

Supplementary Information

Table S1. Survey measures completed by case study participants

| Survey Measures/Scale | Items | Scale Mean | SD | Terciles |
|--|--|------------|------|-------------------------------------|
| Chemistry Mindset (self)/10-point semantic differential ("I can't change at all" to "I can change a lot") | <ol style="list-style-type: none"> 1. My problem-solving ability in chemistry is something... 2. My ability to understand concepts in chemistry is something... 3. My ability to apply chemistry knowledge is something... 4. My ability to master chemistry content is something... 5. My ability to visualize chemical structures and processes is something... 6. My ability to use mathematical and logical reasoning in chemistry is something... 7. My overall chemistry intelligence is something... | 6.93 | 1.68 | >7.57 7.57-6.29 <6.29 |
| Nature of Chemistry Intelligence (others)/6-point Likert | <ol style="list-style-type: none"> 1. Some people naturally understand chemistry more easily. 2. Some people are just smarter in chemistry and can do well without much effort. 3. If you have to work harder than others in chemistry, it doesn't come naturally to you. 4. Students who pick up on chemistry concepts faster are gifted. | 4.15 | 0.91 | >4.50 4.50-3.75 <3.75 |
| Incremental Behaviors/6-point Likert | <ol style="list-style-type: none"> 1. I prefer challenging chemistry work that I'll learn from, even if I make a lot of mistakes. 2. When something in chemistry is hard, it just makes me want to work more on it, not less. 3. When I encounter challenges in chemistry, I don't question my ability to overcome them. 4. I feel motivated to understand a chemistry problem when I get the wrong answer. | 4.03 | 0.92 | >4.50 4.50-3.75 <3.75 |
| Entity Behaviors/6-point Likert | <ol style="list-style-type: none"> 1. I prefer chemistry homework that I can do perfectly without any mistakes. 2. When I have to work hard in chemistry, it makes me feel as though I'm not very smart. 3. I often question whether I can actually improve my ability in chemistry. 4. When I experience failure at a learning task in chemistry, such as getting homework problems wrong, I feel less motivated to continue trying. | 3.53 | 1.11 | >4.00 4.00-3.00 <3.00 |
| Open-ended Questions | <ol style="list-style-type: none"> 1. How do you define chemistry intelligence? What experiences or observations have led you to this belief? Please write at least 3-4 sentences. 2. Please describe these experiences with challenge during this semester of chemistry briefly and what specifically you did to overcome them. | | | |

Table S2. Interview analysis codebook descriptions and examples.

| Lens | Code | Description | Example Quote |
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| Behavior | Avoidance | self-reliance, ignoring problems, avoiding help or evaluation | Raquel: "I think, because if I know that I messed up, I'll get sensitive and I will already know that I messed up. So I don't need other people to point it out to me." |
| | Comparison | positive or negative comparison of performance or understanding | Teresa: "Well, for the one, where it says feel dumb when others perform better in Chem, I would say like, in a class setting, that's more of what I felt." |
| | Decrease Effort | procrastination, laziness, less effort than others, lack of effort, try less | Camille: "I would say from the interactions that I've had in the past, they can tell that I... if I were to apply myself more, I would do a lot better in the class." |
| | Performance | career goals or GPA as reason for effort, going through the motions for the grade, desire to showcase ability to others through grades, show others i can be successful here, perfectionism with mistakes, maintain self-esteem, ignoring challenges, demonstrating ability | Elle: "I wanted to because I already had a B in chem 1211. And then going down from getting a B to B minus felt like very -- I might as well have failed the class. Because my GPA for science matters a lot, because I definitely want to get into medical school." |
| | Helplessness | self-doubt, low confidence, negative thoughts about ability to improve, questioning ability, blaming the topic for struggles | Teresa: "Then I really start questioning like, can I actually, even if I feel confident with the way that I think I can apply what I know to the questions like, can I actually do them when I'm taking a test or a quiz?" |
| | Mastery | utility value (usefulness of the content), interest in learning chemistry, relevant to life, process oriented, effort celebrated during process rather than focusing on grades as measurement of intelligence, sometimes the process isn't well tuned and could impact the outcome, for the love of chemistry, for understanding and mastering content | Kevin: "But in college, I really appreciate it a lot more. You know, I really like a math now. Like before I was getting the grade to get the grade, but I'm taking the time now to understand the meaning behind it and it turned out to be something that I could at least enjoy spending my time, putting music on the background and working through the problems, understanding it." |
| | Increase Effort | necessary, put forth a lot of effort, comes with effort, praised effort (positive attention), studying, practicing, applying effort | Kevin: "Versus nowadays, I see I actually have to apply a lot more effort and use what have in order to sort of rank higher or get the results I want." |
| | Persistence | don't doubt self, don't give up, learn through challenge, ignore negative feedback, confront challenges, goal commitment, dedication to success, willingness to improve, to learn from mistakes, understand deficiencies or weak areas, self-improvement | Natalie: "I mean, I-- there's grades that I've gotten that I'm not so proud of, but I feel like I always put in a good effort. And while it may have taken a fair number of tears and a lot of external resources I usually got there eventually." |
| | Responsible | control over own learning, work ethic, student responsibility, time management, organization, monitoring progress, self-awareness | Johnny: "And what I did was I was like, okay, now, have the materials that I know I'm going to need next semester. I can go ahead and basically, treat myself, like, I'm still in the class and like focus on internalizing all of that stuff now so that when I get to it, I'll be ready for, like, organic chem 2, but still be doing organic chem 1. And it will be more like, you know, ingrained in me. So I won't feel pressures." |
| Help-Seeking | asking instructor or tutor, studying with others, using external resources, recognizing need for help | Yosef: "Ask for feedback on how I can improve in chem. I go to office hours, talk to my professor, and she really just says stuff. Like, do these problems, do you understand what's going on, and whatnot." | |

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| Challenge | Difficult | chemistry is hard, it's right or wrong, the content is complex or challenging to understand, not getting it | Elle: "How challenging I feel chemistry is? Very challenging and I mean...well, yeah, very challenging and it also changes on, like, the level of chemistry -- like the chemistry class that you're taking. I feel like it's very difficult." |
| Learning Environment | | classroom context, online learning, peer interaction, teaching styles, adjusting to college, instructor interactions, learning style doesn't match teaching, not engaged with presented content method, assessment style, easier ability for a person (such as problem-solving or creativity) | Raquel: "The fact that in class, if I don't understand something, you know, I can raise my hand and ask. Instead of having to watch the entire lecture, and then there's this thing in the middle that I didn't understand and then I have to go and figure it out using the textbook or whatever. And then I have to go back and rewatch it, now that it actually makes sense. Just take so much longer that way, instead of just being able to raise my hand and ask." |
| Low Dedication | | not interested, amount of motivation prevents success, self challenges, laziness, procrastination, low dedication to success, low commitment, poor time management | Elle: "I kinda just gave up and I ended up with a B minus in that class in the spring. And that was honestly that wasn't good at all." |
| Subject Ability | | chemistry ability relative to other subjects, science and math ability, depends on the subject for a particular cognitive strength/weakness, challenges in past inform current beliefs about ability, mental block about changing | Camille: "My ability to visualize chemical structures and processes, I would say, like a 4 or 5 for that. Visualization is not my strongest suit, And so, yeah." |
| Tedious, Dense | | simple recall, too much information, retention, too many tasks, have to memorize | Elle: "Memorizing mechanisms and...Yeah, that was really difficult. Memorizing different mechanisms for particular reactions. That was probably the most difficult for me." |
| Mindset | Confidence | don't question, self talk, confidence and belief, high self-esteem, ignoring comparisons, positive attitude, good self-concept | Natalie: "I think, in chemistry, evidence that they had improved would be sort of question types that call upon that skill, like, more consistently feeling confident and getting those questions, right." |
| | Context-dependence | aware of ability to change mindset or how mindset has changed with maturity, mindset can fluctuate based on performance, setting intentions, or feelings | Camille: "And as of right now, I feel like my mindset is set on, I can Change it, depending on how I'm feeling that day, or, like, how key factors that are around me are influencing and affecting my ability at that moment and so it could, if you asked me this tomorrow, it could have been a strongly disagree, yesterday could've been a somewhat disagree, but yeah." |
| | Foundation | cultural background, types of intelligence depend on culture, previous experiences, educational background, preparation, outside influence, family educational encouragement, peer support in learning, resources to develop intelligence | Elle: "I would say, I don't think my high school gave me a very good chemistry...um, foundation for going into, um college. Limited, I didn't really do anything with chemistry outside of school. So, yeah, just basic and limited." |
| | Willingness to Learn | behavior driven toward improvement, wanting to improve enough to do something about it, tying effort to improvement | Yosef: "Definitely, yeah, because you can't, you know, you can't do something if you don't like it. Or you can't make someone do something they personally don't even want to do. Yeah, it's just gonna not really end well." |
| | Malleable | can change, can be developed, developable deficiency, learning grows intelligence, growth experience, improvement | Kevin: "I think just being a firm believer that nothing is set in stone. I don't like the concept of destiny or fate. I feel like everything for the most part is in one's control. If you want them to change, then see to it and it will change." |

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| Maturation | maturity, common sense, development over time, growing up, natural development | Teresa: "Well, it could be either tutors or teachers. They've seen more of chemistry than I have, and they've like how I said they've gone through the more advanced classes, so they've attained more of the chemical knowledge by learning new concepts, new equations, new mathematical concepts as well, so I mean, obviously the more, you know, the-- I guess that you could say more intelligent you are." |
| Natural | brain-sidedness, learning style, types of input that click, types of tasks that come easily | Elle: "Probably in early childhood. And also being just born with the good genetics, also." |
| Stable | can't change, unchanged, not developing | Raquel: "Because if you're not a naturally like creative person or a person who can't naturally see images of what you're learning about in your head, I feel like that is extremely, extremely difficult to be taught how to do that. You either are good at it or you're not. And you can improve it to a certain extent, but it's, that's very difficult." |
| Intelligence Comparison | strengths and weaknesses, depends on the person and the subject, different levels of understanding content between people | Camille: "I think it's something that shines stronger in certain students than others, but as a whole it's in every student, it's just a matter of whether that student is able to or willing to apply themselves to the topic." |
