

DG 4: Teaching Research for the 21st Century



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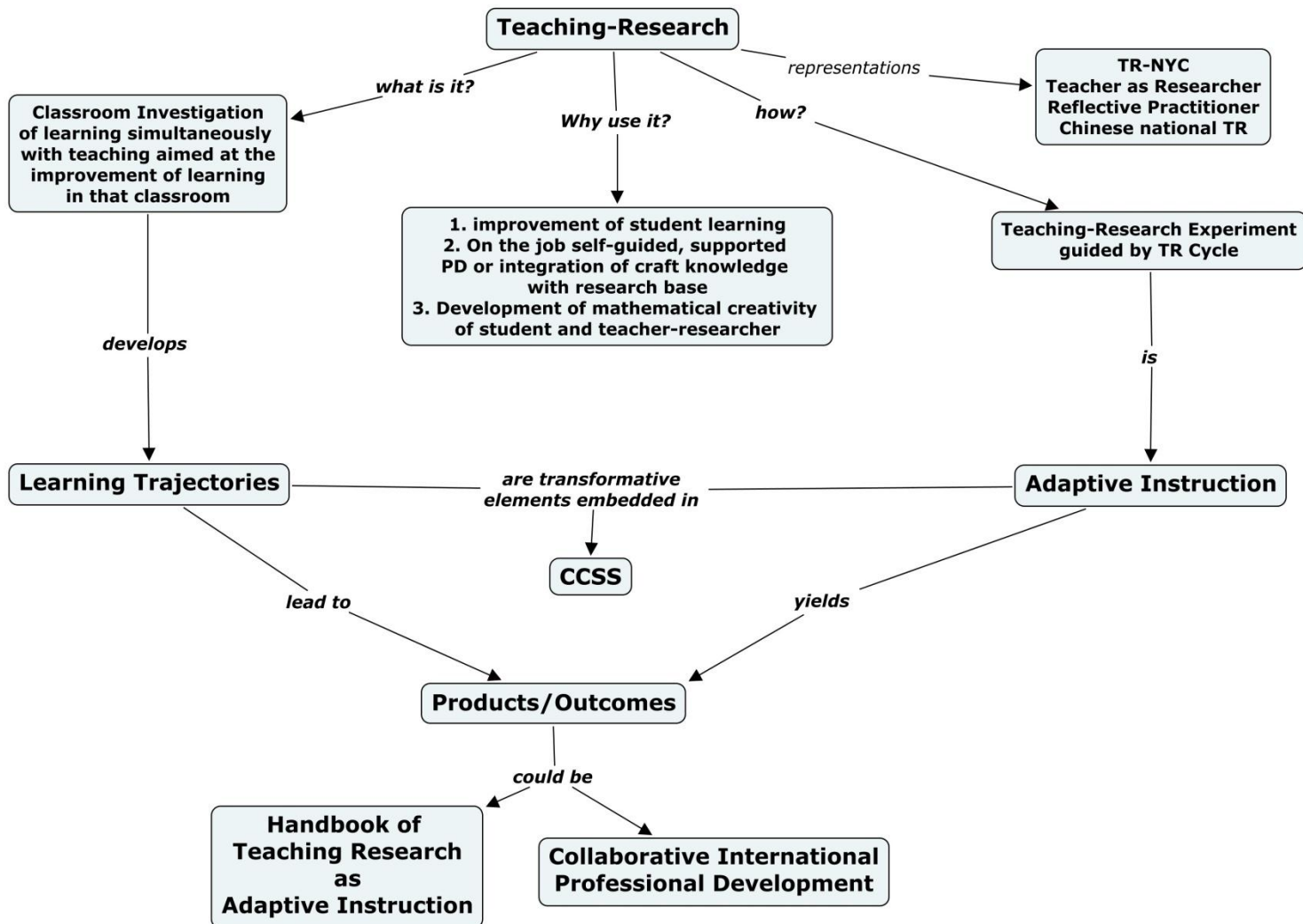
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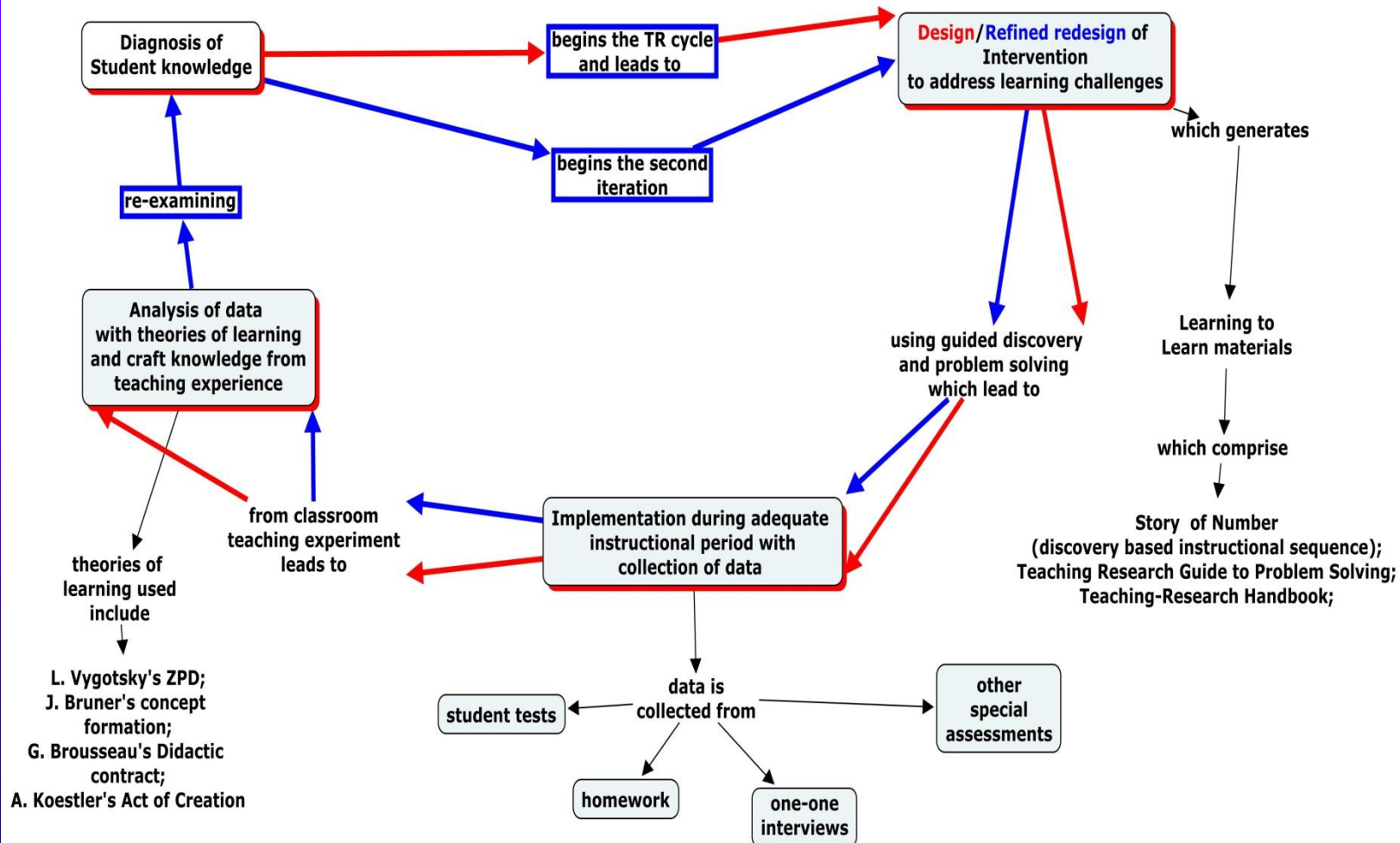
OVERVIEW OF WORK FOR THE DG 4

TR DG PME 36
July 15, 2012



TEACHING-RESEARCH CYCLE

Teaching-Research Cycle
shown in 2 iterations
first is shown in red
and second in blue





TR: DIFFERENT APPROACHES: Invitation to discussion

- ◆ **Action Research** (Levin, 1949)-**Teacher as Researcher**
- ◆ **Teaching- Research** (Stenhouse 1975); in China, there is the national policy in school-based teaching-research groups in every school.
- ◆ **Teaching Research NYC**-(Czarnocha and Prabhu, 2006) is the investigation of classroom learning simultaneously with teaching in the explicit purpose to improve it in the very same classroom, and beyond.
- ◆ **Reflective Practitioner** (Schoen 1983, Crawford and Adler 1996);



US Common Core Standards: TRANSFORMATION OF TEACHING INTO TEACHING-RESEARCH???

- ◆ “Teachers must receive extensive training in mathematics education research on the mathematics concepts that they teach so that they can better understand the evidence in student work (from OGAP-like probes or their mathematics program) and its implications for instruction. They need training and ongoing support to help capitalize on their mathematics program’s materials, or supplement them as evidence suggests and help make research based instructional decisions.” (Daro et al, 2011)
- ◆ To a limited extent, research directly influences classroom practice when teachers and researchers collaborate in design experiments, or when interested teachers incorporate ideas from research into their classroom practice. This appears as the only line directly linking research and practice...(How People Learn, 1999)

TEACHING-RESEARCH: HOW?



- CREATIVITY OF TEACHERS AND STUDENTS
- ADAPTIVE INSTRUCTION
- LEARNING TRAJECTORIES

CREATIVITY:

WHEN DOES IT TAKES PLACE?

(Koestler, *The Act of Creation*, 1964)

- ◆ Perceiving of a situation or an idea L, in two self-consistent but habitually incompatible frames of reference M, N. The event L, in which the two intersect, is made to vibrate simultaneously on two different wavelength, as it were; L is bissociated with M and N.
- ◆ Examples: Teaching-Research itself, number line, mathematics writing.





ADAPTIVE INSTRUCTION:
instruction which adapts itself to the nature of
mathematical thinking of students.

- ◆ For that to happen, teachers are going to have to find ways to attend more closely and regularly to each of their students during instruction *to determine where they are in their progress* toward meeting the standards, and *the kinds of problems they might be having along the way*. Then teachers must *use that information to decide what to do to help each student continue to progress*, to provide students with feedback, *and help them overcome their particular problems* to get back on a path toward success (Daro et al, 2011).



THEREFORE, ADAPTIVE INSTRUCTION MEANS:

- ◆ DIAGNOSTIC ASSESSMENT (*to determine where they are in their progress; the kinds of problems they might be having along the way.*)
- ◆ DESIGN OF INSTRUCTION IN RESPONSE TO ASSESSMENT (*use that information to decide what to do to help each student continue to progress*)
- ◆ CLASSROOM IMPLEMENTATION with data collection and fast analysis (to provide students with feedback)
- ◆ REFINEMENT OF DESIGN and second implementation if needed – two TR cycles (*and help them overcome their particular problems*).



LEARNING TRAJECTORY (LT)

- ◆ Several different definition depending on who is using them (Clements & Sarama, 2009; Confrey et al, 2010).
- ◆ Teachers' view (Simon, 1995). Hypothetical LT:
 1. Mathematical goal, a concept.
 2. Hypothetical developmental path for the concept;
 3. Instructional sequence, which is supposed to propel the student along that path.



Students' errors in terms of TR Cycle.

- ◆ We treat this exam problem as the diagnosis of students' knowledge concerning an important aspect of solving two linear equation with two unknowns. We see several possible errors and misconceptions in these type of solutions:
- ◆ It is clear the student is not very aware of algebraic meaning of the “equality” symbol: student added $(-3x)$ to one side of equation only.
- ◆ By doing so the student reduced the problem to the equation with one unknown making it much easier to solve in accordance with known elementary technique. Thus the difference between two unknown and one unknown type of equations maybe foggy for student as well. Finally what also might be foggy is the meaning of the expected answer, that is a functional relationship between x and y . Each of those possibilities correspond to a distinct meaning of the variable x : as unknown, as general number and a variable in a functional relationship (Ursini, Trigueros, 2010). Therefore we need to design an instruction which addresses one (or several) of those misconceptions. We are at the upper right corner of the cycle

CONTINUATION: Students' errors in terms of TR Cycle

- ◆ The designed and implemented discovery instruction started with the reading and understanding of the instruction. The break in understanding took place as hypothesized between the process of “solving for...” an equation with one variable and “solving for...” an equation with two variables. “When there is just x , then solve for x means that x is alone on one side and the number-solution is on the other side. When there is x and y , then solve for x means that there is a number and an additional variable on the other side” – was the understanding reached by the class through the guided inquiry. Here we are at the implementation stage of the cycle.
- ◆ The data from the subsequent test were collected showing that the decisive majority of the class had grasped the concept. There were however several students who repeated the error and the analysis of their work revealed that their errors, more in the class of “careless” ones had always had one purpose and that is to eliminate one variable so as not to have to deal with it at all. With this diagnosis we are at the left upper corner of the cycle ready for the next iteration after we design the instruction (possibly out of regular class) to address newly discovered misconceptions in these student thinking. TR NYC cycle insists on two cycles as the unit of improvement because only with two consecutive cycles the instructor has an opportunity to improve one's own approach by re-design.





THE AIM:

- ◆ Handbook of Teaching-Research as Adaptive Instruction

- ◆ Associated International Professional Development


TRAIL T

(Teaching-Research as Adaptive Instruction with Learning Trajectories)



What is it that the Discussion Group at PME has to offer to the participants?

- ◆ It is about the development of the creativity of both the teacher and the students and it is through the making sense of learning and teaching that it occurs. Each participating teacher enters with her or his craft knowledge, best practices so to say and through this inherent or natural interest finds a connection to the broader research field and finds the utility of the field in her, his classroom and in doing so, one's own teaching becomes more effective, productive, satisfying and the impact of this can be seen on the learning of the students and they in turn take greater interest and so the community of learning formed in the classroom creates the direction and scope for its own development and improvement.



Continuation: What is it that the Discussion Group at PME has to offer to the participants?

- ◆ Internationally the best teachers are complaining about the absence of whole hearted support in the learning process from their students. Everyone at least that we have encountered has had some wish of greater interest in learning, from their own students. This absence of interest of students translates directly into a need for us ourselves as teachers to find a way to keep up our motivation to teach with greater demand on our energies. This absence of wholehearted interest on the part of our students also results in a need for us to find job satisfaction in spite of students not wholeheartedly enjoying learning. All in all, it strikes into our creativity, that our creativity needs to constantly keep up if we are to not be too distanced from it by the negativity that surrounds us.

DG 4: Teaching Research for the 21st Century. 2nd session.

- ◆ Teaching-Research and what are its results:
 - ◆ the need for highly structured learning environment which promotes creativity of students and teachers
 - ◆ the significant role of learning algebra on the development of language in ESL classrooms
 - ◆ the fact that problem solving approach doesn't depend on the particular method of conducting it.
 - ◆ The fact that creativity of students and teachers proceeds the best when two frames of thinking are being employed simultaneously:
 - ◆ The definition of the limit of a function at a point is difficult to understand for students in the existing form and a developmental progression that incorporates the phases of (a) discrete to discrete comparison, (b) discrete and continuous and finally (c) continuous to continuous is helpful
 - ◆ Logical reasoning, use of quantifiers
 - ◆ Fraction visualization, proportional reasoning
 - ◆ In general, it takes our spontaneous teaching ideas and puts on scientific basis,
 - ◆ Hanz: what are the routes to effective problem solving in 3D geometry and linear algebra
 - ◆ Teaching sequence regarding finding the center of figures





The idea and the reason behind our quest for teaching-research presence?

- ◆ exactly in between teaching and research; a part unoccupied by anyone And tremendously needed.
- ◆ Teaching, and research as special case of teaching-research.
- ◆ The methods of research are generalized methods of teaching.
- ◆ Investigation of teaching sequences and its relation to what is known in research results.
- ◆ What is the general idea behind the TR Handbook – to direct oneself to teachers from teachers point of view, yet at the same time joining teaching and research, from ... to...those who do similar work, derived from experience, but at the same time having the component research:
- ◆ To give the tools of self-improvement and the improvement of teaching
- ◆ At the same time those of us who are a bit closer to official research can help in finding appropriate research results in literature from the particular topic and then we collaborate

Problem (*invitation to discussion*):

Solve for y in terms of x

$$3x - 2y = 6$$

$$4x - 3y - 12 = 0$$

Student solution 1:

◆ $3x - 2y = 6$

◆ $\underline{-3x}$

◆ $-2y = 6$

◆ $y = -3$

◆ Student solution 2

◆ $4x - 3y = 12$

◆ $-3y = 12 - 4$

◆ $-3y / -3 = 8 / -3$

◆ $y = -2 \frac{2}{3}$

Where are the problems?

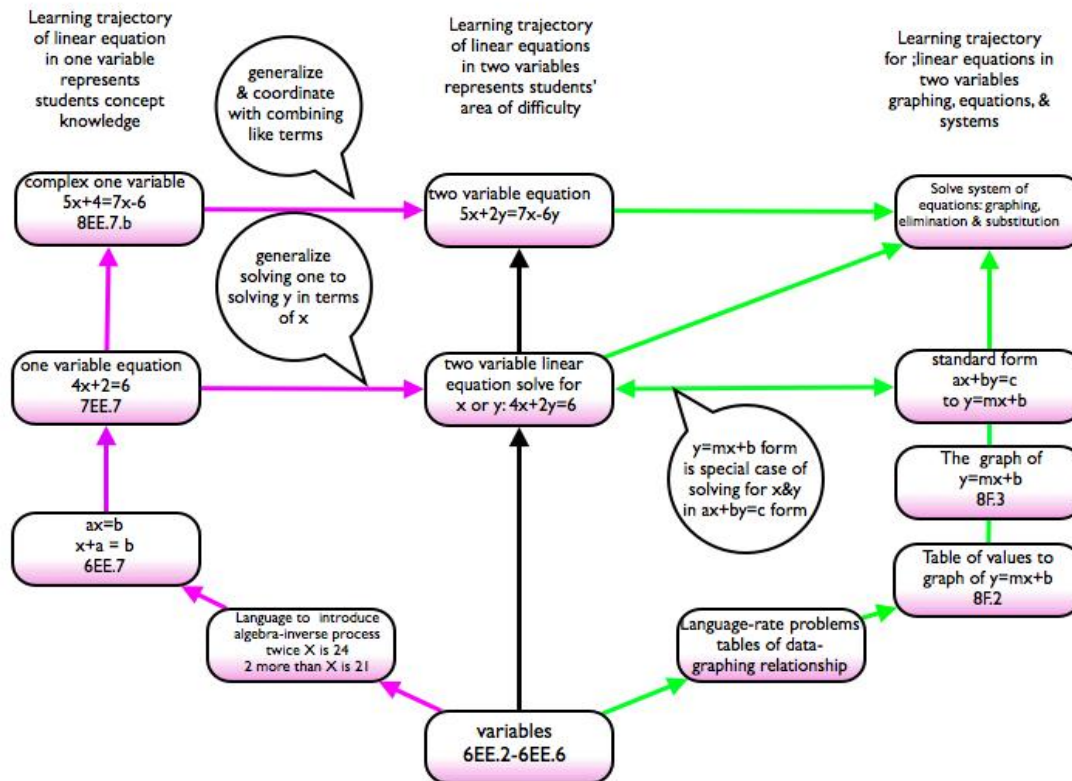
What is the relation to relevant mathematics?

How to design adaptive instruction?

How to collect the data?



Learning Trajectory Concept Map





PLAN OF WORK: A SUGGESTION FOR THE DISCUSSION.

- ◆ Creation of the Internet forum for discussions and support (www.hostos.cuny.edu/mtrj).
- ◆ 1st cycle-1st semester, 2nd cycle - 2nd semester. First drafts in winter to be reviewed by 2,3 of members of the group
- ◆ 2nd drafts ready for the PME In Germany, when we create the Working group of the book.
- ◆ 2013-2014 production of the book to be ready by the Fall 2014.

Handbook of Teaching-Research as Adaptive Instruction- possible designs/list of content.

POSSIBILITY 1

- ◆ **Part 1**-Descriptions of conducted classroom adaptive instruction cycles. Each chapter – one description.
- ◆ **Part 2** -
- ◆ Chapter 1 – methods of diagnosis
- ◆ Chapter 2 – methods of design
- ◆ Chapter 3 – methods of classroom data collection and analysis
- ◆ Chapter 4 – refinements of instruction
- ◆ Chapter 5 – Learning Trajectories

POSSIBILITY 2

- ◆ **Part 1** -
- ◆ Chapter 1 – methods of diagnosis
- ◆ Chapter 2 – methods of design
- ◆ Chapter 3 – methods of classroom data collection and analysis
- ◆ Chapter 4 – refinements of instruction
- ◆ Chapter 5 - Learning Trajectories
- ◆ **Part 2**-Descriptions of conducted classroom adaptive instruction cycles
- ◆ Each chapter – one description/One (or several) author.

