# Exploring ways to combat learning inequities in college chemistry through question-embedded videos and an asset-based evaluation of first-generation students

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## An Asset-based Approach in Understanding how First-Generation Students Navigate College

### Asset-based vs Deficit-based Approach

STEM fields have historically been dominated by white men, resulting in growing attention towards increasing representation of historically marginalized groups (HMG), such as women, Hispanic, and Black populations[1]. Despite these efforts, academic institutions and STEM jobs in general still struggle from a lack of diversity. Among HMG, first-generation students comprise at least a quarter of the undergraduate population in the U.S. and include a significant population of underrepresented minorities such as Latinos and Blacks.[2]

Previous studies on HMG have utilized a deficit-based approach, focusing on what holds students back from success: educational and financial barriers and a lack of representation in academic curriculum, for example.[3] While it is important to understand the systemic challenges that HMG face, many argue that deficit thinking may foster the mindset that certain students need to fit into the "norm" to succeed, resulting in educators potentially overlooking and not utilizing students' strengths originating from unique cultural and life experiences. [4]

In this study, we take an asset-based approach in illuminating the strengths of first-generation students, their preferred support systems, and the relevance of chemistry to their lives. In doing so, we hope to fill the gap in chemical education research regarding the asset-based analysis of first-generation students, aid educators in providing the proper counterspaces based on frequently used support systems and promote the representation of HMG in teaching.

We perform a thematic analysis of qualitative data for our three research questions. For the first question, we follow the community cultural model proposed by Dr. Yosso of UCR.[5]

**Asset-based**

Rather than comparing participants' knowledge to a predetermined standard, asset-based perspectives describe how participants use their existing knowledge and experiences as resources[6].

**Deficit-based**

A blame the victim way of thinking that attributes students' failures to their individual, family or community traits[5]

### Methods

Cohort of 12 first-gen chemistry and biochemistry students at BU ⇨ Individual interviews and Focus Group interviews Spring 2023

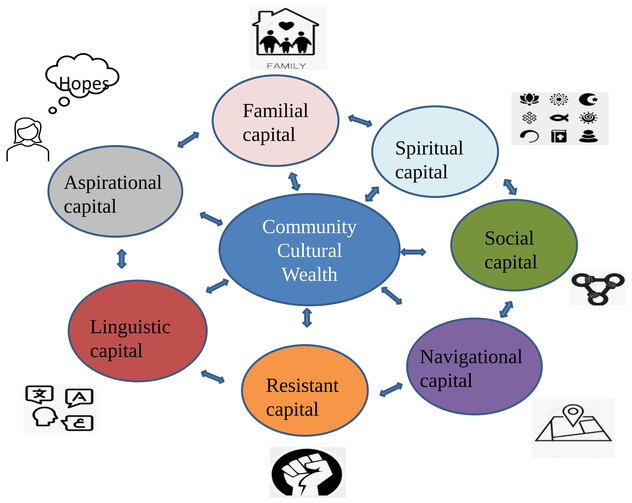
Transcription followed by Deductive-Inductive thematic analysis ⇨ Using themes and patterns to inform suggestions for university faculty

Future Directions:

- Submit proposal to receive funding for a longitudinal study that follows cohorts of first-gen students from freshman year to graduation
- Collect additional interviews, journal entries, and focus group data in the fall

- Interviews for the asset-based analysis were conducted through Zoom.
- Participants were given a code name through which their interviews would be analyzed.
- Interviews range from 30 min to an hour.
- Participants were given a gift card for their efforts.

### Community Cultural Wealth Model




### Interview & Focus Group Questions

- Reflecting on your experience taking chemistry courses, what strengths did you realize you have that empowered you to succeed in schoolwork when it's challenging?
- What kind of advice would you give to faculty and administrators about how to help first-generation students in STEM succeed?
- How do you see chemistry as relevant to your life, and has that changed from the beginning of your college journey?
- Share with your group how you managed to get through a difficult time this past semester. How did you utilize your strengths to help you navigate the situation?
- Please, discuss what academic and non-academic support systems you relied on this semester. What other forms of support do you think are beneficial for students enrolled in your chemistry class?

### Support Systems

Newbury Center – 40%
Teaching fellows/learning assistants/office hours – 40%
Family – 100%

Friends – 100%
Other communities outside school – 50%
UROP – 20%
BU Advisors- 20%

## Question-Embedded Videos (QEV)

### Problem

Data analysis shows that students entering General Chemistry often **lack essential pre-requisite knowledge** in stoichiometry, measurement, matter, and more. These are skills that students are expected to have **prior** to the course, otherwise known as "hidden prerequisites".

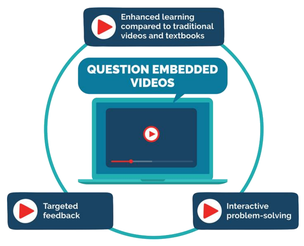
Furthermore, some subcategories within these topics are associated with single digits of percent understanding. A solid grasp of these topics, along with ones such as finding Intercepts, Matter, and Atoms, Ions, and Molecules, is correlated with an increase in course GPA.

Examples of pre-req topics and the average percent of students who got questions in that category correct →

| Topic Name | Average |
|---|---|
| Multiplication and division of measurements | 1% |
| Calculating and using the molar mass of diatomic elements | 2% |
| Adding or subtracting and multiplying or dividing measurements | 2% |
| Finding mole ratios from chemical formulae | 2% |
| Finding the side length of a cube from its volume in liters | 3% |
| Counting significant digits when measurements are added or subtracted | 3% |
| Standard chemical and physical states of the elements | 3% |
| Setting up a unit conversion | 4% |
| Using the Avogadro Number | 4% |

Among these "hidden prerequisites", **historically marginalized students** have higher educational debts as the academic resources they had access to entering college may be fewer than that of their non-HMG peers.[8] Black female students display the highest debt across multiple topics, most notably in Measurement and Atoms, Ions, and Molecules. Hispanic females follow with high debts in Measurement and Stoichiometry.

### Proposed Solution

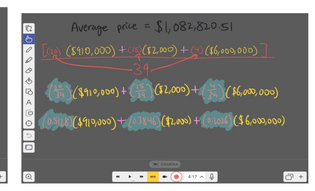



QEVs prevent passive video watching as students work on problems alongside the lesson. The videos can also help reduce cognitive load by emphasizing important information and increase learning outcomes by promoting student engagement through various interactive features.[7]

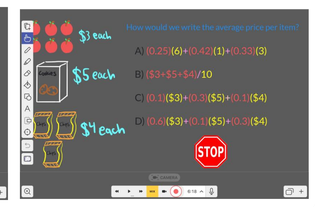
Effective QEVs use:

- Signaling (directing attention to a certain part of the screen)
- Weeding (eliminating extraneous information
- Targeted feedback (insight on chosen answer)
- Segmenting (chunking and organizing information)

Audio was recorded first and animations were added using ExplainEverything. Videos will be deployed through Edpuzzle to facilitate students' transition into General Chemistry in the fall.

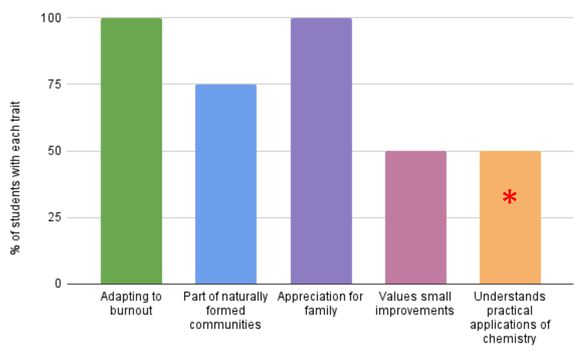





### Research Questions

1. How do first-generation students majoring in chemistry and biochemistry utilize their assets throughout different stages of their degree?
2. What are the networks of support that first-generation students majoring in chemistry and biochemistry identify as contributors to their success throughout different stages of their degree?
3. What are ways that chemistry is relevant to first-generation chemistry and biochemistry students' lives?

### Themes




*Students who understood real-life applications did so **prior** to the course

### Expressions of Cultural Capital

#### *Navigational and Resistant Capital*

**"I'm like able to push through without like**, even though, like I get a low grade like last semester, there was three exams, and my -- the second exam, I didn't do as well as I should have, but instead of focusing on just like, **why did I do bad? Why did I do bad? Like, I push myself to learn from it, and just change my ways of studying because I am -- I -- I think I'm an organized individual. It's just -- I hadn't found the right way of studying, which I think I found now.** "

"Don't think of it all at once and then get stressed about it like, **take it step by step, and it will work out, and then also focus on yourself** when like, of course, study, but **don't put too much pressure on yourself at studying that you forget to take care of yourself**, because at the end of the day, like, if you're not fine, then the studies will not go fine. **So you need to like work to find that balance, and then you'll be fine.**

**"I think I'm like open to knowing that there's like different ways to like answer a question**, like different, like if I'm thinking about a way to answer a question, **I wouldn't be like, this is the only way...**Oh, yeah, so like, if there, if I'm like, open to understanding them, **I feel like you learn way more than just being closed off and just like thinking about your way.** So I think that's one thing that, like I listen to my classmates in class and like I learn from them. And **they learn from me because of our different ways**, which I find is really useful."

"I feel like just being in a STEM Major, and like taking STEM courses, **failure is definitely a big part of it**, and a lot of it is just trial and error. And just making sure that I keep **reminding myself to be able to bounce back and do even better and strive for better."**

"I cared enough to be able **to sit down and to work through the concepts I'm struggling** -- whether it was a form of practice problems, revisiting my notes or rewriting them **or looking through other resources outside the lecture just to see that maybe I process the concepts in a different way**...see maybe I can get clarifications outside of the lecture."

#### *Familial Capital*

"My dad never really wanted me to like be like a doctor, specifically, or a lawyer specifically like, like, you have some college students that come in there, and, like, oh, my parents want me to like just be this specific career. Like my dad, **he literally told me that like, you know, at my high school graduation, that all he ever wanted for me was just to be a professional**... at something."

Even though, like, they probably don't understand like the chemistry things, like my mom, like, she tries -- **like she will try her hardest** to be like **to give me like revision goals or set these topics by date, but even though she can't help like specifically with the details.**

"They brought us here, and honestly worked so hard to get us to where I am, and **honestly I feel so privileged just to be here**, and get this education. So yeah, honestly, **I really want to make them proud**."

**"I'm probably gonna be taking care of him, you know, in his old age,** along with my sisters, and I want to be there to like help them with that. I don't**... I don't want to like continue to be as far away from my family** like as... so that I can help them out."

#### *Social Capital*

Yeah, so I -- I think, first, I found out from my friends, and **they were like, have you done this? Like I'm already registering. And I'm like, okay, okay, I need to get my game going.**

"It's just me and my friend, and we're just **teaching each other**. We take a room and an empty room, **and just write out all the problems in the board and just talk about it. And we just talk about it the entire day**, and like, somehow, it really helps.

"We're all -- majority are first-gen students, and **also every single one of us have immigrant parents**. I feel like this -- that -- kinda -- like **we knew the experience from each other**, like know what it felt like to have first-gen parents, parents that weren't from here, like had different **experiences, like culture experiences compared to us."**

### Key Quotes & Takeaways

"So I feel like it's just more about making a difference with my family, just like being better like making **sure their sacrifices didn't go like unguaranteed or unwarranted**."

"**I did what my parents wanted to do when they were younger**. It's just. It means a lot. It means a lot. Because **if I if I didn't go to college**, I... I probably would be working in the restaurants with, with my dad, **or I wouldn't like realize my potential**."

"For instance, they learn -- I feel like as a person we learn, **we process information much differently than compared to students that are continuing**."

"I feel like having a school where -- where you have a lot of first-gen students coming in, **I feel like that should be a badge of honor, because of all of the very first colleges that they could have chosen/ They chose to just study here."**

"So everything that I did here, **everything I do here is on my own accord, is not through any networks. It wasn't given to me**. That's **a fight through tooth and nails** to even get to BU but it is a satisfying experience though..."

- Numerous first-gen students struggle with hyper independence and burnout at the start and adapt in different ways, such as **improving study habits**, **finding a mentor, integrating themselves into supportive communities, or talking with family.**
- Financial stability is unsurprisingly a definition of success for many students, with participants wishing for stability, happiness, and security.
- All first-gen students were **unable** to detail real-life applications of chemistry, excluding those with preconceived notions prior to the course.
- Several students demonstrate mature thought: they **expressed a deep appreciation** for the opportunity to attend college and for their family's sacrifices. Many feel a **responsibility** to succeed, help family members, and **think of others** when making career choices. Many view attending college as a big step for their family, not just themselves.
- Students express a desire for greater visibility in resources.
- Many place an emphasis on being **open-minded and taking advantage of all opportunities to succeed.**

### Recommendations for Faculty

- Being open to students' concerns and being approachable, "leave nothing up to assumption"
- More transparency with resources available to first-gen students
- Making classes organized and cohesive (ensuring that labs, lectures, assignments match up)
- Keeping office hours consistent
- Creating an open and understanding environment – be flexible with office hours/offer individual meetings
- Accommodating small group study sessions
- Resources on how to pursue different career paths
- Having mentors who are first-gen and/or minority in STEM to talk to

Effort and Reward Systems

- Students value small steps of improvement, treasure independence and growth → gain confidence and sense of belonging

## References & Acknowledgements

1. Nadeem, Reem. "STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity." Pew Research Center Science & Society, Apr. 2021, www.pewresearch.org/science/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/. Accessed 7 Aug. 2023.
2. Dika, Sandra L., and Mark M. D'Amico. "Early Experiences and Integration in the Persistence of First-Generation College Students in STEM and Non-STEM Majors." Journal of Research in Science Teaching, vol. 53, no. 3, Wiley-Blackwell, Dec. 2015, pp. 368–83, https://doi.org/10.1002/tea.21301. Accessed 7 Aug. 2023.
3. Cahalan, M., et al. "Indicators of Higher Education Equity in the United States: 2018 Historical Trend Report." Pell Institute for the Study of Opportunity in Higher Education, Pell Institute for the Study of Opportunity in Higher Education. 1025 Vermont Avenue NW Suite 1020, Washington, DC 20005. Tel: 202-638-2887; Fax: 202-638-3808; e-mail: info@pellinstitute.org; Web site: http://www.pellinstitute.org, 2018, eric.ed.gov/?id=ED583543. Accessed 7 Aug. 2023.
4. "It's Not a Deficit. And You Don't Need to 'Fix' It." University of Nevada, Las Vegas, 20 Sept. 2021, www.unlv.edu/news/article/its-not-deficit-and-you-dont-need-fix-it. Accessed 7 Aug. 2023.
5. "Whose Culture Has Capital? A Critical Race Theory Discussion of Community Cultural Wealth." Race Ethnicity and Education, 2023, www.tandfonline.com/doi/abs/10.1080/1361332052000341006. Accessed 7 Aug. 2023.
6. Gray, Ron, et al. "What You Find Depends on How You See: Examining Asset and Deficit Perspectives of Preservice Science Teachers' Knowledge and Learning." Studies in Science Education, vol. 58, no. 1, Taylor & Francis, Mar. 2021, pp. 49–80, https://doi.org/10.1080/03057267.2021.1897932. Accessed 7 Aug. 2023.
7. "Effective Educational Videos: Principles and Guidelines for Maximizing Student Learning from Video Content." CBE—Life Sciences Education, 2017, www.lifescied.org/doi/10.1187/cbe.16-03-0125. Accessed 7 Aug. 2023
8. "The Education Debt." National Education Policy Center, NEPC, 20 Nov. 2018, nepc.colorado.edu/publication/newsletter-education-debt-112018#:~:text=Gloria%20Ladson%2DBillings%20coined%20the,directed%20at%20students%20of%20color. Accessed 7 Aug. 2023.

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