Overview
This study, conducted in the fall of 2020, explores the impact of the disruptive shift from face-to-face to distance learning in the US for higher education faculty in STEM fields.

- 73% of respondents converted face-to-face coursework to remote learning, yet more than 33% had no prior online instruction experience.
- There were many barriers to implementing face-to-face courses online for STEM faculty:
  - Perceived lack of engagement with students and lack of student motivation
  - Lack of equity among students with and without access to technology and connectivity was exacerbated
  - No experience or access to online labs
  - Additional research is needed to understand these barriers and improve the effectiveness of online courses in STEM

Respondents represented all STEM disciplines, were largely male (58%), not adjuncts (86%), and had more than 20 years of teaching experience (65%). Most respondents (62%) were from institutions with greater than 10,000 students.

Methodology
A national sample of faculty representing all STEM fields was obtained using a multi-stage process. Using data from a commercial provider representing 93% of all teaching faculty, faculty teaching at least one course in a STEM field were selected. A random sample of this list, proportional to each Carnegie Classification, was obtained. This list was checked against opt-out lists as well as non-functioning email addresses to obtain the final sampling frame.

Results

**Figure 1**
Access to education for underserved students

Female professors were significantly (p=0.026) more likely to answer that moving to online during the pandemic significantly lowered access to education for underserved students.

**Figure 2**
Discrimination by race, ethnicity, or sexual orientation

Male faculty believed there was significantly (p=0.033) less discrimination or no change in discrimination during the pandemic.

**Figure 3**
Status of the laboratory

Facility at institutions that are primarily minority serving found access to education was significantly (p=0.002) greater when moving to online during the pandemic.

**Figure 4**
Access to education for underserved students

Facility at minority-serving institutions believed there was significantly (p=0.023) less discrimination during the pandemic.

Faculty Voices

**Figure 1**
Access to education for underserved students

• It is very hard to teach when looking at a screen filled with names; many or all students do not turn their video on. I can sympathize with them (it is hard to share at a screen the whole day), but it also makes it hard to interact: they see you but you do not see them.
  - Mathematics Faculty

"STEM courses, specifically laboratory courses, provide a authentic education when taught online with no hands-on experience."
  - Biological and Biomedical Sciences Faculty

"I do worry... how many disadvantaged students we will lose or have lost due to equity and financial issues that are a result of the pandemic."
  - Biological and Biomedical Sciences Faculty

"My students are succeeding in the online environment. They love the remote synchronous format."
  - Mathematics Faculty

"There is a physical technique associated with quite a bit of the chemistry lab work that I value. Students need to feel the pipette, move the stop-cock with their hands, etc."
  - Physical Sciences Faculty

Conclusion

Like most US higher education, STEM classes were forced to move away from traditional face-to-face instruction due to COVID-19 during the fall of 2020.

- In our survey of STEM faculty, 72% believe inadequate online laboratories are the unique and most important barrier to online education. Many faculty are not aware of online laboratory solutions that already exist.
- Other barriers to teaching STEM online were similar to our surveys of all faculty during the pandemic, with academic integrity and student motivation being most important.
- Respondents believe that the transition to online learning has exacerbated the divide between the haves and the have-nots, as a lack of resources unfairly impacts underserved student populations.

Future

The report raises many additional questions that we hope to continue to explore in future projects:

- What sources of information can guide in addressing perceptions and utilization of online STEM materials?
- How does online STEM education impact equity issues?
- Do labs and collaborative learning represent a unique challenge within the STEM disciplines?
- How does online STEM education impact equity issues?
- What is the long-term impact of COVID-19 on perceptions and utilization of online STEM materials?

If interested in collaborating, please reach out: isabel@bayviewanalytics.com