The Committee of International Affair,
The Society of Japan Science Teaching

SJST INTERNATIONAL SEMINAR 2014

On the Research Trends on Science Teacher Education: Focusing on at the Post Graduate School Level

Dec. 13th (Sat), 2014　13:30-16:30

at Campus Innovation Center
in Tamachi Campus, Tokyo Institute of Technology

< Report Presenter >

1. JAPAN　Mr. Y. Kiyohara (Chief Inspector for Schools, MEXT)
The Issue of the Science Teacher Training in Japan and Expectation for Graduate Education

2. U. S. A.　Prof. J.E. Pedersen (University of Nebraska-Lincoln)
Trends in Post-Baccalaureate Science Teacher Education in U.S.A.

3. ENGLAND　Prof. J. Ryder (University of Leeds)
Science Teacher Education in England: Current Approaches and Recent Policy Trends

4. FRANCE　Prof. M. Coquidé (École Normale Supérieure de Lyon)
French Science Teacher Education Contents: Which? Why? How?

5. FINLAND　Prof. J. Viiri (University of Jyväskylä)
Trends on Science Teacher Education in Finland

The issue of the science teacher training in Japan
And expectation for graduate education

Ministry of Education, Culture, Sports, Science and Technology (MEXT)

KIYOHARA Yoichi

Chief Inspector for Schools
Elementary and Secondary Education Bureau

The fundamental view which is in charge of revision of the science course of study of Japan

- ☐ To fix the fundamental concept about science to a student certainly.
  - ・To structurize the contents focusing on a scientific fundamental concept.
  - ・To improve connection of an elementary school, a junior high school, and a high school.
- ☐ to raise scientific thinking power and power of expression.
  - ・To conduct the observation with a sense of purpose active and highly motivated, and an experiment.
  - ・To raise a student's scientific research capability.
- ☐ To raise the concern about science. To make the meaning which studies science, and usefulness realize.
  - (Issue) The student does not realize the meaning or usefulness which study science.
  - ・As important and guide relation with everyday life.
- ☐ To aim at scientific experience and substantial natural experience.
  - (Issue) The student runs short of the experience activities of natural experience etc.
  - ・To enrich study through observation or an experiment.
  - ・To enrich study of craftsmanship, natural experience, etc.

The background of educational fullness of the science and mathematics in elementary secondary education of Japan

(Present condition recognition)

○ "Knowledge base society"

Technology is the fountainhead of competitive power and a productivity drive.

The global competition involving scientific research or technology is intensifying focusing on fields, such as life science, nanotechnology, information science, etc. after the middle of the 1990s.

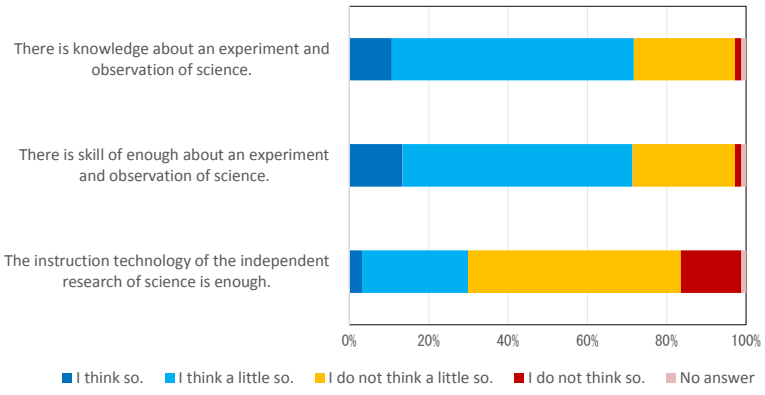
What is made into technology for the development which human-beings society can maintain?

A issue with still more important training of the technology system talented people who bear the next generation

○ The result of technology is utilized even for a society's as a whole all the corners.

→ To improve the fundamental knowledge about every citizen's science is an important issue.

Consciousness about a junior high school science teacher's instruction



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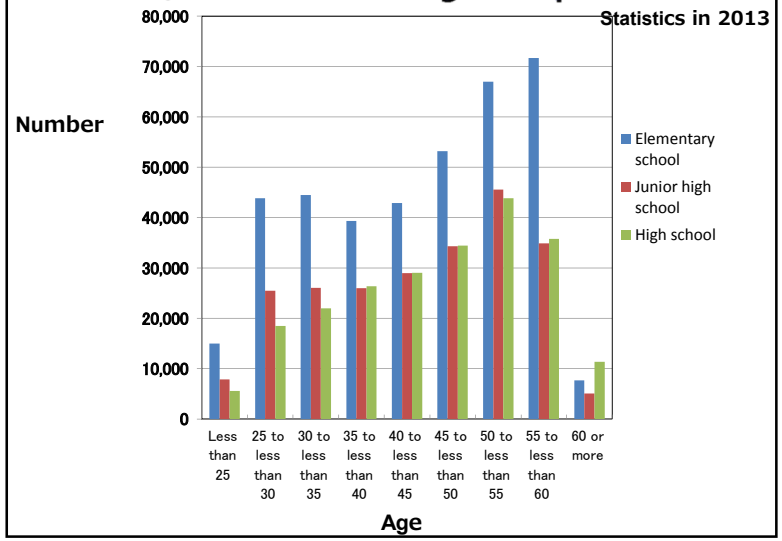
A Japanese teacher's age composition



"About reform, fullness, etc. of teacher training of a graduate school stage"

(October 15, 2013, The cooperator meeting towards enforcement of the present improvement policy concerning a teacher's improvement in nature capability Report)

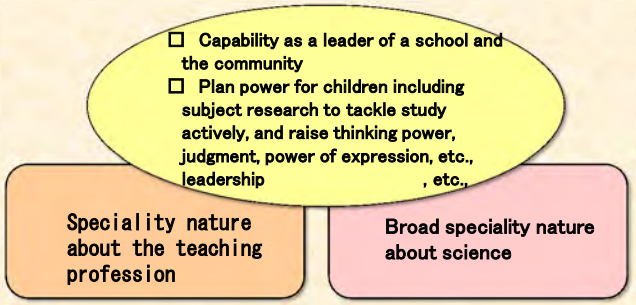
The issue in the present condition and teacher training which surround school education

- As the present condition which surrounds the school education accompanying a rapid change of society,
  - ① New correspondence through which I study and pass
  - ② Correspondence to the contemporary subject in the school spot
  - ③ Correspondence based on the extensive retirement, extensive employment, etc. of a teacher
  - ④ The necessity for school leader training
- The quality of a curriculum needs to be guaranteed.
- The necessity of offering the systematic program for training the hard-core teacher who plays an active part in a graduate school stage at the school spot

The feature of Japan of a TALIS result

- ○ Both teachers study each other in everyday life through school-grounds training etc. And the teacher is raising an improvement of educational guidance and volition.
- ● A teacher's participating volition to training is high. However, there is a issue in the schedule of business, the support for expense and participation, etc.
- ● The teacher considers that a student's active learning is important. On the other hand, a teacher's confidence over pulling out a student's active learning is low.
- ● More nearly especially [than other participating nations] a teacher's office hours is long.

About science teacher training I expect graduate education.



At a graduate school, while a graduate school teacher, the graduate student who entered a school of higher grade directly from the university, the graduate student who experienced the teaching profession, the board of education, etc. have relation mutually, I expect to raise the great teacher who becomes a leader of a school.

Trends in Post-Baccalaureate Science Teacher Education

Dr. Jon E. Pedersen, Associate Dean
College of Education and Human Science
University of Nebraska-Lincoln

- During the late nineteenth century universities started adding chairs in pedagogy or education.
- Early 20th century--Normal schools were re-structured into four year, degree granting teachers colleges supported by the public
- Since 1945, most teachers colleges have expanded their educational missions and become liberal-arts colleges offering a broad general education in addition to specialized courses in pedagogy.
- The Normal School model went through a rapid evolution, form normal school to state teachers college to general purpose state college to regional state university.

University Role in Teacher Preparation

- First public school opening was in the 1630's
- The first formal training for teachers would not be initiated until almost 200 years later (1820'-1830's)
- Few women were given the opportunity to learn, the profession remained predominantly male into the 1800s.
- The nation's first private normal school-for elementary-school teachers-was opened 1823
- The first state-supported normal school was opened in1839
- Rapid growth occurred the late 1800s with an emphasis on elementary school teachers
- Preparation for secondary-school teaching was still left to liberal arts colleges and would remain so until after 1945

History

- By the 1960's teacher education was moving to the university setting under the leadership of professors in a school or college of education.
- Since the 1970's, teacher education has been a wholly owned subsidiary of the university.
- This evolution was due in part to the need for local, affordable, and accessible form of higher education.
- Normal schools (focusing initially only on teacher preparation) had no choice but to be flexible and meet the needs of a broader audience.
- However…things continue to change and evolve

Modern Era

College of Education and Human Science

- Certification requirements for teaching have advanced with educational opportunity and each state has been able to establish its own requirements.
- The trend in certification has been toward requiring more complete training, with practice teaching and extensive graduate work for specialized positions.

Certification

College of Education and Human Science

- Transformation of Values—Learning for all not just a few
- Improving society through higher level work versus individual gains (Learn More Earn More)
  - Higher Income
  - Better Job
  - Greater Personal Satisfaction
- Informed citizens
- Research leads to improvements and solutions
- Increase in the diversity of college students
- Earning power increases

Current Trends in Higher Education

College of Education and Human Science

- Increase Desire for Education
- College degrees is an aspiration for millions
- Nearly a 10 fold increase in the number of institutions in the U.S. over the last 140 years (118,736 doctorates in 2012)
- Worldwide enrollment has doubled in 20 years

Current Trends in Higher Education

College of Education and Human Science

- An overall **decrease** in funding for higher education
  - ✓State level
  - ✓Federal level (extramural funding for research)
  - ✓More students
  - ✓Smaller share of dollars

Current Trends in Higher Education

College of Education and Human Science

- Universities are still mired in a 19th century perspective
  - A department store mentality (something for everyone)
  - Specialization is becoming the key
  - No longer solo efforts…but collective efforts (research)
  - With decreased funding we can no longer be everything to everyone…specialization becomes a critical issue
- Stuck in "old" programs
  - "Old" pedagogies and practices
  - Mismatch between faculty and learning/pedagogy/curricular design for a digital-global community
  - Must innovate in order to survive

Current Trends in Higher Education

College of Education and Human Science

- Needs of students' world wide regardless of their home base
- Access
- High quality instruction
- Moving beyond degrees to "badges" and "certificates"

Current Trends in Higher Education

College of Education and Human Science

- In addition…our students are…Internationalization/Globalization of the citizenry
- More students looking to study abroad
- More international students coming to campuses
- Impact of global issues (economy, environment, societal issues)—we are part of the whole cloth and cannot ignore the global impact

Current Trends in Higher Education

College of Education and Human Science

- Increased public and government scrutiny
- Performance and outcomes will be an ever increasing focus
- Affordability is a key issue
- Graduation rates
- Higher education is no longer immune to public questioning and government is under pressure to guarantee quality education
  - ✓Benefits of higher education
  - ✓Learning outcomes
  - ✓Contribution of graduates to betterment of society

Current Trends in Higher Education

College of Education and Human Science

- Conceptual Change
- Professional Development
- Socio-scientific Issues
- The Nature of Science
- Professional Content Knowledge

Science Education: Research trends

College of Education and Human Science

- Pedagogical Content Knowledge—PCK
- Transforming content knowledge into accessible forms by students
- Pairing content courses with pedagogical courses

Science Education

College of Education and Human Science

- Subject Matter Knowledge—SMK
  - ✓More content does not mean better teacher
  - ✓Dilemma of elementary and secondary teachers
  - ✓Influence of the Next Generation Science Standards
  - ✓Trend to develop content focused programs

Science Education

College of Education and Human Science

- Professional Development Opportunities
- Science coaching
- Engineering as a part of science teaching
- On-line learning opportunities
- MOOC's and other massive audience participation
- The role of professional associations
- NO LONGER SOLEY THE DOMAIN OF TEACHER EDUCATION

Science Education

College of Education and Human Science

- We can no longer rely on the status quo to make an impact—think creatively of how to address the needs of a very diverse and "distant" audience
- Must be change agents…no longer can we rely on our "status" as professors/higher education
- Must be able to develop "nimbleness" and respond to needs
- Accept that a new model or paradigm for higher education exists with a focus on
  - ✓ Enrollment
  - ✓ Retention
  - ✓ Graduation rates
  - ✓ Dollars
  - ✓ Accountability

Where do we go from here?

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Science Teacher Education in England: Current approaches and recent policy trends

Jim Ryder, Professor of Science Education
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School of Education, University of Leeds, UK

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SJST, December 2014

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Science teacher education in England

Typically a one-year university-based course, after a relevant undergraduate degree.

Postgraduate Certificate in Education (PGCE) awarded by a university (one third of a full Masters level qualification).

Qualified Teacher Status (QTS) – the national professional standards for teaching.

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Overview

- Structure of science teacher education in England
- Content and pedagogy: Example of student misconceptions
- Recent policy trends

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Science teacher education in England

Course includes:

- university-based lectures, seminars and tutorials (40%)
- teaching experience in two schools (60%)

Organised by school-university partnerships.

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University lectures/workshops (6 weeks)

First school practice (8 weeks)

University lectures/workshops (7 weeks)

Second school practice (13 weeks)

University (1 week)

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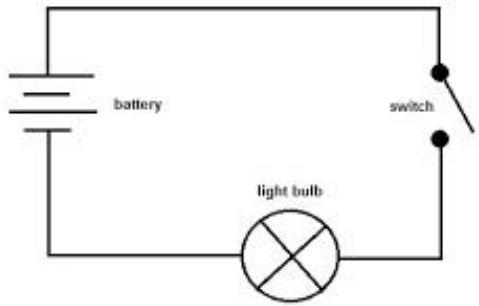

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Content and pedagogy. Example of university session: Pupils talking about electric circuits

- Pupil 'starting points'; based on research into student misconceptions
- Identifying the 'learning challenge'
- Teaching approaches to address these learning challenges

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1. Explain in as much detail as you can (thinking about both battery and bulb) why you think the bulb lights up.

because the battery stores electricity and when the electricity passes down the wire it lights the bulb

2. a) How could you change the circuit to make the bulb brighter?

you could shorten the wire

b) Explain why this would work.

because you wouldn't need as much electricity to get to the ~~wire~~ bulb

3. If the circuit is left, why will the battery go FLAT eventually?

because the bulb would use up all of the electricity in the battery

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Where does the 'electricity' come from?

- Students' thinking: 'The electricity flows out of the battery when the circuit is complete'
- Physics view: The electric charges originate in the circuit. When the circuit is completed the charges start flowing in all parts of the circuit simultaneously.

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What to do about it?

- The BIG circuit!
- The ROPE loop analogy

[Key issue: supporting the transfer of these insights introduced in the university into their school practice]

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The BIG problem!

- From point to point…
- the circuit is initially empty and fills with 'electricity' that eventually reaches the bulb and causes it to light.
- the 'electricity' travels from point to point and affects each component in turn

- To all at once…
- When the circuit is completed the charges all around the circuit are set in motion simultaneously

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An example of a resource used in initial teacher education

- Institute of Physics: Supporting Physics Teaching (SPT) materials
- http://supportingphysicsteaching.net/ElHome.html

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Physics narrative: an account of the physics at the level it will be taught in the classroom

Teaching & Learning issues: key teaching issues plus common misconceptions and confusions amongst pupils

Teaching Approaches: resources, teaching tools and strategies which also address the teaching and learning issues

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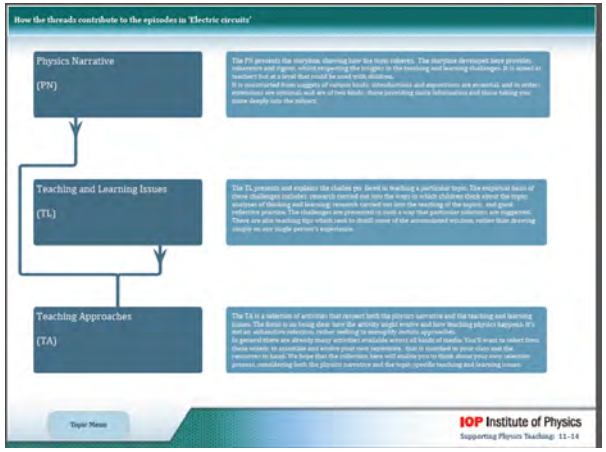

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Initial Teacher Education is changing…
Current policy trends

- A change in balance of leadership, control, funding for initial teacher education from universities to schools
- 'School Direct',
- 'School-Centred Initial Teacher Training (SCITT)
- Science is a 'shortage subject' in teacher education:
  - enhanced funding for science teacher education students (especially physics)
  - developing undergraduate degrees that lead to Qualified Teacher Status in physics teaching

French Science Teacher Education Contents : Which? Why? How?

SJST The International Seminar 2014 on The Research Trends on Science Teacher Education
Tokyo december 2014

Maryline Coquidé
maryline.coquide@ens-lyon.fr

Outlines

1. French system teacher education and Master MEEF's elements : university education and professionalizing
2. Knowledge in teaching (pas sur, teaching knowledge?): different models
   - The Shulman model and PCK
   - *Didactique des sciences*
3. Discussion

2

French teacher education system

3

Master in teaching and education careers (MEEF)

- Offered by ESPE (Ecole Supérieure du Professorat et de l'Education) in *Universities*
- Universities define Master's contents
- Current content: *National standards* of teachers' competencies

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National standards General competencies in teaching and education careers (2013)

G1. To share values of the Republic

G2. To enter action in accordance with the fundamental principles of the education system

G3. To know the students and the learning process

G4. To take into account students' diversity

G5. To support students in their training

G6. To act as an responsible educator and follow ethical principles

G7. To master French language for communication

5

National standards General competencies in teaching and education careers (2013)

G8. The command of a foreign language

G9. To master the digital culture elements necessary for the exercise of his profession

G10. To cooperate in team

G11. To contribute to the work of the educational community

G12. To cooperate with parents

G13. To cooperate with school partners

G14. To engage in individual and collective professional development process

6

Specific teachers' competencies (2013)

Within the teaching staff, teachers accompany each student in the construction of his training courses. So that their education promotes and supports the learning process, know-how and attitudes, they take into account the fundamental concepts related to the development of the child and adolescent, mechanisms of learning and the results of research in these areas.

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National standards Specific teachers' competencies (2013)

P1. To master the subject knowledge and its *didactic*

P2. To master the French language as part of his teaching

P3. To build, to implement and to facilitate teaching and learning situations, taking into account the diversity of students

P4. To organize a mode of promoting group learning and socialization of students

P5. To assess progress and achievement of students

8

P1. To master the subject knowledge and its *didactic*

- To know thoroughly discipline or teaching areas. To situate the fundamental benchmarks, epistemological and educational problems.
- To control objectives and teaching requirements of the common core of knowledge, skills and culture as well as the achievements of the previous cycle and the next cycle content.
- To contribute to the development of interdisciplinary projects serving enrolled in the curriculum objectives.

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P3. To build, to implement and to facilitate teaching and learning situations, taking into account the diversity of students

- To know how to prepare sequences class and, for this set of programming and progressions; identify the objectives, content, devices, educational barriers, shoring strategies, methods of training and evaluation.
- To differentiate their teaching to learning rhythms and needs. Adapt their teaching to pupils with special educational needs.
- To take into account the prerequisites and social representations (gender, ethnicity, socio-economic and cultural background) to deal with any difficulties in access to knowledge.
- To select appropriate skills development targeted educational approaches.
- To promote skills integration (creativity, responsibility, cooperation) and the learning transfer through appropriate procedures.

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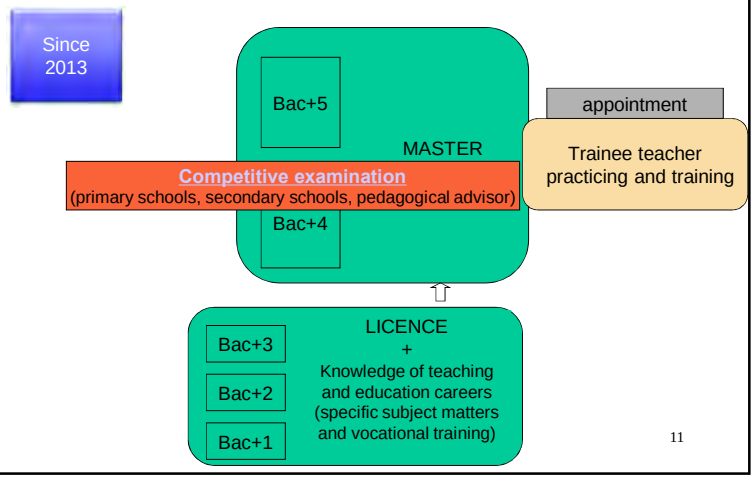
French system of teacher education



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Master in teaching and education careers (MEEF)

General principles:

Combining *theoretical* (acquisition of subject matter, pedagogical and didactical knowledge) and *practical* training (lesson preparation, classroom management)

- University courses and introduction to research
- Periods of work experience:
  - shadowing
  - accompanied practice
  - responsibility

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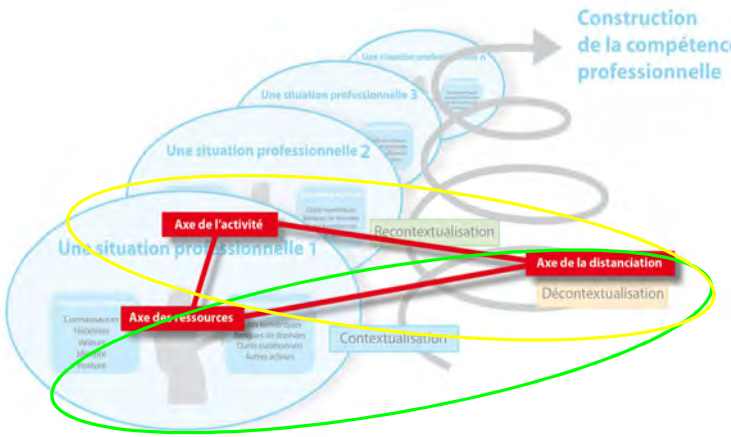

Three complementary areas of vocational competences
(Le Boterf, 2005)

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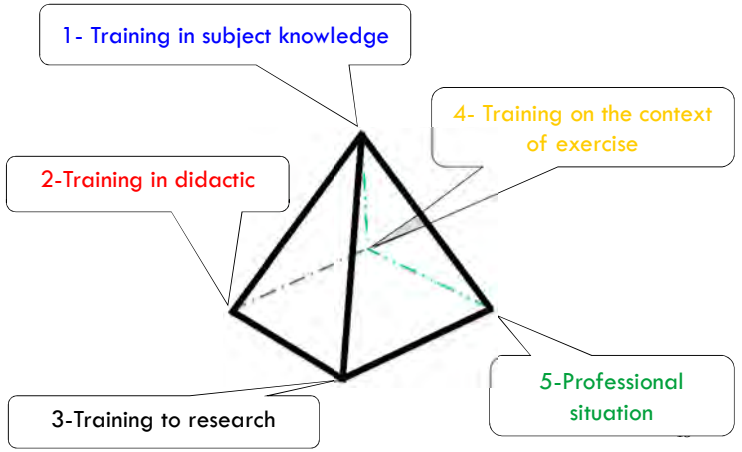
Institutional framing of the master MEEF



Principles MEEF training courses

- "Integrative" alternation
- "Mixed" tutoring
- Individual trainees monitoring

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National coordination by « block »

Document (committee of Master's degree)

	Bloc 1 *Disciplinaire*	Bloc 2 *Didactique*	Bloc 3 *Recherche*	Bloc 4 *Contexte d'exercice du métier*	Bloc 5 *Mises en situation professionnelle*
Master 1	30 (*2) ECTS	15 (*2) ECTS	6 (*+2) ECTS	6 (*2) ECTS	3 ECTS
S1	18	6	3	3	Validation au S2
S2	12	9	3	3	3

	Bloc 1 *Disciplinaire*	Bloc 2 *Didactique*	Bloc 4 *Contexte d'exercice du métier*	Bloc 3 et 5 *Recherche et Mises en situation professionnelle*
Master 2	8 (*2) ECTS	16 (*2) ECTS	6 (*2) ECTS	30 ECTS (intégrant 10 ECTS relatifs au mémoire et à la soutenance au S4 : S3 = 10 / S4 = 20)
S3	6	11	3	
S4	2	5	3	

31 ECTS
ECTS: average of 10 hours

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Which knowledge?

- Knowledge in (or for?) teaching?
- Know what?
- Know how?

Reflecting in/on practice
(Schön 1983, 1987)

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Differents kinds of knowledge
(Shulman 1987)

- Knowledge of subject matter;
- Pedagogical content knowledge;
- Knowledge of other content;
- Knowledge of the curriculum;
- Knowledge of learners and their characteristics;
- Knowledge of educational aims (purposes and values and their philosophical and historical backgrounds);
- Knowledge of educational context (features of school communities and cultures);
- General pedagogical knowledge (broad principles and strategies of classroom management and organisation).

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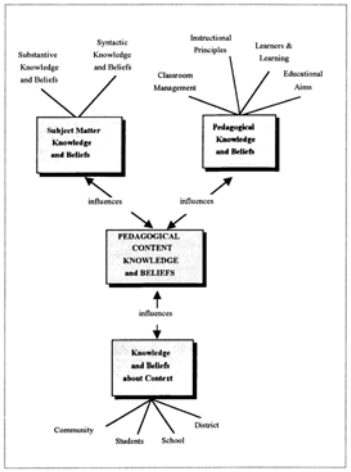
Model of relationships among the domains of teacher knowledge (Grossman 1990)



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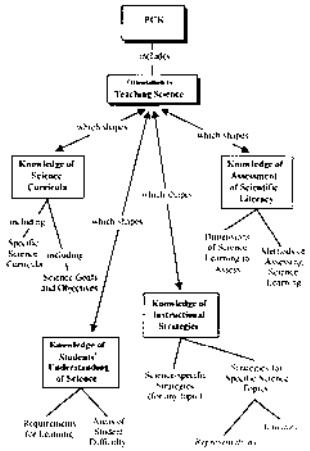
Components of PCK
(Magnusson et al., 1999, p. 99)



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PCK Program Orientations

- Study of the specific structure of PCK in the teacher's knowledge base
- Study of its elaboration in teacher education
- Study of how knowledge is reorganized during action and pedagogical reasoning

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French *Didactique*

- Didactic and pedagoy
- Didactic of a school discipline
- Didactic of science
  - Didactic of experimental sciences
  - Didactic of physical science
  - Didactic of chemistry
  - Didactic of biology
  - Didactic of Technology

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S1	18	6	3	3	Validation au S2
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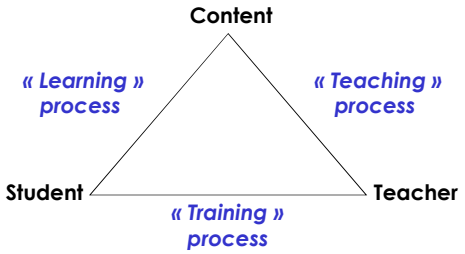
31 ECTS
ECTS: average of 10 hours

22

Didactic System



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Some didactics research tasks

- The interpretation of the logical thinking of the learners
- The analysis of taught knowledge and content
- The construction of situations and teaching tools

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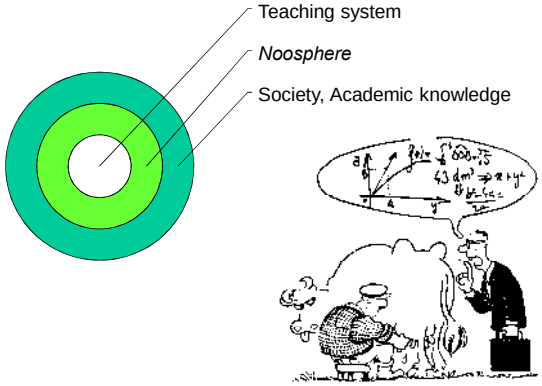
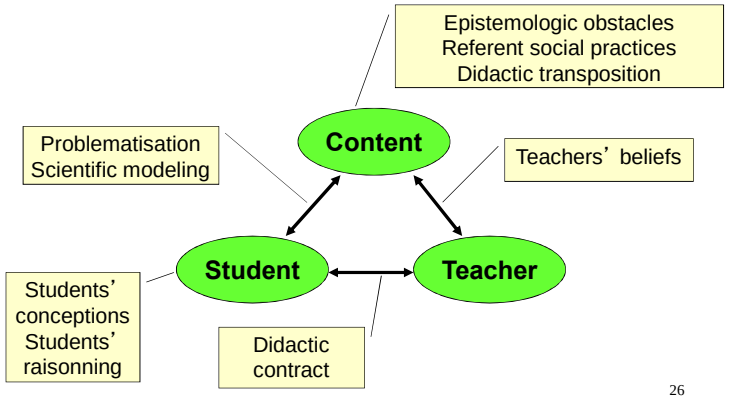
Didactic transposition (Chevallard, 1985)
Social practices (Martinand, 1986)



Some didactics concepts



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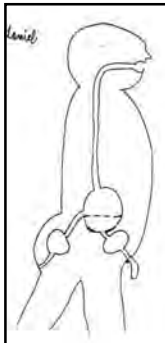
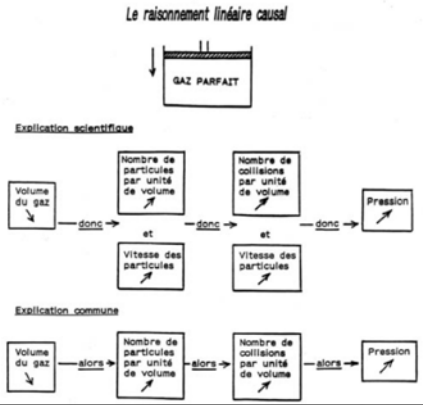
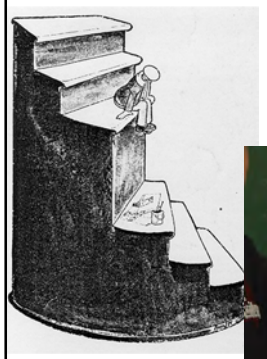
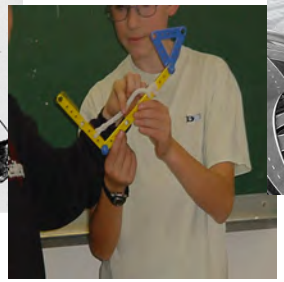
Students' representations
Students' reasoning
Obstacles





To manage tools and devices
To elaborate *situations*





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Conclusion on didactic approach

Discussion

PCK versus Didactics ?

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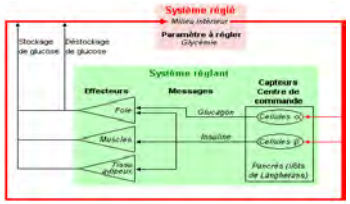
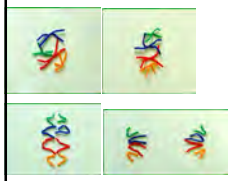
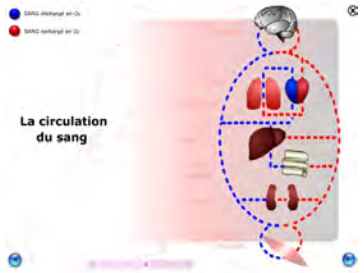
An entry in scientific thought







Thank you for your attention

Finland: Trends On Science Teacher Education In Finland

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Content

- Science teacher education in Finland
- Examples of topics in pedagogical courses
  - *Classroom discourse*
  - *Multiple representations*
  - *Practical work*
  - *Knowledge of students' conceptions*
- Conclusion

Subject Teacher Education

NOTE:

For simplicity, in the following slides I will take as an example physics teacher studies

Subject Teacher ed…

- physics teacher students are students of the physics department (faculty of science)
- studies in physics do not in general differ from the courses given to students studying for the physicists' line
- some special courses, e.g. physics school demonstrations, history of physics, school physics

Subject Teacher ed…

- the subject teacher education is in total 300 ECTS (study points)
- 240 study points in subject studies at the faculty of science
  - e.g. 180 credits physics and 60 credits of another subject e.g. mathematics or chemistry
- Master's thesis at the department of physics
  - The thesis could deal with pure physics or pedagogy of physics.

Subject Teacher ed…

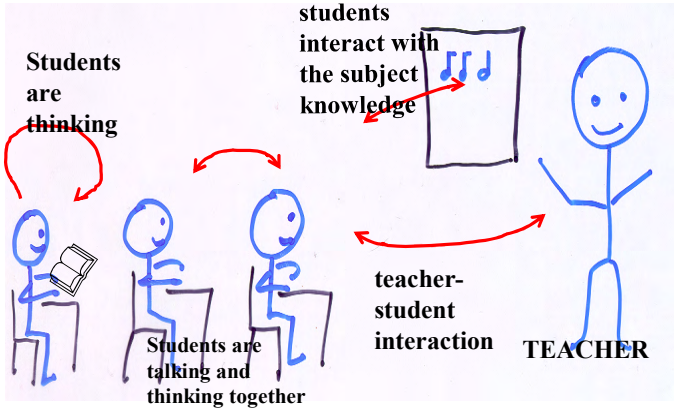
- 60 study points in pedagogical studies
- at the department of teacher education at the faculty of education
- After graduation from a university, students are licensed as teachers and may apply for teaching positions in schools.

Subject Teacher Education

	Bachelor's Degree	Master's Degree	300 ECTS
Teacher's pedagogical studies including teaching practice	25-30 5	30-35 15	60
Major studies in subject matter Research methods	60 (including BA thesis)	60-90 (including MA thesis)	120-150
Minor academic studies	25-60	0-30	25-90
Language and communication studies, incl. ICT	35-40	0-30	35-70

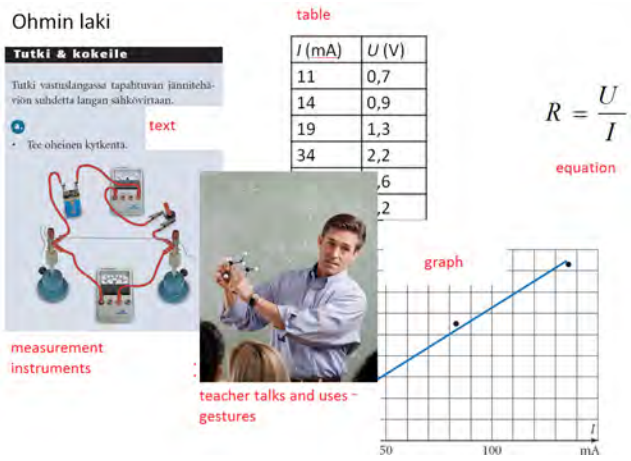
Classroom discourse

Interactions in teaching-and-learning



Multiple representations

- One of the main cultural constructs of science is the use of models and representations.
- Multiple representations e.g., text, diagram, graph and equation, are often required for the understanding of scientific concepts and for problem solving



Multiple representations for Ohm's law.

Practical work

- "the core purpose of practical activity in science teaching is to help the student make links between the domain of objects and observable things, and the domain of ideas" Millar, Le Maréchal and Tiberghien (1999)
- This linking of observations and theory is not very common (Abrahams & Millar, 2008; Jokiranta, 2014).

Knowledge of students' conceptions

- Knowledge of students' science conceptions is part of science teacher's knowledge
- Shulman (1986) teacher knowledge:
  - content knowledge (subject matter knowledge),
  - general pedagogical knowledge and
  - pedagogical content knowledge (PCK).

- content knowledge refers to
  - knowledge of science topics
  - the nature and structure of science (NOS),
- general pedagogical knowledge
  - knowledge of broad principles and strategies,
  - knowledge of learning theories
  - classroom management.
- PCK refers to
  - knowledge of methods of representing and formulating topics that will make them comprehensible to students.
  - understanding of what makes the learning of a specific topic easy or difficult,
  - the conceptions that students bring to the topic.
  - PCK refers to particular topics

Conclusion

- In science teacher education students learn both abstract pedagogical theories and practice teaching in training schools.
- I have described four topics which are dealt during the pedagogical lectures and which ideas students can then also test in their practice lessons and hopefully also remember and use as in-service teachers.

ARIGATO!