

**Chemical Thinking Learning Progression Project**  
University of Massachusetts Boston and Boston Public Schools

This is the transcript of the interview available at [https://youtu.be/01DfaRPA\\_kc](https://youtu.be/01DfaRPA_kc)  
The prompts for this cognitive interview are available on the CTLP website:  
<https://acctproject.org/formative-assessments/gokart/>

| <i>The INTERVIEWER asks the questions on the first page (GoKart Challenge)</i>                              |   |
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| 1.  | INTERVIEWER: Have you ever been to an amusement park?   |
| 2.  | STUDENT: Yup.   |
| 3.  | INTERVIEWER: And have you seen something that looks like a GoKart like this?  |
| 4.  | STUDENT: Hmm hmm.   |
| 5.  | INTERVIEWER: All right. So you're on a design team to create a new exhibit at an amusement park that's going to have GoKarts, and your job is going to be to decide what fuel to use to power the GoKart. Okay. And you've got four different choices. You're considering four fuels. The first one is gasoline, which is made mostly of octane, and it's derived from petroleum. And the second one is also gasoline, but instead, it's derived from wood pellets. |
| 6.  | STUDENT: Okay.  |
| 7.  | INTERVIEWER: The third one is natural gas, which is mostly made of methane. And the last one is something called E85, which is mostly ethanol. So those four are listed right here. And if the fuels— Let's just say for right now that the fuels happen to cost the same per gallon.   |
| 8.  | STUDENT: Okay.  |
| 9.  | INTERVIEWER: All right. So can you tell me which one you think you would use to power the GoKart?   |
| 10.   | STUDENT: Probably natural gas.  |
| 11.   | INTERVIEWER: Okay. How come?  |
| 12.   | STUDENT: Cause it says natural in the word.   |
| 13.   | INTERVIEWER: Okay. And why would that be better?  |
| 14.   | STUDENT: Cause usually when you use the word natural, it means, it's like from nature, and that's like what we're trying to protect, like choosing the best choice.   |
| 15.   | INTERVIEWER: So if it comes from nature, then that's going to be better for, for using? How come?   |
| 16.   | STUDENT: Cause, um, like if we're trying to protect the nature, then like, if you use something more natural, then it's going to like not affect the environment as much.   |
| 17.   | INTERVIEWER: I see. Yeah, that makes sense. You know, scientists don't have any one, one answer about this. Like when you interview scientists, they give different answers, because they, they don't agree on an answer.   |
| <i>The INTERVIEWER continues, now asking the questions on the second page (How the fuels are available)</i> |   |
| 18.   | INTERVIEWER: So it turns out that we know some more information about these fuels. We know that gasoline from petroleum is available as a liquid, and gasoline from wood pellets is also available as a liquid. Natural gas is available as a gas. And E85...   |
| 19.   | STUDENT: Wait, it's not available as a liquid though?   |
| 20.   | INTERVIEWER: Nope. It's available as a gas. It comes as a gas.  |

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| 21. | STUDENT:     | Okay.  |
| 22. | INTERVIEWER: | And E85 is available as a liquid.  |
| 23. | STUDENT:     | Okay.  |
| 24. | INTERVIEWER: | So do you think this information's important for making a decision about what fuel would be best to power the GoKart?  |
| 25. | STUDENT:     | No.  |
| 26. | INTERVIEWER: | Okay. How come?  |
| 27. | STUDENT:     | Cause it doesn't matter what substance is it, it is.   |
| 28. | INTERVIEWER: | Um, doesn't matter if, by substance you mean like liquid or gas?   |
| 29. | STUDENT:     | Yeah.  |
| 30. | INTERVIEWER: | Okay. So it doesn't matter—  |
| 31. | STUDENT:     | What kind of fluid it is.  |
| 32. | INTERVIEWER: | Okay. Why does it not matter what kind of fluid it is?   |
| 33. | STUDENT:     | I don't know.  |
| 34. | INTERVIEWER: | Well, you must have some reason why you said that, right?  |
| 35. | STUDENT:     | Well, what would, how would it make a difference?  |
| 36. | INTERVIEWER: | Why do you think— So how come you think it wouldn't make a difference?   |
| 37. | STUDENT:     | Because I don't know what difference it would make.  |
| 38. | INTERVIEWER: | Hmm, okay. So you're not sure if it would make a difference, so—   |
| 39. | STUDENT:     | It might make a, it might make a difference.   |
| 40. | INTERVIEWER: | Okay. And what could it make a difference in?  |
| 41. | STUDENT:     | Like liquids and gases might burn differently or something.  |
| 42. | INTERVIEWER: | All right. So how would they burn differently?   |
| 43. | STUDENT:     | I don't know.  |
| 44. | INTERVIEWER: | Okay. All right. But they would burn differently, like they would— Like if you're burning a gas, and then if you're burning a liquid, [gesture showing two separated hands cupped] what kinds of things would be different about it?   |
| 45. | STUDENT:     | Um, I don't know. I don't know.  |
| 46. | INTERVIEWER: | All right. Well, but they might burn differently, so that might—   |
| 47. | STUDENT:     | Maybe. I don't think, like they're still the same like thing. Like if you could get natural gas to be like cold enough that it was a liquid, then, then it would still burn the same way, because it's the same thing.   |
| 48. | INTERVIEWER: | I see. Okay. All right, so it could be, so natural gas could be a gas. It could be in a gas form, or it could also be in a liquid form, depending on its temperature?  |
| 49. | STUDENT:     | Yeah.  |
| 50. | INTERVIEWER: | Okay. All right, that makes sense. Good. All right. You know, I have another question for you about this. So we have gasoline from, that comes from petroleum, and it's mostly octane and it's a liquid. And we have gasoline that comes from wood pellets, and it's mostly octane, and it's a liquid. Is gasoline from petroleum the same or different than gasoline from wood pellets? |

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| 51.   | STUDENT:     | Well, obviously it's different.   |
| 52.   | INTERVIEWER: | Okay. Why?  |
| 53.   | STUDENT:     | Well one is made out of petroleum, and one is made out of wood pellets.   |
| 54.   | INTERVIEWER: | So that makes that them be different, different kinds of gasolines?   |
| 55.   | STUDENT:     | Yeah.   |
| 56.   | INTERVIEWER: | Okay. What would be different about them?   |
| 57.   | STUDENT:     | They're made from different things?   |
| 58.   | INTERVIEWER: | Okay. And that makes them different?  |
| 59.   | STUDENT:     | Yeah.   |
| 60.   | INTERVIEWER: | That's cool. That's very cool.  |
| <i>The INTERVIEWER continues, now asking the questions on the third page (What the fuels are made of)</i>     |              |   |
| 61.   | INTERVIEWER: | All right, so it actually turns out we know even more about them. Have you heard of carbon and hydrogen and oxygen before?  |
| 62.   | STUDENT:     | Yup.  |
| 63.   | INTERVIEWER: | All right. So gasoline from petroleum is made from carbon and hydrogen, and gasoline from wood pellets is also made from carbon and hydrogen. And natural gas is also made from carbon and hydrogen. But E85 is made from carbon, hydrogen, and oxygen. Do you think that this information is important for making a decision about which fuel would be best for your GoKart? |
| 64.   | STUDENT:     | Um, I think this one is important, because like, um, cause I think like when you burn it to make the fuel, make it like make fuel, you know, like it's a chemical reaction, so it like affects differently with different, like with different elements. So, it might affect differently with the E85, because it has oxygen it it also.                                      |
| 65.   | INTERVIEWER: | Okay. And so when it affects differently, does that make something—   |
| 66.   | STUDENT:     | Like it might produce more gas of some sort into the air.   |
| 67.   | INTERVIEWER: | Okay. So what gets produced from burning it might be different because of what's inside of it?  |
| 68.   | STUDENT:     | Hmm hmm.  |
| 69.   | INTERVIEWER: | Okay. And do you have any sense of which one might be better or which one might be worse?   |
| 70.   | STUDENT:     | [shakes head]   |
| 71.   | INTERVIEWER: | No. You just said that they're different.   |
| 72.   | STUDENT:     | Hmm hmm.  |
| 73.   | INTERVIEWER: | Okay. Makes a lot of sense. You're doing a great job.   |
| <i>The INTERVIEWER continues, now asking the questions on the 4th page (Particles that make up the fuels)</i> |              |   |
| 74.   | INTERVIEWER: | Okay. So it turns out we know also a little bit more about this. We know how the particles are arranged in the fuels.   |
| 75.   | STUDENT:     | Okay.   |
| 76.   | INTERVIEWER: | All right. So in oxygen, this is the arrangement of the, um, of the carbon and the hydrogen.  |

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| 77.  | STUDENT:     | You mean octane?  |
| 78.  | INTERVIEWER: | Sorry, in octane. Yes, thank you. In octane, this is the arrangement of the carbons and the hydrogens in it. And this drawing right here is the arrangement of the carbons and the hydrogens, or the carbon and the hydrogens in, in a methane. And then this is the arrangement of the carbons and the hydrogens and the oxygen in an ethanol. |
| 79.  | STUDENT:     | Okay.   |
| 80.  | INTERVIEWER: | So do you think this information's important for making a decision about what fuel would be best?   |
| 81.  | STUDENT:     | Um, well, if I knew like what kind of, kind of the chemical reactions could be possible with the different ones. Like these are similar, cause they have the same things.   |
| 82.  | INTERVIEWER: | Octane and methane are similar?   |
| 83.  | STUDENT:     | Yeah, but they're still arranged [too] differently. So yeah, but um— Wait, which ones are the gasoline ones?  |
| 84.  | INTERVIEWER: | Gasoline is octane.   |
| 85.  | STUDENT:     | Okay. So those are both of the, um, the gasoline ones?  |
| 86.  | INTERVIEWER: | Hmm hmm.  |
| 87.  | STUDENT:     | So before, what, since they were made of, like they were called different things, there are two of them that were octane, were there the same like molecules in each of those substances, in each of those things that it came from?  |
| 88.  | INTERVIEWER: | Yeah. Both of them have octane in them.   |
| 89.  | STUDENT:     | Okay. So they're the same thing. They just come from different places.  |
| 90.  | INTERVIEWER: | Okay.   |
| 91.  | STUDENT:     | Um, um—   |
| 92.  | INTERVIEWER: | And so you were saying that these two are made of the same, same things [pointing to octane and methane]. They're made of carbons and hydrogens. But ethanol is different, cause it also has oxygen in it.  |
| 93.  | STUDENT:     | Yeah.   |
| 94.  | INTERVIEWER: | Okay. And then you were saying that they might burn differently? What do you mean by that?  |
| 95.  | STUDENT:     | Um, well, I don't know how like, how fire, like, it like, it's a chem-, fire is like a chemical reaction, right, so?  |
| 96.  | INTERVIEWER: | Hmm hmm.  |
| 97.  | STUDENT:     | But I don't know what really happens. So like, um, like the different molecules might cause different things to happen with it being burned.  |
| 98.  | INTERVIEWER: | Hmm hmm. And they cause different things to happen because they're arranged differently?  |
| 99.  | STUDENT:     | Because they're, yeah.  |
| 100. | INTERVIEWER: | Okay.   |
| 101. | STUDENT:     | Also, this one [pointing to ethanol] has like H and O, which is, and it's like this, the same thing as water.   |

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| 102.   | INTERVIEWER: | Oh, okay. So water has H and O in it too.  |
| 103.   | STUDENT:     | Yeah, and so you could make like water out of this if there was something. So maybe when it burned, it turned into water or something.   |
| 104.   | INTERVIEWER: | Yeah, that makes a lot of sense. So the ethanol could turn into water, but the other ones couldn't, cause they don't have oxygen in them?  |
| 105.   | STUDENT:     | [nods]   |
| 106.   | INTERVIEWER: | Okay. And would that be, would that make it a better fuel or make it a worse fuel, or what?  |
| 107.   | STUDENT:     | Um, well, I'm guessing that gasoline and, that octane and methane make like pollution, but I'm not sure about ethanol, because— Maybe it does also, but because those two are made of the same thing, so, and I know that gas, like all kinds of gas do make pollution.  |
| 108.   | INTERVIEWER: | [nods] By gas, you mean gasoline?  |
| 109.   | STUDENT:     | Well, like fuel, just fuel in general.   |
| 110.   | INTERVIEWER: | Okay. All fuels make pollution.  |
| 111.   | STUDENT:     | Um, and when you said like what's the best kind, that means like, for, the best for the environment. So if you're trying to make it like, um, better for the environment, you wouldn't, you would want less pollution, and that would mean— So, and this one [pointing to ethanol] has like the same as, the same things as H <sub>2</sub> O. So that might make the thing that comes out at the end of the car different. So, and since— Well, I'm not sure, but maybe, like it might have like water in it or something. |
| 112.   | INTERVIEWER: | Okay. And having water in it is better, or not as good?  |
| 113.   | STUDENT:     | Well there's water in the air all the time, so—  |
| 114.   | INTERVIEWER: | Okay.  |
| 115.   | STUDENT:     | Yeah.  |
| <i>The INTERVIEWER continues, now asking the questions on the 5th page (Pollution)</i> |              |  |
| 116.   | INTERVIEWER: | So you actually just anticipated my next question, which was that when fuels are used in engines, they make pollution. They cause pollution. So if you're trying to figure out which of the four fuels would affect the environment, or how the fuels would affect the environment, which one of the fuels do you think would be better than the other ones to use?  |
| 117.   | STUDENT:     | Like is this one natural gas? [turns to previous page and points to ethanol]   |
| 118.   | INTERVIEWER: | No, the natural gas is methane.  |
| 119.   | STUDENT:     | Which, which one do I think would be the best one to use?  |
| 120.   | INTERVIEWER: | Hmm hmm.   |
| 121.   | STUDENT:     | I don't know. I don't think it's gasoline.   |
| 122.   | INTERVIEWER: | Okay. How come?  |
| 123.   | STUDENT:     | Cause, I don't know. This, this one, the natural gas [points to methane] was like [makes air-quotes] natural, and this one has oxygen in it [points to ethanol]. I don't know. Just like different than that one.  |
| 124.   | INTERVIEWER: | So methane and ethanol are different than octane, because—   |

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| 125. STUDENT:     | Well, they're all different, but I don't know. This one's like natural [points to methane], and this one has oxygen [points to ethanol], and— Well, I don't know if the name is like, has anything to do with the actual molecule, but, yeah. |
| 126. INTERVIEWER: | So does that help you to figure out which one would be the best one to use as a fuel if you're trying to, if you were worried about pollution?  |
| 127. STUDENT:     | Um, well I think like we use this one, I think [points to octane].  |
| 128. INTERVIEWER: | We use octane. Hmm hmm.   |
| 129. STUDENT:     | We use octane, and we make pollution. Like I think all of these make pollution.   |
| 130. INTERVIEWER: | Hmm hmm.  |
| 131. STUDENT:     | But you're trying to find the one that makes the least pollution?   |
| 132. INTERVIEWER: | Yeah.   |
| 133. STUDENT:     | Okay. Um, hmm. Maybe this one, since it's the smallest? [points to methane]   |
| 134. INTERVIEWER: | Okay. That's reasonable. And it would make the least pollution because it's smallest?   |
| 135. STUDENT:     | Yeah.   |
| 136. INTERVIEWER: | Okay. Good. Well thank you.   |