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):
  - Why are teacher design activities relevant? Why would they design?
  - What would teachers design? What are the most interesting/challenging design tasks?
  - How 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
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?

<table>
<thead>
<tr>
<th>External resources that teachers access always are some kinds of generic objects</th>
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<tr>
<td>Teachers’ design activity, if carefully supported, can be an essential component of their professional development</td>
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<td>Adaptation when not at all anticipated must be made on the spot, which is source of work overload and counter-productive didactic decisions</td>
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<td>Teachers’ experience and specific expertise is necessary in design teams</td>
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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
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
Takeshi Miyakawa
Joetsu University of Education
Japan
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

**Individual work**

- Task design
- Lesson design and writing of a lesson plan
- Trials in class
- Writing of a report

1 month or more

**Collective work**

- Discussion of task in a small group
- Discussion of lesson plan in a bigger group
- Open lesson
- Discussion of a lesson
Binyan Xu
East China Normal University
China
- **Why** 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 of students...
Playing these roles

- Structured knowledge
- Sequence of learning task
- Creative strategy
- Evaluation of process
- Adjustment of process / strategy

Realizing educational tasks

Reflect some Natures of Design
What 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

- Existing action: Focusing on individual experience of teaching
- New design: Focusing on designing of the lesson based on new perceptions of teaching
- New action: Focusing on the adjustment of student behaviors

- Updating ideas
  Reflection 1: searching the gap between myself and others

- Improving action
  Reflection 2: searching the gap between the lesson plan and its implementation

- Analyzing lesson cases as the foundation of the collaboration between teachers and researchers: learning theories, design lessons and reflections.
• 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”.
Teacher as designer of curriculum materials: some contributions from Brazil

Verônica Gitirana
LEMATÉC – EDUMATEC
Federal University of Pernambuco, Brazil
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 **long-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

Cultural and social diversity

Inequality on Regional distribution
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.

Activities developed in the project:
• 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

1. Do the task as simple as possible

2. Motivation

3. Curricular material

4. Context/game

5. Math knowledge

6. Difficulties on identifying math on playing

7. Resource transparency

8. Obstacles on ludic aspects/board

9. Relate play strategy/math knowledge

10. Pupils’ plays reveal play strategy/Knowledge

11. Discover new contents mobilized

12. Test in class

13. Analyze didactic aspects

14. Test the game in a class

15. Analyze the context of CM

16. Test with specialists

17. Create curricular material (CM)

18. Prototype

19. Recreate a math game

20. Playing with a math game

21. Session

22. Design

23. Teachers training

24. Mapp of prospective teachers’ documentation

25. Motivation

26. Curricular material

27. Context/game

28. Math knowledge

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43. Playing with a math game

44. Session

45. Design

46. Teachers training

47. Mapp of prospective teachers’ documentation
Mapp of prospective teachers’ documentation

Motivation

Curricular material

Context/game

Math knowledge

Session

Design

Teacher Training

2017.2

2018.1

Write about the experience

Analyze the results

Analyze and write the experience

 Argue based on data

Predict new strategies

Redesign

Organize the web doc to share

Document the product

Write about didactic aspects

Share

Present their WD in the course

Discuss about their math game

Own request to do another test in class

Students’ voices and strategies

Role of curricular resources – ident. Pupils’ difficulties

Obstacles on ludic aspects/board

Flexibility math content/school grade

Designing Teacher Training Session Math knowledge

Motivation

Context/game

Curricular material

Math knowledge

Teacher Training

Session

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Redesign

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Own request to do another test in class
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