Teachers' Discursive Moves in Nurturing Reflective Learners

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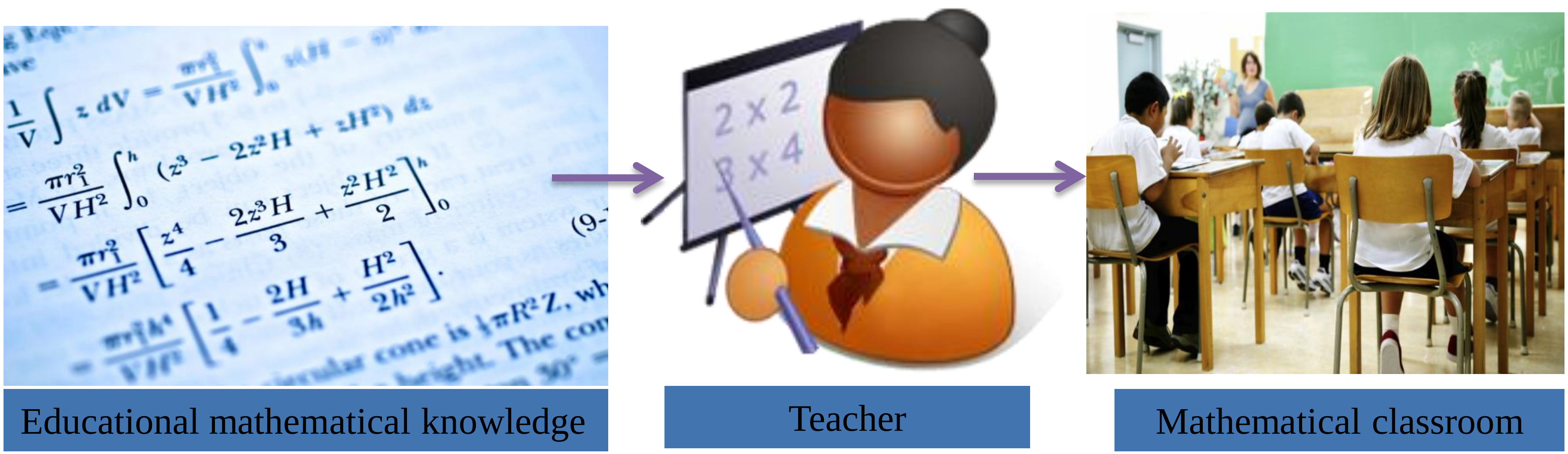
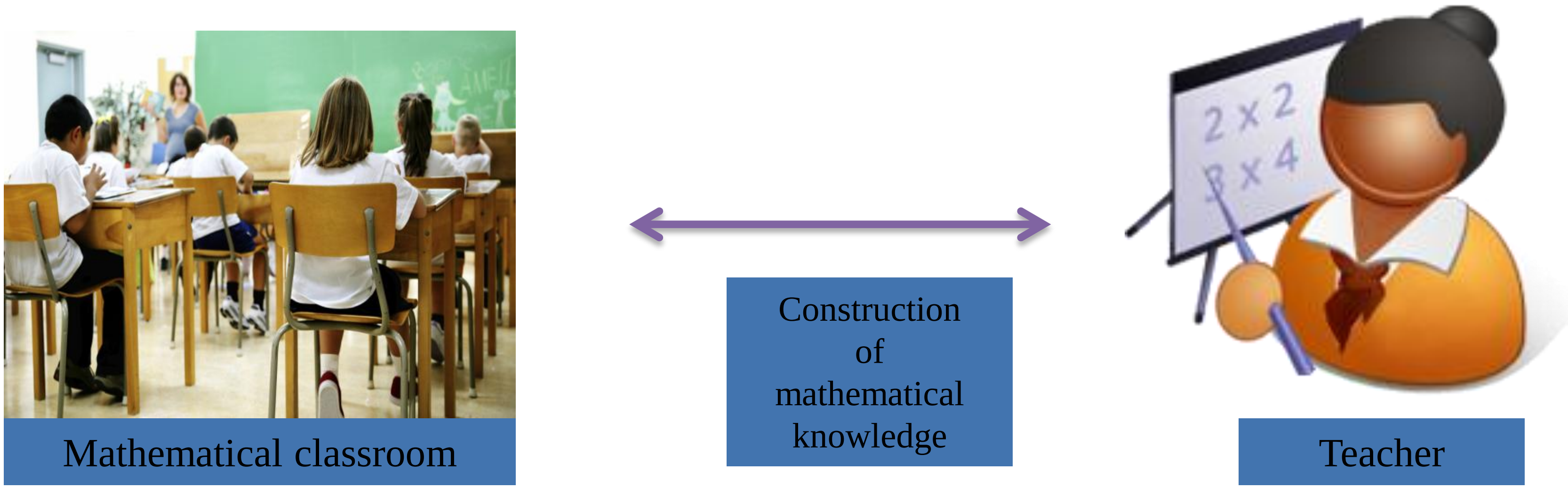
Teaching practices for reflective learning

- Universities generally, and university-based teacher educators particularly, have no right to recommend to teachers any teaching practices that they have not themselves used successfully at the university(Russell, 1999).


Educational mathematical knowledge
Teacher
Mathematical classroom


Mathematical classroom
Construction of mathematical knowledge
Teacher
2 x 2
3 x 4

Conceptualization of reflection

- Reflection involve not simply a sequence of ideas, but a consequence a consecutive ordering in such a way that each idea determine the next as its proper outcome, while each outcome in turn leans back on, or refers to its predecessors (Dewey, 1933, p.4).

chain of thoughts
"linked together so that there is a sustained movement to a common end"

Conceptualization of reflection

- Active, persistent, and careful consideration of and belief or supposed form of knowledge in the light of grounds that support it and the further conclusion to which it tends, constitutes reflective thought (p.9).

Teaching as telling

Charles Schultz (Courtesy United Features Syndicate, Inc.)

An example of inquiry-oriented mathematics instruction:

Inquiry-Oriented Differential Equations

Background theory

From the Discipline of Mathematics

- Dynamical systems point of view
- Connecting central ideas on graphical, numerical, and analytic techniques
  - DE Applets

Innovative curriculum

Innovative technological tools

From the Discipline of Mathematics Education

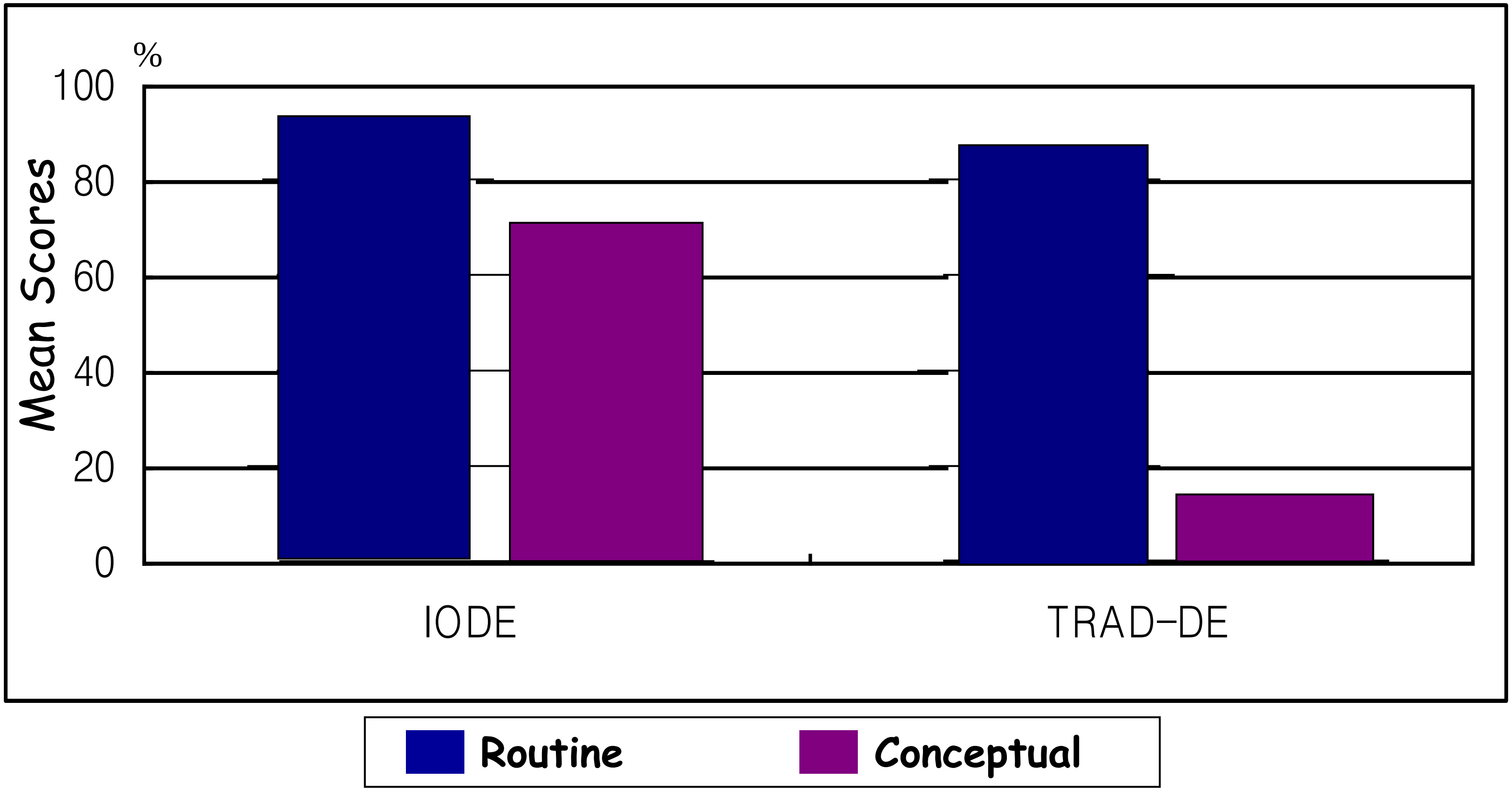
- Instructional design theory of Realistic Mathematics Education (Freudental, 1991; Gravemeijer, 1999)
- Social Negotiation of Meaning (Cobb & Bauserfeld, 1995)

Innovative pedagogy

Why study inquiry-oriented teaching?

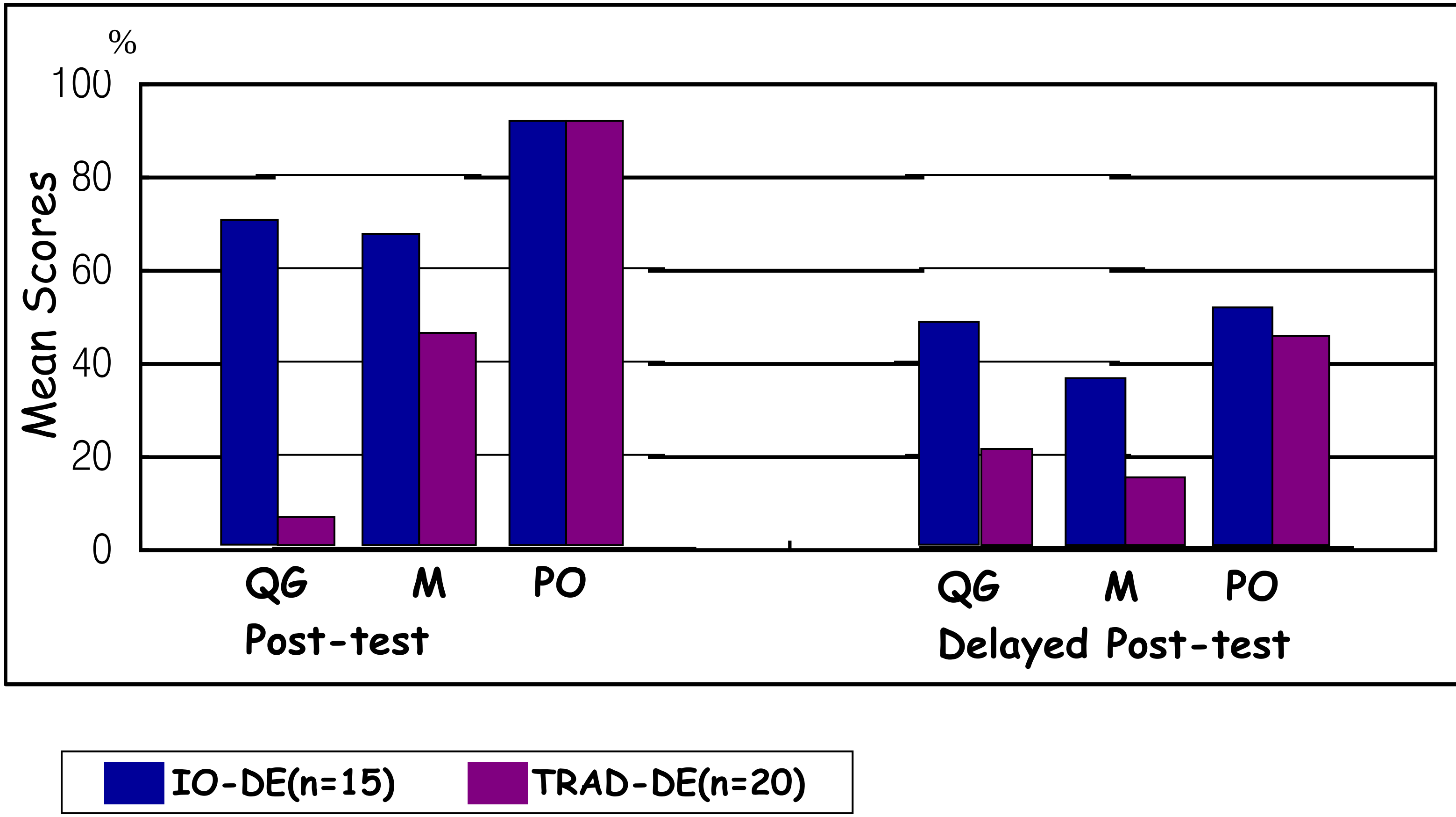
- Need to understand specific teacher actions in relation to student reinvention
- What is it that teachers actually do in an inquiry-oriented classroom?
- Case studies of particular teachers can offer insight and inspiration for others to rethink their own practice
- Inquiry-oriented classes are intended to provide the opportunity for students to learn mathematics through active participation into authentic practices of mathematics.

Is there evidence that students are learning mathematics more deeply in such approaches?



- 4 different sites, N = 111

(Kwon, Rasmussen, & Allen, 2006)



(Kwon, Rasmussen, & Allen, 2006)

An inquiry-oriented approach

Student inquiry

A - Learn new mathematics by engaging in genuine inquiry

B - Affect beliefs about themselves and about the nature of mathematics and the nature of school learning

Teacher inquiry

A - Build models of student thinking

B - Learn new mathematics

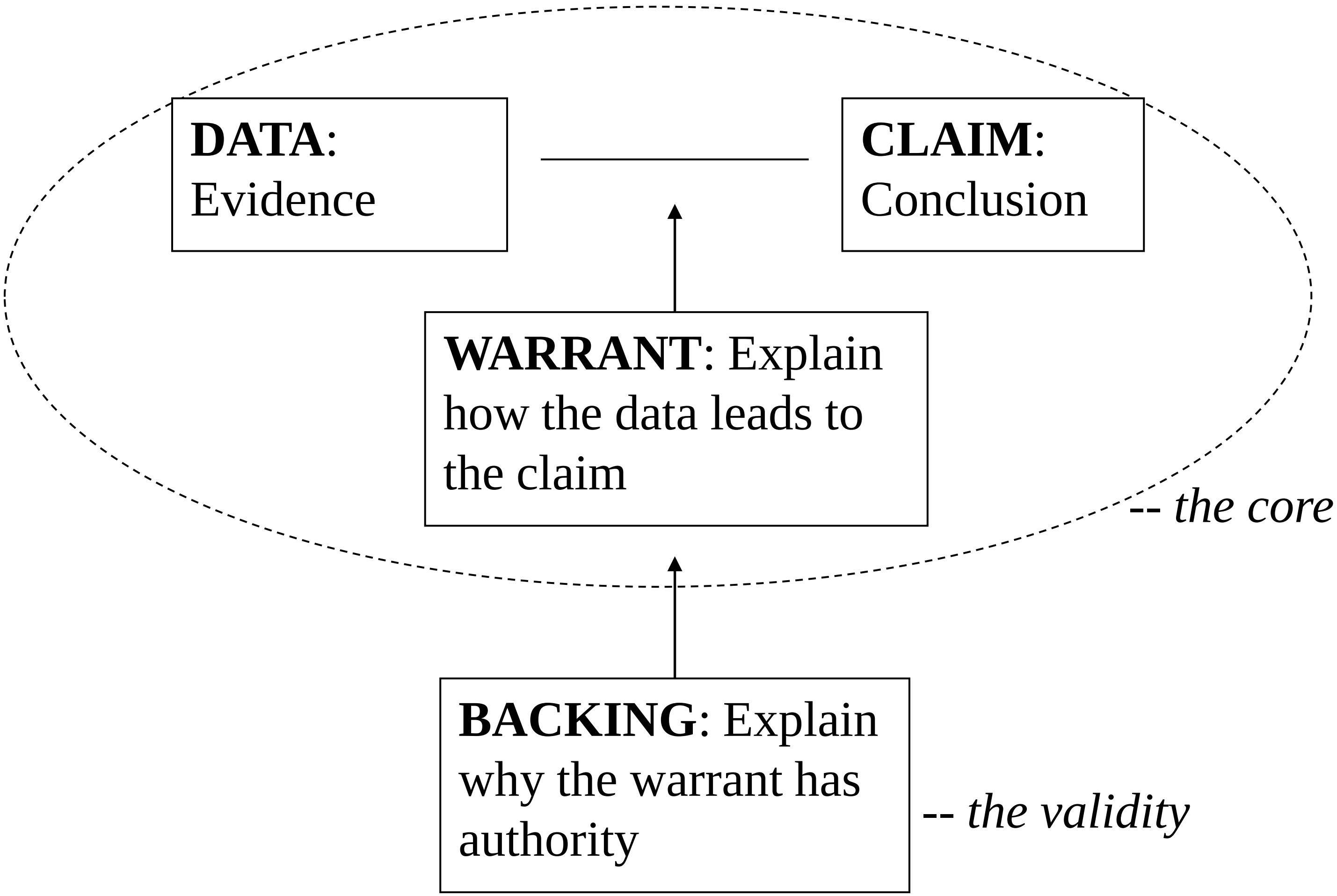
C - Figure out what next question or task to pose

(Rasmussen, & Kwon, 2007)

Methodology

- Eight week classroom teaching experiment (4 class sessions); Videorecordings from two cameras
- Complete transcripts of all whole class discussions
- Split teacher's turn at speaking into one or more utterances. An utterance is not a conventional unit, like a sentence, but a unit nonetheless in the sense that it is marked out in the boundaries of speech (Bakhtin, 1986)
- Grounded theory analysis to develop coding scheme
- Multiple coders and external checks for reliability

- **Phase I**: whole class discussion
  Toulmin's(1969) argumentation scheme



- **Phase I**: whole class discussion

  Toulmin's(1969) argumentation scheme

- **Phase II**: Teacher's and students' utterances

- **Phase III**: cross phase analysis

teacher's activity as it relates to student argument

Research questions

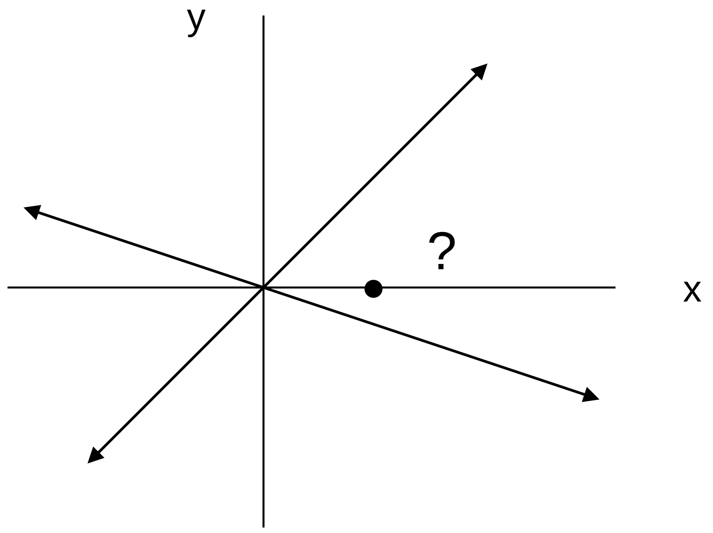
- What characterizes the types of teacher's discursive exchanges with students as reflective learners?
- What patterns, if any were there in the student-teacher exchanges related to the student generator of arguments?

Mathematical Context - systems of differential equations

$$\begin{pmatrix} x(t) \\ y(t) \end{pmatrix} = k_1 e^{t} \begin{pmatrix} -2 \\ 1 \end{pmatrix} + k_2 e^{4t} \begin{pmatrix} 1 \\ 1 \end{pmatrix}$$

$$\frac{dx}{dt} = 2x + 2y$$
$$\frac{dy}{dt} = x + 3y$$

What does the phase plane graph of the solution with initial condition (1,0) look like? How do you know?



Teacher's Discursive Moves

A deliberate action taken by a teacher to participate in or influence the discourse in the mathematics classroom(Krussel, Edwards, & Springer, 2004).

Revoicing

Reuttering of someone else's utterances.

- Reporting

Telling

Stating information or demonstrating procedures.

- Summarizing

Questioning/Requesting

Checking for understanding, requesting to explain thinking, requesting to justify thinking and so on.

Managing

Stating a specific behavior that the teacher wants students to perform

Phase I

	Approx time in WCD	# of student arguments	# of teacher arguments	# of student-teacher arguments	Total
Day 1	25 min (50%)	6	3	0	9
Day 2	19 min (38%)	5	3	4	12
Day 3	20 min (40%)	2	2	0	4
Day 4	42 min (80%)	21	1	4	25
Total		34 (68%)	8 (16%)	8 (16%)	50

Argumentation summary per day

Phase II

	Student	Teacher	Total
Day 1	41	63	104
Day 2	12	32	44
Day 3	14	30	44
Day 4	70	100	170
Total	137 (38%)	225 (62%)	362

Total number of teacher and student utterances

Revoicing(1)

R1. **Repeating** – Teacher repeats a student's utterance using (essentially) the same words or a portion thereof.

S: e^{4t} is a positive exponential and it's growing up exponentially, so it's not going to go backwards to zero, it's going to go forward.

T: e^{4t} is a positive exponential.

Revoicing(2)

R2. **Rephrasing** – Teacher states a student's utterance in a new or different way.

S: e^{4t} is a positive exponential and it's growing up exponentially, so it's not going to go backwards to zero, it's going to go forward

T: So e^{4t}, as time goes on this becomes bigger and bigger and bigger and bigger.

Revoicing(3)

R3. **Expanding** – Teacher adds information to a student’s utterance.

S: The only equilibrium solution is at (0, 0)

T: The only one here is $x(t) = 0$ and $y(t) = 0$.

Revoicing(4)

R4. **Reporting** – Teacher attributes an idea, claim, argument to a specific student.

T: Recall that Julio argued that these are the same graphs, but just shifted along the t-axis.

Questioning(1)

Q1. **Evaluating** - The intention is to check for understanding against what the teacher sees as an expected response.

T: Now as time goes on, this is your speed controller and when time is 1,2,3, what happens as time gets up to like 10,20,30, what happens to this number?

S: It gets smaller and smaller

Questioning(2)

Q2. **Clarifying** - Purpose of the request is to seek clarification of detail (either for the teacher or for others) what a student is saying.

T: How about if t goes to negative infinity? [pause] T is negative, what happens? [long pause] Nathan.

S: Goes negative.

T: Goes negative. Okay, so which way should I go. Should I go negative. I should go

S: opposite direction.

T: Opposite direction

T: And how far do I go the opposite direction? Do I keep going?

S: No, stop, go to zero.

Questioning(3)

Q3. **Explaining** -Teacher asks students to share ideas, however tentative

T: Tuan, what do you think the graph of the solution with this initial condition will look like?

S: Could it be similar to…well, it's half of, it's in the middle, so it's also straight and 3D would be exponential decay, possible?

Questioning(4)

Q4. **Justifying** - Requests to provide warrants or backing for a some conclusion.

T: So, raise your hand if you agree that they do not touch zero.

T: Anybody want to argue that they touch zero? [long pause, no response from students] What's the justification for them not touching zero then?

S: The graphs on the x(t) and y(t) plane are both negative exponential.

Telling(1)

T1. **Initiating** - Teacher describes a new concept, directs students to a new problem, or reminds students of previous conclusions

T: All right, let's go ahead and get started.
We were examining this system of differential equations associated with the spring mass:
$dx/dt = y$ and $dy/dt = -2x - 3y$.
We found two places where there are straight line solutions along $y = -2x$ and $y = -x$.

Telling(2)

T2. **Facilitating progress** - Teacher provides information to students in the midst of a task

T: Let me offer a way to do it and then you can add and elaborate additional ways to think about why this is critical. [Teacher goes on to give an explanation.]

Telling(3)

T3. **Responding to students** - Teacher answers a question or evaluates a student's response

S: We have e^t and e^4t which means it's going away from zero towards infinity.

T: Okay, so Michelle is right on target.

Telling(4)

T4. **Summarizing** - This discursive move summarizes (selected) ideas, highlights particular mathematics of importance, and/or points to next steps related to the summary.

T: So the point is that any other solution along this straight line can be obtained by taking a multiple of your first one.

Managing(1)

M1. **Arranging** -Teacher tells a student to carry out an action

T: Get in your small group and work on the next problem and discuss the ideas in your group.

Managing(2)

M2. **Directing** - Teacher tells a student to carry out a particular mathematical action

T: Just to make sure everyone is up to speed and can do what we are doing right now, I want you do find the x(t) and y(t) equations for the initial condition, see I have it in the sheet, I have it in the sheet: (1,1).

Managing(3)

M3. **Motivating** - This type of utterance provides encouragement or motivation for students.

T: That's an excellent idea. I encourage you to follow through.

Managing(4)

M4. **Checking** - Check on current status of student progress.

T: Any questions or comments on this? I don’t intend this to be new, just a recap of things we already found. [long pause]

	Revoicing	Telling	Questioning	Managing	Total
Day 1	16	12	23	12	63
Day 2	8	8	8	8	32
Day 3	6	8	12	4	30
Day 4	20	20	44	16	100
Total	50 (22.2%)	48 (21.3%)	84 (37.3%)	40 (17.8%)	225

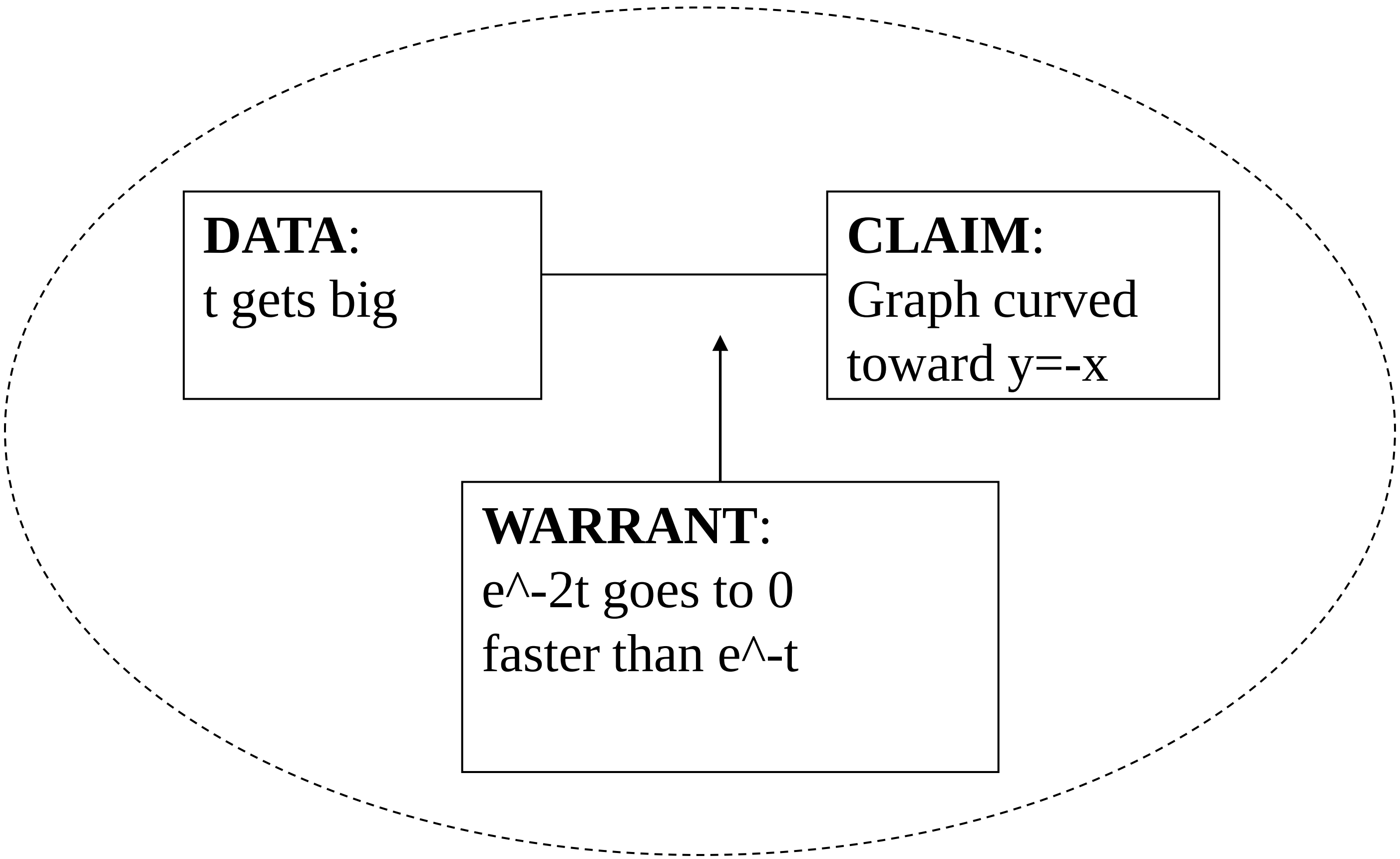
Total number of teacher utterances by type

Phase III: cross phases analysis

Teacher	Okay, Brady, why don’t you say a little bit. Do you want to come up here to the board? So, Brady and Juan had a way to think about this a nd they were using this form of the x(t) and y(t) equations, so come a nd show us your arguments.

Brady	Okay, I just looked at what happened when t [time] got really big. Thi s one goes e^-2t and this one goes e^-t, so this one [e^-2t] goes to zer o a lot faster, so as t increases, this one starts to go away [e^-2t] and y our left with only this one [e^-t]. The –1 line. So, as you increase t, it starts to look more like that one, so I said it went down [curved towar ds y = -x as opposed to y = -2x towards zero] towards that one.

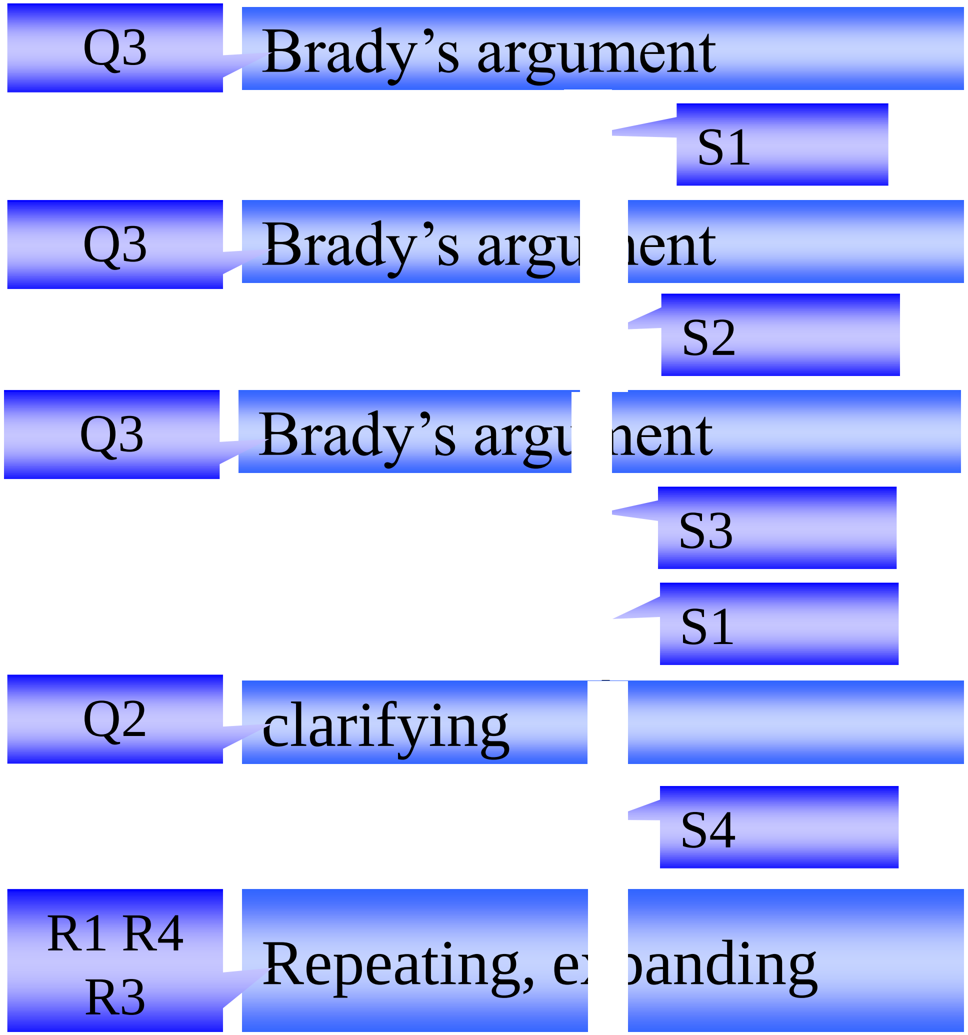
Brady’s Argument



Teacher (Q3)	Lucy, can you repeat his argument in your own words?
Lucy	I’m kind of confused. I understand exactly what he said, I’m just not getting the relationship yet between.
Teacher (Q3)	Who wants to try?
Enrique	So, you can say that e^-2t just obviously goes to zero faster since you’ve got a 2 coefficient outside the huh 2e^-t, it’s going to stay a little larger and not go to zero as fast.
Brady	Well, I’m not even really worried about that 2 because what’s going to determine how fast it goes to zero and how the coefficients, but I think the exponents. This one goes to zero twice as fast.
Teacher (Q3)	Anna, Do you want to rephrase in your own words his argument?

Anna	I guess he's saying that since the equation that depends on t as t gets bigger, is that what you said, then the e^-t of the last part of the equation gets closer to zero
Teacher (Q2)	This one?
Anna	Yes. So, if he says that the curve we get would be, I'm pretty much repeating his words, would be, would look like the e, well closer to the first line.
Teacher (R1)	More like this one because that one goes to zero faster than this part.
Anna	I guess it would pull [inaudible]
Teacher (R4R3)	Oh, so this component you're saying, this one goes to zero, so the solution gets drawn in and it gets pulled by this component. So, if the solution starts here, it gets pulled in this direction towards the slope line of negative one. Because this contribution. Think about the two solutions of this solution being composed of this one and this one. As time goes on, this one goes to zero a lot faster than this one. So this one is hanging on longer and therefore pulling the other, this solution towards it. So, we have two solutions that we are adding together to get this solution. As time goes on, this one goes to zero pretty quickly whereas this one stays here. So, that is why this one is getting pulled towards here.

Interactive pattern: an example



Four roles of revoicing

Revoicing as a binder

Teacher's revoicing signals that a mathematical position has been identified and provides an opportunity for students to bring up diverse mathematical positions. In this way, a teacher's revoicing enables students to attend to critical ideas in order to generate more comprehensive mathematics by connecting diverse perspectives.

Revoicing as a springboard

Teacher's revoicing recruits students' attention to a specific claim and prompts the speaker to clarify and elaborate one's own claim. Thus, a teacher's revoicing scaffolds students to clarify, to elaborate, and to extend their mathematical positions through reflection.

Kwon, Ju, Rasmussen, Marrongelle, Park, and Cho (2008)

Revoicing for ownership

Teacher's revoicing makes reference to whom the mathematical position belongs to and helps every classroom participant make sense of it. Also when the mathematical concepts or contents that the teacher wants students to discuss about do not appear fully, revoicing enables a teacher to reveal available mathematical resources arising in the voices of students. As a consequence, mathematics is represented as being collectively constructed by the course participants themselves instead of being given by the teacher. In this regard, revoicing creates a sense of classroom as a community of practice and a sense of mathematics as their own practice.

Revoicing as a means for socialization

In revoicing, a teacher can demonstrate the cultural way of doing mathematics to support students' transformation as practitioners of mathematics. In this regard, teacher's revoicing contributes to transform students' practice of mathematics and ultimately to support their socialization into the cultural organization of mathematics community.

Mehan's IRE pattern

Initiation - Reply - Evaluation

Speaker A: What time is it, Denise?

Speaker B: 2:30

Speaker A: Thank you, Denise.

Speaker A: What time is it, Denise?

Speaker B: 2:30

Speaker A: Very good, Denis.

Funneling and focusing pattern (Wood, 1994)

A teacher asks a series of questions for the purpose of narrowing or scaffolding student responses until the lass arrives at the expected response

Significances

Interactive pattern: Q3-S1-Q3-S2-Q3-S3-S1-Q3-S4-Q2-S4-R1R2R3

- Engage students in clarifying, explaining, and justifying their ideas and the ideas of their classmates

- Function of referencing to whom a mathematical position belong

Reflective Learner

- Reveal mathematical resources arising in the voices of students.

Teacher Discursive Move	Teacher Inquiry			Student Inquiry	
	A	B	C	A	B
Revoicing					
Repeating					
Rephrasing					
Expanding					
Reporting					
Questioning/Requesting					
Evaluating					
Clarifying					
Explaining					
Justifying					
Telling					
Initiating					
Facilitating					
Responding					
Summarizing					
Managing					
Arranging					
Directing					
Motivating					
Checking					

Student inquiry

A - engage in arg.

B - affect beliefs

Teacher inquiry

A - model std thinking

B - learn new math

C - Next tasks, ques.

- http://www.icme12.org

When is ICME-12, Where?

- July 8 – 15, 2012
- COEX, Seoul, Korea

Thank You for Your Attendance

Comments/Questions welcome anytime via e-mail:

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