Using the Inq-Blotter Dashboard to Support Teachers and Students on Science Practices

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GSE Brown Bag

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Presentation Outline

- Background and Prior Work
- Research Studies
  - Study 1: Inq-Blotter
  - Teacher Inquiry Practice Supports (TIPS) Development
  - Study 2: Inq-Blotter with TIPS
- Discussion and Future Research

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Background

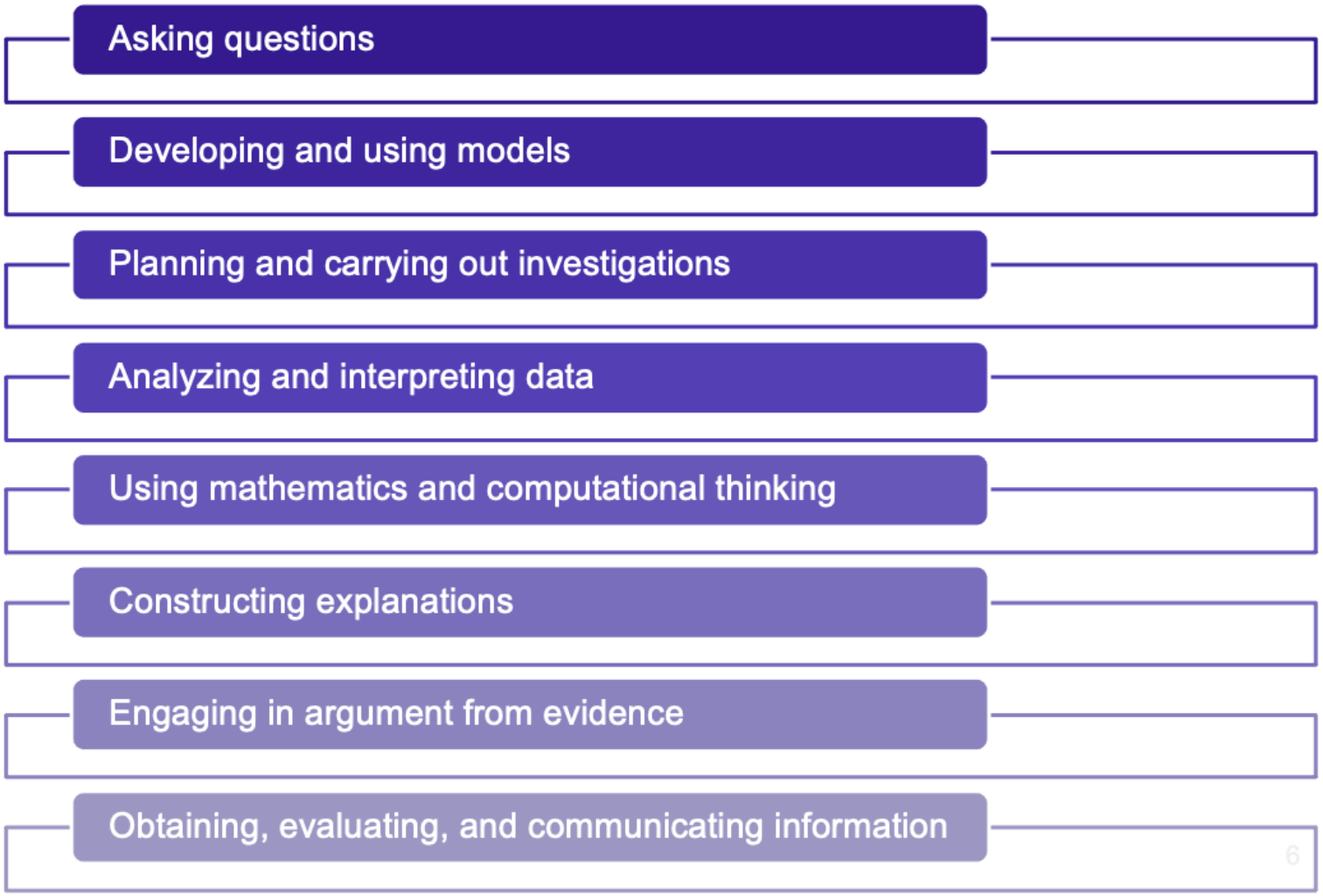
- The number of opportunities in Science, Technology, Engineering, and Mathematics (STEM) are increasing

- Students in the United States are under performing in STEM on international benchmarks
  - Ranking 26th in Science and 40th in Math on PISA

- National reform efforts attempt to direct focus towards inquiry
  - e.g., Next Generation Science Standards

(NGSS,2013; NRC, 2012; Pruitt, 2014; OECD, 2016a, 2016b)

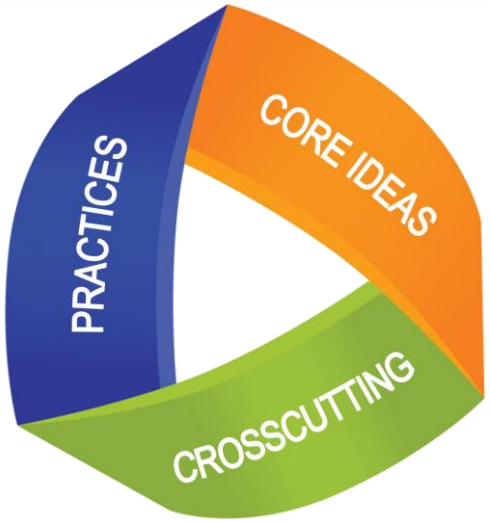
Science Inquiry Practices



(NGSS, 2013; NRC, 2012)

Assessing and Supporting Inquiry

- Inquiry practices are difficult to operationalize and measure
- Inquiry practices are challenging
- Science inquiry is multi-dimensional
  - Procedural understandings
  - Conceptual understandings
  - Content understandings, etc.



(NGSS,2013; NRC, 2012; Pruitt, 2014)

Technologies for Science Inquiry

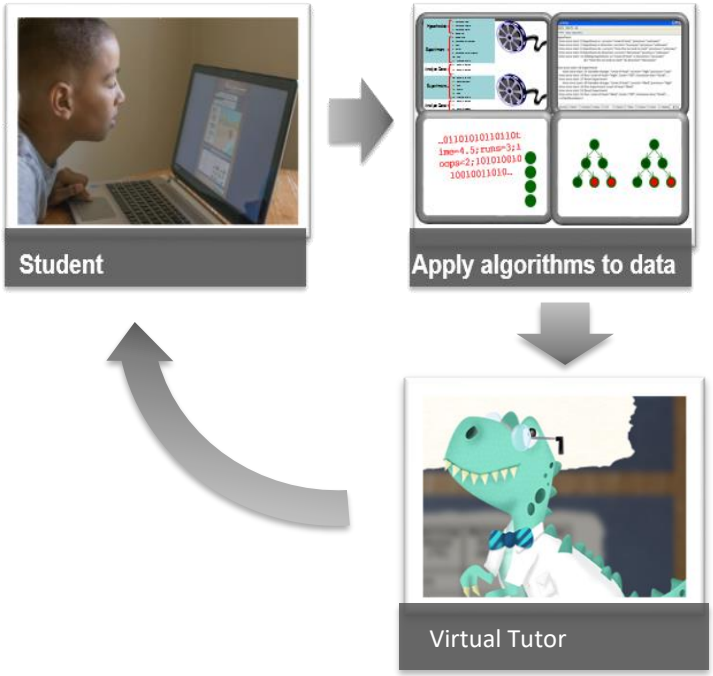
- Online science environments can automatically assess and support students

- Teacher **dashboards** allow for monitoring students within online environments through:
  - Reports of student activity and contributions
  - Visualizations of student scores on questions
  - Alerts on student progress, etc.

HOWARD Dashboard (Lajoie et al., 2021)

(Davenport et al., 2017; Linn et al., 2003; Matuk et al., 2016; Quellmalz et al., 2012; Raes & Schellens, 2016)

Inq-ITS (Inquiry Intelligent Tutoring System) & Inq-Blotter Teacher Dashboard



(Dickler et al., 2019a, 2019b; Gobert et al., 2014, 2016, 2019)

Prior Studies on Inq-ITS & Inq-Blotter

- Inq-ITS was explicitly designed to capture students' **sub-practice** performance
  - Inq-Blotter can then send fine-grained, actionable **alerts** to teachers with information at the sub-practice level

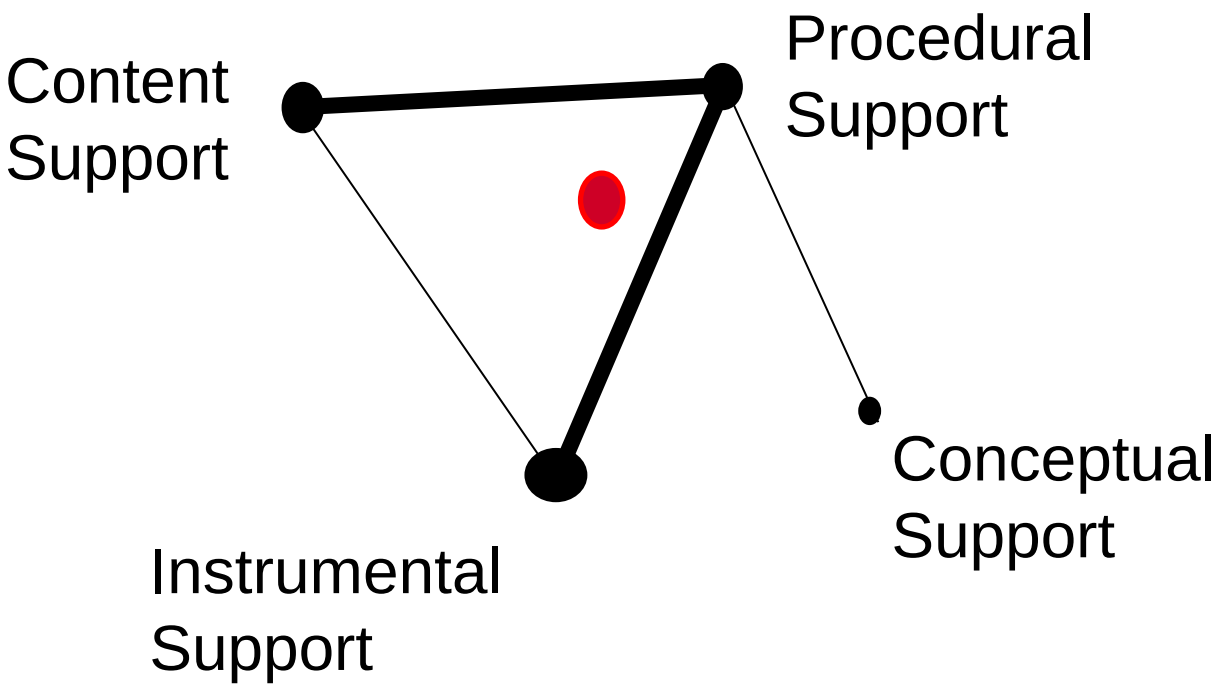
- When teachers use Inq-Blotter with real-time alerts, students significantly improve on science practices more than when no dashboard is available

- It is essential to also explore *how* the alerting dashboard is used

(Dickler et al., 2019a, 2020; Sao Pedro et al., 2019)

Epistemic Network Analysis (ENA)

- ENA is a method that is used to examine connections between coded qualitative data in networks



(Shaffer et al., 2016)

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Study 1: Inq-Blotter

RQ1) Are real-time alerts for inquiry practices associated with student improvement?

RQ2) Does the pattern of teacher support provided to students differ in relation to performance on practices?

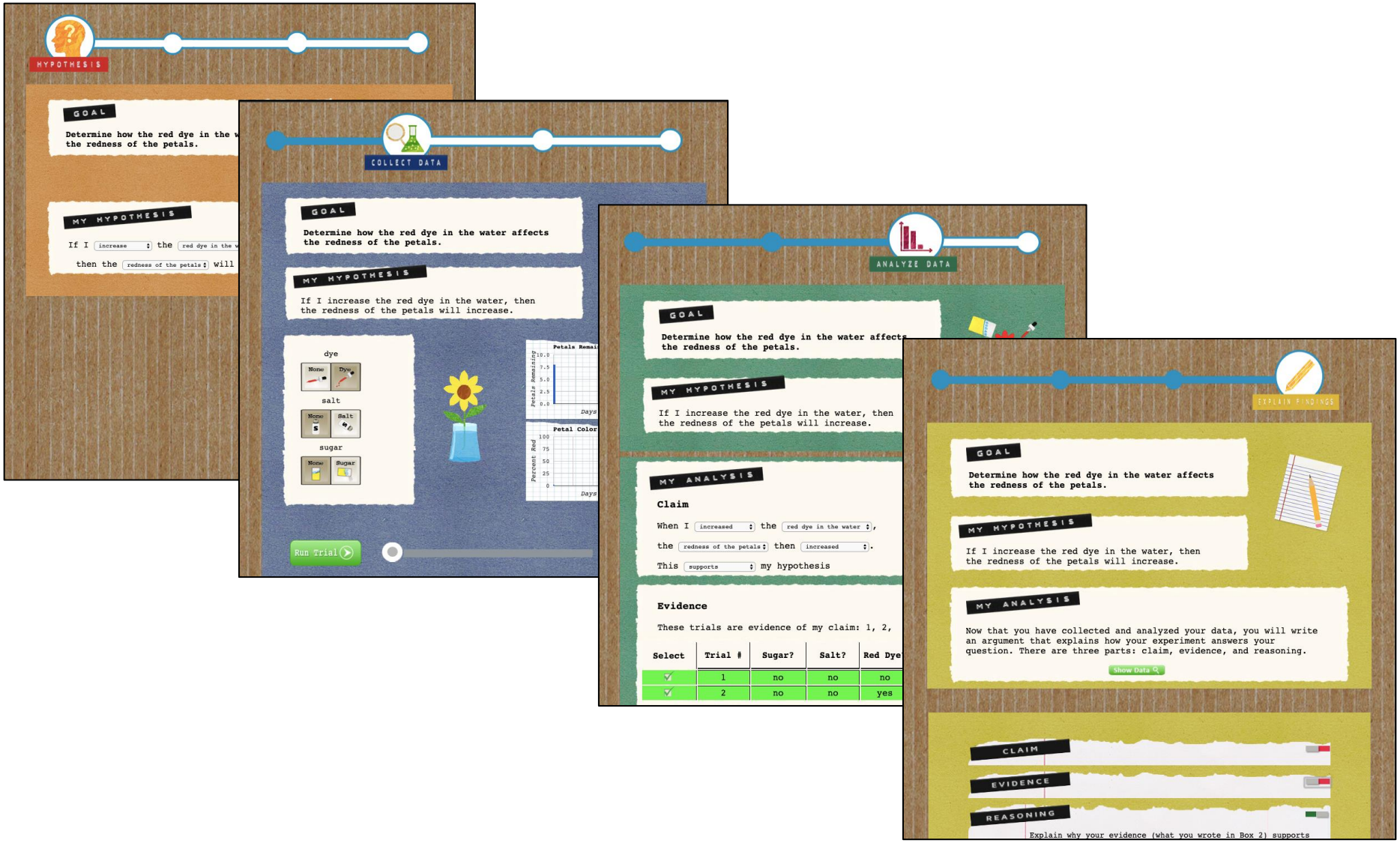
(Dickler, Gobert, & Sao Pedro, 2021)

Methods

- Participants:
  - 2 middle school teachers
  - 211 middle school students

- Procedure:
  - Students completed three Inq-ITS lab activities
  - Teachers used Inq-Blotter as students completed Inq-ITS labs
    - Audio data of interactions were recorded

Materials: Inq-ITS Virtual Lab Activity

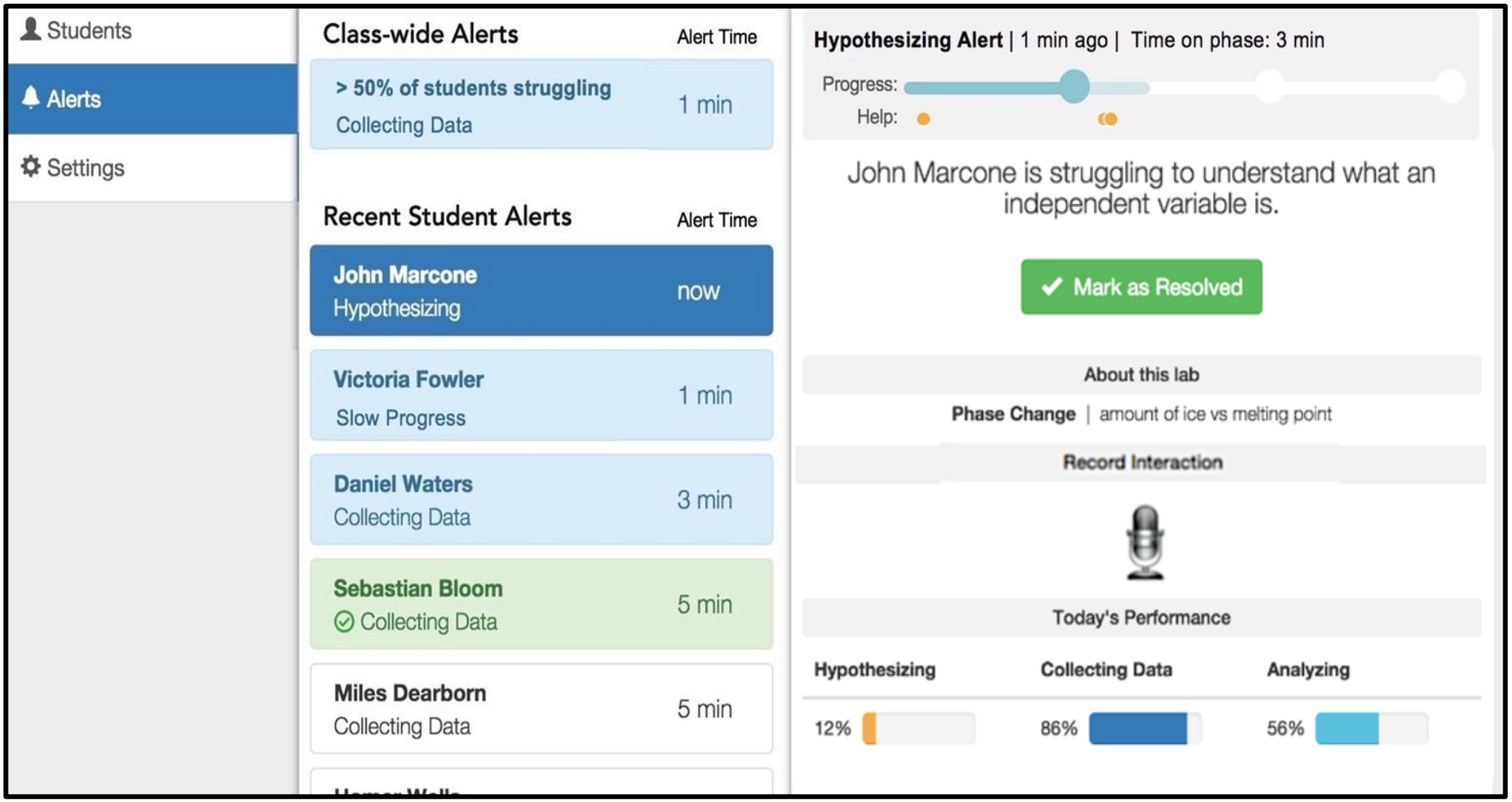


Measures: Inq-ITS Log Data

Inquiry Practice	Automatically Scored Sub-Practices
Asking Questions/ Hypothesizing	Selecting an independent variable (IV)
	Selecting a dependent variable (DV)
	Determining the target IV based on the goal
	Determining the target DV based on the goal
Carrying out Investigations/ Collecting Data	Designing a controlled experiment
	Running sufficient trials
	Testing the question/hypothesis
Analyzing and Interpreting Data	Identifying whether results support the initial hypothesis
	Making a claim regarding the target IV and DV
	Interpreting the relationship between the IV and DV
	Selecting sufficient trials to support the claim
	Selecting controlled trials to support the claim
	Selecting appropriate trials to support the claim
	Selecting trials that support the claim

(Gobert et al., 2013, 2018; Sao Pedro et al., 2013)

Materials: Inq-Blotter Teacher Dashboard



Measures: Inq-Blotter Log Data

- Log data from Inq-Blotter was examined in terms of:
  - alerts that appeared for the teacher
  - the student alerts accessed by the teacher
  - the content of alerts
  - timestamps

(Gobert et al., 2013, 2018)

Measures: Audio-Recordings

- *N* = 35 recordings were captured and transcribed
- Teacher turns were coded by two raters for types of supports provided
  - i.e., science practices, content, evaluative, etc.

(Gobert et al., 2013, 2018)

Teacher Discourse Codebook

Support Type	Definition
Orienting	Directing attention to a particular practice
Conceptual	Definition/explanation of an inquiry practice
Procedural	Information on the steps involved in an inquiry practice
Instrumental	The exact actions to take to complete the inquiry practice
Content (Comment)	A statement regarding scientific domain-related content
Content (Question)	Asking the student about scientific domain-related content
Evaluative	Statements regarding whether work is correct or incorrect

(Dickler et al., 2018, 2019a, 2019b, 2021)

Analyses: RQ1

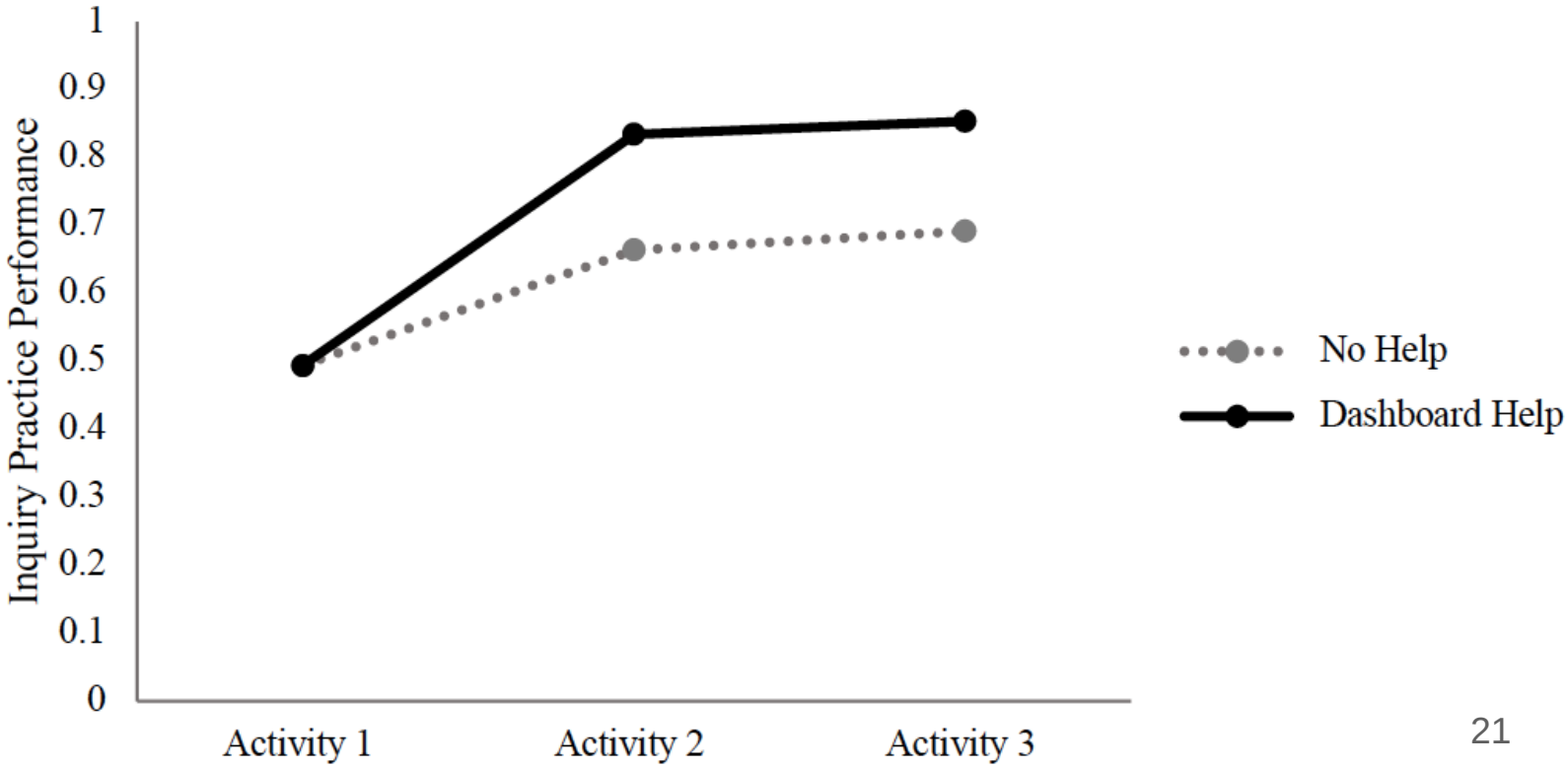
RQ1) Are real-time alerts for inquiry practices associated with student improvement?

- Triangulated log data from Inq-ITS and Inq-Blotter
  - Identified students who were helped (*n* = 35 students) and matched students who were **not** helped (*n* = 35 students)

- A Mixed Model Analysis of Variance (MM ANOVA) was used to compare student performance across activities between conditions
  - i.e., help versus no help

Results: RQ1

- The MM ANOVA revealed that students helped based on an alert had marginally significantly greater improvement across activities
  - i.e., interaction effect, $F(2, 136) = 2.60$, $p = 0.078$



Analyses: RQ2

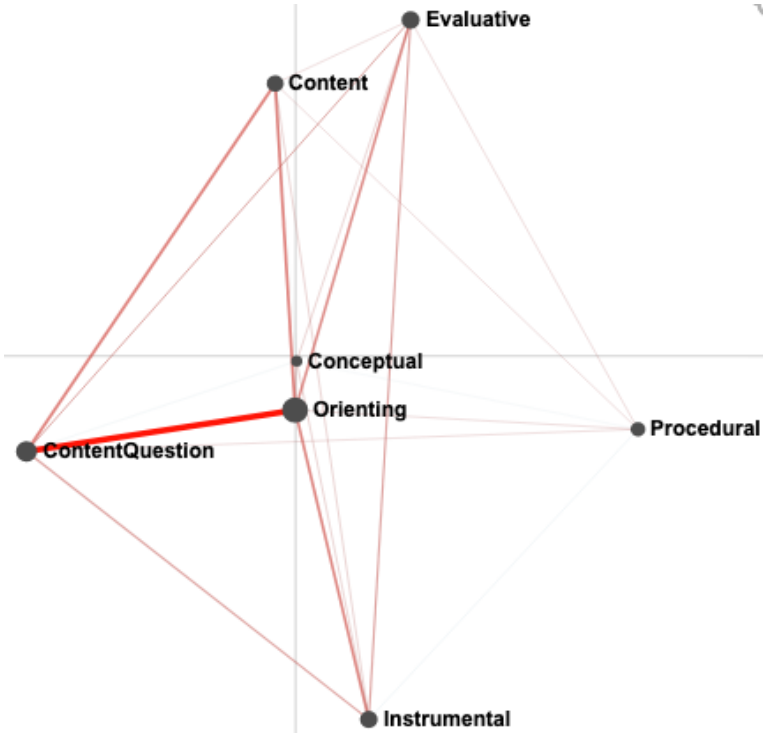
RQ2) Does the pattern of teacher support provided to students differ in relation to performance on practices?

- Triangulated log data with coded audio transcripts
- Compared patterns in support when helped students improved or did not improve on their next activity
  - Epistemic Network Analysis (ENA) was used to make quantitative and qualitative comparisons of patterns of support

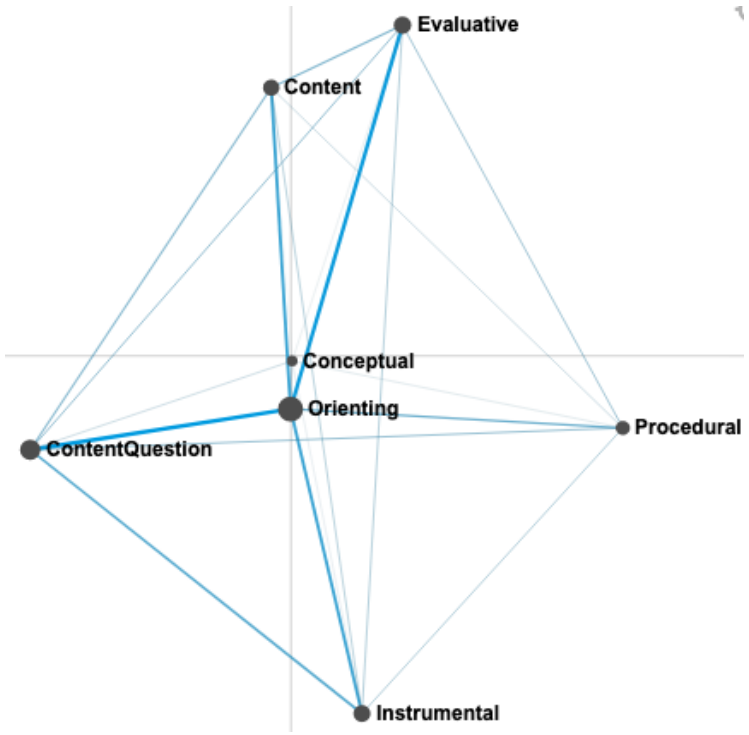
Results: RQ2

- The pattern of support associated with improvement was significantly different, $t(34) = 2.45$, $p = .04$

No Improvement



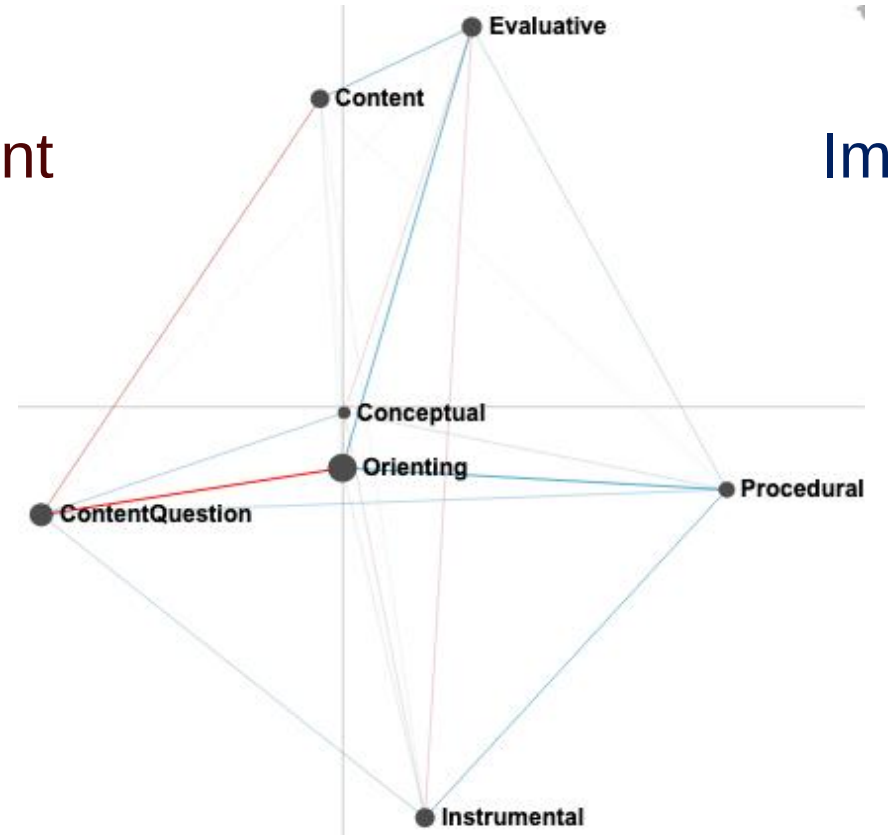
Improvement



Results: RQ2 (continued)

- Students who did *not* improve received combinations of lower-level/content supports more frequently

No Improvement



Improvement

Discussion

- The results of this study demonstrate the potential of an alerting dashboard to guide teacher support on inquiry practices
  - The majority of students who were helped by a teacher significantly improved and maintained their improvement

- The pattern of discursive support significantly differed by whether students improved or did not improve

- These findings have important implications for designing alerts to promote explicit practice support
  - Prior studies indicate potential of providing teachers with example prompts to guide interactions (e.g., Morris & Chi, 2010)

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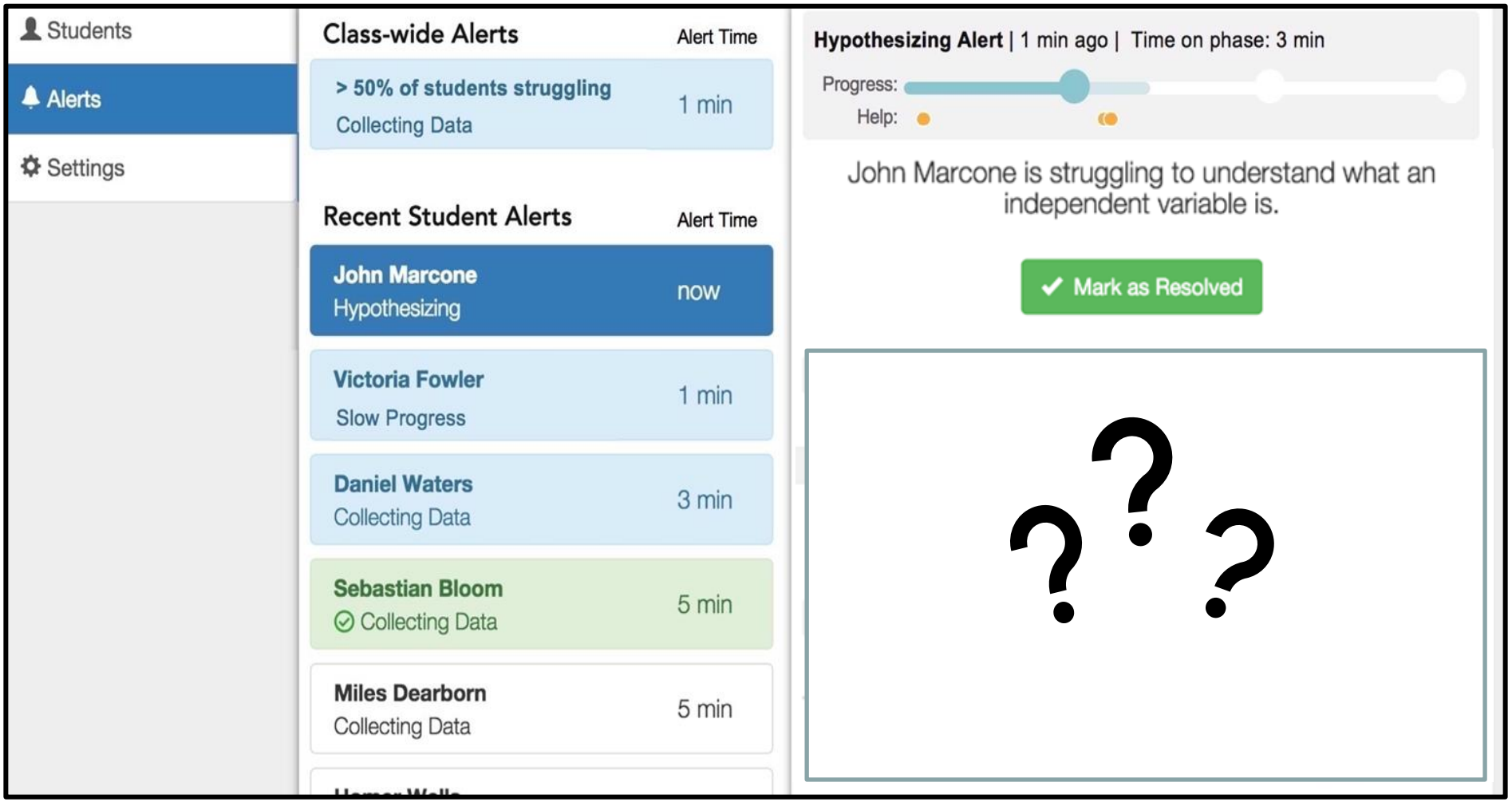
Motivation for Updated Inq-Blotter Alerts



TIPS Development

- **T**eacher **I**nquiry **P**ractice **S**upports – prompts directed at supporting the student's inquiry practices
  - TIPS are sent directly to the teacher within alerts in Inq-Blotter

- Four Categories of Support:
  - Orienting - direct student to a specific practice
  - Conceptual - define or explain an inquiry practice
  - Procedural - inform students of inquiry steps
  - Instrumental - give student exact actions to complete the practice

(Adair et al., 2020; Gobert et al., 2018)

TIPS Development (continued)

Obtained 219 teacher-spoken segments from recorded conversations with the 2 middle school teachers from Study 1

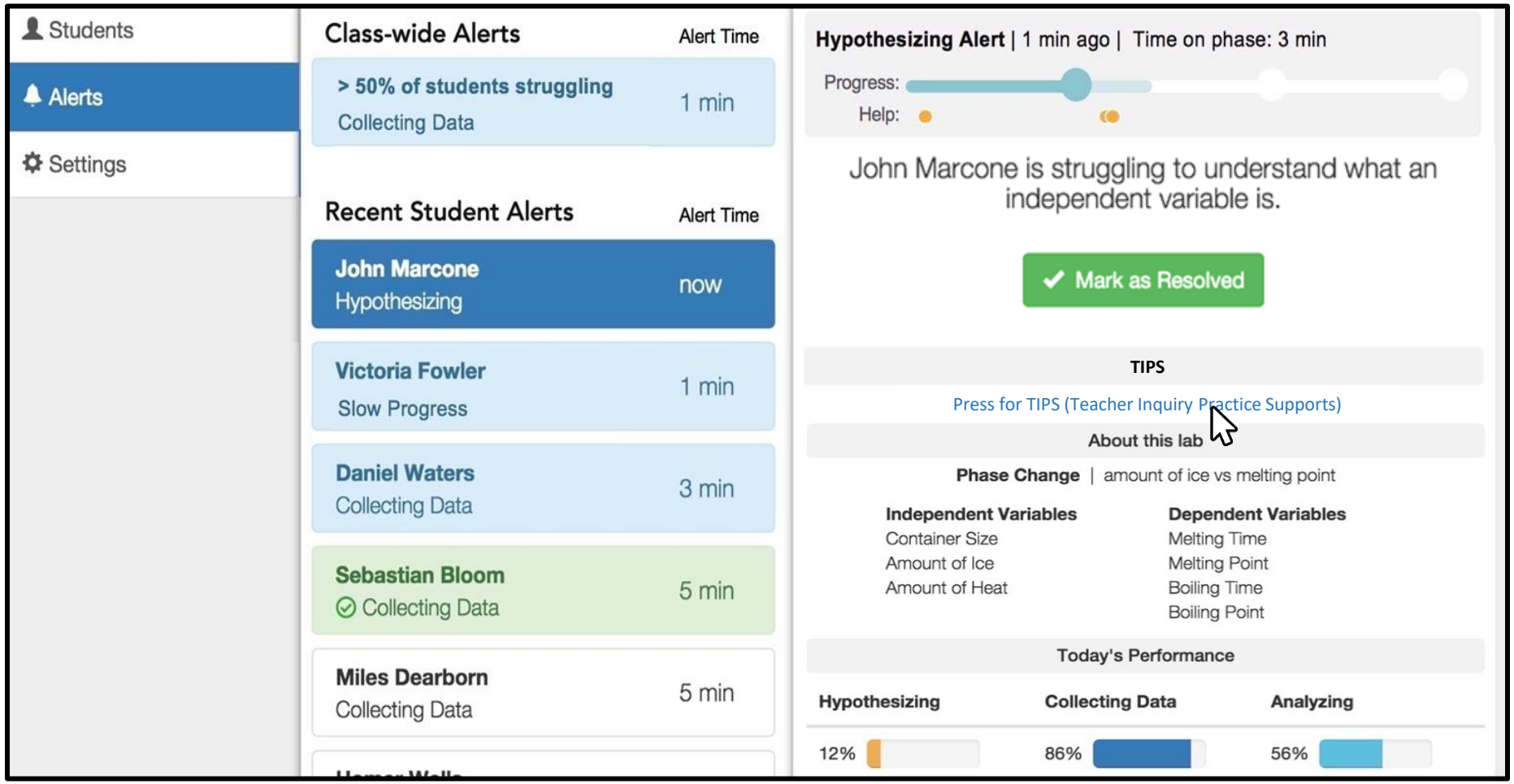
Used segments that had previously been coded for four categories of support (i.e., orienting, conceptual, instrumental, procedural)

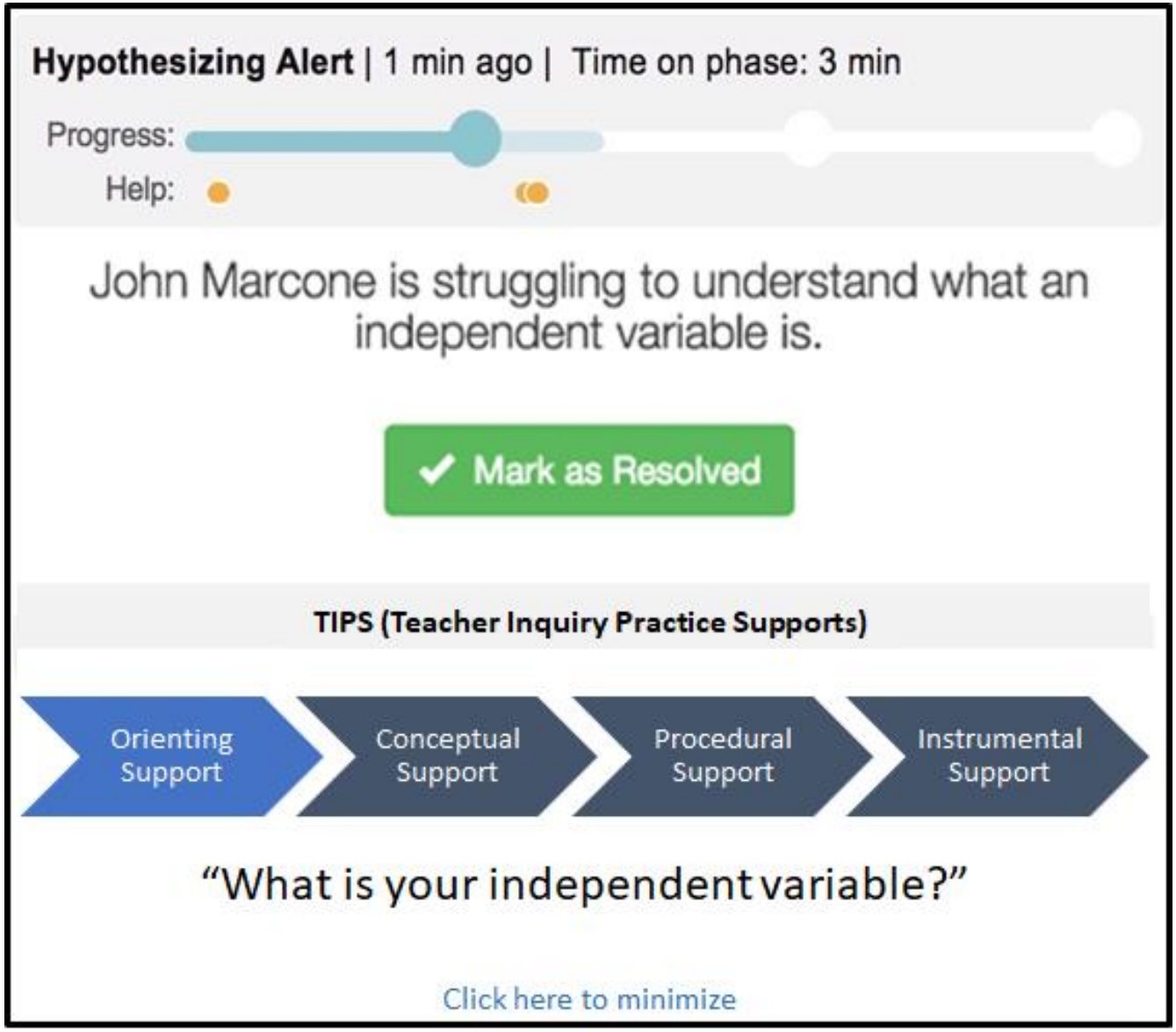
Filtered segments for which students improved on the practice after receiving support from the teacher

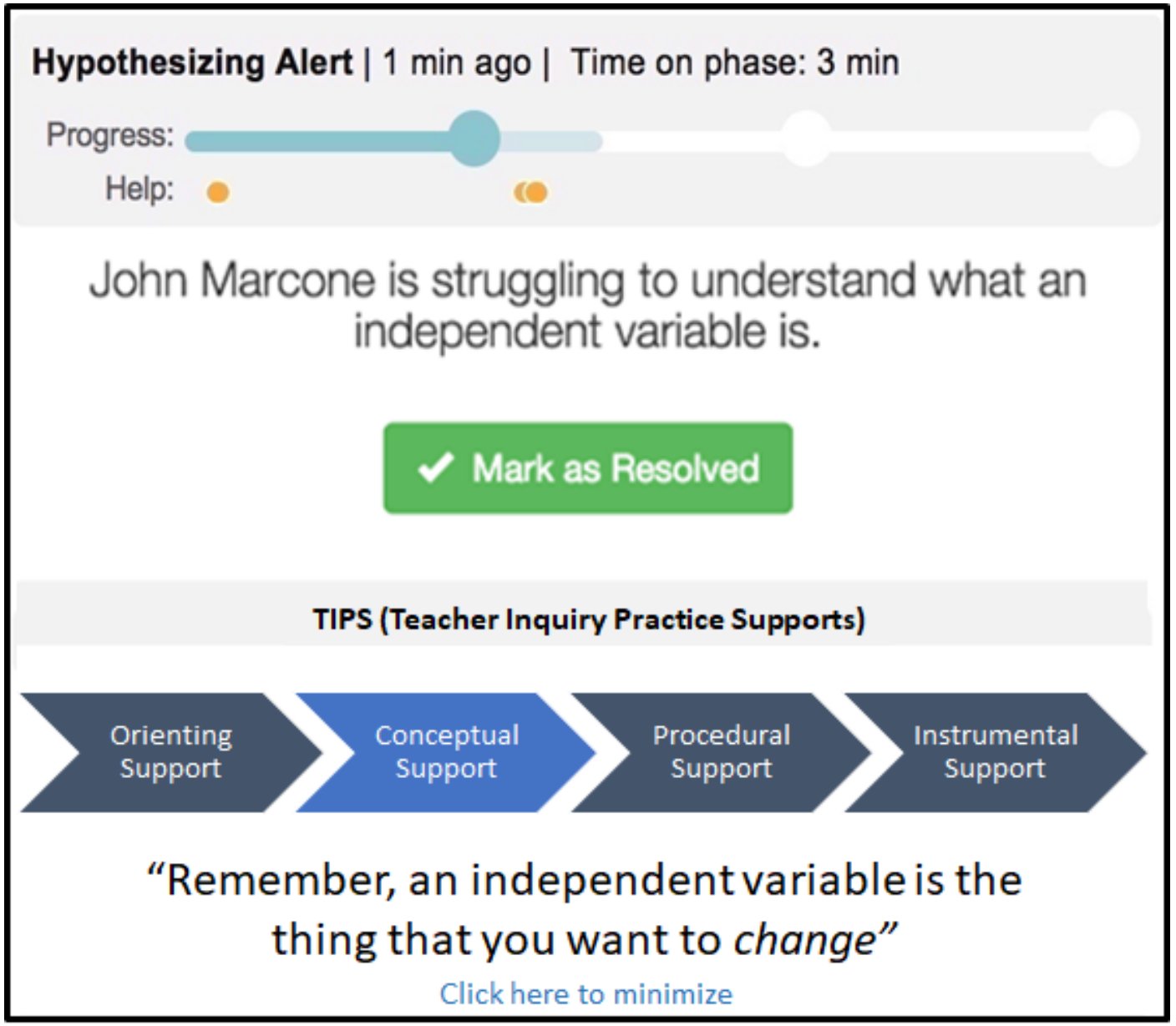
Constructed TIPS for each category of support based on filtered teacher segments

Embedded TIPS into the Inq-Blotter system

1. Teacher can select “Press for TIPS (Teacher Inquiry Practice Supports)” if she wants to access the prompts




Hypothesizing Alert | 1 min ago | Time on phase: 3 min
Progress:
Help:
John Marcone is struggling to understand what an independent variable is.
Mark as Resolved
TIPS (Teacher Inquiry Practice Supports)
Orienting Support
Conceptual Support
Procedural Support
Instrumental Support
"What is your independent variable?"
Click here to minimize


Hypothesizing Alert | 1 min ago | Time on phase: 3 min
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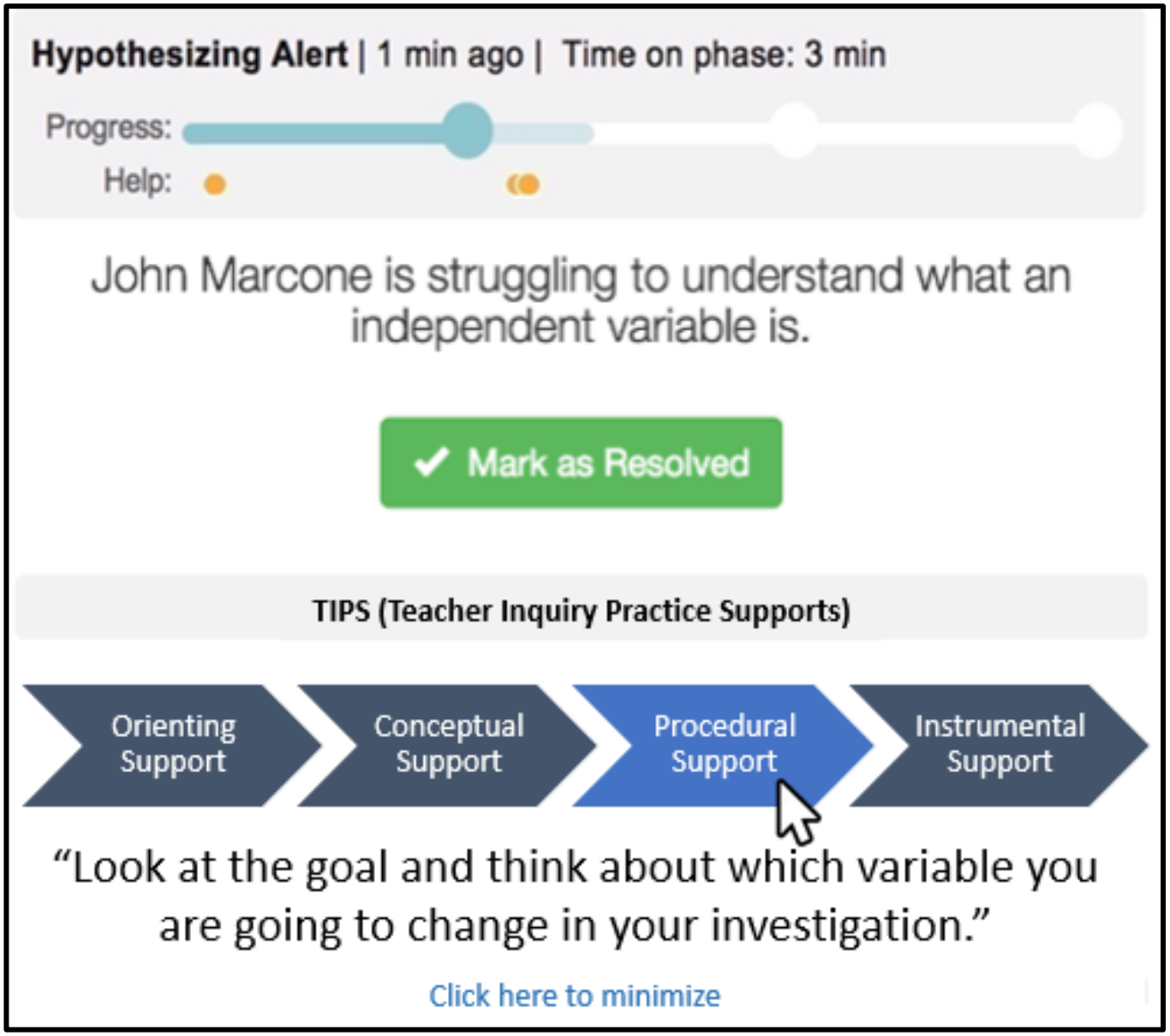
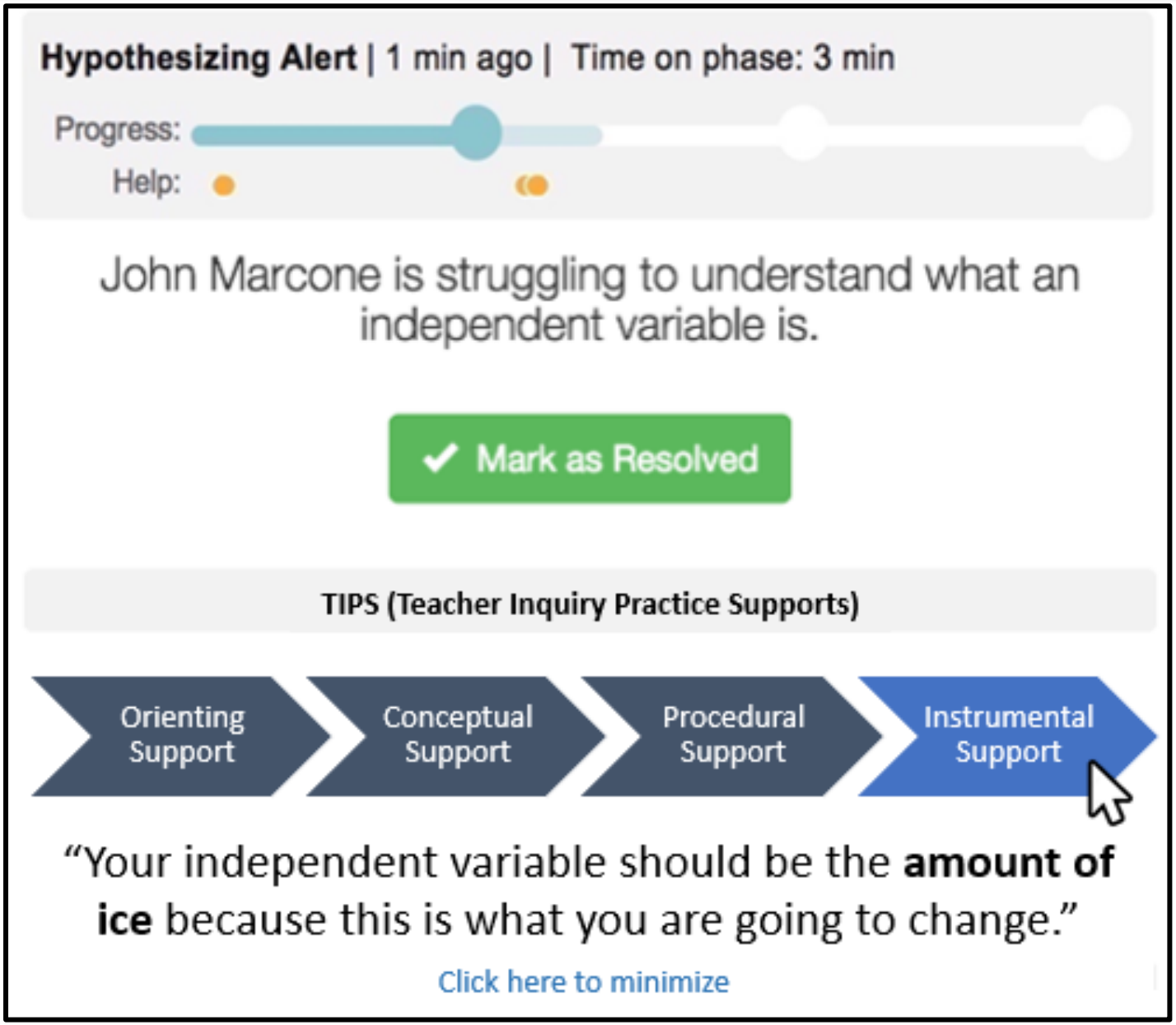
Help:
John Marcone is struggling to understand what an independent variable is.
Mark as Resolved
TIPS (Teacher Inquiry Practice Supports)
Orienting Support
Conceptual Support
Procedural Support
Instrumental Support
"Remember, an independent variable is the thing that you want to *change*"
Click here to minimize


Hypothesizing Alert | 1 min ago | Time on phase: 3 min
Progress:
Help:
John Marcone is struggling to understand what an independent variable is.
Mark as Resolved
TIPS (Teacher Inquiry Practice Supports)
Orienting Support
Conceptual Support
Procedural Support
Instrumental Support
"Look at the goal and think about which variable you are going to change in your investigation."
Click here to minimize


Hypothesizing Alert | 1 min ago | Time on phase: 3 min
Progress:
Help:
John Marcone is struggling to understand what an independent variable is.
Mark as Resolved
TIPS (Teacher Inquiry Practice Supports)
Orienting Support
Conceptual Support
Procedural Support
Instrumental Support
"Your independent variable should be the amount of ice because this is what you are going to change."
Click here to minimize

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Study 2: Inq-Blotter with TIPS

RQ1) How do TIPS impact the ways in which teachers support students?

Methods

- Participants:
  - 4 teachers from different schools
    - 2 Remote (Fully Online, Synchronous)
    - 1 In-Person/Traditional
    - 1 Hybrid

- Procedure:
  - Teachers used **Inq-Blotter with TIPS** as students completed Inq-ITS labs
  - Teachers were interviewed about their experiences

Measures

- Inq-Blotter with TIPS Log Data
  - Clickstream data of the types of alerts and supports that teacher selected and timestamps
- Audio-Recordings
- Teacher Interviews

Analyses

RQ1) How do TIPS impact the ways in which teachers support students?

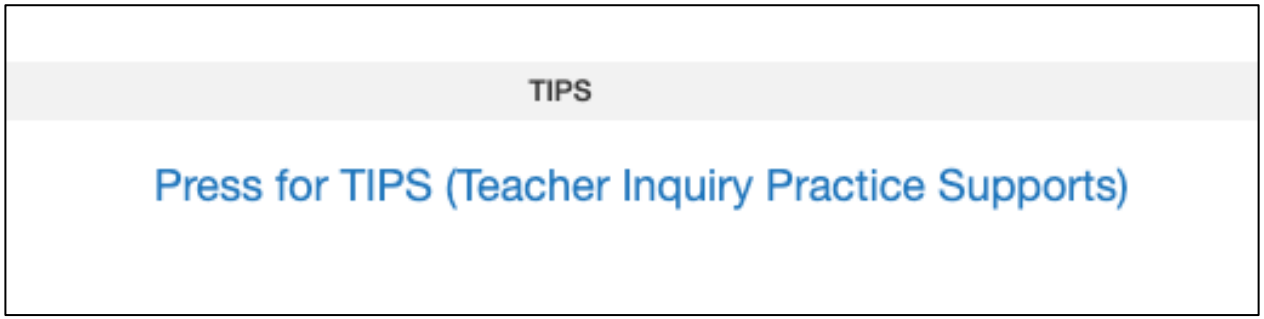
- Researchers examined data for initial themes that emerged from the data

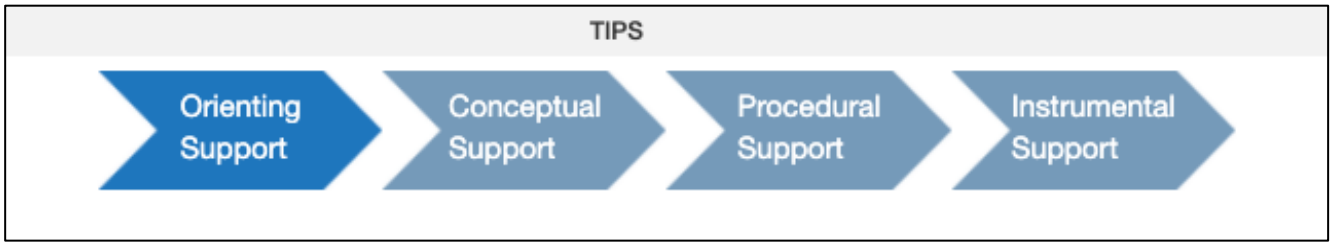
Preliminary Results

- Three initial themes were identified from the data:
  - Design recommendations for improved usability
  - TIPS helped teachers differentiate levels of support
  - TIPS helped teachers with timeliness

Preliminary Results – Theme 1

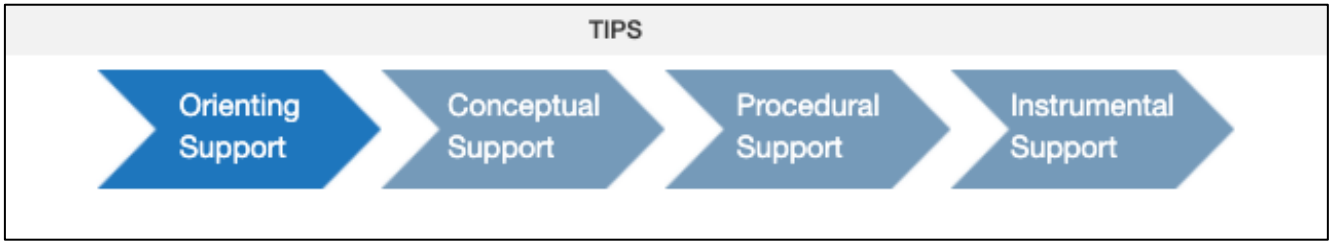
- Design recommendations for improved usability
  - Remove need to "Press for TIPS"
  - Simplify language of TIPS terminology
  - Update graphics (i.e., arrows)





Preliminary Results – Theme 2

- TIPS helped teachers differentiate levels of support
  - "In general, it was **helpful to remind me to not jump straight to giving kids the answer**. I had a few kids surprise me. They figured things out on their own using the TIPS more often than I thought they would."
  - "I talk to my kids all the time, but it made it easier to identify like a **laser what I needed to talk to them about**."



Preliminary Results – Theme 3

- TIPS helped teachers with timeliness
  - "The **TIPS saved me time** to clarify what is going on...I was able to make my way around the room to more students. When you add [that] up...it really saves me time."
  - "[TIPS] helped me with **starting that communication with the students**. How much did that decrease the amount of time? Probably 1-2 minutes. I get those TIPS, and that's what I would send the kids online."

Discussion

- The preliminary results of this study provide insights that can inform future design iterations of Inq-Blotter with TIPS
- Our early findings also suggest alerts that include helpful suggestions, like TIPS, may be useful in promoting the support that teachers provide to their students on science inquiry practices
- On-going analyses will look at log data to determine how students' performances changed as a result of teachers using TIPS in their instruction

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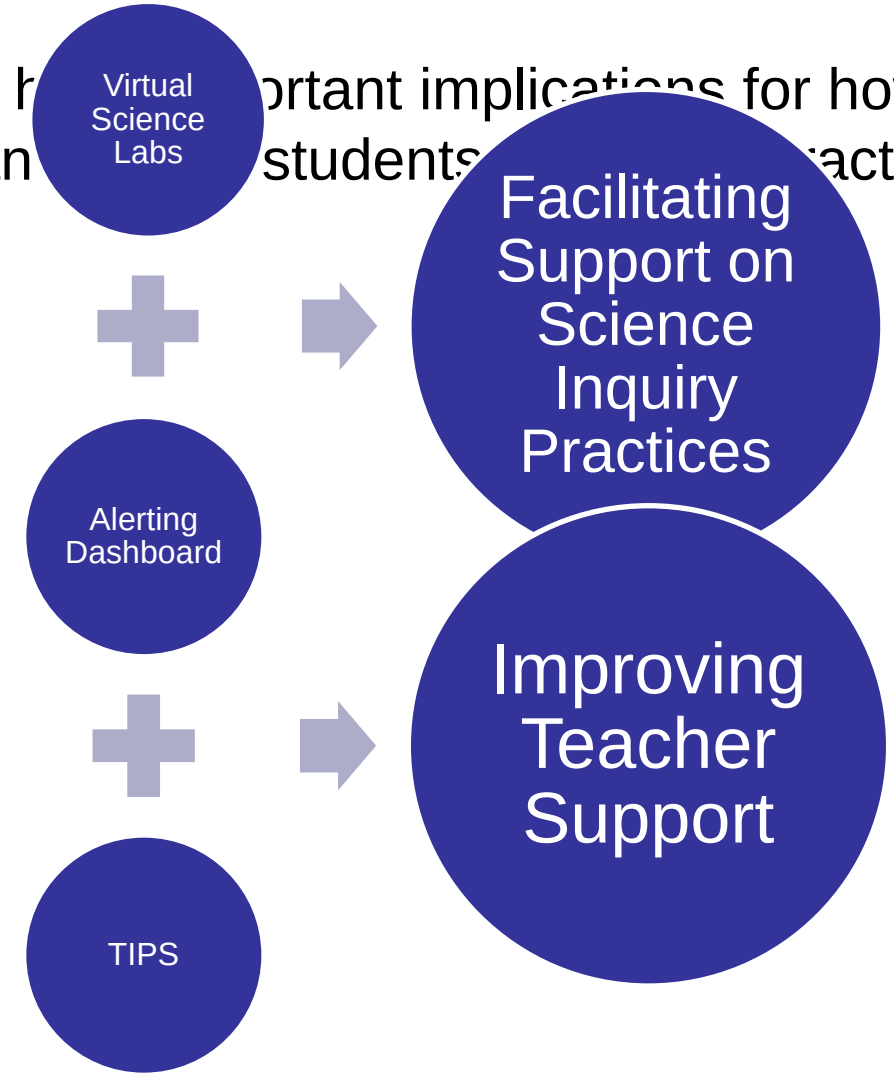
Discussion

- These findings h ortant implications for how alerting dashboards can students actices



Future Research

- Future work will examine:
  - Testing updated design elements
  - Examining discourse and running controlled comparisons to explore student performance in relation to design features
  - Expanding the systems to support Using Mathematics in Science at the high school level

Acknowledgements

- A huge thank you to the Rutgers Inq-ITS Team and Apprendis Team!

Thank you!

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