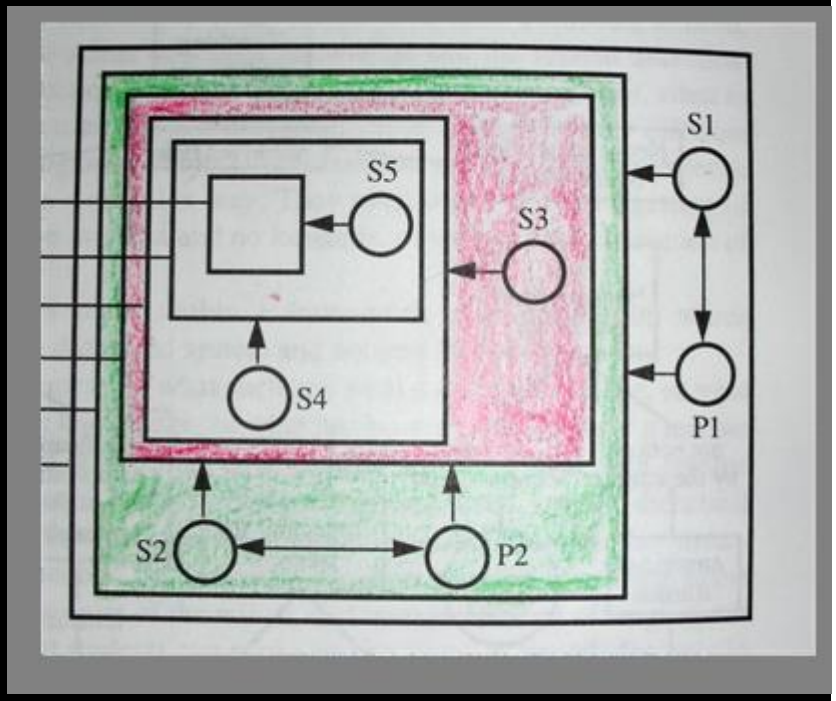
Descriptive research considers LS as an *object of study* with research questions like
- what does LS *consist of* (description of « interior »)
- what are the *essential* parts (« boundary »)
- what are the essential *conditions for* LS (« external »)
- what is LS *about* (what are its objects and aims)

Intervention research uses LS as a *method* to study more specific questions about mathematics teaching and learning, teacher education etc.

In both cases, researchers need *explicit models of LS and its « surroundings »* in order to make their questions, methods and results *precise*, *intelligible* and *open to scientific debate (including critique).*

Scientific Models

"complex reality"



Model: "simple" structure, described within a theory (i.e. a scientific register)

All models are wrong but some are useful
(George E.P. Box)

What is LS about?

FIRST NAIVE ANSWERS

Object of LS (what it is ”about”)
- *Teaching, by teachers* (more specifically, a lesson)
- *Learning by students*

Objective of LS : to promote
- *Learning, by teachers, related to the previous two objects.*

LS thus is about *very specific forms of human practice and knowledge:*
- *Mathematical Practice and Knowledge* (by students, teachers)
- *Didactic Practice and Knowedge* (by teachers)

Here, ”didactic” refers to the act of teaching or, more broadly, ”inducing others into a certain practice / knowledge”.
”Didactic practice” is fundamental to *all* human practices!

The notion of *praxeology* (praxis + logos) (Chevallard, 1999)

THEORETICAL BLOCK:
'know that and why'
Techniques can be described and justified

Theory

Technology (techne + logos)

PRACTICAL-BLOCK:
'know how'
Tasks, solved by techniques

Technique

Type of tasks

PRAXEOLOGY

Example of a mathematical praxeology:

- Type of task: find *all x satisfying* $ax^2 + bx + c$ (for given a, b, c)
- Technique: computation based on $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
- Technology: explanation of formula (how, when, why,…))
- Theory: algebraic definitions, rules, etc. to justify technology

Mathematical and Didactic Praxeologies

Mathematical Praxeology (MP):
this is what the students should learn; we can model it with the precision we need for a given research project

Didactic Praxeology (DP):
1. the didactic *practice* (tasks and techniques) can be observed:
   - tasks of teaching (related to some MP)
   - techniques (what the teacher does to some those tasks)
2. the corresponding *didactic technology* and *theory* is not observable in the classroom – the teacher (normally) neither explains nor justifies his practice there.

NOTICE:
- A DP is always *intimately related* to a MP (for math. teaching)
- technology and theory of DP ~ *core of teacher knowledge*
- The tendency of didactic technology and theory to be "personal", "non-shared", fragmented etc.

What is LS about? Praxeological models

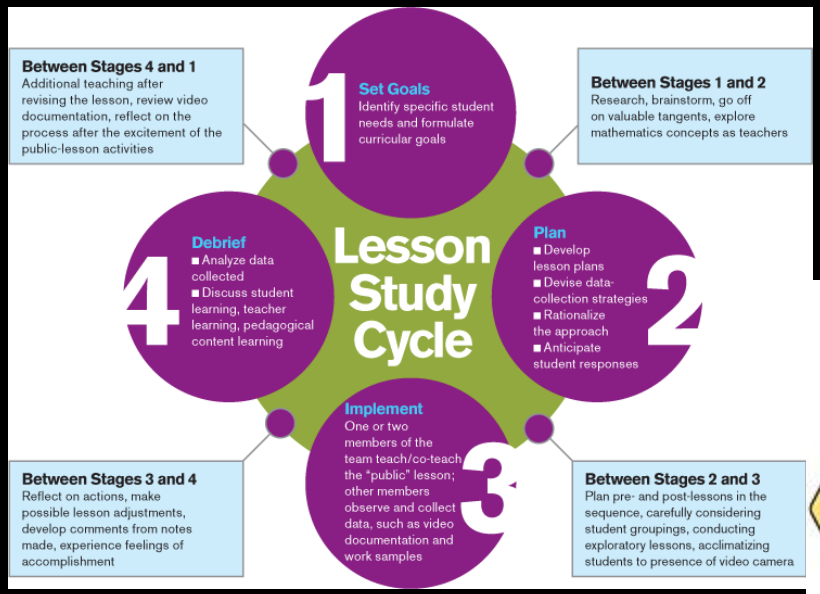
Object of LS (what it is "about")
- *Didactic Practice* (planned, observed, discussed)
- *Mathematical Praxeologies* (of students – in LS, planned/anticipated, observed and discussed)

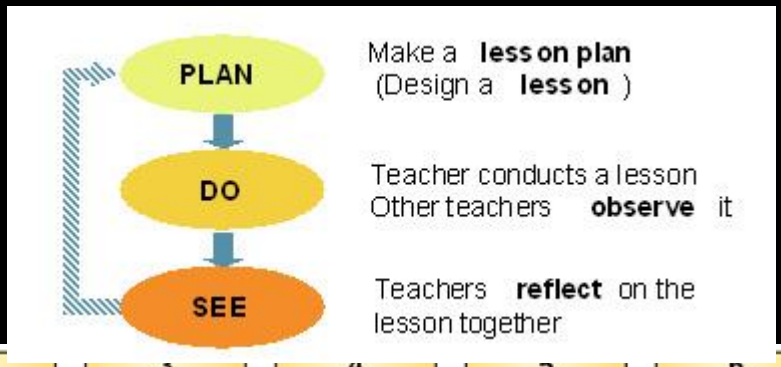
Objective of LS : to develop teachers' didactic knowledge (technology, theory)
- *Shared didactic technology and theory needed, and developed, in both planning and reflection meetings*

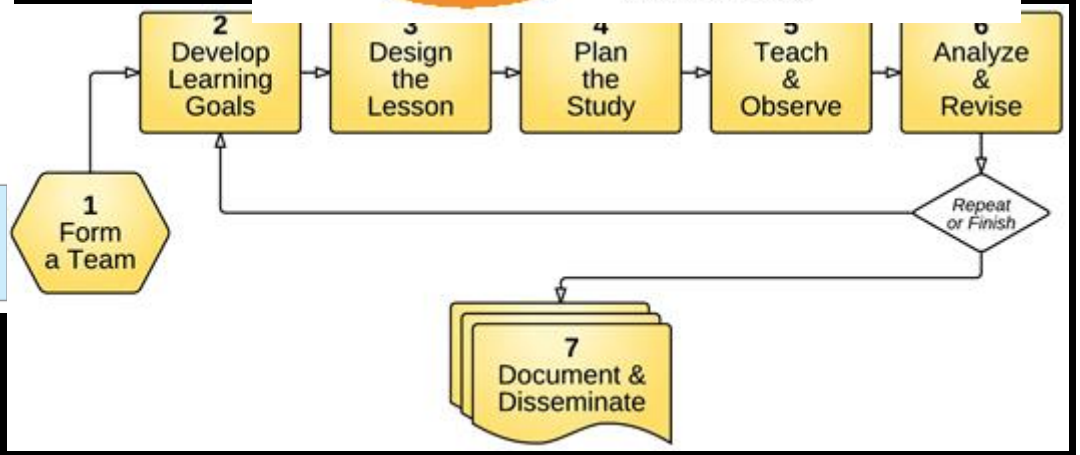
An example of analysing a lesson study activity (mainly lesson plan, lesson and reflection) can be found in Miyakawa & Winsløw, JMTE 2013.

3 – Model of what LS *is*

LS is often described in terms of ”cycles” or other indications of a process that unfolds in time







But to analyse our observations of a specific LS, this model is far too simple. We are interested in the specific MP and DP at stake. So what is LS itself, relatively to these?

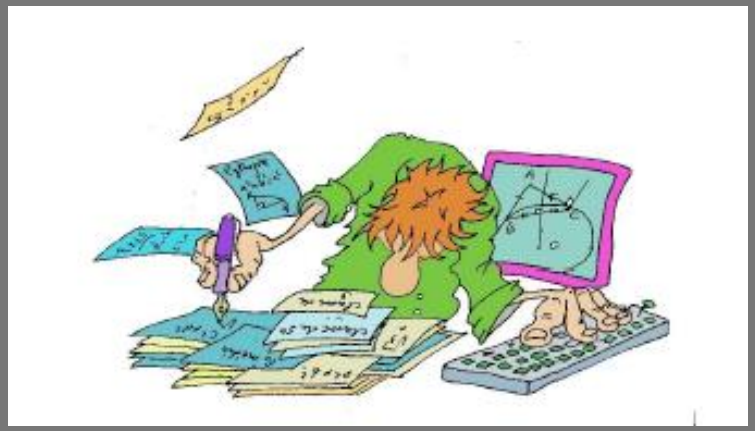
3 – Model of what LS *is*

All human activity suppose what I call a *praxeological infrastructure… [which] comprises in particular some small and large facilities [*dispositifs*] which are works, and which allow the development of superstructural activities – the execution of some technique being supported by an infrastructure*…
(Chevallard 2009, summer school at Clermont-Ferrand)

Mathematical infrastructure (for MP)
Works as ”facility” for *mathematical practice*
Ex1 ▯ used to compute rotation by α $\begin{cases} x' = x\cos\alpha - y\sin\alpha \\ y' = x\sin\alpha + y\cos\alpha \end{cases}$
Ex2 Computer algebra system
Didactic infrastructure (for DP)
Artefacts and ressource systems as facility for *didactic practice*
Exs: textbook, smartboard, CAS, lesson plan,…

3 – Model of what LS *is*

Paradidactic practice



Teachers' work outside classrooom

Didactic practice

Teachers' work in classroom

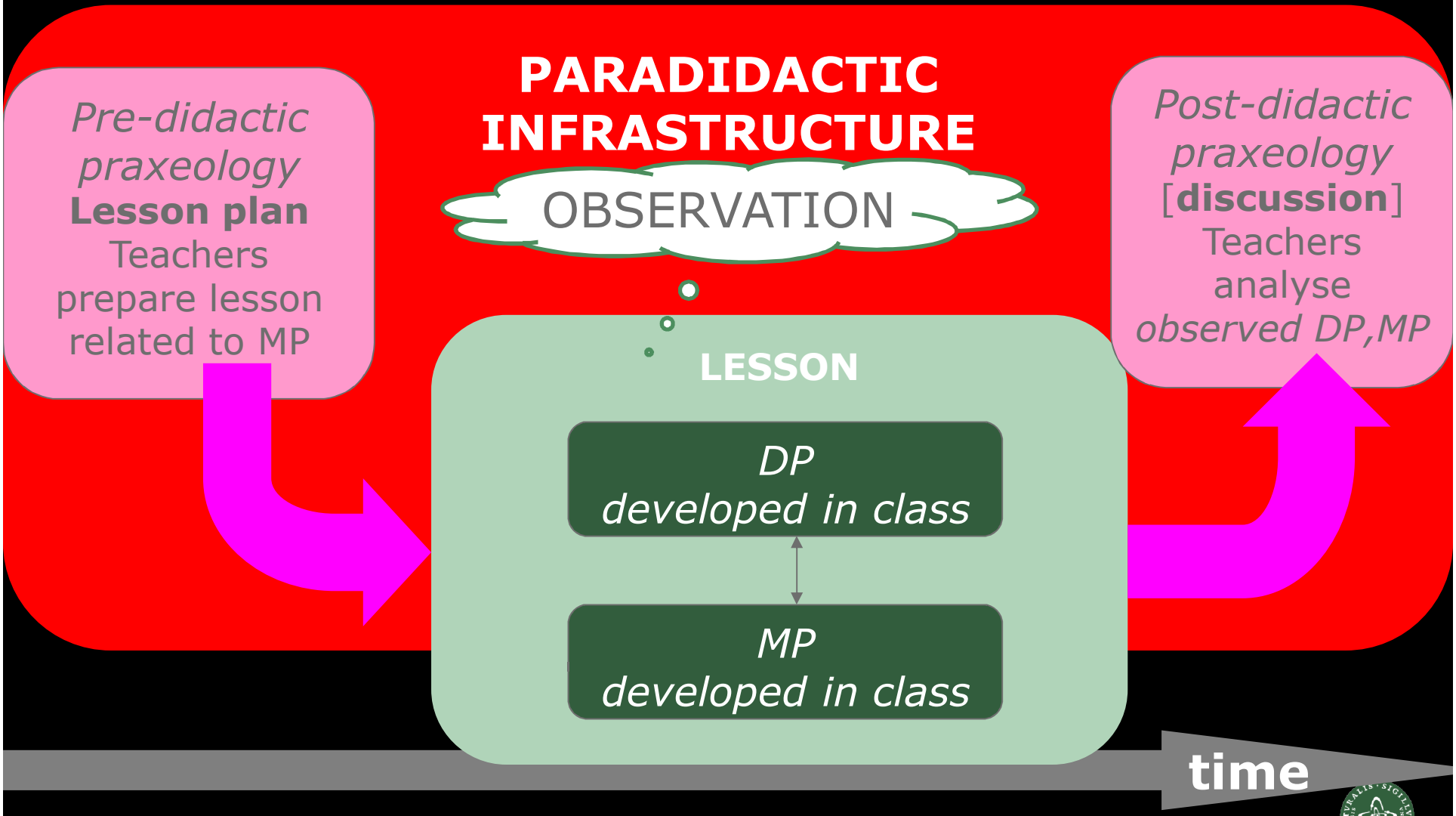
Paradidactic infrastructure: in addition to some of the didactic infrastructure, special "facilities" for the work of *t,* such as office space, teacher guide, personal notes etc. Paradidactic praxeologies develop personal knowledge of *t.*

How about institutionalization?

Elements of paradidactic infrastructure in Japan:

- Konaikenshyuu (study groups of teachers within each school), with grants, activity reports etc.
- Lesson study
- Mathematical circles (teacher seminar accross schools)
- Open lessons (municipal, regional national) with invited and registered participants
- Conferences with invited and registered participants
- Teacher journals and books
- School math dictionnary
- Videos with ”super-lessons”
- TV-shows with famous teachers (”fun math” with kids)

The case of lesson study (Miyakawa & W, 2013)



Paradidactic infrastructure of a school institution: the total of conditions for teachers work outside "class" (MW,2013)

Miyakawa & Winsløw (2013). For a specific LS, coherent analysis of "what teachers learn" (DP theory block), the lesson itself (DP practice), and "what students learn" (MP).

Rasmussen (PhD-thesis, 2015). Analysis of postdidactic praxeology in LS embedded in multidisciplinary teacher education, showing the potential for developing didactic knowledge "to the benefit of prospective teachers, educators and researchers alike".

Østergaard (PhD-thesis, 2016). Analysis of the common "gap" between DP practice and knowledge blocks, and between MP and DP, as developed in teacher education … interventions with LS has strong potential to bridge those gaps

Carlsen (PhD-thesis, forthcoming). During practicum LS, teacher students develop (new) didactic technology about CAS-use in lower secondary algebra.

Bahn (Phd-thesis, forthcoming). Experimenting, with success, a concrete paradidactic infrastructure for implementing LS in DK.

An example (Miyakawa & Winsløw, 2013)

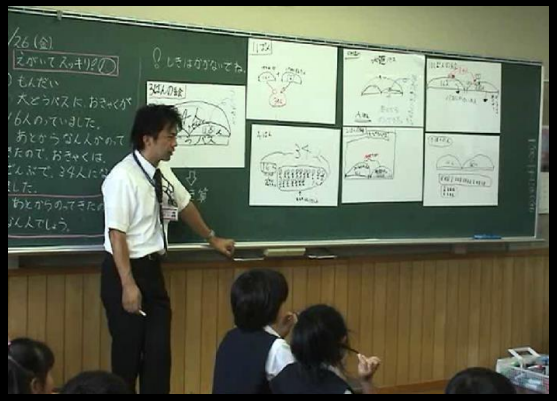
School festival, June 2009

- Primary school attached to Joetsu U.
- Held every year at this school (Friday+Saturday)
- 70 open lessons in all subjects, in two days
- 700 guests in 2009 (from all of Japan) – teachers and…
- All aspects of the school life on display, but the primary aim is to share and develop knowledge for teaching

The lesson

- Grade 2 (students about 7 years old), 40 students
- Lesson no. 16 in a series of 17 lessons, duration 65 mins
- Series title: *Sukkiri* as we draw!

  (sukkiri ≈ experience of clarity, « aha »)
- Japanese « open approach » (Nohda, 2004)
- Student assignment : find solution and make a drawing which, to a group of students, give « clarity » (of solution and method, and on who are convinced of what and why)



A mathematical task, wide choice of techniques

Task

- [t_0 : to formulate t] [didactic technique]
- t (the task) : There were 16 persons on a bus. Later, more people got on, so there were 34 in total. How many had got on the bus ?
- T (type of task) : Given a total N and a part A, find rest B (N = A + B; given N and A, find B).

Techniques

- τ_0 : identify numbers (16, 34); choose the right operation (+/-); execute (results: 16+34 or 34-16 or …)
- τ_1 : represent situation symbolically and solve
  (34 = 16 + rest → rest = 34 – 16).
- τ_2 : represent situation by a drawing (abstraction from concrete situation) showing situation and solution « in one » (as opposed to arithmetic/algebraic approaches).

Reflection meeting : the meaning of « *sukkiri* »

Main questions

- Why this acitivity « *sukkiri* by drawing » ?
- What is the meaning of « sukkiri » ?

Comment of a participant

- *« sukkiri » it's to have a drawing that helps them to get the answer, to set up a calculation, or to see what is the object of the interrogation sign – not to have drawing which depicts the problem exactly*

The paradidactic practice

- The « new » notion of *sukkiri* (a priori not didactic technology) facilitates an shared development of didactic technology and theory, focusing on the production and use (by students) of more or less non-standard mathematical ostensives

Reflection meeting : techniques for managing the students' presentations

Participants

- Evoke pupil mathematical techniques observed in the lesson (e.g., 34 + 16) and possible explanations (e.g., the wording of the problem implies addition since « *the whole* » ~ sum) ;
- Propose alternative or motified didactic techniques for an DO in which the task is to teach « drawing techniques » for subtraction (τ_2).

The paradictic practice

- Question the planned and observed DO by taking into accound the MO realised in the class, as well as the didactic technology of the lesson plan

Reflection: theory level

Principal question

- To what extent are the choises and arguments of the planned DP justified?

Justifications mentioned

- National programme (curriculum);
- Philosophy of this school (« prepare the pupils to live in human society ») ;

→ Comment of the guide (prof. Nunokawa): the importance of interaction in society, even if you have a strong personality (« sukkiri »)

Paradidactic practice

- The discussion allows for reflection on more general didactic principles, firmly based on the common observation of a concrete DP
- Development of possible new didactic technology *("sukkiri")*

ATD welcomes you with:

- An elaborate system of theoretical tools to model and design mathematical and didactical knowledge and practice
- A research community with active researchers in many countries (Japan, Korea, France, Spain, Germany, Denmark, Sweden, Brazil, Canada, USA, …), international congresses etc.
- A research *programme* with a tight network of questions, methods, results and so on
- A definite potential for LS research

Conclusion: the profession of teaching

Etzioni, quoted by Chevallard (2009):

Criteria for a Profession

1. Professions provide essential services to the individual and society.

2. Each profession is concerned with an identified area of need or function (e.g., maintenance of physical and emotional health).

3. The profession possesses a unique body of knowledge and skills (professional culture).

4. Professional decisions are made in accordance with valid knowledge, principles, and theories.

5. The profession is based on undergirding disciplines from which it builds its own applied knowledge and skills.

6. Professional associations control the actual work and conditions of the profession (e.g., admissions, standards, licensing).

7. There are performance standards for admission to and continuance in the profession

Crucial: existence of paradidactic infrastructure!
… to enable a collective development of knowledge (DP technology and theory), as in LS.

Thanks
ありがとう