# Mathematics Teachers as designers: an international perspective

Chair: Birgit Pepin

Eindhoven University of Technology, NL

Panel:

Michele Artigue

Verônica Gitirana

Binyan Xu

Takeshi Miyakawa

Kenneth Ruthven

# Structure of the session

- Introduction (by the chair) (10 minutes)
- Each panel participant answers the following three **W**- questions (approx. 10 minutes each):
  - **W**hy are teacher design activities relevant? Why would they design?
  - **W**hat would teachers design? What are the most interesting/challenging design tasks?
  - Ho**w** would teachers design? What sorts of design approaches would they use, and under which conditions?
- Plenary Discussion (30 minutes)

# Teacher Design Capacity

(Pepin, Gueudet, & Trouche 2017)

- A **goal**, or point/s of reference, for the design
- A set of **design principles**: (a) firm/robust and (at the same time) (b) didactically flexible
- "**Reflection-in-action**" type of (often implicit) understandings

Michèle Artigue
Université Paris-Diderot
France

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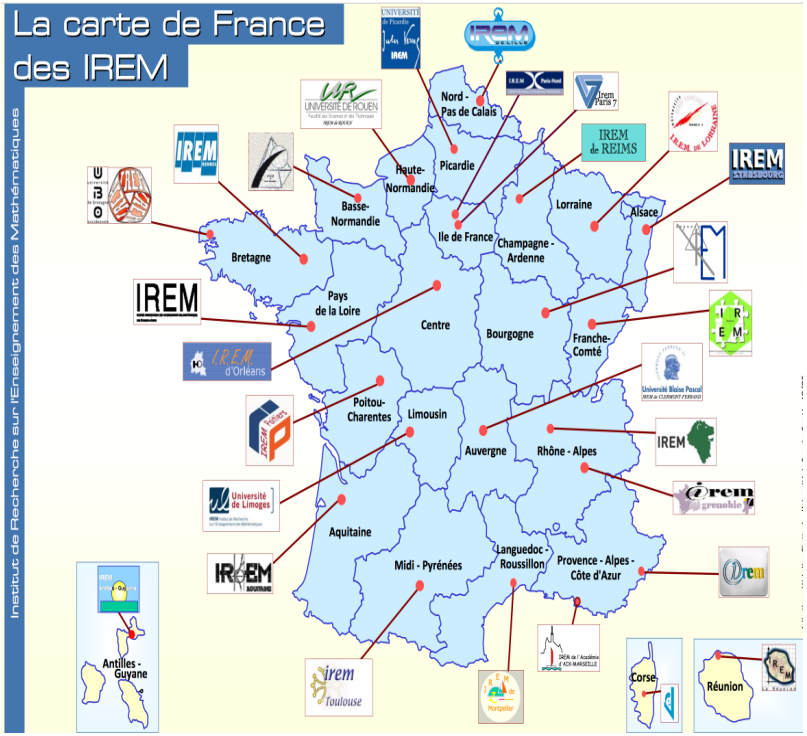
# Some contextual characteristics

- The IREM network and the specificity of this structure in which mixed thematic groups develop a design activity.
- The fact that design is considered a normal teacher activity in the French education system.
- The diversity of existing resources and sources for these.



# Why, What, and How?

- Answers depend on the exact meaning given to ‘design activity’.
- I adopt a wide vision in line with DAD, including in it any form of combination, complementation, and redesign of existing resources (design /Design).
- Within this vision, this is clear that **teachers do design.**

# Why?

What needs do teacher design answer?
What does this design offer more globally, beyond answering teachers' personal needs?

External resources that teachers access always are some kinds of generic objects

Adaptation when not at all anticipated must be made on the spot, which is source of work overload and counter-productive didactic decisions

Teachers' design activity, if carefully supported, can be an essential component of their professional development

Teachers' experience and specific expertise is necessary in design teams

# What?

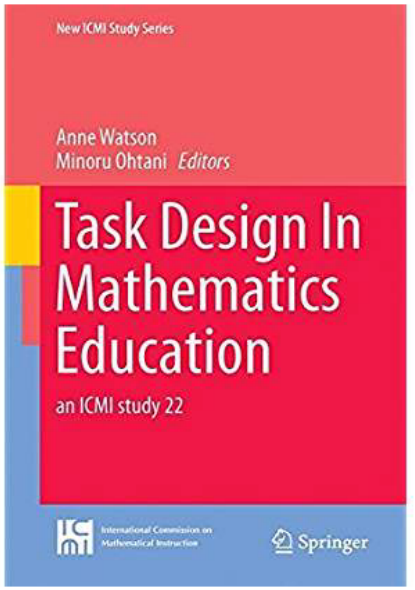
**What would teachers design?**
Why would we limit the extension of teacher design?

**What are the most interesting/ challenging tasks?**
Interesting/challenging for whom?
The individual teacher?
Some collective (s)he belongs to?
Others?

Some examples of challenging design activities in my recent IREM activities:

- designing for real interdisciplinary projects, taking into account the systemic conditions and constraints;
- designing sequences of tasks combining the progression of mathematics knowledge and that of more transversal competences, such as modelling.

# How?

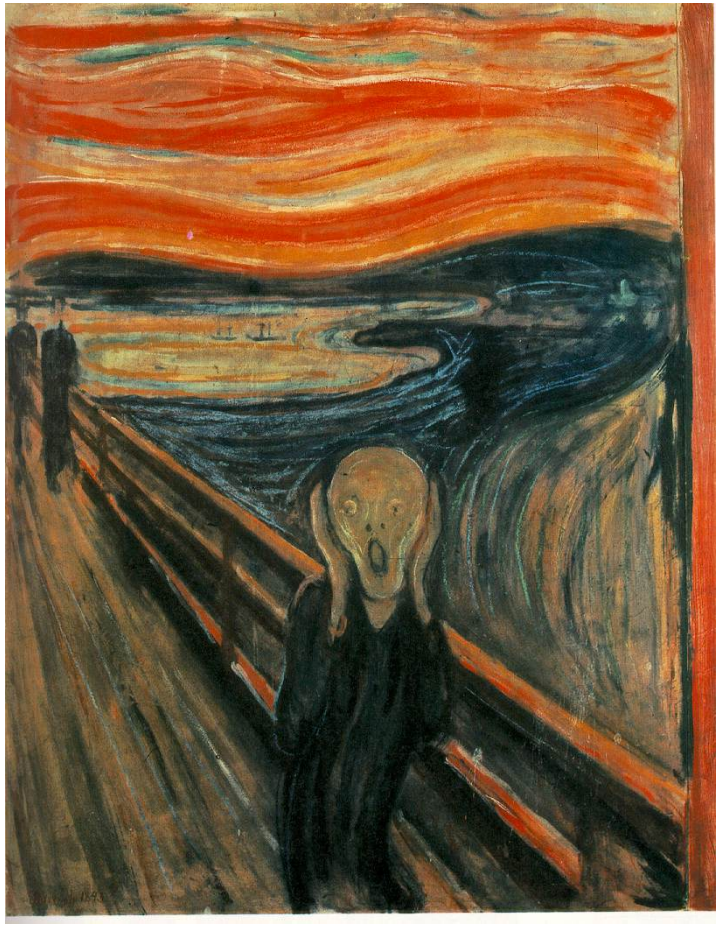



- The ICMI-Study 22 book makes clear the diversity of possible

  answers to this question.
- In the French didactic culture, TDS and now ATD with

  the concept of SRP, the model of didactical engineering, obviously influence the vision of possible answers.
- Personally, and certainly due to my IREM experience, I am especially sensitive:
  - to the affordances of collective, iterative and reflective design for teachers;
  - to the importance of designing sequences providing a teaching progression, and taking in charge the different moments of the study process;
  - to the difficulties that we still meet at having research knowledge taken into consideration.

# The design double-bind?



Kenneth Ruthven,
University of Cambridge
UK

# Teacher design

- [We] regard “design” as the practice of designing for teaching, as in lesson preparation (that is design before enactment), as well as in teaching, what we labeled as “design-in-use” that happens during enactment of the resources/materials
- [A]ccording to Brown (2009) teachers’ pedagogical design capacity (PDC) is the capacity to utilize and transform existing curricular resources effectively, and to design/create new materials, for the purpose of effective mathematics instruction

(Pepin, Gueudet & Trouche, 2017)

# Double bind

- a situation in which a person is confronted with two irreconcilable demands or a choice between two undesirable courses of action

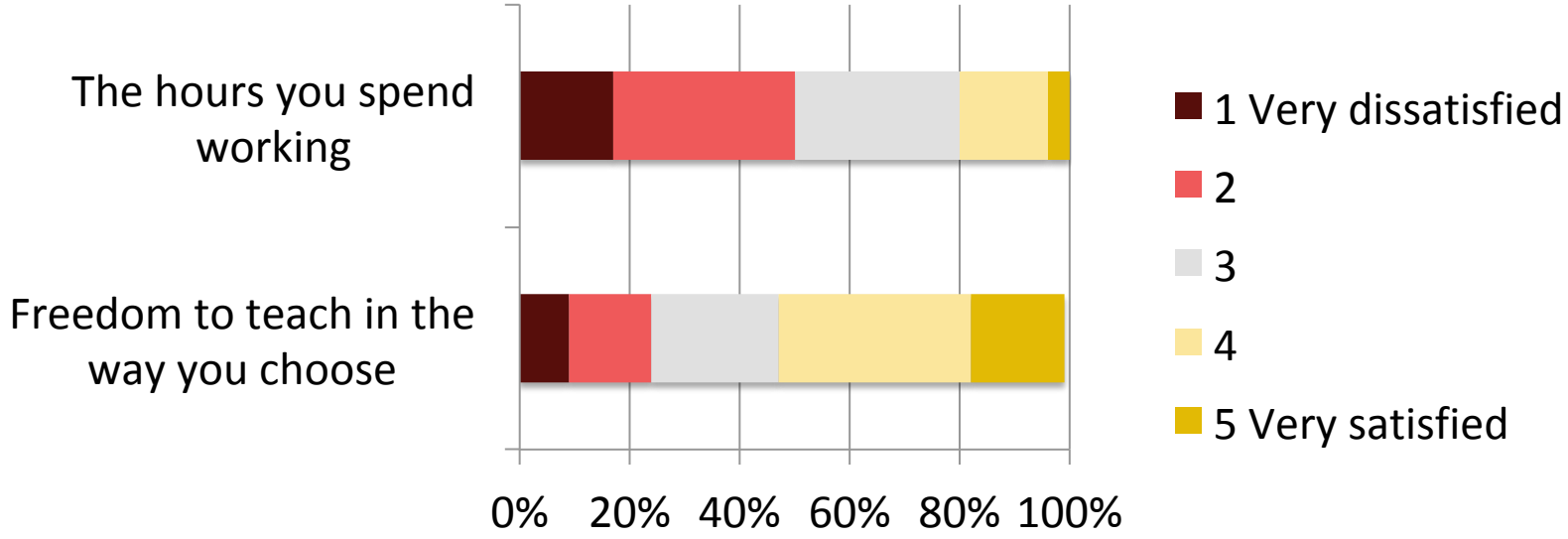
The Observer

Lintell was overwhelmed by two things: pouring his soul into "choreographing the classroom" five times a day; and seeing any hope of recovery disappear under a mountain of preparation for the next day's performances.

"You're meant to spend no more than an hour preparing for each lesson, but if you're going to do a half-decent job, you need two hours. If you have 25 hours of lessons a week, that's already 50 hours. And then you've got marking and other things on top."

Welcome to England's classrooms in 2018. Every teacher knows someone who has left the profession, retired early, had a breakdown, or been signed off work with stress. Just under 40,000 teachers quit the profession in 2016 - the latest figures available - representing about 9% of the workforce,

# Freedom, workload and retention: National survey of mathematics teachers




- Likelihood of remaining in teaching associated with:
  - Level of satisfaction with working hours (r=.22)
  - Level of satisfaction with freedom to teach (r=.22)

(NFER, 2006)

# The design double-bind

- Teacher satisfaction derives from
  - Exercising freedom to teach as you choose (i.e. undertaking teacher design)
  - Having reasonable working hours
- However (given the number of lessons that teachers are expected to teach each day, as well as the other duties that they are required to fulfill) this produces a double-bind, wherein:
  - Exercising freedom to teach as you choose (i.e. undertaking teacher design) increases working hours to an unreasonable level

# Teacher design

- How much?
  - Teachers should be expected to engage in design only to such an extent that their workload remains reasonable
- Why?
  - Those design activities that teachers do undertake should:
  - Increase the satisfaction that they derive from teaching
  - Clearly help improve the quality of their teaching
- What?
  - Whatever can be shown to satisfy the criteria above
- How?
  - However can be shown to satisfy the criteria above

# RE(S)SOURCES 2018

Takeshi Miyakawa
Joetsu University of Education
Japan

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# Resource design

- Who?
  - In general, teachers should not be expected to design their own curricular resources
  - Such resources should be designed by highly skilled teams, including members who have relevant teaching experience and who have particular expertise relevant to the curricular aims of the resources
  - At the same time, such resources should be trialled by ordinary teachers, refined in the light of insights gained through such trialling, and shown to be effective in a suitably wide range of circumstances, before being generally distributed

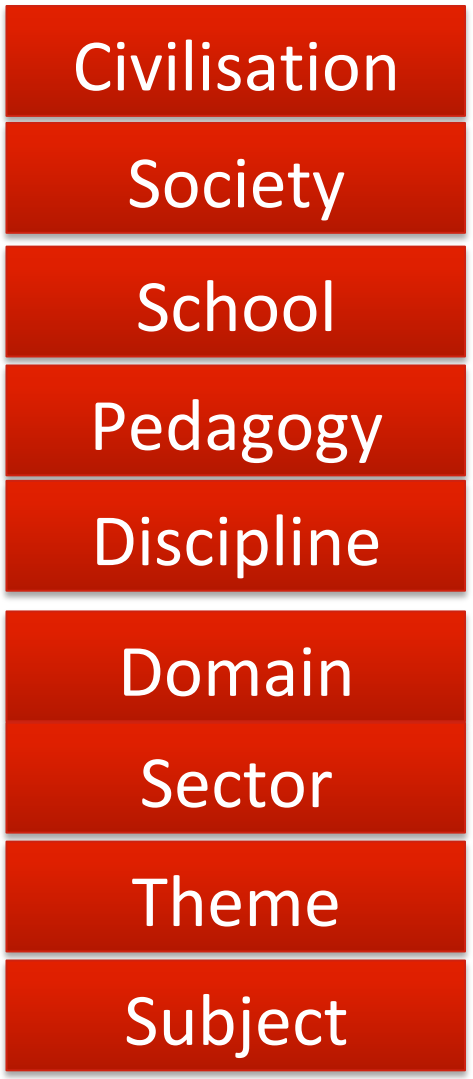
# Why are teacher design activities relevant?

- In ordinary teaching
  - Use of textbook
  - Roles of teachers:
    teacher designer vs teacher free textbook

- Professional development
  - Lesson Study in Japan
  - Practice research (or action research)

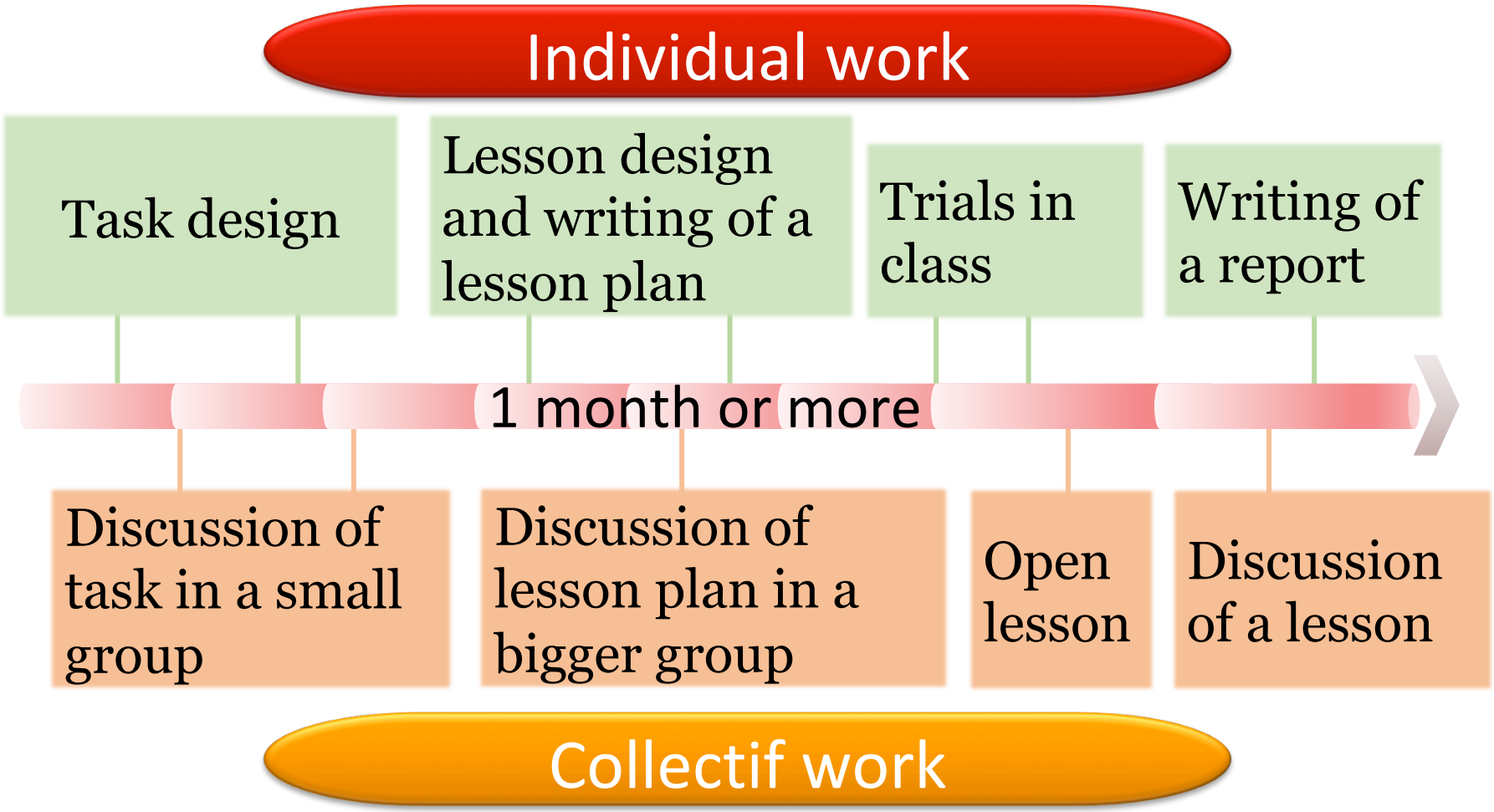
# What would teachers design?

- From Japanese perspective
  - Task design
  - Lesson design
- From ATD perspective
  - Levels of didactic codetermination (cf. Chevallard, 2002)
  - “Thematic confinement” (cf. Barbé et al, 2005)



# How would teachers design?

- Lesson Study in Japan



Binyan Xu
East China Normal University
China

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AUF Agence Universitaire de la Francophonie Europe de l'Ouest
AUF Agence Universitaire de la Francophonie Europe de l'Ouest
EPIC
Sciences Société S2HEP Éducation
ReVEA Ressources vivantes pour l'enseignement et l'apprentissage
EducTice
ifé Institut Français de l'Éducation
Université de Lyon
ENS DE LYON
ENS DE LYON

- **W**hy are teacher design activities relevant? Why would they design? (Binyan Xu)

- In China, a teacher plays multiple **roles** in school
  - Do teaching
  - Do research
  - Do consulting
  - Lifelong learner

**Educational Tasks**: To develop students' ability to analyse and solve problems, to build the self confidence、self esteem of students….

Playing these roles

Structured knowledge

Sequence of learning task

Creative strategy

Evaluation of process

Adjustment of process / strategy

Reflect some Natures of Design

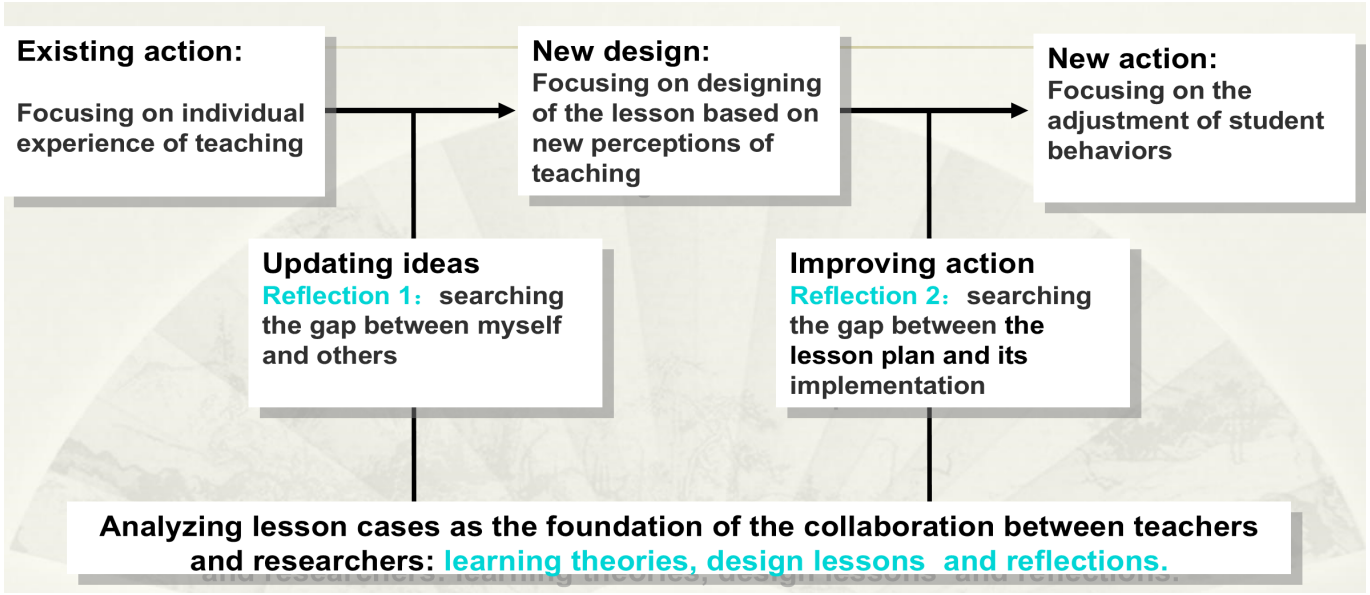
Realizing educational tasks

- **W**hat would teachers design? Micro level:
- learning targets of each lesson
- Sequence of mathematics tasks
- Assessment tools
- Lesson plan

- Macro level:
  - Teaching research propose focused on practices problems
  - Online whole Learning plan (学案)
  - Professional development program

- What are the most interesting/challenging design tasks?
  - Tasks that arouse students' interesting and exploration (HPM perspectives)
  - Task that eliminate students' misunderstanding (variation)
  - Task that present inter-relation between mathematics and other subjects (STEM)

- How would teachers design? What sorts of design approaches would they use, and under which conditions?




Action education- design research

- Action education offers one effective way for teachers and researchers to collaborate, so that they may improve themselves through learning from each other. This contributes to the resolution of the “missing paradigm” in teachers’ professional learning and to the design of more effective and realistic learning programmes.
- Action Education uses the “scientific discovery theory” and feedback mechanism in the developmental process. Teachers agree to try a theory-based idea from the researchers, with the help of a well-established mechanism for collecting feedback systematically and regularly. In the process of decision making there is strong interaction between experience and theory, which inform each other.

## The procedure of the model of Action Education is as follows.

- *Step 1.* A group of teachers invites one or two researchers to study related materials and share their views and experience with the aim of enriching teachers' professional knowledge of educational theory. They can choose a specific lesson as a case for discussion in order to look for ways to improve their pedagogical skills.

- *Step 2.* Colleagues and researchers participate in observation of the revised lesson, reflect on the effectiveness of this lesson, and make amendments to the lesson plan.

- *Step 3.* The revised lesson is implemented and is followed by post-lesson discussion and the teacher's reflective writing on the process. Such a process is repeated several times in each school term so as to set up a knowledge base for "action education".

# RE(S)SOURCES 2018

## Teacher as designer of curriculum materials:
### some contributions from Brazil


**Verônica Gitirana**

LEMATEC – EDUMATEC

Federal University of Pernambuco, Brazil

Financial Support

# Questions

**Why** are teacher design activities relevant?

Teachers' documentation genesis – Gueudet, Pepin & Trouche (2012)

In-service and preservice teachers' training

Curriculum ergonomic – Chopin et al (to appear)

**What** would teachers design: actions, or artefacts? **What** are the most interesting/challenging design tasks?

I will point out some interesting design tasks, that involves design curricular materials, and actions, on how to use it.

**How** would teachers design? What sorts of design approaches would they use? Would they design individually, or collectively? Under which conditions ? Short-term, or l**ong-term**?

It was inspired on instructional design together with reflective methodology (from DAD), in a collective process of design for long-term.

# Brazilian social and cultural diversity

Brésil 8,514,876 km2.
Bahia 567.295 km²
France 643.801 km²

Riverside school in Amazon

Children in Communities

Music valorization

Cultural and social diversity

Inequality on Regional distribution

Munduruku indian in historical problem for their land.

Multigrade schools


Group of children in the communities

Children Playing football in the garden

# Curriculum Ergonomic

**How to have effective use curriculum material in this cultural and social diversity with inequality of richness distribution ?**

Remillard (2018) - A Look across Cultural Boundaries

The importance of teachers' knowledge about:

- students' knowledge and behavior;
- students' social reality – relevant problems;
- students' time to do each task;
- school community.

# In-service teacher training

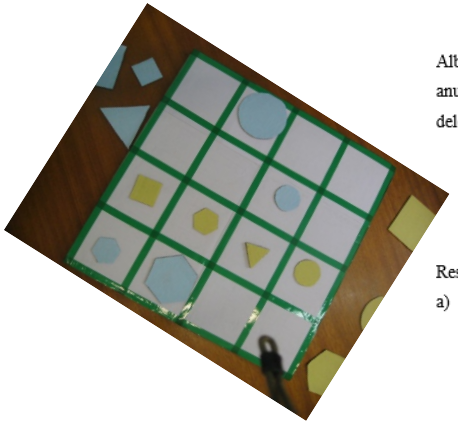
## Project - Game with recycle material in Mathematic Education

Gitirana et al (2013) - Project with Secretary of Education

In-service teacher training project

2 835 teachers, who teach math.





**Atividade 1**

Alberto e Raquel estavam no meio de uma partida, quando o sinal anunciando o fim do recreio. Observe, abaixo, como estava o jogo deles, ao final do recreio.


Responda agora:

a) Sabendo que no início da partida, cada cova tem 5 sementes. Quantas sementes já foram retiradas do tabuleiro?

- Re-design a math game using waste;
- Design activities contextualized within the game;
- Design a modelling lesson based on constructing the game with waste;
- Test it with pupils;
- Write a text about the math game;
- Publish the results;
- Train others teachers to use it.

# Pre-service teacher training project

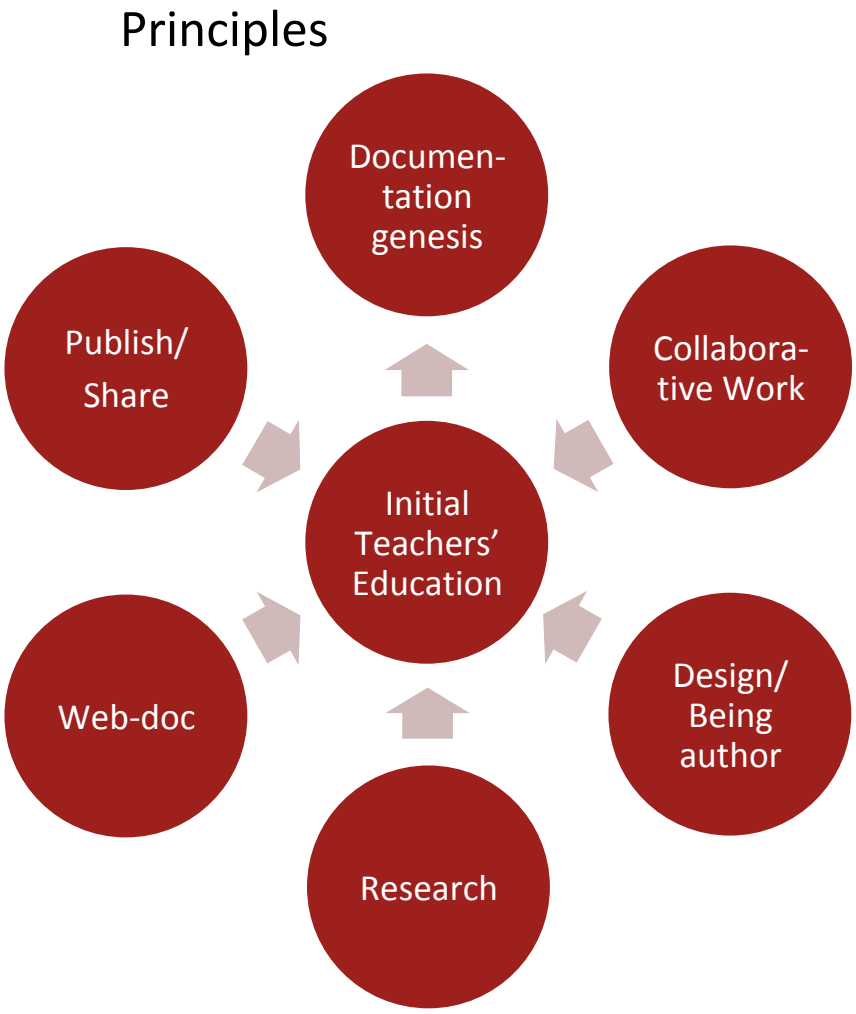
Gitirana, V. Project of the Stage Senior year
Trouche, Rodrigues, Lucena, Bellemain

A project of pre-service math teacher training – 15 students, working in four math game re-design.

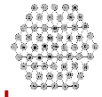
Activities:

- Construct a map of resource
- Playing with math game and analyze math mobilized;
- Re-design a math game;
- Describe it;
- Test it;
- Investigate its use;
- Write about this investigation on web-base (web-doc);
- Share the game and the results, as product and as a research action in the web.

A two years Project.



# Mapp of prospective teachers' documentation

| | | | | |
|---|---|---|---|---|
| Motivation | | Do the task as simple as possible | | |
| Curricular material | | | Resource transparence | Pupils' plays reveal play strategy/ Knowledge |
| Context/ game | | | Obstacles on ludic aspects/ board | |
| Math knowledge | Difficulty on identifying math on playing | | Relate play strategy/math knowledge | Discover new contents mobilized |
| | 2017.1 | | | 2017.2 |
| Session | Playing with a math game | Recreate a math game  | Test the game with colleagues | Test the game in a class |
| Design | Immersion | Prototype | Test with specialists | Test in class |
| Teachers training | Content mobilized  | Create curricular material (CM) | Analyze the context of CM | Analyze didactic aspects |

# Mapp of prospective teachers' documentation

Own request to do another test in class

Motivation

Students' voices and strategies

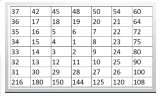
Curricular material

Role of curricular resources – ident. Pupils' difficulties

Argue based on data
Predict new strategies

Context/ game

Obstacles on ludic aspects/ board



Math knowledge

Flexibility math content/school grade

2017.2

20.18.1

Session

Write about the experience

Organize the web doc to share

Present their WD in the course

Design

Analyze the results

Redesign

Document the product

Share

Teacher Training

Analyze and write the experience

Write about didactic aspects

Discuss about their math game

# Conclusions

**Why** are teacher design activities relevant?

Teacher design activities is relevant in cultural and social diversity country as in Brazil, because we need teachers flexibility to recreate activities adequate to their cultural and social context.
Integrating the actor (teacher) who knows better didactic variables of their own students – motivation, times, previous knowledge, and all the variables of their own work.

# Conclusions

**Why** are teacher design activities relevant?

It showed to be a relevant set of activities for teachers training – redesign a math game, write, test, redesign, investigate, and publish, in a long-term design process, because:

- Being an author is a moment: to be involved in a reflect; to shorten the time they consider some important resources in their documentation, such as pupils' voices and observing their strategies as a resource to rethink teaching aspects;
- It showed to be an a-didactical situation for teachers' training – they assume as their product, and the way they perceive it's well done or not.
- Liberty to think, creativity to innovate, self-confidence;
- Change their behavior relating to the error. They started to speak about their own error or the absence of knowledge.

# Plenary Discussion