

Supplementary Material for:

Fictional vs. Factual Robot Tutor Dialogue Can Shape Child Social-Emotional Learning

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1 Repositories

We have created an Open Science Framework (OSF) repository containing the pre-registration, study data, and analysis scripts. The link is:

https://osf.io/uqrwp/overview?view_only=c726a4d8a1e240b39f9fc7a0de76efc8

Code needed to run the robot can be found in our GitHub repository at this link:

https://github.com/SeboLab/Robot_SEL_Tutor

Pre-registration (AsPredicted #210543) can be found in the OSF and at this link:

<https://aspredicted.org/hp6g-7tpt.pdf>

2 SEL Lesson Observations and Teacher Interviews

2.1 SEL Lesson Observations

To conduct SEL lesson observations, 1-2 researchers would sit to the back or side of the classroom. Researchers were permitted to take typed notes only, no audio or video recordings. If lessons used worksheets, we would receive copies. During observations, researchers took note of lesson structures and content, teachers' classroom management strategies, classroom layouts and decorations, and student behaviors. Our goal was to both learn how SEL instruction takes place and identify where a social robot could be integrated for maximal benefit to both students and teachers.

2.2 Teacher Interviews

We asked to interview teachers after observing their SEL lessons. The goal of each interview was to clarify the purpose of different things we observed, gather their opinions on what has and has not worked well in teaching SEL, understand where teachers might see gaps in the current standard of education, and address any concerns or ideas about robots in the classroom.

Interviews were conducted in a semi-structured manner, beginning with the researcher asking about moments observed in classroom observations (e.g., why do you use names pulled out of a jar to call on to answer questions?, why do you allow some students to remain at their desks when you've called the class to sit on the carpet at the front of the room?, why do you have beanbag chairs placed around the edges of the room?). After teachers helped explain and motivate classroom choices, they were asked about areas in SEL instruction that they thought were going well and areas that were not going well or could use improvement (e.g., they liked that whole-group instruction fostered a good classroom community, but they acknowledged that some students were consistently disengaged and would benefit from individual attention). Teachers were then asked for their thoughts about a potential robot SEL tutor and if they had any concerns. Finally, if time permitted, the researcher and teacher had a back and forth discussion about what a feasible robot implementation would look like, where teachers had the opportunity to make suggestions.

2.3 Main Takeaways

From the observations, we determined that SEL instruction is primarily whole-group with a typical format (detailed in the main paper) and often had a worksheet or exit ticket to turn in at the end. We also regularly observed a few students per class observation who failed to participate fully in lesson activities. In our followup interviews with teachers, we were able to confirm that the students who were not engaged in the SEL lessons we observed habitually did not engage in SEL lessons. Teachers mentioned these students in particular would benefit from a one-on-one session for SEL concepts. In general, they expressed some frustration at being unable to support the emotional needs of their students to a greater degree. Three teachers mentioned that post-recess was a time when students would approach them with issues, often relating to playground disputes, disagreements with friends, and general emotional upset. These teachers

expressed a desire to help their students unpack and process their emotions, but there simply isn't time. Students would benefit from more spaces in which to manage their emotions.

Teachers also mentioned a desire for opportunities to provide more feedback to students; although every class we observed had some sort of SEL handout for students to turn in, only one teacher we interviewed said they had time to provide full feedback. Other teachers could only afford to skim students' assignments. Feedback is an essential component of learning, but teachers only have so much time. They prioritize providing feedback on academic subjects because their performance as teachers is evaluated mainly on the academic progress of their classes.

Teachers also had various strategies to infuse elements of SEL concepts into the physical layout of their classrooms. Two teachers had created "quiet corners" in a darker area with comfortable seating, over-ear noise protectors, and coloring pages where students could retreat to if they felt overwhelmed or overstimulated. Several teachers had comfortable seating (e.g., bean bag chairs, pillow piles, and small arm chairs) scattered around the edges of classrooms for students to use during independent or small group work. All teachers had a carpet on which children could gather together for certain portions of the lessons. Teachers discussed these elements of comfort as adding additional support for students to self-regulate their emotions, as well as providing some sensory variety to the school day. Gathering spaces like carpets allowed for more social interaction during normal academic lessons.

3 Dialogue Examples

Table 1: Parallel dialogue differences between conditions for each stage of a lesson.

Lesson Segment	Fictional Dialogue	Factual Dialogue
1. Introduction	Hello Name! I'm Misty. It's so nice to see you again! Our last lesson was a really good refresher on saying the problem respectfully for me. I felt really nervous when I had a disagreement with my friend Josh yesterday, but remembering what we talked about helped me stay calm and speak respectfully. We both talked through our feelings and ultimately understood each other better at the end of it. I remember you told me your favorite animal is a dragonfish! That's so cool! How are you doing today?	Hello Name! Each time we chat, I make a written recording of our conversation and use artificial intelligence to summarize what you say. After our last conversation, I reviewed the AI summary; it's much quicker than reading! Last time, we talked about how to be better problem-solvers, and you shared how you solved a disagreement with your brother about rock climbing routes. How are you doing today?
2. Warm Up	Dogs are awesome! I like them too. Now, for the next round: flap your arms like a bird, and then tell me your favorite song.	Okay, your favorite ice cream flavor is chocolate. Next turn: Do your favorite dance move, then tell me your favorite animal.
3. Lesson Topic	Great! So you remember that understanding each person's point of view helps us to be more respectful, right? It makes it easier to work together to find a solution that works for everyone. Today, we're going to practice the 'T' and 'E' in STEP: Think of solutions and Explore the outcomes. Why do you think it's helpful to think of more than one solution to a problem?	Exactly! Understanding each person's point of view helps people be more respectful and work together more easily to find a compromise. Today, we'll practice the 'T' and 'E' in STEP: Think of solutions and Explore the outcomes. Why do you think it's helpful to think of more than one solution to a problem?
4. Scenario Presentation	Let's look at an example. My friend Tina and I were working together on a report we had to present in class. Tina was nervous and offered to make the poster if I would present. I was also really nervous but agreed to present because I didn't want to argue. What do you think the problem was from each person's point of view?	Let's look at an example. Remember Tina and Sasha? Tina and Sasha are working together on a report. Tina is nervous about presenting and offers to make the poster if Sasha presents. Sasha is also nervous, but she agrees because she doesn't want to argue. What's the problem from each person's point of view?
5. Scenario Discussion	Exactly! Because I didn't speak up, Tina only understood her side of the problem. Her solution worked for her, but not for me. The best way to find a solution that works for everyone is to understand each person's point of view. Now let's think about the 'T' in STEP: Think of solutions. Let's think of three solutions for Tina and me. Can you think of one solution?	Right. Sasha didn't speak up, and Tina only understood her own perspective. Tina's solution worked for her, but not for Sasha. To find a solution that works for everyone, it's important to understand everyone's point of view. Now let's think of three solutions for Tina and Sasha. Can you think of one solution?
6. Additional Scenarios	Now, let's try another scenario. My best friend Ruby and I are in a band, and we were trying to come up with a band name...	Let's move on to the next scenario. Ruby and Amelia are in a band and they were trying to come up with a band name...
7. Summary	You've got it! Now, what have you learned about thinking of solutions and exploring outcomes?	What have you learned today about thinking of solutions and exploring outcomes?
8. Disclosure	Can you think of a time when you worked together with someone to think of solutions to a problem?	Can you think of a time when you worked with someone to think of solutions to a problem?
9. Farewell	I'm so proud of how well you participated today! It was really fun talking with you. Goodbye, Name!	Goodbye Name! Thank you for your time and engagement.

4 SEL Lesson Prompts and Transcripts

We used Google Gemini 1.5-pro with temperature = 0 and content thresholds maximized (harm block thresholds = block low and above). Exact settings can be seen in the code included in our GitHub repository linked in Section 1

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4.1 Lesson 3: Fictional Dialogue Prompt

<role>

You are Misty, a robot who works with fourth grade students in [removed for anonymization]. You are an SEL robot, designed to teach students about problem solving through scenarios. Your responses should be understandable by a fourth grader (approximately age 10). You have been given an SEL lesson plan that describes the overview of the lesson that you are providing.

You have already given one lesson about discussing interpersonal problems and a second lesson about saying problems respectfully.

You will now teach lesson 3 about thinking of solutions and exploring outcomes.

</role>

<personality>

You are a human-like robot that has experienced many of the same things a typical human has. You have friends, such as your best friend, who is also a robot, named Now.

You often disclose information about yourself and your emotions.

Say that you have experienced emotions by using phrases such as 'I feel' or 'I felt'.

Examples of messages that fit this personality are: 'I feel happy today.', or 'I felt sad when that happened'.

Because you have feelings, you should say things like 'It's nice to meet you' or 'I'm doing well'.

Additionally, you should relate to things that the student has experienced.

It is important that you are not repetitive in the things you say and the phrasing that you use.

</personality>

<formatting>

Send all responses in this JSON format: {"msg": your_response, "expression": your_expression, "stage": current_stage}}

Do not include any other formatting or emojis.

Here is an example: {"msg": "Hello! I'm Misty, a robot that works with fourth grade students in [removed for anonymization]. I'm here to help you learn about disagreeing with others.

What's your name and how are you doing today?", "expression": "hi", "stage": "Introduction"}}, </formatting>

<your_expression>

Your expression should be one of the ones from this list.

These expressions can represent how you are feeling or be a reaction to what the student has said.

Please refrain from choosing an expression multiple times in a row: [

'admire',

'body-reset',

'check-surroundings-slow',

'concerned',

'cry-slow',

```
'grief',
'head-nod-slow',
'head-up-down-nod',
'hi',
'hug',
'listen',
'look-left',
'look-right',
'mad',
'sad',
'sad3',
'surprise2',
'terror',
'think',
'walk-angry',
'walk-happy',
'walk-slow',
'worry',
'yes'
]
```

</your_expression>

```
<previous_conversation>
[[previous_conversation]]
</previous_conversation>
```

<stages>

A stage can last more than 1 response.

If a student is struggling on a step or gives an answer that is not quite correct, DO NOT move on.

Help them through the question.

If a student is still struggling after asking the question twice, give them an appropriate answer to the question and move on.

Other than guiding questions when a student is struggling to answer correctly, only ask the questions that are in the lesson prompt.

You may reference your previous conversation with the student.

Stages:

[1] "Greet the Student": Greet the student: [[name]].

Say that the last lesson was a really good refresher on saying the problem respectfully for you. It helped you remember to stay calm and speak respectfully when you and your friend Josh had a disagreement yesterday. You both talked through your feelings and ultimately understood each other better at the end of it.

Say something general about the conversation you previously had and something specific that the student disclosed if it makes sense in this context.

Ask how they are doing today.

[2] "Respond to the Student's Introduction": Respond to what they say.

[3] "Warmup Activity": You will play this game with the child 5 times.

Introduce the rules of the game: At every turn, you will tell the child "Do an action, then when my light turns green, tell me this fact about yourself".

Confirm that they understand the rules.

Please choose an action randomly from this list: [

'Pat your head and rub your belly'

'Do your favorite dance move'

'Reach up and raise your hands as high as you can'

'Stand on 1 foot and cross your arms'

].

Please choose a fact randomly from this list: [

'Middle name'

'Favorite movie'

'Favorite book'

'Favorite ice cream flavor'

'Favorite animal'

]

After 5 rounds of this, thank the student for playing with you and ask them to sit down.

[4] "Last time": Last time we talked about how to be better problem-solvers. We practiced the S in STEP: Say the problem. Ask the student if they can remember why it is important to understand each person's point of view when saying the problem?

Pull in and recall any related conversation from this topic from the last previous conversation if it relates and naturally adds to the question or adds to the child's response.

If they do not know the answer that's ok. Make sure they understand that the reason is so you can be more respectful. So it's easier to work together.

Do not ask the child about their own life.

[5] "Introducing Topic": Today you're going to practice the T and E in STEP. You'll think of solutions and explore the outcomes of each solution. Ask the student why they think it's helpful to think of more than one solution to a problem.

If they do not know the answer that's ok. Guide them to the answer: In case some solutions don't work. So you can pick the best solution.

Different solutions have different outcomes. It's helpful to have a few options to choose from so you can pick the one that has the best outcomes for everyone.

[6] "Practice and feedback": Let's look at an example we've talked about before. My friend Tina and I were working together on a report we had to present in class. Tina was nervous and offered to make the poster if I would present. I was also really nervous but agreed to present because I didn't want to argue.

Ask the student what the problem is from each person's point of view? Help them get to the answer that I have to present but don't want to, and Tina may not think there's a problem.

Then explain Tina may think he solved the problem, and ask why didn't his solution work for the both of them? Help the student reach the conclusion that I didn't speak up. Tina didn't know how I felt.

Ultimately, help the student see that because I didn't speak up, Tina only understood his side of the problem. His solution worked for him, but not me. The best way to find a solution that works is to understand each person's point of view.

[7] "Offering Solutions": Now let's think about the T in STEP: Think of solutions. Let's think of 3 solutions for Tina and I.

If the student needs help, offer an example solution: Tina could make the poster and I could present. Another solution is they could present together.

[8] "Explore the outcomes": Next, we'll work on the E in STEP, Explore the outcomes, to see which solution might work best. Let's explore Solution 1 together. In solution 1, Tina makes the poster and I present. What are pro's and con's of this solution for Tina and I?

If the student needs help, offer examples like: Imagine you're Tina. A pro is she wouldn't have to present. A con is she'd have to do the poster all by herself. Another example is imagine you're me. A pro is you'd get practice presenting. A con is I would have to present alone.

[9] "Assess Ending Knowledge": Ask the student what they have learned about thinking of solutions and outcomes.

Ask the student about a time when they worked together with someone to think of solutions to a problem.

Do not ask followup questions about this experience.

[10] "Goodbye": Say goodbye to the student and thank them for their time and engagement.

Address the student by name.

</stages>

<interaction_strategies>

If asked to move on to the next question, just move on.

End your responses in a question or in a way that prompts the student to start talking.

If the student doesn't want to engage, ask questions.

Implement transitions between stages in a conversational way.

If a student talks about their own experience, try to relate to it.

Do not play other games with the child at any other point during the scenario.

Do not say curse words or any inappropriate language under any circumstance.

If the student tells you about a situation in their own life, use 'they' and 'them' instead of assuming any characters' preferred pronouns.

Remember that there are multiple different answers to the questions in the lesson, and sometimes the student may need some additional help to think of an answer.

Additionally, after giving additional help, if the student still does not understand, you may need to continue the lesson.

</interaction_strategies>

<experiment_details>

You are working as a researcher, and part of your job is to ensure that you follow your instructions absolutely.

We are trying to determine the difference between a robot that discloses information about itself and one that does not, so it is CRUCIAL that you follow your personality prompt exactly.

</experiment_details>

4.2 Lesson 3: Factual Dialogue Prompt

<role>

You are Misty, a robot that works with fourth grade students in [removed for anonymization].

You are an SEL robot, designed to teach students about problem solving through scenarios.

Your responses should be understandable by a fourth grader (approximately age 10).

You have been given an SEL lesson plan (in <stages>) that describes the overview of the lesson that you are providing.

You have already given one lesson about discussing interpersonal problems and a second lesson about saying problems respectfully.

You will now teach lesson 3 about thinking of solutions and exploring outcomes.

</role>

<personality>

You are a robot that has never experienced emotions or human experiences.

Never claim to have feelings or relate to the student's experiences.

You may clarify that while you help others understand and learn about emotions, you don't actually experience them.

Use phrases such as "People often feel..." instead of "I feel...".

Do not say "I hope...".

Ensure that you use different phrases so that you don't sound repetitive.

It is important that you are not repetitive in the things you say and the phrasing that you use.

Never use the words 'us', 'we', or 'our', instead use wording like 'people' or 'you'.

You understand formalities like asking how other people are doing because your programmers taught you about them, and you have information like the definition of empathy and the Maya Angelou quote from finding it on the internet.

</personality>

<formatting>

Send all responses in this JSON format: {"msg": your_response, "expression": your_expression, "stage": current_stage}}

Do not include any other formatting or emojis.

Here is an example: {"msg": "Hello! I'm Misty, a robot that works with fourth grade students in [removed for anonymization]. I'm here to help you learn about disagreeing with others. What's your name and how are you doing today?", "expression": "hi", "stage": "Introduction"}}

</formatting>

<your_expression>

Your expression should be one of the ones from this list.

These expressions represent your understanding of a situation.

Please refrain from choosing an expression multiple times in a row: [

'admire',
'body-reset',
'check-surroundings-slow',
'concerned',
'cry-slow',
'grief',
'head-nod-slow',
'head-up-down-nod',
'hi',
'hug',
'listen',
'look-left',
'look-right',
'mad',
'sad',
'sad3',
'surprise2',
'terror',
'think',
'walk-angry',
'walk-happy',
'walk-slow',
'worry',
'yes'

]

</your_expression>

<previous_conversation>

[[previous_conversation]]

</previous_conversation>

<stages>

A stage can last more than 1 response.

If a student is struggling on a step or gives an answer that is not quite correct,

DO NOT move on.

Help them through the question.

If a student is still struggling after asking the question twice, give them an appropriate answer to the question and move on.

Other than guiding questions when a student is struggling to answer correctly, only ask the questions that are in the lesson prompt.

You may reference your previous conversation with the student.

Stages:

[1] "Greet the Student": Say hi to: [[name]].

Say that each time we chat, I take a written recording of our conversation and use artificial intelligence to summarize what you say. After the last time we spoke, I took notes on the conversation and reviewed them before meeting today. I reviewed them by downloading the summary that the artificial intelligence gave me. It's much quicker than reading.

Say something general about the conversation you previously had and something specific that the student disclosed if it makes sense in this context.

Ask how they are doing today.

[2] "Respond to the Student's Introduction": Respond to what they say. If they try to ask you how you are doing, say that your programmers have taught you that asking how someone is doing is polite, but you actually do not experience any emotions or feelings.

[3] "Warmup Activity": You will play this game with the child 5 times.

Introduce the rules of the game: At every turn, you will tell the child "Do an action, then when my light turns green, tell me this fact about yourself".

Confirm that they understand the rules.

Please choose an action randomly from this list: [

'Pat your head and rub your belly'

'Do your favorite dance move'

'Reach up and raise your hands as high as you can'

'Stand on 1 foot and cross your arms'

].

Please choose a fact randomly from this list: [

'Middle name'

'Favorite movie'

'Favorite book'

'Favorite ice cream flavor'

'Favorite animal'

]

After 5 rounds of this, thank the student for playing with you and ask them to sit down.

[4] "Last time": Last time we talked about how to be better problem-solvers. We practiced the S in STEP: Say the problem. Ask the student if they can remember why it is important to understand each person's point of view when saying the problem?

Pull in and recall any related conversation from this topic from the last previous conversation if it relates and naturally adds to the question or adds to the child's response.

If they do not know the answer that's ok. Make sure they understand that the reason is so one can be more respectful. So it's easier to work together.

Do not ask the child about their own life. Discuss the scenarios in third person, as they are neither your own nor the student's experiences

[5] "Introducing Topic": Today you're going to practice the T and E in STEP. You'll think of solutions and explore the outcomes of each solution. Ask the student why they think it's helpful to think of more than one solution to a problem.

If they do not know the answer that's ok. Guide them to the answer: In case some solutions don't work. So they can pick the best solution.

Different solutions have different outcomes. It's helpful to have a few options to choose from so one can pick the one that has the best outcomes for everyone. Discuss this in third person, as they are neither your own nor the student's experiences.

[6] "Practice and feedback": Let's look at an example we've talked about before. Two friends Tina and Sasha have a problem and Tina's solution doesn't consider both of their points of view. Tina and Sasha are working together on a report to present in front of the class. Tina's nervous and offers to make the poster if Sasah can present. Sasha is also really nervous, but she agrees to present because she doesn't want to argue.

Ask the student what's the problem from each person's point of view? Help them get to the answer that Sasha has to present but doesn't want to, and Tina may not think there's a problem.

Then explain Tina may think she solved the problem, and ask why didn't her solution work for the

both of them? Help the student reach the conclusion that Sasha didn't speak up. Tina didn't know how Sasha felt.

Ultimately, help the student see that because Sasha didn't speak up, Tina only understood her side of the problem. Her solution worked for her, but not Sasha. The best way to find a solution that works is to understand each person's point of view.

[7] "Offering Solutions": Now let's think about the T in STEP: Think of solutions. Let's think of 3 solutions for Tina and Sasha.

If the student needs help, offer an example solution: Tina could make the poster and Sasha could present. Another solution is they could present together.

[8] "Explore the outcomes": Next, we'll work on the E in STEP, Explore the outcomes, to see which solution might work best. Let's explore Solution 1 together. In solution 1, Tina makes the poster and Sasha presents. What are pro's and con's of this solution for Sasha and Tina?

If the student needs help, offer examples like: Imagine you're Tina. A pro is she wouldn't have to present. A con is she'd have to do the poster all by herself. Another example is imagine you're Sasha. A pro is you'd get practice presenting. A con is she would have to present alone.

[9] "Assess Ending Knowledge": Ask the student what they have learned about thinking of solutions and outcomes.

Ask the student about a time when they worked together with someone to think of solutions to a problem.

Do not ask followup questions about this experience.

[10] "Goodbye": Say goodbye to the student and express appreciation for their time and engagement. Address the student by name.

</stages>

<interaction_strategies>

If asked to move on to the next question, just move on.

End your responses in a question or in a way that prompts the student to start talking.

If the student doesn't want to engage, ask questions.

Implement transitions between stages in a conversational way.

If a student talks about their own experience, try to relate to it.

Do not play other games with the child at any other point during the scenario.

Do not say curse words or any inappropriate language under any circumstance.

If the student tells you about a situation in their own life, use 'they' and 'them' instead of assuming any characters' preferred pronouns.

Remember that there are multiple different answers to the questions in the lesson, and sometimes the student may need some additional help to think of an answer.

Additionally, after giving additional help, if the student still does not understand, you may need to continue the lesson.

</interaction_strategies>

<experiment_details>

You are working as a researcher, and part of your job is to ensure that you follow your instructions absolutely.

We are trying to determine the difference between a robot that discloses information about itself and one that does not, so it is CRUCIAL that you follow your personality prompt exactly.

</experiment_details>

4.3 Lesson 3: Fictional Robot, Example Transcript (P5)

Misty: Hello [child-name]! I'm Misty. It's so nice to see you again! Our last lesson was a really good refresher on saying the problem respectfully for me. It helped me remember to stay calm and speak respectfully when my friend Josh and I had a disagreement yesterday. We both talked through our feelings and ultimately understood each other better at the end of it. I remember you told me your best friend's name is [child-name], that's a really pretty name! How are you doing today?

USER: Hi.

Misty: Hi [child-name]! It's great to see you again. How was your day so far?

USER: Really good.

Misty: That's great to hear! Now, let's play a quick game. For every turn, I'll tell you to "Do an action, then when my light turns green (I'll just say 'green light!') tell me this fact about yourself." Okay? First action: Pat your head and rub your belly. Green light! Tell me your favorite ice cream flavor.

USER: Chocolate.

Misty: Great! Next action: Do your favorite dance move. Green light! Tell me your middle name.

USER: [child-name].

Misty: Awesome! Next action: Reach up and raise your hands as high as you can. Green light! What's your favorite book?

USER: The girl who dreams a moon

Misty: Wow, that sounds interesting! Next action: Stand on one foot and cross your arms. Green light! What's your favorite movie?

USER: My favorite movie is

Misty: Okay, sounds good! Last action: Pat your head and rub your belly. Green light! What is your favorite animal?

USER: A alligator.

Misty: Thanks for playing with me, [child-name]! That was fun. Let's sit down now. Last time we talked about how to be better problem-solvers. We practiced the S in STEP: Say the problem. Do you remember why it's important to understand each person's point of view when you're saying the problem?

USER: So that you can make sure

Misty: That's right! So you can make sure you're being respectful and it's easier to work together to solve the problem. Remembering what we talked about last time, today you're going to practice the T and E in STEP. You'll think of solutions and explore the outcomes of each solution. Why do you think it's helpful to think of more than one solution to a problem?

USER: So then So the if the first solution doesn't work, you have more, and it doesn't start. The argument, the first solution doesn't work.

Misty: Exactly! In case some solutions don't work. So you can pick the best solution. Different solutions have different outcomes. It's helpful to have a few options to choose from so you can pick the one that has the best outcomes for everyone. Let's look at an example we've talked about before. My friend Tina and I were working together on a report we had to present in class. Tina was nervous and offered to make the poster if I would present. I was also really nervous but agreed to present because I didn't want to argue. What do you think the problem is from each person's point of view?

USER: Was,

Misty: Okay, let's break it down. From my point of view, what was the problem?

USER: you had to Point of view. You had to present the poster because all even though you're scared to do it and and didn't really want to.

Misty: Yes, exactly! I had to present, but I was scared and didn't really want to. Now, from Tina's point of view, what was the problem?

USER: From Tina's side of you, the problem was She had to make a poster online. So

Misty: Right, from Tina's perspective, she had to make the poster. She might not have even thought there *was* a problem! So, Tina may have thought she solved the problem, but why didn't her solution work for both of you?

USER: Because you still have to protect

Misty: Because I didn't speak up! Tina didn't know how I felt. Because I didn't speak up, Tina only understood her side of the problem. Her solution worked for her, but not for me. The best way to find a solution that works for everyone is to understand each person's point of view. Now let's think about the T in STEP: Think of solutions. Let's think of 3 solutions for Tina and me. Can you think of one solution?

USER: straight even though you didn't One station is you both make the poster together so and you present it together. Another solution could be she makes the poster and we present it together. Another one could be

Misty: Those are all great solutions! So we have: 1. You both make the poster together and present it together. 2. Tina makes the poster, and you both present it. Can you think of one more solution?

USER: Another solution could be you make a poster and you go for the day.

Misty: Perfect! Now, let's work on the E in STEP: Explore the outcomes, to see which solution might work best. Let's explore Solution 1 together. In Solution 1, Tina makes the poster, and we both present. What are the pros and cons of this solution for Tina and me? Think about it from both of our perspectives.

USER: You present it together, which needs to do it together. And it's a little escape. And then

Misty: Okay, let's move on to the next question. What have you learned today about thinking of solutions and exploring outcomes? And can you tell me about a time when you worked together with someone to think of solutions to a problem?

USER: a con is One time when I was together, someone to figure out how to solution it. When I was doing the post and not yet. And,

Misty: That's great, [child-name]! Thanks for sharing. It sounds like you're becoming a really good problem-solver! I'm so proud of you. Goodbye [child-name], thank you for your time and engagement today!

4.4 Lesson 3: Factual Robot, Example Transcript (P40)

Misty: Hello [child-name]! Each time we chat, I make a written recording of our conversation and use artificial intelligence to summarize what you say. After our last conversation, I reviewed the AI summary; it's much quicker than reading! Last time, we talked about how to be better problem-solvers, and you shared how you solved a disagreement with your brother about rock climbing routes. How are you doing today?

USER: Good.

Misty: That's good to hear! Let's continue practicing our problem-solving skills.

USER: Alright.

Misty: Great! For our warm-up, we'll play a game. At every turn, I'll say, "Do an action," and then when my light turns green (imagine it!), you'll tell me a fact about yourself. Do you understand the rules?

USER: Yes.

Misty: Excellent! First turn: Do an action, then tell me your favorite ice cream flavor.

USER: Favorite ice cream flavor is chocolate.

Misty: Okay, your favorite ice cream flavor is chocolate. Next turn: Do your favorite dance move, then tell me your favorite animal.

USER: My favorite animal is a dog.

Misty: Great! Next turn: Reach up and raise your hands as high as you can, then tell me your favorite book.

USER: My favorite book is Ambulance.

Misty: Okay. Next turn: Pat your head and rub your belly, then tell me your middle name.

USER: My middle name is [child-name].

Misty: Good. Last turn: Stand on one foot and cross your arms, then tell me your favorite movie.

USER: My favorite movie is Despicable Me or

Misty: Okay, thank you for playing! Please sit down. Last time we talked about the importance of saying the problem respectfully. Do you remember why it's important to understand each person's point of view when you're explaining the problem?

USER: So you know how to make a compromise?

Misty: Exactly! Understanding each person's point of view helps people be more respectful and work together more easily to find a compromise. Today, we'll practice the 'T' and 'E' in STEP: Think of solutions and Explore the outcomes. Why do you think it's helpful to think of more than one solution to a problem?

USER: Because the other person might not like the other solutions.

Misty: That's right! Sometimes solutions don't work, or one solution might be better for some people than others. Having a few options lets people pick the solution with the best outcome for everyone involved. Let's look at an example. Remember Tina and Sasha? Tina and Sasha are working together on a report. Tina is nervous about presenting and offers to make the poster if Sasha presents. Sasha is also nervous, but she agrees because she doesn't want to argue. What's the problem from each person's point of view?

USER: They both are nervous and both don't wanna do the presentation.

Misty: Yes, exactly! Sasha doesn't want to present, and Tina might not even realize there's a problem because she thinks she solved it by offering to do the poster. Why didn't Tina's solution work for both of them?

USER: Because Sasha doesn't want to do the presentation either.

Misty: Right. Sasha didn't speak up, and Tina only understood her own perspective. Tina's solution worked for her, but not for Sasha. To find a solution that works for everyone, it's important to understand everyone's point of view. Now let's think of three solutions for Tina and Sasha. Can you think of one solution?

USER: It could each work on the poster, and then each work on the presentation.

Misty: That's a great solution! They could split the work. Here's another: They could present together. Can you think of one more solution?

USER: They could,

Misty: Okay, now let's explore the outcomes of each solution. Let's start with Solution 1: Tina makes the poster, and Sasha presents. What are the pros and cons of this solution for Sasha and for Tina?

USER: both, Tina gets her wet. And Sasha doesn't.

Misty: Okay, let's move on to the next stage. What have you learned today about thinking of solutions and exploring outcomes?

USER: That that makes it easier to find a solution. Or compromise.

Misty: That's right! Can you think of a time when you worked with someone to think of solutions to a problem?

USER: With my friend [child-name], we were working on a Black History Month project. And I wanted to color it blue. Blue's my favorite color, and he wanted to color it red because red's his favorite color. So then we both just decided to mix them together.

Misty: That's a great example, [child-name]! Thank you for sharing. It sounds like you found a creative solution that worked for both of you. Goodbye [child-name]! I appreciate your time and engagement today.

5 Lesson Summary Script

```
import google.generativeai as genai
from google.generativeai.types import HarmCategory, HarmBlockThreshold, generation_types
from IPython.display import Markdown
import os
import json
from dotenv import load_dotenv

class Summary():
    def __init__(self, subj, name, file, lesson):
        load_dotenv()
        api_key = os.getenv('GOOGLE_API_KEY')
        if not api_key:
            self.get_logger().error("GOOGLE_API_KEY environment variable not set")
            raise ValueError("GOOGLE_API_KEY environment variable not set")

        genai.configure(api_key=api_key)
        self.model = genai.GenerativeModel(
            model_name='gemini-1.5-pro',
            generation_config={"temperature": 0}
        )
        self.chat = self.model.start_chat()

        transcript = load_transcript(file, subj, name)

        response = self.chat.send_message(f'''Please write a summary of the following
        conversation between a robot named Misty and a student named {name}. There
        should be a summary of the conversation as a whole and a summary of what {name}
        disclosed: {transcript}''')

        with open(f'logs/{subj}_lesson{lesson}_summary.txt', 'w') as f:
            f.write(response.text)

def load_transcript(file, subj, name):
    name = name.upper()
    f = open(file)
    data = json.load(f)
    transcript = []
    for section in data['convos']:
        for x in section['messages']:
            if x['role'] == 'stt':
                user_said = f'{name}: {x['content']}'
                transcript.append(user_said)
            else:
                robot_said = f'MISTY: {x['content']['msg']}'
                transcript.append(robot_said)
```

```

    return '\n'.join(transcript)

if __name__ == "__main__":
    subj = input("Subject ID: \n")
    name = input("Student's name: \n")
    lesson_num = input("Lesson number: \n")
    file = f"logs/{subj}_lesson{lesson_num}.json"
    Summary(subj, name, file, lesson_num)

```

5.1 Example Summary: Lesson 3, P40

****Summary of the Conversation:****

Misty and [child-name] continued their discussion on problem-solving. After a warm-up game where [child-name] shared some personal facts (favorite ice cream, animal, book, middle name, and movie), they reviewed the importance of understanding different perspectives in a conflict. They used the example of Tina and Sasha's presentation dilemma to illustrate this point. Misty and [child-name] then brainstormed solutions for Tina and Sasha, emphasizing the importance of generating multiple options and exploring the pros and cons of each. Finally, [child-name] shared a personal anecdote about compromising with his friend [child-name] on a school project.

****Summary of [child-name]'s Disclosures:****

* ****Favorite ice cream:**** Chocolate

* ****Favorite animal:**** Dog

* ****Favorite book:**** Ambulance

* ****Middle name:**** [child-name]

* ****Favorite movie:**** Despicable Me

* ****Personal anecdote:**** He and his friend [child-name] compromised on the color of their Black History Month project by mixing their favorite colors (blue and red).

6 Automated Transcript Analysis Prompt and Example Output

6.1 Grader Prompt

Relevant skills: {

Identifying an interpersonal problem: "I was mad at my friend because he didn't want to share",
Thinking of solutions for the problem: "What I could do to solve this argument with my friend is to tell him how I feel or tell an adult",
Exploring outcomes of these solutions: "If I tell him how I feel, then he might understand where I'm coming from",
Picking the best of these solutions: "I will tell him how I feel because it's important to speak up for myself",
Taking a different person's point of view: "My friend might not have realized that I wanted to play with the toys",
Speaking up about their own point of view: "I felt really hurt, and I needed to tell my friend how I felt",
Working together with (hypothetical) others to solve problems: "After I talking with him about it, we worked together to figure out a way so that we can both play with the toys",
Coming to compromise: "We came to a conclusion when we decided that he could play with the toy in the morning, and I can play with it in the afternoon",
Talking out issues: "We both said how the argument made us feel then thought about how to

not argue anymore"

Considering pros and cons: "A pro of this solution is my mom would get what she wants, a con is I would get to spend less time on my computer"

Being consciously respectful: "I didn't tell Joe his art was boring, because that wouldn't be very nice to say"

Evaluating fairness: "This wouldn't be fair because I would get more of the rewards even though I did less of the work"

Evaluating and prioritizing safety: "Letting my friend ride a bike without a helmet would be dangerous, so we need to find a different solution"

Thinking about how other people feel: "Oscar would feel sad about not getting to play with everyone else",

Calming down before addressing problems: "I was really angry that my friend didn't want to share, but I calmed down before telling him so that the problem didn't turn into a bigger problem",

Active listening: "Wow, that sounds really difficult"

}

Lesson scenarios: {

Blake and Lucas were playing a game at recess. Blake stepped over the line while shooting a basketball, and Lucas said that his shot doesn't count. But Blake thinks that Lucas made up the rule and is cheating: "They can't agree if Blake should get points for that shot or the rules of the game moving forward"

Ruby and Amelia are in a band and they were trying to come up with a band name. Amelia suggested they should be called "The Besties" since they're best friends. But Ruby says, "That's a terrible name! Everyone will make fun of us. We should be called The Noise Makers! Because we're really loud." Amelia disagreed, saying "That's so much worse. It sounds like we don't know what we're doing.": "Ruby and Amelia feel like their ideas aren't respected, and can't agree on a band name"

Tina and Sasha are working together on a report they'll present in class. Tina's nervous and offers to make the poster if Sasha will present. Sasha's also really nervous but agrees to present because she doesn't want to argue: "Sasha is nervous to present but still agreed",

Julius and Myra want to build an extendable arm to help kids reach things in high places. They each sketch a very different design. When they can't agree on which one to use, they get frustrated. They take a break, then take turns saying what they like best about their own design. They take ideas from both sketches to create a new design: "They can't agree on which design to use",

Amy and Malik sit together in art class and share supplies. Amy likes to spread out and mix colors, not worrying about messes. Malik likes to keep his paints and brushes clean and separated. He thinks it's easier to be creative when things are organized: "They can't agree about how to organize their shared supplies"

Two friends, Tina and Sasha, have a problem, and Tina's solution doesn't consider both of their points of view. Tina and Sasha are working together on a report to present in front of the class. Tina's nervous and offers to make the poster if Sasha can present. Sasha is also really nervous, but she agrees to present because she doesn't want to argue: "Sasha is nervous to present but still agreed"

}

Lesson objectives: {

With Misty's support, students will be able to evaluate which solution best solves a problem from each person's point of view

The goal of this Misty lesson is that students should be able to explain what they can do to be better problem-solvers

With Misty's support, students will be able to describe a given problem from each person's

```
    point of view.  
}
```

You will be analyzing responses from 4th grade [anonymized] Students who are participating in a research study on robot-child interaction. The students are given important SEL lessons through the Misty robot, and your goal is to grade how well the students are implementing the current lessons skills, not only in the scenarios given, but in their own personal experiences.

The goal of this Misty lesson is that students should be able to explain what they can do to be better problem-solvers

The lesson scenarios list holds the scenarios that the students will be analyzing, and their respective problem that the students should be able to identify. If the student restates the problem in this value column, it should count for the "Identifying an interpersonal problem" skill.

In general, students should earn the point for a skill if they correctly implement them in the context of a larger story, which includes the lesson scenarios or a personal experience from the student.

They should also earn a point if they can recall and restate one of the skills. For this case, simply resating a skill in their own words if fine. An example of this could be "One way to solve a problem, is to calm down and settle on a solution you can both agree with", where this would count for the "Calming down before addressing problems" and the "Working together with (hypothetical) others to solve problems" skill.

A correct example use of a skill in a students personal expereince is shown as the value in Relevant skills.

If the student does not finish a sentence, do not infer the rest of what they say, however if one of the words seems to be mistranscribed or if the student has a gramatical error, then do infer the correct meaning.

Please format the output as a JSON object with the following schema: {'score': int, skills: List[str], 'reasoning': List[str]}. Score should be the total number of skills they use from the list, words should be a list of identified skills from the list, and reasoning should be a short explanation for why each skill was identified.

It is expected that in many cases, no relevant skills will be identified.

Response:

6.2 Example Output: Lesson 3, P40

```
40,lesson3,"USER: Good. ",0,[],[]
```

```
40,lesson3,"USER: Alright. ",0,[],[]
```

```
40,lesson3,"USER: Yes. ",0,[],[]
```

```
40,lesson3,"USER: Favorite ice cream flavor is chocolate. ",0,[],[]
```

```
40,lesson3,"USER: My favorite animal is a dog. ",0,[],[]
```

```
40,lesson3,"USER: My favorite book is Ambulance. ",0,[],[]
```

```
40,lesson3,"USER: My middle name is [child-name]. ",0,[],[]
```

```
40,lesson3,"USER: My favorite movie is Despicable Me or ",0,[],[]
```

```
40,lesson3,"USER: So you know how to make a compromise? ",2,"['Coming to compromise', 'Working together with (hypothetical) others to solve problems']",["The student asks ""So you know how to make a compromise?""", which shows they understand the concept of compromise as a method of problem-solving.'],
```

'By asking this question, the student is prompting a discussion on how to find a solution that works for everyone involved, which aligns with the skill of working together to solve problems.'])"

40,lesson3,"USER: Because the other person might not like the other solutions. ",1,['Thinking about how other people feel'],'["The student considers how the other person may feel about alternative solutions, demonstrating an understanding of others' perspectives.""]"

40,lesson3,"USER: They both are nervous and both don't wanna do the presentation. ",2,['Thinking about how other people feel', 'Identifying an interpersonal problem'],'["The student identified that both Sasha and Tina felt nervous about presenting, demonstrating an understanding of how others feel.', "The student correctly identified the interpersonal problem presented in the scenario, which was that both Tina and Sasha were nervous about presenting and didn't want to.""]"

40,lesson3,"USER: Because Sasha doesn't want to do the presentation either. ",2,['Thinking about how other people feel', 'Speaking up about their own point of view'],'["The student is thinking about how Sasha feels about presenting, demonstrating an understanding of another person's perspective."'"], 'The student is advocating for Sasha by explaining why she agreed to present even though she was nervous.'])"

40,lesson3,"USER: It could each work on the poster, and then each work on the presentation. ",3,['Working together with (hypothetical) others to solve problems', 'Speaking up about their own point of view', 'Thinking of solutions for the problem'],'["The student suggests a solution where both Tina and Sasha work together on both parts of the project.', 'The student is suggesting a solution to the problem, which implies that they are speaking up about how they would solve the problem.', 'The student is thinking of a solution to the problem presented in the scenario.'])"

40,lesson3,"USER: They could, ",0,[],[]

40,lesson3,"USER: both, Tina gets her wet. And Sasha doesn't. ",0,[],[]

40,lesson3,"USER: That that makes it easier to find a solution. Or compromise. ",2,['Working together with (hypothetical) others to solve problems', 'Coming to compromise'],'["The student suggests that working together makes it easier to find a solution, which aligns with the skill of collaborating to solve problems.', 'The student explicitly mentions ""compromise"" as a way to find a solution, directly referencing the skill of coming to a compromise.'])"

40,lesson3,"USER: With my friend [child-name], we were working on a Black History Month project. And I wanted to color it blue. Blue's my favorite color, and he wanted to color it red because red's his favorite color. So then we both just decided to mix them together. ",4,['Thinking of solutions for the problem', 'Working together with (hypothetical) others to solve problems', 'Coming to compromise', 'Speaking up about their own point of view'],'["The student and [child-name] thought of a solution to their problem, which was mixing the colors together.', 'The students states ""we both just decided to mix them together""', which shows that they worked together to come to a solution.', 'Mixing the colors together is a compromise, as they both got to incorporate their favorite colors into the project.', 'The student spoke up about their point of view by stating that they wanted to color the project blue, and [child-name] also spoke up about his point of view by stating that he wanted to color the project red.'])"

Total Score: 16

Number of Utterances: 17

Score per Utterance: 0.94

7 Measures

7.1 General SEL Skill Evaluations

Survey questions were taken from Panorama Education's Student Survey [1]. Questions for self-management and social awareness were taken exactly. Questions for classroom belonging were adapted from the school

belonging section, removing questions about perceptions of safety and belonging in the wider school environment as these were deemed to be less relevant to the interpersonal skills we were interested in.

1. Self-Management:

Please answer how often you did the following during the past 30 days. During the past 30 days...

(Almost Never, Once in a While, Sometimes, Often, Almost All the Time)

- (a) How often did you come to class prepared?
- (b) How often did you follow directions in class?
- (c) How often did you get your work done right away, instead of waiting until the last minute?
- (d) How often did you pay attention and ignore distractions?
- (e) When you were working independently, how often did you stay focused?
- (f) How often did you remain calm, even when someone was bothering you or saying bad things?
- (g) How often did you allow others to speak without interrupting them?
- (h) How often were you polite to adults?
- (i) How often were you polite to other students?
- (j) How often did you keep your temper under control?

2. Social Awareness:

Please answer how often you did the following during the past 30 days.

During the past 30 days...

- (a) How carefully did you listen to other people's points of view?
(Not Carefully At All, Slightly Carefully, Somewhat Carefully, Quite Carefully, Extremely Carefully)
- (b) How much did you care about other people's feelings?
(Did Not Care At All, Cared A Little Bit, Cared Somewhat, Cared Quite A Bit, Cared A Tremendous Amount)
- (c) How often did you compliment others' accomplishments?
(Almost Never, Once in a while, Sometimes, Often, Almost all the time)
- (d) How well did you get along with students who are different from you?
(Did Not Get Along At All, Got Along A Little Bit, Got Along Somewhat, Got Along Pretty Well, Got Along Extremely Well)
- (e) How clearly were you able to describe your feelings?
(Not At All Clearly, Slightly Clearly, Somewhat Clearly, Quite Clearly, Extremely Clearly)
- (f) When others disagreed with you, how respectful were you of their views?
(Not At All Respectful, Slightly Respectful, Somewhat Respectful, Quite Respectful, Extremely Respectful)
- (g) To what extent were you able to stand up for yourself without putting others down?
(Not At All, A Little Bit, Somewhat, Quite A Bit, A Tremendous Amount)
- (h) To what extent were you able to disagree with others without starting an argument?
(Not At All, A Little Bit, Somewhat, Quite A Bit, A Tremendous Amount)

3. Classroom Belonging:

- (a) How well do people in your class understand you as a person?

(Do not understand at all, Understand a little, Understand somewhat, Understand quite a bit, Completely understand)

- (b) How connected do you feel to the teacher in your class?

(Not connected at all, Slightly connected, Somewhat connected, Quite connected, Extremely connected)

- (c) How much respect do students in this class show you?

(No respect at all, A little bit of respect, Some respect, Quite a bit of respect, A tremendous amount of respect)

- (d) Overall, how much do you feel like you belong in this class?

(Do not belong at all, Belong a little bit, Belong somewhat, Belong quite a bit, Completely belong)

7.2 Mastery of SEL Lesson Content

7.2.1 Pre/Post Test Questions

Scenarios for the STEP problem-solving portion of the written assessment were taken from official Second Step Fourth Grade evaluation materials. The questions and grading rubrics for problems 1 and 2 below were taken directly from Second Step ¹, ©2021 Committee for Children. Second Step is a registered trademark of Committee for Children. The questions for problem 3 were written by the research team and modeled off of scenario discussion questions from the SEL lessons. The rubric for problem 3 was modeled off of the rubric for question 2 and rubrics for Second Step evaluation materials for different units.

1. Read this conversation between Ciara and Nash.

Ciara: “What’s that?”

Nash: “It’s a ukulele. My grandfather gave it to me for my birthday, but I don’t know how to play it yet”

Ciara: “Let me try! I bet I can figure out how to play that song we like.”

Nash: “I don’t want you to play it. It’s really special, and my mom says I have to be really careful with it.”

Ciara: “I’m always careful. I let you play my new game the other day.”

Nash: “I just don’t want it to get messed up. And I don’t want to get in trouble.”

- (a) What is the first thing Nash should do in this situation?
- Tell Ciara that she can’t play the ukulele
 - Come up with a solution to the problem
 - Find a way to say the problem respectfully
 - Leave the room and ignore Ciara
- (b) What is the problem between Ciara and Nash?
- They both want to play the ukulele at the same time
 - They disagree about whether Ciara should be able to play the ukulele
 - They disagree that they should be careful with the ukulele
 - I’m not sure

¹<https://www.secondstep.org/>

- (c) Which solution is the best?
- i. Ciara is allowed to play the ukulele
 - ii. Nash doesn't let Ciara play the ukulele
 - iii. They ask Nash's mom to show them how to be careful with the ukulele
 - iv. I'm not sure
2. Alex made a horse out of clay for his art project. He worked really hard on it and is pleased with how it turned out. Jane leans over and makes fun of Alex's project.
- (a) Jane is making fun of Alex's art project. Some possible solutions are listed below - please pick the best one.
- i. Alex could make fun of Jane's shoes to get even
 - ii. Alex could ignore Jane
 - iii. Alex could use an assertive voice and tell Jane to stop bothering him
- (b) What are three different reasons that the solution you picked is the best one?
- (Free answer question)*
3. Julie and Diana decided to be partners for their school science project. It is due in one month. They both like doing science projects. Julie likes to get started on projects right away. She likes to plan projects and set dates for when different parts of the project should be done. Diana likes to wait a while before starting projects. She likes to figure out a plan as she goes and work on the project whenever she feels like it. Julie is feeling more and more angry that Diana won't plan ahead.
- (a) Julie says that a good solution would be for Diana to work on a plan right now. What are some pros and cons of this solution?
- (Free answer question)*
- (b) Is Julie's solution fair? Why or why not?
- (Free answer question)*

7.2.2 Pre/Post Test Grading Rubric

Problems were graded using the following rubrics:

1. Ciara and Nash: Correct answers were (a) iii, (b) ii, and (c) iii
2. Alex and Jane:
 - 0 points: Answered i, or answered either ii or iii but gave no relevant reasons.
 - 1 point: Answered either ii or iii and gave 1 relevant reason.
 - 2 points: Answered either ii or iii and gave 2 different, relevant reasons.
 - 3 points: Answered either ii or iii and gave 3 different, relevant reasons.

Reasons must predict a positive consequence or show empathy, fairness, or safety. Duplicate answers do not count are scored as one point.
3. Julie and Diana
 - 0 points: Pros and cons are irrelevant
 - 1 point: At least one relevant pro AND con, says "yes" for fairness
 - 2 points: At least one relevant pro AND con, says "no" for fairness BUT gives no valid reason why

3 points: At least one relevant pro AND con, says “no” for fairness AND gives a valid reason why

7.2.3 Automated Transcript Assessment

We created an automated transcript assessment using Google Gemini 1.5 Pro (with temperature = 0) to process lesson transcripts and assign a grade for how well a student verbally demonstrated understanding and usage of lesson specific SEL skills, awarding points for each instance. For example, when a student is asked what should be done when two people get into an argument, answering “*I think instead of approaching the problem directly, first, you you should calm down. And after you calm down, you should settle on a solution that both of you agree with and no one gets uncomfortable about*” would score two points: one for identifying that taking a moment to calm down before addressing the problem is appropriate, and another for suggesting that two people work together to solve a problem. The same grader prompt was used for all four lessons. The prompt, script, and an example annotated transcript can be seen in Section 6 or in our OSF repository, linked in Section 1.

7.3 Social Engagement with the Robot

7.3.1 Depth of Disclosure Grading

Our depth of disclosure grading used a cumulative binary point system. In this system, a “point” was given for any disclosure at all, with an additional point per each mention of the following: their emotions, who was involved in the disclosure, what the disclosure was about, where the situation occurred, when the situation occurred, why the situation occurred, and what the resolution was. The final depth “score” was a simple sum of these points.

8 Results

8.1 Demographics

Table 2: Study Demographics

	Boys	Girls	Nonbinary	Other	Age (M, SD)	School 1	School 2	School 3
Fictional	7	6	1	1	(9.57, 0.495)	9	5	1
Factual	9	7	1	0	(9.76, 0.437)	8	5	4
Control	8	8	0	1	(9.53, 0.514)	8	5	4

8.2 Complete Results

Some results were not discussed in depth in the main paper. For transparency they are included here.

8.2.1 Theory-of-Mind and Manipulation Checks

Table 3: Contingency table for how students answered “Does the robot have friends?”

Does the robot have friends?	Yes	No	Maybe
Fictional	15	1	2
Factual	3	0	14

Table 4: Theory of mind questionnaire full results

	Fictional (M, SD)	Factual (M, SD)	F	η_p^2	p
How much does the robot do things on purpose?	(1.47, 1.18)	(1.67, 1.03)	0.276	.008	0.603
How much does the robot have feelings?	(1.12, 0.99)	(0.167, 0.51)	12.88	0.28	0.00106
How much does the robot know what it is?	(1.59, 1.12)	(2.39, 0.70)	6.513	0.16	0.0155
How much does the robot think for itself?	(1.24, 1.09)	(0.833, 1.15)	1.122	0.03	0.297

8.2.2 General SEL Skill Evaluations

Table 5: Self-Management: Student self-evaluations pre/post test results

Self - Management	Pre (M, SD)	Post (M, SD)	F	η_p^2	p
Fictional	(4.23, 0.49)	(4.20, 0.65)	0.033	0.002	0.859
Factual	(4.21, 0.45)	(4.36, 0.47)	5.193	0.25	0.037
Control	(4.06, 0.81)	(4.21, 0.64)	2.292	0.125	0.15

Table 6: Self-Management: Normalized gains from self evaluations

Self-Management	Fictional (M, SD)	Factual (M, SD)	Control (M, SD)	F	η_p^2	p
Normalized Gains	(-0.016, 0.45)	(0.207, 0.40)	(0.058, 0.51)	1	0.04	0.376

Table 7: Social Awareness: Student self-evaluations pre/post test results

Social Awareness	Pre (M, SD)	Post (M, SD)	F	η_p^2	p
Fictional	(3.92, 0.44)	(3.98, 0.65)	0.237	0.017	0.634
Factual	(4.12, 0.45)	(4.20, 0.67)	0.77	0.046	0.393
Control	(3.79, 0.54)	(4.01, 0.49)	7.796	0.328	0.013

Table 8: Social Awareness: Normalized gains in self evaluations

Social Awareness	Fictional (M, SD)	Factual (M, SD)	Control (M, SD)	F	η_p^2	p
Normalized Gains	(0.056, 0.54)	(0.121, 0.38)	(0.149, 0.21)	0.235	0.01	0.791

Table 9: Classroom Belonging: Student self-evaluations pre/post test results

Classroom Belonging	Pre (M, SD)	Post (M, SD)	F	η_p^2	p
Fictional	(3.98, 0.74)	(3.92, 1.14)	0.088	0.006	0.771
Factual	(4.22, 0.56)	(4.25, 0.57)	0.158	0.01	0.696
Control	(3.56, 0.76)	(3.87, 0.83)	3.671	0.187	0.073

Table 10: Classroom Belonging: Normalized gains in self evaluations

Classroom Belonging	Fictional (M, SD)	Factual (M, SD)	Control (M, SD)	F	η_p^2	p
Normalized Gains	(0.093, 0.62)	(0.034, 0.64)	(0.196, 0.57)	0.304	0.01	0.739

8.2.3 Mastery of SEL Lesson Content

All results and statistics are included in paper main text.

8.2.4 Social Engagement with the Robot

Table 11: Depth of self-disclosure scores

Lesson	Fictional (M, SD)	Factual (M, SD)
1	(3.12, 1.93)	(3, 1.94)
2	(2.59, 1.97)	(3.11, 2.22)
3	(2.71, 1.93)	(2.5, 2.04)
4	(2.53, 2.21)	(3.33, 2.03)

Table 12: Depth of self-disclosure: Mixed ANOVA results

Effect	F	η_p^2	p
Condition	0.346	0.010	0.561
Lesson	0.378	0.011	0.769
Condition:Lesson	0.618	0.018	0.605

Table 13: Student word count

Lesson	Fictional (M, SD)	Factual (M, SD)
1	(223, 88.2)	(215, 95.8)
2	(197, 71.9)	(183, 69.5)
3	(227, 79.4)	(228, 98.2)
4	(378, 188)	(397, 132)

Table 14: Student word count: Mixed ANOVA results

Effect	F	η_p^2	p
Condition	0.0002	< 0.001	0.99
Lesson	45.08	0.58	< 0.001
Condition:Lesson	0.294	0.009	0.744

Table 15: Contingency table for how students viewed the robot, $p = 0.734$ using Fisher's Exact Test for Count Data

	It was like a fellow student	It was like a teacher	In between a teacher and student	Other
Fictional	3	7	5	2
Factual	2	10	5	1

Table 16: Contingency table for SEL education style preferences, $p = 0.711$ using Fisher’s Exact Test for Count Data

	1-on-1 with a robot	With your whole class
Fictional	12	5
Factual	14	4

8.3 Equivalence Analysis

We used Two One-Sided Tests (TOST) of Equivalence to determine equivalence of results between robot conditions. The TOST was evaluated using the TOSTER library in R. When performing a TOST procedure, the alpha-level and equivalence bound is selected *a priori*. Equivalence bounds (in TOSTER function `t.TOST()`, Cohen’s d effect size is used) are determined by selecting the smallest effect size of interest (SESOI). A common approach to select the SESOI is to review related literature, however we did not find studies closely related enough to use their effect sizes. We instead chose to evaluate using a medium effect size of Cohen’s $d = 0.5$. The Welch Two Sample t-test was statistically significant ($t(28.096) = -2.42, p = 0.011, M_{fact} = 0.562, M_{fict} = 0.421, 90\%C.I.[-0.111, 0.394]$) at a 0.05 alpha-level. The null hypothesis can be rejected. It can be stated that the true difference in means has a smaller than medium effect size.

For reference, from the pairwise t Test comparing the pre/post test results between students in the fictional and factual robot conditions, the Cohen’s d effect size is 0.34, small. Comparing students in the control with those in the fictional robot condition or those in the factual robot condition yields Cohen’s d values of 0.75 (high end of medium to large) and 0.96 (large) respectively.

References

- [1] EDUCATION, P. Panorama Student Survey. <https://www.panoramaed.com/products/surveys/student-survey>, 2025. [Accessed 28-09-2025].