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An exploratory study of the use of digital resources in math class: orchestration and mathematical workspaces

TIME, Mexico

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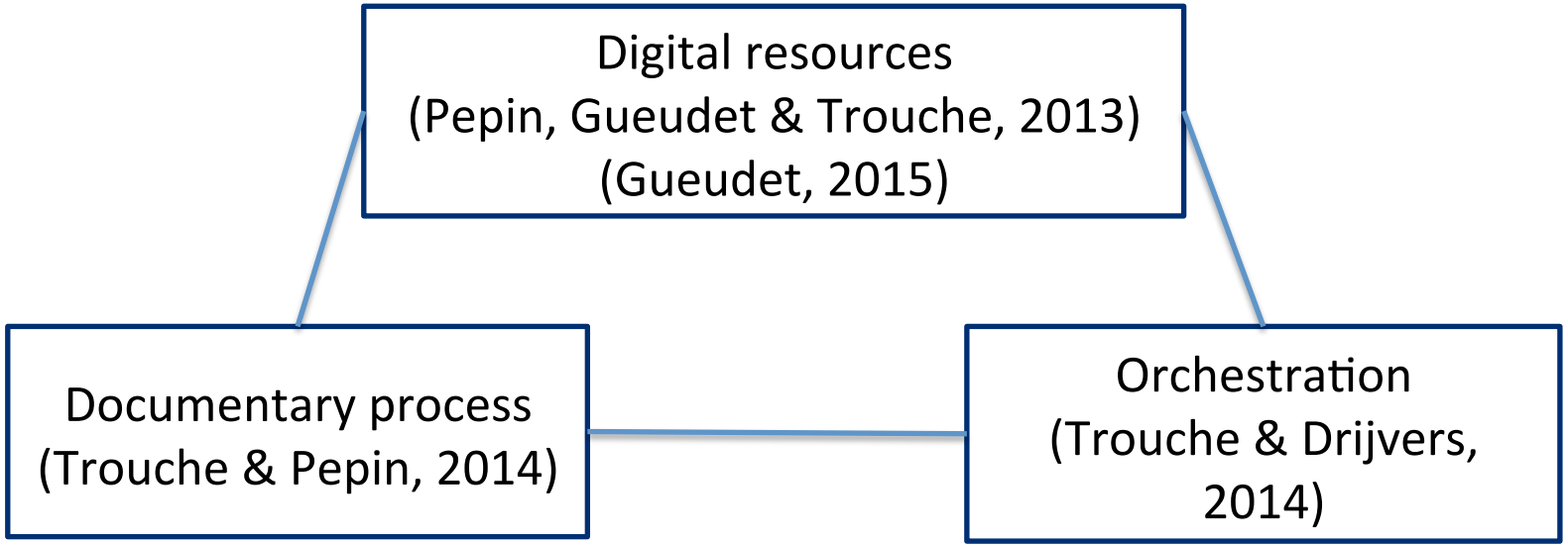
Teachers and resources

- Teachers work with digital resources in their math classes,
- but we know little on how they select or use them.

We present a research project on…

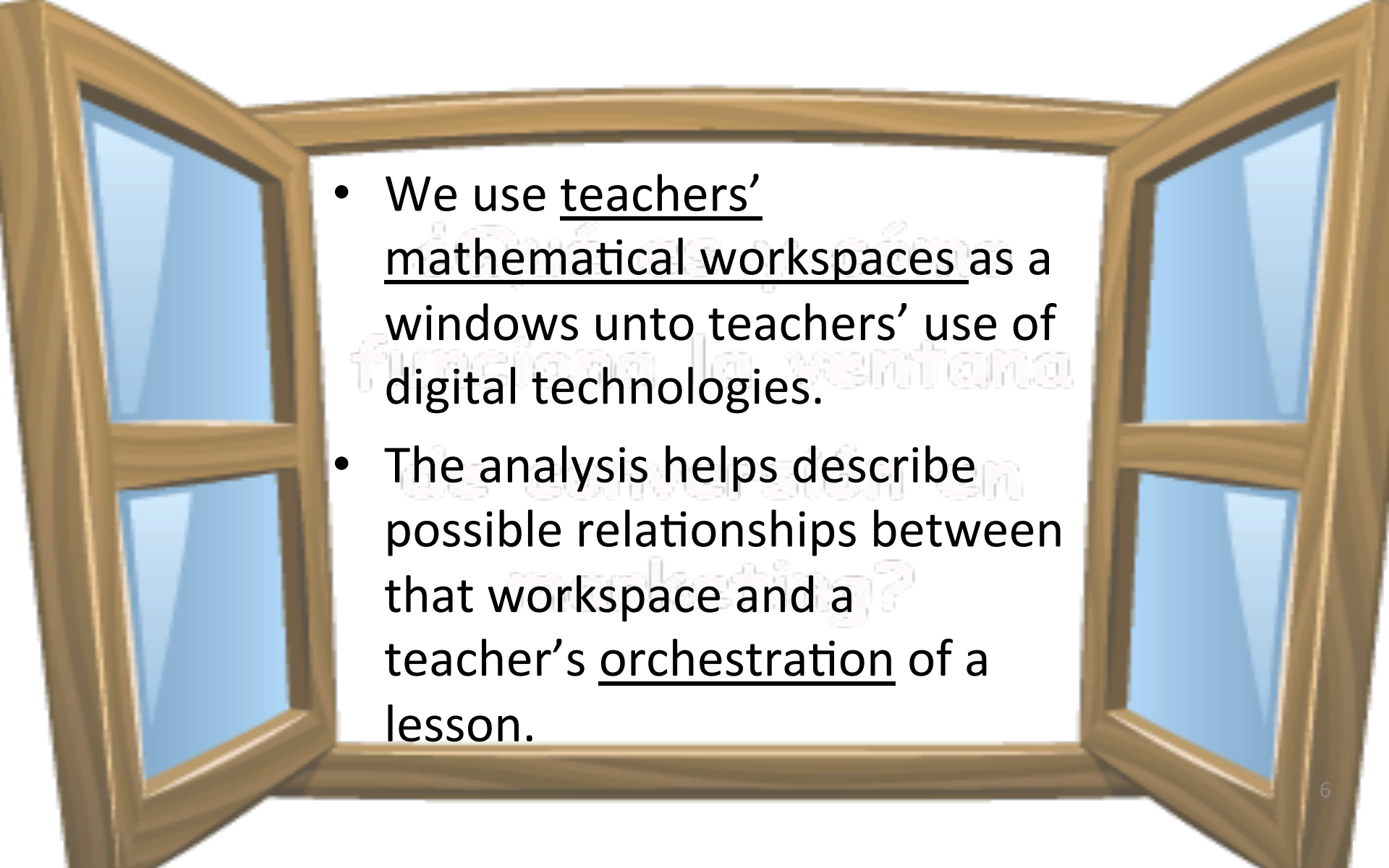
the selection and use of digital resources
by primary-school teachers
experienced in the use of resources and
technological tools.

Theoretical Framework



Mathematical workspace and resources

- An organized environment, orchestrated to facilitate the mathematical work of students and teacher
- On 2 levels:
  - Epistemological level: signs, artefacts and referential-theoretical
  - Cognitive level: visualization, construction and proof



- We use teachers' mathematical workspaces as a windows unto teachers' use of digital technologies.
- The analysis helps describe possible relationships between that workspace and a teacher's orchestration of a lesson.

Methodology

- Our study is mainly exploratory and qualitative
- Using the documentational approach
  we analyze **two cases studies** of 2 primary school teachers who:
  - gained experience through several teacher training programs for the use of digital technologies in teaching, &
  - usually use digital resources in their classes.

Data collection

- A questionnaire (in order to get insights into the teachers' professional development, their professional experience and their practice)
- Classroom observations (of a 2-hour class, for each teacher) that were videotaped
- Pre- and post-interviews with the teachers and students

Cases Studies: John and Peter

- John is a computer engineer and a certified primary-school teacher. He has been teaching for 14 years; now he teaches first grade (teaching all subjects).
- Peter has degrees in mathematics and in computational system technologies. He has been teaching for 9 years; the last 3 years teaching (only mathematics) in grades 4 and 5.

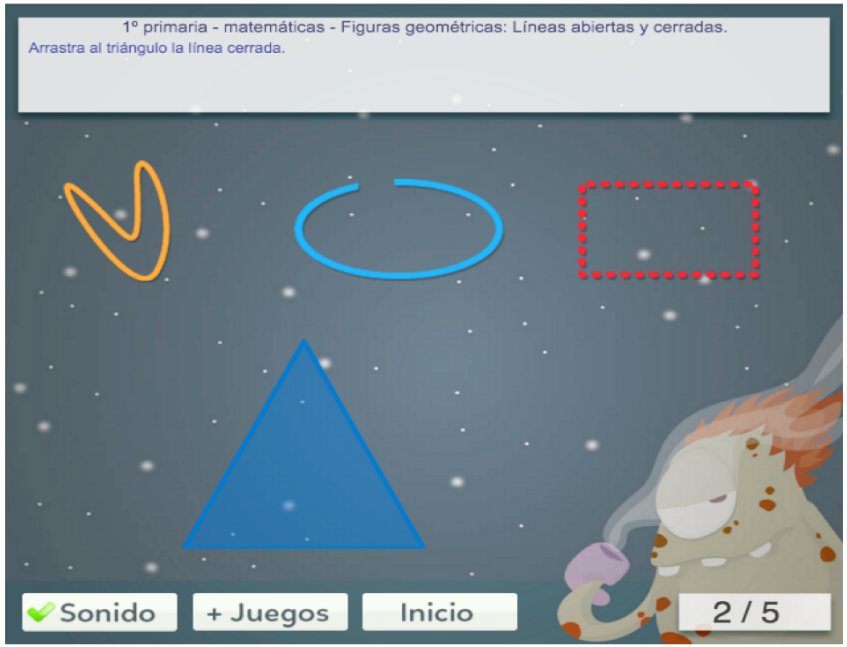
Emphasis on technical and didactical aspects of the resource: John's case

- John's class consists of 43 first-grade 6-7 year-old children.
- His goal for the learning of the students: focus on the following geometrical ideas from the school curriculum and the textbook used by John:
  - *Open lines* (*straight or curved*), *those not delimited by points;*
  - *closed lines, those in polygons or other closed figures*

For this class, John selected a resource from an online primary-school repository.

(*Juego de curvas abiertas y cerradas para niños de primaria*)

http://www.mundoprimaria.com/juegos-matematicas/juego-curvas-abiertas-y-cerradas



John's selection criteria for the resource

Local goal: Differentiate between open and closed geometrical lines.	
Local selection criteria for the resource	**Type of criteria**
Resource must be a free, easy-to-access and easy-to-use (for the children, in terms of selecting and dragging) online resource.	Technical (not only for him but also taking into account the children)
The resource must come from a reliable source: "*I check whether it was published by a recognised [institution] such as a university or something similar … which gives me confidence that it is good quality… and that other teachers use it and recommend it*"	Technical
Must provide continuity and link with themes covered in previous lessons (curricular coherence): "*The topic must be in accordance to what we are covering in class*"	Curricular
"*[The resource] must have an adequate methodology because not all [resources] are good,… and that it is good for the children's age-group.*"	Didactical
Must provide feedback to the students in terms of their actions and "present a good strategy for students to learn"	Didactical
"*The tasks must be such that children can carry them out on their own and then one can come-in to reinforce.*"	Didactical

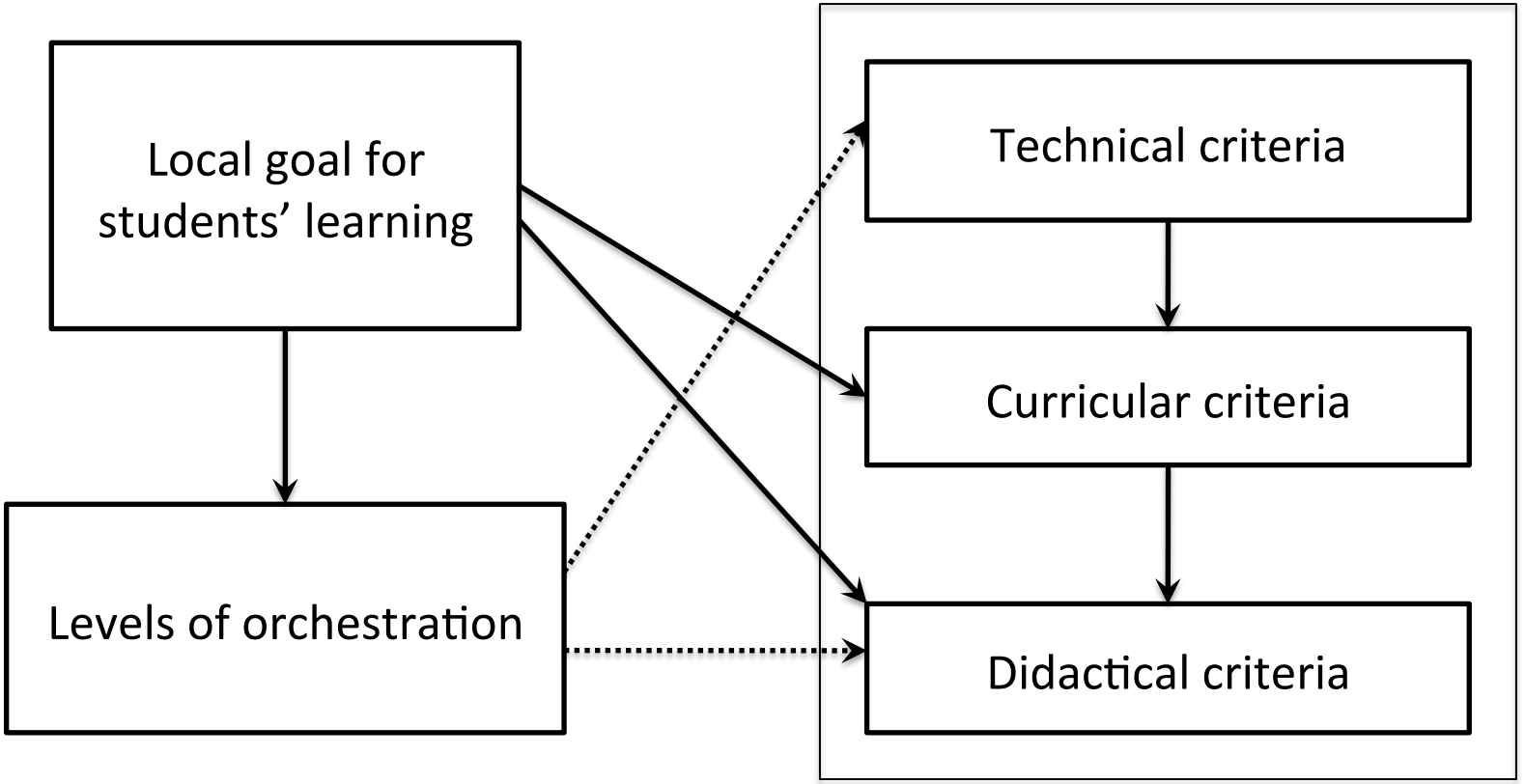
John's orchestration

Level of orchestration	John's orchestration of the resource
Student-resource	He proposes a classroom organization that emphasises students' individual work. The knowledge is validated through students' actions with the resource. The resource's feedback to the children is given a central role.
Teacher-resource-student	John interacts with students individually one-to-one. His actions are: checking students' work, post reflection questions, clarify and validate the knowledge generated. John uses the information gathered in the latter actions, to conduct whole-class interventions and feed the rest level of orchestration.
Teacher-resource-class	John gathers all the children and selects students that will project their work with the resource to the whole class. He uses this to pose more reflection questions and to validate the knowledge generated.

John’s aim was for students to first work individually, and then have a plenary session

Students' knowledge is mobilised when feedback is given by the resource

John's paths for the selection of the resources and orchestration: the construction of mathematical workspace



The digital resource as a context for exploration and construction: Peter's case

- Peter's observed group, was formed by 46 fifth-grade, 10-11 year-old children.
- The class observed was the first lesson in a long-term classroom project for the second quarter of the school year, where students would design and build a house;
- this project had as underlying mathematical concepts, the measure of lengths and areas.

Peter talks about his selection of Sweet Home 3D

Peter's selection criteria for the resource

Global (long-term) goal:

Measures of areas in the context of the design of a house.

Global didactical criteria:

1 Collaborative work (student pairs)

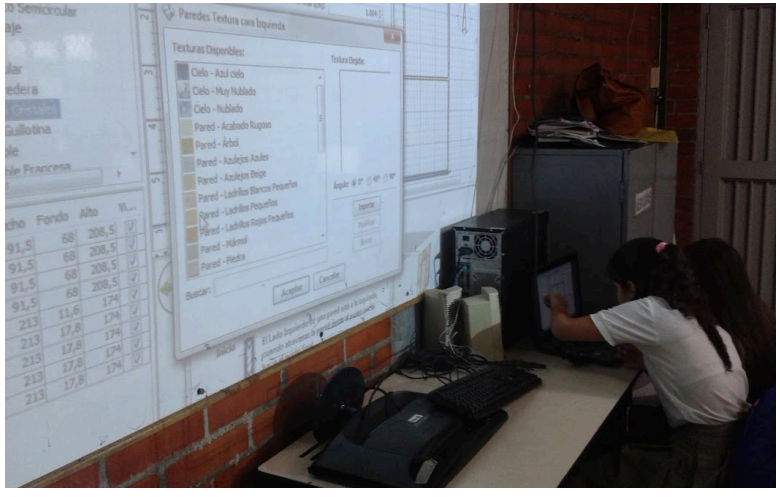
2 One pair guides the work of the whole class by projecting their work.

Global selection criteria for the resource	Type of criteria
Resource must be a free, easy-to-install.	Technical
Resource must facilitate exploration and construction tasks by students	Didactical
It must have different tools and facilitate 2D and 3D visualization. (The software chosen has mathematical measuring tools.)	Technic-Mathematical
Must be coherent with the didactical goals: "*I check carefully how the topic will be worked out; I carry out the tasks myself beforehand trying to predict how students will solve them and what they will learn… and that they learn something related to what we are covering in the [mathematics] classroom*".	Didactical
It must have good mathematical content: "*We must pay attention to the mathematical part: make sure there are no mistakes or contents that do not correspond to the level of the children... if [the mathematics] is too complicated, it can confuse them*"	Mathematical

Peter's orchestration

Level of orchestration	Peter's orchestration of the resource
Student pairs-resource	The resource provides a context for each pair of students to work on the project of the design and construction of the house, using the blueprints they drew in their notebooks.
Guiding student dyad - resource - class - teacher	The guiding pair of students, by projecting their work on the screen, is a reference for the rest of the class. The teacher uses the guiding pair's productions as examples and/or to give explanations.
Teacher - resource - student pairs	Peter makes small interventions to all the working pairs of students: poses reflection questions, clarifies points, and makes suggestions. He feeds his interventions for the whole group, from his interactions with the different pairs of students.

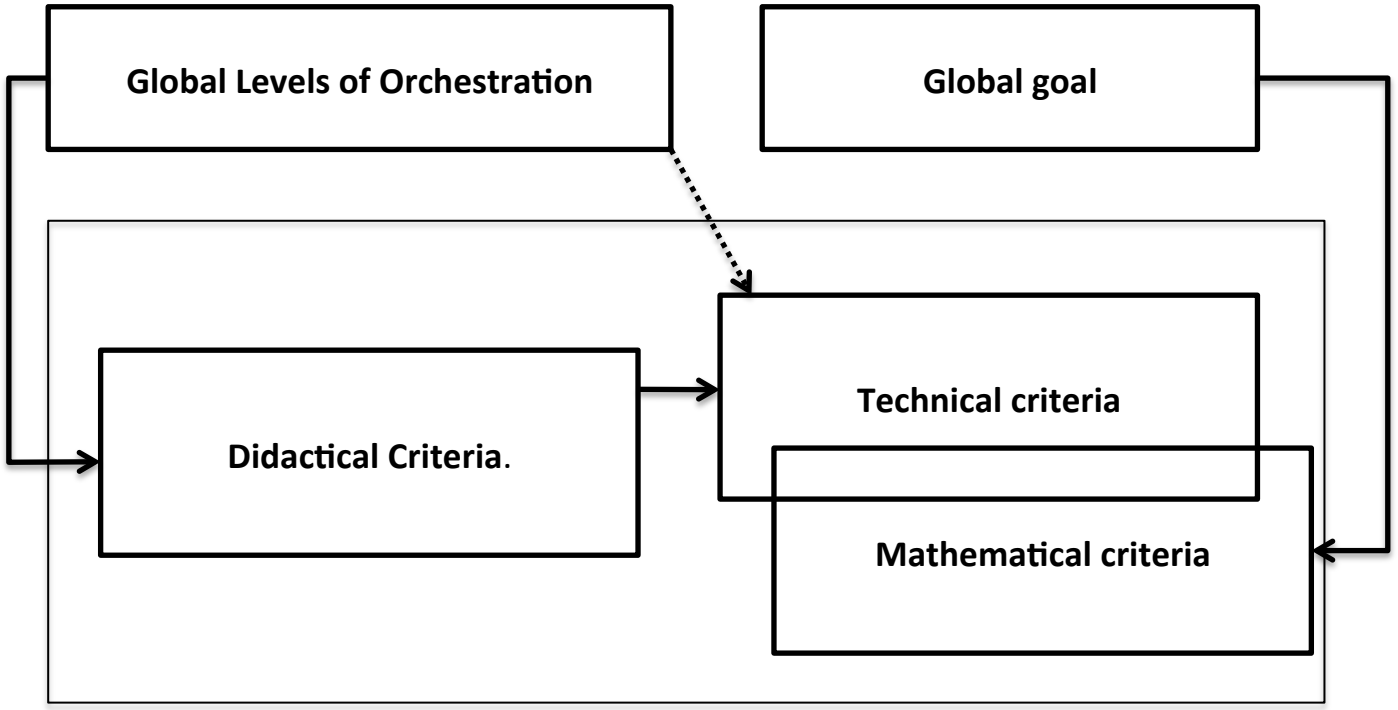
Student pairs-resource



Guiding student dyad - resource - class - teacher

Teacher - resource - student pairs

Peter's paths for the selection of the resources and orchestration



Concluding remarks

- The paths followed by John and Peter illustrate **different ways** in which experienced teacher-users of technology select the digital resources they will use and how they will orchestrate their lessons with these resources.
  - The technical requirements in terms of the resources being free, easy-to-use and access, and of good quality/reputation.
  - The goals set for the learning of the students and the levels of orchestration, all of which involve didactical considerations.

- The resource selection criteria -- technical, curricular, mathematical or didactical— has more or less importance depending on the didactical aims that determine the teacher's practice
- The analysis of the mathematical workspace provided insights into the use of digital resources:
  - mathematical content of the resource,
  - feedback to student actions and
  - validation of knowledge.

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Thanks

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