

# Revising Tutor Responses in Math Education: Teacher Insights and NLP Strategies



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# Text-based tutoring is a common approach to tutoring

- Advantages: Flexible (on-the-go demand and supply) and convenient

Let's take a look at some real examples of these text-based tutoring conversations

# Example 1 (note: this is a real tutor-student conversation)

**Lesson topic:** 3.5B.Word Problems with Division

**Question:**  $81 \div 9 = ?$

**Original conversation:**

**S** student  
answer 90

tutor (you)  
Give it your best shot!

**S** student  
cause it says  $81 \div 9$  so it subtracting

tutor (you)  
How could you check that your answer is correct?

**How would you respond to this student?**

# Example 1 (note: this is a real tutor-student conversation)

**Lesson topic:** 3.5B.Word Problems with Division

**Original conversation:**

S student  
answer 90

S student  
cause it says 81 9 so it subtracting

**How would you respond to this student?**

tutor (you)  
Give it your best shot!

tutor (you)  
How could you check that your answer is correct?

tutor (you)  
But it looks like your answer is incorrect.

tutor (you)  
Please recheck your work.

# Example 2 (note: this is a real tutor-student conversation)

Lesson topic: 6.7A.Order of Operations

Question:  $3^3 = ?$

Original conversation:

**s** student  
9

tutor (you)

You earn one point for your good beginning.

tutor (you)

That was a good try.

tutor (you)

What is the value of  $3^3$ ?

**How would you respond to this student?**

# Example 2 (note: this is a real tutor-student conversation)

Lesson topic: 6.7A.Order of Operations

Question:  $3^3 = ?$

Original conversation:

**S** student  
9

tutor (you)

You earn one point for your good beginning.

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That was a good try.

tutor (you)

What is the value of  $3^3$ ?

tutor (you)

That was a good try.

**How would you respond to this student?**

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**Lesson topic:** 6.7A.Order of Operations

**Question:**  $3^3 = ?$

**Original conversation:**

**s** student  
9

tutor (you)  
You earn one point for your good beginning.

tutor (you)  
That was a good try.

tutor (you)  
What is the value of  $3^3$ ?

tutor (you)  
That was a good try.

tutor (you)  
An exponent is a number or letter written above and to the right of a mathematical expression called the base.

tutor (you)  
It indicates that the base is to be raised to a certain power.

tutor (you)  
3 is the base and 3 is the exponent or power.

tutor (you)  
So, you have to multiply 3 for 3 times

**How would you respond to this student?**



# Issues with current responses to student mistakes

Tutors have domain knowledge about mathematics but

- They provide **unhelpful responses to students who struggle.**

tutor (you) - REVISE THIS MESSAGE!

But it looks like your answer is incorrect.

tutor (you) - REVISE THIS MESSAGE!

Please recheck your work.

tutor (you) - REVISE THIS MESSAGE!

That was a good try.

tutor (you) - REVISE THIS MESSAGE!

An exponent is a number or letter written above and to the right of a mathematical expression called the base.

tutor (you) - REVISE THIS MESSAGE!

It indicates that the base is to be raised to a certain power.

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3 is the base and 3 is the exponent or power.

tutor (you) - REVISE THIS MESSAGE!

So, you have to multiply 3 for 3 times.

tutor (you) - REVISE THIS MESSAGE!

Good work so far.

- They do **not respond to the type of error the student makes.**

# Our solution: Leveraging teacher insights and NLP-augmented methods to automate revisions

Lesson topic: 6.7A.Order of Operations

We want to encourage context-sensitive and helpful responses.

Conversation:

tutor (you)

You earn one point for your good beginning.

tutor (you)

That was a good try.


tutor (you)

What is the value of  $3^3$ ?

S

student

9

 *Let's first ask how the student got their solution. It seems like the student is mistaking exponentiation for multiplication.  
Suggestion: How did you get 9?*

Text

That was a good try.



# Our solution: Leveraging teacher insights and NLP-augmented methods to automate revisions

Lesson topic: 6.7A.Order of Operations

Conversation:

S student  
9

S student  
multiply 3

tutor (you)  
You earn one point for your good beginning.

tutor (you)  
That was a good try.

tutor (you)  
What is the value of  $3^3$ ?

tutor (you)  
How did you get 9?

Text

$3^3$  means we multiply 3 times:  $3 \times 3 \times 3$ . Could you try calculating  $2^3$ ?



# Our solution: Leveraging teacher insights and NLP-*augmented* methods to automate revisions

Lesson topic: 6.7A.Order of Operations

Conversation:

**For example, the model lacks domain knowledge in scaffolding problems.**

S student  
9


S student  
multiply 3

tutor (you)  
You earn one point for your good beginning.

tutor (you)  
That was a good try.

tutor (you)  
What is the value of  $3^3$ ?

tutor (you)  
How did you get 9?

 *Suggestion: Could you try calculating  $3^4$ ?*

Text

$3^3$  means we multiply 3 times:  $3 \times 3 \times 3$ . Could you try calculating  $2^3$ ?



# Ongoing work and next steps — feedback welcomed!

## Collaborating with math teachers to collect a large revision dataset

**Step 1: Does the conversation provide enough context on the problem being discussed?**

Yes or no

**Step 2: Why do you think the student made this mistake?**

Student math error

**Step 4: What was your high-level strategy in making the initial revision?**

Select all that apply.

Revision strategy

- Explain concept
- Ask a question to hint at the mistake
- Ask a question to diagnose their mistake
- Simplify the question
- Provide a hint
- Provide a worked example
- Other (please specify in textbox)

Lesson topic: 6.7A.Order of Operations

Conversation:

tutor (you)

You earn one point for your good beginning.

tutor (you)

That was a good try.

tutor (you)

What is the value of  $3^3$ ?

S student  
9

tutor (you)

How did you get 9?

S student  
multiply 3

role:

TUTOR

STUDENT

Text

$3^3$  means we multiply 3 times:  $3 \times 3 \times 3$ . Could you



**Evaluate large language models like ChatGPT and GPT4 on this task**

**Train our own models with this data and investigate the importance of revising wrt. student error type**