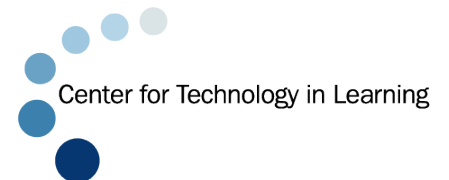# Productive Dispositions for Math Teaching:
An Exploratory Study of Adaptive Expertise

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Productive Dispositions for Teaching

"Teachers should think:

- that mathematics, their understanding of children's thinking, and their teaching practices fit together to make sense, and

- that **they are capable of learning** about mathematics, student mathematical thinking, and their own practice themselves **by analyzing what goes on in their classes**."

Adding It Up, p. 384

Adaptive Expertise as a Lens

"The development of 'adaptive expertise' provides an appropriate **gold standard** for becoming a professional."
Darling-Hammond & Bransford, 2005
Preparing Teachers for a Changing World

Routine Experts

- A routinized, fixed knowledge base

- Strengths: efficiency, accuracy, automaticity in solving familiar problems

- Potential weakness: limited flexibility for innovation

Adaptive Experts

- Learning orientation to work, with a flexible, adaptable, growing knowledge base

- Strengths: tendency to explore, learn, and innovate in complex and dynamic situations

- Potential weakness: lack of efficiency

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High-Level Research Question

How do we take this intuitively appealing idea and begin to develop it as a construct that can be used in a systematic manner to inform research, teacher practice, teacher education, and policy?

An Exploratory Study to Develop the Empirical Construct: Adaptiveness in Teaching (AIT)

1. Review research literature → working operational framework for AIT

2. Develop an instrument to measure AIT (interview / coding rubrics)

3. Examine research questions about AIT within a teaching population

- What is the distribution of AIT over the sample?
- How does AIT relate to other important constructs?
  - Content knowledge
  - Other dispositional constructs
  - Instructional goals
  - Student achievement
  - School context

Overview of Operational Framework for AIT

Dimension 1: Habits of mind

From motivation theory (e.g., Dweck)

- Implicit theory of teaching competence ("fixed" vs. "incremental")
- Tendency to experiment and take on challenges
- Locus of responsibility for student success/failure

Dimension 2: Adaptation and knowledge-building through practice

From research on student thinking, formative assessment, knowledge building (e.g., Carpenter, Fennema, Franke; Black & Wiliam; Ball)

- Elicitation of student thinking (what they understand)
- What they do with this information
  - Use it to adjust instruction
  - Use it as part of a deliberate knowledge-building about their own practice
- When they adjust instruction, the breadth of strategies beyond reteaching

Dimension 3: Pursuit/creation of professional learning opportunities

- Self-directedness and purposefulness

Research Design

Participants: Experienced Middle School Math Teachers in High-Poverty Schools

Number of teachers	36
Years teaching full time	13.8 (7.6)
Teacher ethnicity (%)	
African American	8.3
Hispanic/Latino-Latina	11.1
Asian/Pacific Islander	13.9
White	61.1
Number of schools	21
Mean % qual for lunch	72 (43-99)
Number of students	9,924
Student ethnicity (%)	
African American	17.5
Hispanic/Latino-Latina	44.8
Asian/Pacific Islander	17.6
White	19.7
Native American	0.4

Procedure

All by mail, phone, and web…

- Respond to recruitment flier

- Phone interview (2 hours)

- Written surveys (2 hours)

- Optional web-based learning task

Sources of Data

To investigate AIT

1. **In-depth semi-structured phone interview**
   Probes each facets of the AIT framework

To examine relationships with other important constructs

2. **Assessment of MKT for middle school math**
   Based on validated instruments in our prior work; Aligned with MS NCTM Focal Points (proportionality & linear function)

3. **Questionnaire battery**
   Validated instruments probing dispositional constructs and aspects of practice

4. **Their students' California Standards Test (CST) scores**
   The prior three years, both incoming and outgoing

Measuring AIT

Properties of the Interview Protocol

- 10 "facets" across the 3 dimensions of the operational framework

- For each facet:
  - Block of questions
  - Corresponding 3-level ordinal coding rubric (criteria are very specific)

- All interviews coded by two coders

Properties of AIT as a Scale

- Overall AIT Index (aggregated across the 10 facets)
  - Cronbach's alpha: .85
  - Inter-rater reliability: .86
- Three dimensions as subscales
  - Reasonable inter-item and inter-rater reliabilities (almost all)

Illustrative Quotes
Dimension 1: Habits of Mind

Implicit theory of professional teaching competence
as "fixed entity" vs. "subject to incremental growth"

Fixed (Ludwig)	Growth (Gigi)
I would lean more toward a natural ability, and it has very little to do with content. I think that's more about being a communicator and knowing your audience and having enthusiasm. You can be a very solid teacher without those qualities… but I think that when you [don't] bring that to the table that's hard to learn.	I think teaching is an art. It's also a skill that you practice and you refine and you collaborate with other people. You watch good teachers and you try things out, you learn, you read, you research. That's not natural; that's an actively learning teacher. So I think anybody, if they want to, could learn some good ways to teach students.

Use of information about student thinking to adjust instruction

Routine (Bonnie)	**Adaptive (Lolita)**
Now we have benchmarks so we have to get through that material before the benchmark, so we are required to keep on a certain amount of, you know, pacing...Whether we have everybody with us or lose half the class....And I disagree with that but, you know, can't do anything about it.	As I'm watching the kids work in the classroom, I am building the sense of what we need to cover in different ways, of what we need to repeat; what we can possibly just sort of skim through and go on to the next concept because there's understanding and fluidity in what they're doing.

Self-directedness in pursuing or creating professional learning opportunities

Routine (Dan)	Adaptive (Lolita)
The principal [prompts me to engage in learning opportunities]… She [tells] me, "Hey this is really good. You should go to this" … Or other colleagues, "Hey, do you want to go to this with me?" … Okay. Or you know might be… a monetary motivation you know … They will come and say, "Hey, we will give you a $1,500 stipend if you come to this class over the summer."	Well, I am always searching for ways to learn more about how to teach math… how to change my practices to be able to reach more students...I hunger for the opportunities to discuss what we're doing in the classroom…[There was] a study for English language learners … I jumped on that because it's that opportunity to . . work with other colleagues and to grow in my math, as well as in my teaching skills.

AIT Normally Distributed Over the Sample
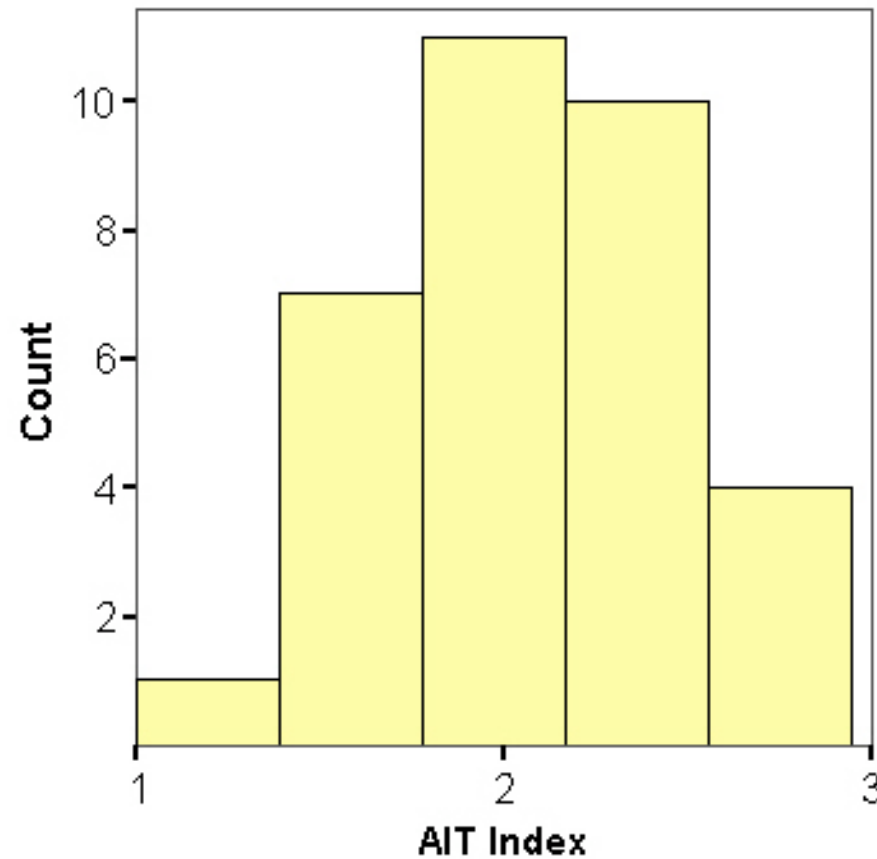
Mean = 2.1 / SD = .45

Relationships of AIT
to Other Variables

The Higher the Adaptiveness, the Higher the MKT

	AIT	**D1** Habits of Mind	**D2** Kn'lg Bldg	**D3** Pursue PD
MKT (instrument based on prior work)	.340	.225	.334	.375

Blue cells significant at .05 level or lower

Note: There was no math in the interview.
What is the direction of causality?

Adaptiveness Related to Other Established Dispositional Constructs

	AIT	D1 Habits of Mind	D2 Kn'lg Bldg	D3 Pursue PD
Positively Related				
Tendency toward curiosity (Kashdan)	.331	.302	.265	.260
Personal teaching efficacy (Midgeley)	.280	.294	.151	.341
Incremental theory of intelligence (Dweck)	.253	.263	.042	.402
Locus of responsibility for student failure lies with the *teacher* (Guskey)	.550	.531	.450	.408
Negatively Related				
Belief that effort cannot improve teaching ability (Dweck)	-.337	-.431	-.013	-.457
Belief in how easy it is to diagnosis someone's intelligence (Dweck)	-.445	-.456	-.302	-.361
Locus of responsibility for student failure lies with the *students* (Guskey)	-.456	-.500	-.256	-.404
Performance orientation to teaching (Button)	-.590	-.580	-.481	-.430

Blue cells significant at .05 level or lower / Green at .07 level

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The Higher the Adaptiveness, the Less Emphasis on Procedural Fluency / Test Prep

Scales from Darling-Hammond et al.	AIT	**D1** **Habits** **of Mind**	**D2** **Kn'lg** **Bldg**	**D3** **Pursue** **PD**	MKT	**Math** **Anxiety** (Hopko)
Cognitively complex practices*	.178	.173	.126	.179	-.071	-.435
Procedural fluency (procedures, algorithms, speed, accuracy)	-.379	-.383	-.329	-.301	-.091	-.008
Preparing students for standardized tests	-.538	-.471	-.534	-.397	-.214	.188

Blue cells significant at .05 level or lower

*Practices
Justification/proof
Problem-solving
Communicating mathematical ideas
Making connections
Using multiple representations

Preliminary Student Achievement Analysis: Does Adaptiveness Predict CST Scores?

- 3-Level HLM Model (student→year→teacher)
  - AIT significantly predicts CST scores the year *before* coming into the teacher's classroom (tracking? Indicator of context?)
  - AIT marginally predicts CST scores the year the student is in the teacher's classroom

- Needs further investigation
  - What are the directions of causality?
  - What are the mechanisms of influence?

What Is the Role of Context?

- None of the variables <u>we</u> measured were related to AIT…

  - Percent free lunch in the school

  - School API

  - Supportiveness of administration and staff
    (self-report scale from Darling-Hammond et al.)

- But qualitatively, there were clearly supports and hindrances

Summary

AIT reveals important interactions at the intersections of context and teacher disposition, learning, knowledge, and practice.

- AIT reveals qualitatively different habits of mind, teaching practices, and approaches to PD
- AIT is somewhat normally distributed over the sample
- AIT has relationships to important educational factors…

Higher Routineness
- Greater instructional emphasis on procedural fluency and test prep
- Greater belief that effort cannot improve teaching
- Greater belief that it is easy to diagnose intelligence
- Performance orientation to teaching
- Locus of responsibility with students

Higher Adaptiveness
- Higher MKT
- Higher tracking, possibly higher student achievement (preliminary)
- Higher curiosity
- Higher self-efficacy
- Incremental theory of intelligence
- Locus of responsibility with teacher

Future Directions

- By what mechanisms might adaptiveness be associated with higher student achievement?
  - Observe actual classroom practices
  - More proximal measures of student learning and engagement
  - Examine more closely MKT ↔ adaptiveness link

- What is the role of context?
  - What supports and hinders adaptiveness?
  - Contrast with high SES contexts

- How can we build on the strengths of the vast number of teachers who are more routine-oriented?

- What does adaptiveness look like in early-career teaching?

- What are potential impacts of interventions to shift dispositional factors? Some research-based interventions in psychology shown to shift potentially relevant factors…
  - Curiosity (e.g., Kashdan)
  - Attribution style (e.g., Seligman)
  - Theory of intelligence (e.g., Dweck)

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Thank you for your attention.

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