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# Dialogic and Mathematical Attributes of Mathematics Teachers' Noticing

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## Background and goals

Fostering learning dialogue between students is a fundamental educational goal. Studies have shown the roles of technology and pedagogy approaches in nurturing dialogue in collaborative learning (e.g., Schwarz et al., 2021; Webb, 2009). Our overall goal is to develop mathematics teachers' ability to notice in-situ dialogue in computer-supported collaborative learning contexts. For that matter, this study aims to identify the mathematical and dialogic attributes of mathematics teachers' noticing.

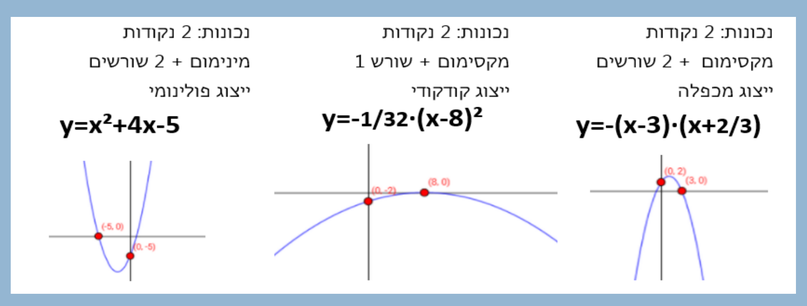
*Noticing:* We build on mathematics teacher education research on *teachers' professional noticing* (henceforward noticing) of classroom events (Stockero, 2021). Analyzing teachers noticing often includes three types of events: what teachers listen to, how they interpret these events, and their pedagogical responses (van Es & Sherin, 2021). Teachers tend to notice events that resonate with their resources, educational goals, and orientation (Schoenfeld, 2011). What teachers do not notice can inflict adverse learning outcomes, such as exacerbating incorrect mathematical conceptualizations (Abdu & Slakmon, in press). Learning analytics can support teachers' noticing by asking students to give different examples for (mathematical) concepts in dynamic mathematics environments and providing details regarding the content-specific properties of the students' answers (Yerushalmy & Olsher, 2020). Such feedback on students' work, we reckon, frees teachers up to nurture dialogue between students.

*Dialogic pedagogy:* We tap on Bakhtin's notion of dialogue to define dialogue as an emerging interaction between two equally–important but distinct voices (Bakhtin, 2013). Successful learning dialogue depends on how the solvers talk together and open up a dialogic space that allows the emergence, sharing, and development of voices. The dialogue expands when new ideas are presented and evaluated in the dialogue in ways that open dialogic gaps within the group or between the learners and the world. A *dialogic gap* is the manifestation of fundamental differences between collaborating students' voices (Wegerif, 2011). Dialogic gaps emerge when students are given time to develop their voices within the context of the group (Abdu et al., 2021). Learning within the context of dialogue happens when students *interanimate* other students' voices—echoing the ideas of the other with their own words—whether agreeing or not. Seeing the world from the other's eyes while being open to the possibility to change within the dialogue are prerequisites for change.

Research Questions:
What are the mathematical and dialogic attributes of mathematics teachers' noticing?
1. What do they listen to?
2. How do they respond to?
3. Does dialogic and the mathematical aspects of noticing converge in teachers' noticing?

**Methodology:**

We present a unified framework for analyzing teachers' noticing of dialogue and present preliminary results from mathematics teachers noticing dyads' solving a problem about the topic of the parabola. We devised a semi-structured interview including a movie of ten episodes presenting dyads creating examples *as different as possible* for parabolas that pass through two randomized points with dynamic mathematical environments (See QR).




*The mathematical task for noticing: Three different examples of parabolas that pass through two random points, and their mathematical attributes.*

Congruent with the noticing paradigm, an experimenter asked participating teachers after every episode to describe what they saw, and if and how would they intervene? Sixteen mathematics teachers from Israel participated in the study and completed the research protocol. All had at least one year of experience teaching the topic of the parable in secondary education. Two independent coders coded the data in three levels, according to the three leading theoretical frameworks: **Stage of noticing, Mathematical activity, and Dialogic activity.** In total, 160 cases were coded (16 teachers X 10 episodes).

## Preliminary findings and invitation to a discussion

1. Teachers noticed mathematics [519] much more than dialogic [138] events.
2. We recorded more occurrences of teachers listening [407] than pedagogical responses [232].
3. Dialogic events most noticed regarded students' agreement and joint attention [39] and imbalance ("one leads other being led" ), [50].
4. Mathematical events most noticed regarded mathematical norms such as correctness [82], mathematical efficacy [66], and algebraic manipulations [58].
5. Other mathematical events regarded task-specific aspects such as parabola's algebraic representation [60], extremum [49], and submitting diverse solutions [37].
6. Teachers listened to dialogue [103] more than proposing dialogic interventions [35].
7. Scarce cases of convergence between dialogue and mathematics [18].

| Dialogic | Math | Listens to | Response |
|---|---|---|---|
| Dialogic Gap | - | 5 | 5 |
| Repeating the other's voice | | 1 | 5 |
| Perspective changing | | 5 | 1 |
| Widening the dialogue | | 0 | 1 |
| Agreement and joint actions | | 28 | 9 |
| Students with equal status | | 3 | 4 |
| One leads other being led | - | 41 | 5 |
| Persuasive interaction | - | 3 | 1 |
| Authoritative interaction | - | 1 | 0 |
| Monologue | - | 1 | 1 |
| - | Extremum type | 10 | 4 |
| - | Algebraic manipulations | 41 | 17 |
| - | Algebraic representation | 40 | 20 |
| - | Points chosen | 14 | 5 |
| - | Functions relocation | 7 | 5 |
| - | Parameters in algebraic form | 19 | 13 |
| - | Mathematical efficacy | 28 | 38 |
| - | Correctness | 53 | 29 |
| - | Attributes of the parabola | 23 | 5 |
| - | Finding extremum | 34 | 15 |
| - | Number of roots | 1 | 1 |
| - | Table use | 4 | 3 |
| - | Understanding the task | 19 | 16 |
| - | Submitting diverse solutions | 11 | 26 |
| Agreement and joint actions | Correctness | 1 | 0 |
| Agreement and joint actions | Understanding the task | 1 | 0 |
| Authoritative interaction | Correctness | 1 | 0 |
| Dialogic Gap | Algebraic representation | 1 | 0 |
| Dialogic Gap | Points chosen | 1 | 0 |
| Dialogic Gap | Correctness | 2 | 0 |
| Dialogic Gap | Understanding the task | 1 | 0 |
| Dialogic Gap | Submitting diverse solutions | 0 | 1 |
| One leads other being led | Algebraic manipulations | 1 | 0 |
| One leads other being led | Functions relocation | 1 | 0 |
| One leads other being led | Understanding the task | 2 | 0 |
| Perspective changing | Submitting diverse solutions | 0 | 1 |
| Persuasive interaction | Finding extremum | 1 | 0 |
| Repeating the other's voice | Algebraic manipulations | 0 | 1 |
| Deepening the dialogue | Correctness | 1 | 0 |
| Widening the dialogue | Table use | 1 | 0 |
| | | 407 | 232 |

Noticing only dialogue (n=120)

Noticing only mathematics (n=487)

Noticing mathematics & dialogue (n=18)

*The amount occurrences of all the combinations of the three levels: **Stage of noticing, Mathematical activity, and Dialogic activity.** Unit of analysis—one teacher's answer to one episode [n=160].*

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