

# Developing and Implementing Teacher Inquiry Practice Supports for Remote and In-Person Instruction

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Graduate School of Education

# NGSS & Inq-ITS

- In both in-person and remote settings, it is challenging for teachers to support their students in developing their competencies with science inquiry practices, as defined by the Next Generation Science Standards (NGSS, 2013).
- To help guide teachers in scaffolding their students' specific difficulties with the inquiry practices as they are working on virtual labs in an intelligent tutoring system environment, we developed Teacher Inquiry Practice Supports (TIPS).



# What are TIPS?

- Teacher Inquiry Practice Supports –potential feedback that the teacher can provide to a student and that is directed at supporting the student's inquiry practices. TIPS are sent directly to the teacher via alerts on a dashboard, Inq-Blotter (Gobert et al., 2018).
- 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
- See video demonstration [here](#)



# TIPS Development

- Obtained 219 teacher-spoken segments from recorded conversations with 2 middle school teachers
- Coded segments 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



# TIPS Implementation

- Participants: 6 teachers across 5 different schools
  - 3 Remote (Fully Online, Synchronous)
  - 2 In-Person/Traditional
  - 1 Hybrid
- Data includes:
  - Teacher-student conversations recorded via video conferencing software (e.g., Zoom, Google Meets)
  - Log files of teachers' interactions with the dashboard
  - Log files of students' performance on the lab activities
  - Post-TIPS intervention interview with teachers



# Preliminary Results

- Design changes for improved usability
- Suggested feedback for 'Slow Progress' alert
- TIPS helped teachers with timeliness



# References

- **Inq-ITS**

- Gobert, J. D., Moussavi, R., Li, H., Sao Pedro, M., & Dickler, R. (2018). Scaffolding students' on-line data interpretation during inquiry with Inq-ITS. In M. E. Auer, A. K. M. Azad, A. Edwards, & T. de Jong (Eds.), *Cyber-physical laboratories in engineering and science education* (pp. 191-218). Springer.

- **Inq-Blotter**

- Dickler, R., Gobert, J., & Sao Pedro, M. (2021). Using innovative methods to explore the potential of an alerting dashboard for science inquiry. *Journal of Learning Analytics*.

- **TIPS**

- Adair, A., Dickler, R., & Gobert, J. (2020). Supporting teachers supporting students: Iterative development of TIPS in a teacher dashboard. In M. Gresalfi & I. S. Horn (Eds.), *14th International Conference of the Learning Sciences, Volume 3* (pp. 1769-1770). International Society of the Learning Sciences.



# Appendices

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# TIPS Walkthrough

The following slides include screenshots of the Inq-Blotter dashboard with the new TIPS:

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

Students

Alerts

Settings

Class-wide Alerts

Alert Time

> 50% of students struggling

Collecting Data

1 min

Recent Student Alerts

Alert Time

John Marcone

Hypothesizing

now

Victoria Fowler

Slow Progress

1 min

Daniel Waters

Collecting Data

3 min

Sebastian Bloom

Collecting Data

5 min

Miles Dearborn

Collecting Data

5 min

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

Press for TIPS (Teacher Inquiry Practice Supports)

About this lab

Phase Change | amount of ice vs melting point

Independent Variables

Container Size

Amount of Ice

Amount of Heat

Dependent Variables

Melting Time

Melting Point

Boiling Time

Boiling Point

Today's Performance

Hypothesizing

12%

Collecting Data

86%

Analyzing

56%

2. Teacher can look through questions and minimize when finished (or scroll to see other information below)

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1 min

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Collecting Data

5 min

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

Orienting Support

Conceptual Support

Procedural Support

Instrumental Support

“What’s your independent variable?”

Click here to minimize

About this lab

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2. Teacher can look through questions and minimize when finished (or scroll to see other information below)

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5 min

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

Orienting Support

Conceptual Support

Procedural Support

Instrumental Support

Remember, an independent variable is the thing that you want to *change*.

Click here to minimize

About this lab

Phase Change | amount of ice vs melting point

Independent Variables

Container Size

Amount of Ice

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Melting Time

Melting Point

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Progress:

Help:

John Marcone is struggling to understand what an independent variable is.

Mark as Resolved

TIPS

Orienting Support

Conceptual Support

Procedural Support

Instrumental Support

“For the independent variable, select which variable you are going to change in your investigation.”

Click here to minimize

About this lab

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Progress:

Help:

John Marcone is struggling to understand what an independent variable is.

Mark as Resolved

TIPS

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

About this lab

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# More Examples

- The next few slides have examples of TIPS for the different types of alerts that may appear



# More Examples - Hypothesizing

Type of Alert	Alert Text
<a href="#">1. Untestable hypothesis</a>	John has created a hypothesis that targets a dependent variable to be manipulated, and an independent variable to be measured. John may be struggling to understand the concept of a variable or what a hypothesis is.
<a href="#">2. IV false</a>	John has created a hypothesis that targets a dependent variable to be manipulated, and may be struggling to understand what an independent variable is.
<a href="#">3. DV false</a>	John has created a hypothesis that targets a independent variable to be measured, and may be struggling to understand what an dependent variable is.



# More Examples - Hypothesizing (continued)

Type of Alert	Alert Text
<a href="#">4. Off Goal (IV &amp; DV)</a>	John has created a testable hypothesis, but the variables selected will not help them reach the goal of the assignment.
<a href="#">5. Off Goal (IV)</a>	John has created a testable hypothesis, but the independent variable selected will not help them reach the Goal of the assignment.
<a href="#">6. Off Goal (DV)</a>	John has created a testable hypothesis, but the dependent variable selected will not help them reach the Goal of the assignment.

# More Examples - Collecting Data

Type of Alert	Alert Text
<a href="#">7. Single Trial</a>	John has attempted to start analysis without enough data – either a single trial or no trials. John may be struggling to understand that analysis requires the comparison of multiple trials.
<a href="#">8. Confounded Trials</a>	John is changing too many variables at once.
<a href="#">9. Not Targeting Hypothesis</a>	John is conducting controlled experiments, but is not targeting their hypothesis. The independent variable John is manipulating is not the independent variable specified in the hypothesis.
<a href="#">10. Nominal or Not exploring the space</a>	John ran a controlled experiment that targeted their hypothesis, but did not run controlled trials for all variables their hypothesis calls for.

# More Examples - Analyzing Data

Type of Alert	Alert Text
<a href="#"><u>11. IV &amp; DV Incorrect</u></a>	<p>John has created a claim that has a dependent variable being manipulated, and an independent variable being measured.</p> <p>John may be struggling to understand the concept of a variable or what a claim is.</p>
<a href="#"><u>12. IV false</u></a>	<p>John claimed that an independent variable was being measured, and may be struggling to understand what an independent variable is</p>
<a href="#"><u>13. DV false</u></a>	<p>John claimed that a dependent variable was being manipulated, and may be struggling to understand what an dependent variable is.</p>

# More Examples - Analyzing Data (continued)

Type of Alert	Alert Text
<a href="#"><u>14. Based on the Claim IV, no valid claim can be made with the data collected</u></a>	John has made a claim that cannot be warranted with the data collected. Either John has collected confounded data with respect to their claim, or has not varied the variable the claim targets.
<a href="#"><u>15. Claim does not match trends in collected data</u></a>	John has claimed a relationship between the independent variable and the dependent variable that is not shown in the data they collected.
<a href="#"><u>16. Not enough trials selected as evidence</u></a>	John has not selected enough trials to use as evidence of their claim. They may have selected only one trial, or not selected any trials.

# More Examples - Analyzing Data (continued)

Type of Alert	Alert Text
<a href="#"><u>17. Selected trials not control</u></a>	John selected trials as evidence that are confounded. Students need to select controlled trials as evidence.
<a href="#"><u>18. Wrong IV Controlled</u></a>	The independent variable John has targeted when selecting evidence does not match the independent variable in the claim.
<a href="#"><u>19. Selected trials do not support claim</u></a>	The trials John has selected as evidence do not support their claim.
<a href="#"><u>20. Student does not understand if their claim supports their hyp</u></a>	When selecting if their claim supported their hypothesis, John did could not correctly identify if their claim supported their hypothesis or not.

# Hypothesizing - 1. Untestable Hypothesis

<b>Type of Alert</b>	Untestable hypothesis
<b>Alert Text</b>	John has created a hypothesis that targets a dependent variable to be manipulated, and an independent variable to be measured. John may be struggling to understand the concept of a variable or what a hypothesis is.
<b>Orienting</b>	Look at the goal. What's the independent variable? What's the dependent variable?
<b>Conceptual</b>	Remember, an independent variable is the thing that you want to change and a dependent variable is the thing that you want to measure.
<b>Procedural</b>	Select an independent variable that you can change and a dependent variable that you can measure. [See below for list of variables]
<b>Instrumental</b>	Your independent variable should be the (IV) because this is what you are going to change. Your dependent variable should be (DV) because this is what you are going to measure.

[Go Back to Hypothesizing Alerts](#)

# Hypothesizing - 2. IV False

<b>Type of Alert</b>	IV false
<b>Alert Text</b>	John has created a hypothesis that targets a dependent variable to be manipulated, and may be struggling to understand what an independent variable is.
<b>Orienting</b>	What's your independent variable?
<b>Conceptual</b>	Remember, an independent variable is the thing that you want to change.
<b>Procedural</b>	For the independent variable, select which variable you are going to change in your investigation.
<b>Instrumental</b>	Your independent variable should be the (IV) because this is what you are going to change.

# Hypothesizing - 3. DV False

<b>Type of Alert</b>	DV false
<b>Alert Text</b>	John has created a hypothesis that targets a independent variable to be measured, and may be struggling to understand what an dependent variable is.
<b>Orienting</b>	What's your dependent variable?
<b>Conceptual</b>	Remember, a dependent variable is the thing that you want to measure.
<b>Procedural</b>	For the dependent variable, select which variable you are going to measure in your investigation.
<b>Instrumental</b>	Your dependent variable should be (DV) because this is what you are going to measure.



# Hypothesizing - 4. Off Goal (IV & DV)

<b>Type of Alert</b>	Off Goal (IV & DV)
<b>Alert Text</b>	John has created a testable hypothesis, but the variables selected will not help them reach the goal of the assignment.
<b>Orienting</b>	What's the goal?
<b>Conceptual</b>	Remember, your hypothesis should match the goal of the investigation.
<b>Procedural</b>	Select the independent variable and dependent variables that help you reach the goal of the assignment.
<b>Instrumental</b>	Your independent variable should be (IV) and the dependent variable should (DV) because this hypothesis helps you reach the goal.

# Hypothesizing - 5. Off Goal (IV)

<b>Type of Alert</b>	Off Goal (IV)
<b>Alert Text</b>	John has created a testable hypothesis, but the independent variable selected will not help them reach the Goal of the assignment.
<b>Orienting</b>	What's the goal?
<b>Conceptual</b>	Remember, an independent variable is the thing that you want to change.
<b>Procedural</b>	Select the independent variable that you want to change and helps you reach the goal of the assignment.
<b>Instrumental</b>	Your independent variable should be the (IV) because this is what you are going to change and relates to the goal of the assignment.

# Hypothesizing - 6. Off Goal (DV)

<b>Type of Alert</b>	Off Goal (DV)
<b>Alert Text</b>	John has created a testable hypothesis, but the dependent variable selected will not help them reach the Goal of the assignment.
<b>Orienting</b>	What's the goal?
<b>Conceptual</b>	Remember, a dependent variable is the thing that you want to measure.
<b>Procedural</b>	Select the dependent variable that you want to measure and helps you reach the goal of the assignment.
<b>Instrumental</b>	Your dependent variable should be (DV) because this is what you are going to measure and relates to the goal of the assignment.

# Collecting Data - 7. Single Trial

<b>Type of Alert</b>	Single Trial
<b>Alert Text</b>	John has attempted to start analysis without enough data – either a single trial or no trials. John may be struggling to understand that analysis requires the comparison of multiple trials.
<b>Orienting</b>	How many trials do you have as evidence?
<b>Conceptual</b>	Remember, you need enough trials to compare the data.
<b>Procedural</b>	What is the minimum number of trials you need as evidence?
<b>Instrumental</b>	You need at least two controlled trials as evidence.

# Collecting Data - 8. Confounded Trials

<b>Type of Alert</b>	Confounded Trials
<b>Alert Text</b>	John is changing too many variables at once.
<b>Orienting</b>	Let's take a look at your data. What data have you collected?
<b>Conceptual</b>	Remember, you should be running controlled trials. Controlled trials is when you only change one variable at a time.
<b>Procedural</b>	Which variable is the one that you should be changing?
<b>Instrumental</b>	You should only change the (IV).

# Collecting Data - 9. Not Targeting Hypothesis

Type of Alert	Not Targeting Hypothesis
Alert Text	John is conducting controlled experiments, but is not targeting their hypothesis. The independent variable John is manipulating is not the independent variable specified in the hypothesis.
Orienting	Let's look at your hypothesis and the data you collected. How does your hypothesis relate to the data you collected?
Conceptual	Remember that you want to collect data to test your hypothesis so that you can make a claim about your findings.
Procedural	What is the variable that you should be changing based on your hypothesis?
Instrumental	Make sure you're testing the (IV) from your hypothesis.

# Collecting Data - 10. Nominal or Not exploring the space

<b>Type of Alert</b>	Nominal or Not exploring the space
<b>Alert Text</b>	John ran a controlled experiment that targeted their hypothesis, but did not run controlled trials for all variables their hypothesis calls for.
<b>Orienting</b>	Let's look at your hypothesis and the data you collected. How does your hypothesis relate to the data you collected?
<b>Conceptual</b>	Remember that you want to collect data to test your hypothesis so that you can make a claim about your findings.
<b>Procedural</b>	What is the variable that you should be changing based on your hypothesis?
<b>Instrumental</b>	Make sure you're testing the (IV) from your hypothesis.

# Analyzing Data - 11. IV & DV Incorrect

<b>Type of Alert</b>	IV & DV Incorrect
<b>Alert Text</b>	John has created a claim that has a dependent variable being manipulated, and an independent variable being measured. John may be struggling to understand the concept of a variable or what a claim is.
<b>Orienting</b>	Let's look at your claim. What's your independent variable? What's your dependent variable?
<b>Conceptual</b>	Remember, an independent variable is the thing you changed. A dependent variable is the thing that was measured. Your claim is based on what you discovered in your investigation regarding your original hypothesis.
<b>Procedural</b>	Think about which variable you changed and which variable was measured - what happened in the investigation with these variables? What does the data show?
<b>Instrumental</b>	When you (increased/decreased) the (IV) in the investigation, the (DV) (increased/decreased).



# Analyzing Data - 12. IV false

<b>Type of Alert</b>	IV false
<b>Alert Text</b>	John claimed that an independent variable was being measured, and may be struggling to understand what an independent variable is.
<b>Orienting</b>	Let's look at your claim. What's your independent variable?
<b>Conceptual</b>	Remember, an independent variable is the thing that you changed.
<b>Procedural</b>	Think about which variable you changed in your investigation.
<b>Instrumental</b>	Your independent variable should be the (IV) because this is what you changed in your investigation.

# Analyzing Data - 13. DV false

<b>Type of Alert</b>	DV false
<b>Alert Text</b>	John claimed that a dependent variable was being manipulated, and may be struggling to understand what an dependent variable is.
<b>Orienting</b>	Let's look at your claim. What's your dependent variable?
<b>Conceptual</b>	Remember, a dependent variable is the thing that was measured.
<b>Procedural</b>	Think about which variable was measured in your investigation.
<b>Instrumental</b>	Your dependent variable should be the (DV) because this is what was measured in your investigation.

# Analyzing Data - 14. Based on the Claim IV, no valid claim can be made with the data collection

<b>Type of Alert</b>	Based on the Claim IV, no valid claim can be made with the data collected
<b>Alert Text</b>	John has made a claim that cannot be warranted with the data collected. Either John has collected confounded data with respect to their claim, or has not varied the variable the claim targets.
<b>Orienting</b>	Let's look at your claim. How does your claim relate to the data you collected?
<b>Conceptual</b>	Remember the purpose of collecting data was to test your hypothesis. Your claim is based on what you discovered in your investigation regarding your original hypothesis.
<b>Procedural</b>	You can adjust your claim to reflect the data the relates to your original hypothesis.
<b>Instrumental</b>	Your claim should demonstrate how the (IV) affected the (DV) from your original hypothesis.

# Analyzing Data - 15. Claim does not match trends in collected data

<b>Type of Alert</b>	Claim does not match trends in collected data
<b>Alert Text</b>	John has claimed a relationship between the independent variable and the dependent variable that is not shown in the data they collected.
<b>Orienting</b>	Let's look at your claim. How does your claim relate to the data you collected?
<b>Conceptual</b>	Remember, an independent variable is the thing you changed. A dependent variable is the thing that was measured.
<b>Procedural</b>	Think about which variable you changed and which variable was measured - what happened in the investigation with these variables?
<b>Instrumental</b>	When you (increased/decreased) the (IV) in the investigation, the (DV) (increased/decreased).

# Analyzing Data - 16. Not enough trials selected as evidence

<b>Type of Alert</b>	Not enough trials selected as evidence
<b>Alert Text</b>	John has not selected enough trials to use as evidence of their claim. They may have selected only one trial, or not selected any trials.
<b>Orienting</b>	Let's look at your evidence. How many trials have you selected?
<b>Conceptual</b>	We want to select multiple trials to show the differences in what's happening.
<b>Procedural</b>	Remember to check as many trials as possible that support your claim.
<b>Instrumental</b>	Select at least two trials that support your claim.

# Analyzing Data - 17. Selected trials not control

<b>Type of Alert</b>	Selected trials not control
<b>Alert Text</b>	John selected trials as evidence that are confounded. Students need to select controlled trials as evidence.
<b>Orienting</b>	Let's look at your evidence. Which trials have you selected?
<b>Conceptual</b>	Remember, you have controlled trials when you only change one variable at a time.
<b>Procedural</b>	Make sure that you only selected controlled trials as evidence for your claim.
<b>Instrumental</b>	You should have only changed the (IV). Make sure you select the trials where you only changed the (IV).

# Analyzing Data - 18. Wrong IV Controlled

<b>Type of Alert</b>	Wrong IV Controlled
<b>Alert Text</b>	The independent variable John has targeted when selecting evidence does not match the independent variable in the claim.
<b>Orienting</b>	Let's look at your evidence. How do the trials you selected relate to your claim?
<b>Conceptual</b>	Remember, you want to select evidence that supports your claim to build an argument.
<b>Procedural</b>	Does the independent variable in your claim match that variable you changed in the trials you selected?
<b>Instrumental</b>	Make sure you select the trials where you only changed the (IV).

# Analyzing Data - 19. Selected trials do not support claim

<b>Type of Alert</b>	Selected trials do not support claim
<b>Alert Text</b>	The trials John has selected as evidence do not support their claim.
<b>Orienting</b>	Let's look at your evidence. How do the trials you selected relate to your claim?
<b>Conceptual</b>	Remember, you want to select evidence that supports your claim to build an argument.
<b>Procedural</b>	Do your selected trials match what your claim says?
<b>Instrumental</b>	When you (increased/decreased) the (IV) in the investigation, the (DV) (increased/decreased). Make sure your evidence supports this claim.



# Analyzing Data - 20. Student does not understand if their claim supports their hyp

Type of Alert	Student does not understand if their claim supports their hyp
Alert Text	When selecting if their claim supported their hypothesis, John did could not correctly identify if their claim supported their hypothesis or not.
Orienting	Let's look at your claim. How does your claim relate to your original hypothesis?
Conceptual	Remember, "supports" means that there is data, or evidence, that aligns with your hypothesis. If the claim does not support your hypothesis, then there is data, or evidence, contrary to your hypothesis.
Procedural	Look at your data to see if it supports or does not support your hypothesis.
Instrumental	Your data (supports/does not support) your hypothesis.