

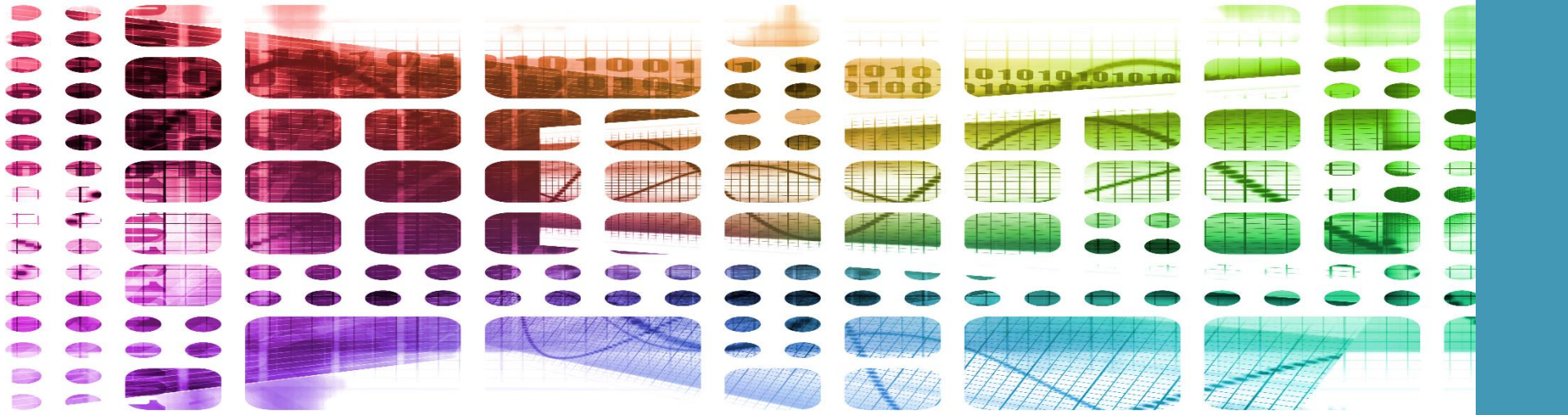


Evaluation of Higher Education Science Laboratory Learning Environments

EDRA CORE

May 23, 2019





01

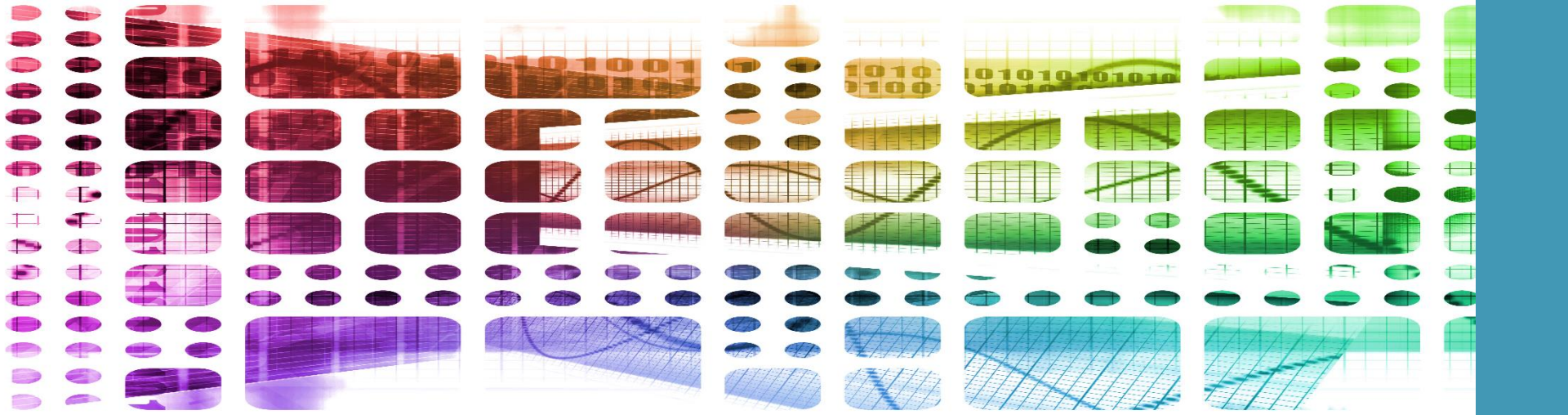
Current Higher Education Design Research

Current Research Evidence

- Very few empirical studies have examined the impact of higher education classroom space on teaching, learning and student outcomes. Even fewer studies examine the impact of the science laboratory classroom environment at the post-secondary level.
- Recent qualitative studies indicate that students perceive that active learning classrooms may provide a more collaborative, interactive learning experience than traditional classrooms, and therefore students feel more motivated to learn therein (Adedokun et al. 2017; Dori et al. 2007) .
- The instructor's use of the physical environment plays a role in student learning (Sawers et al. 2016).
- Research suggests that students recognize when the classroom design and the pedagogy are mismatched (Walczak and Van Wylen 2013).

Current Research Evidence

- Specific environmental attributes of classrooms such as thermal conditions, indoor air quality, acoustic conditions, lighting conditions, furnishings, aesthetics, technology, and views, have an effect on how well students perform and their satisfaction with their courses (Choi et al. 2013).
 - Classrooms with extreme thermal conditions – either “too hot” or “too cold”—have been found to generate distraction among students (Granito and Santana 2016).
 - The amount and placement of windows in laboratory classrooms have been perceived to aid in breaking down barriers between different scientific disciplines (Van Wylen and Walczak 2011; Walczak and Jackson 2013) .
- Post-occupancy evaluations of science-technology-engineering-mathematics (STEM) spaces have typically been done with an eye towards making improvements in the process and the design of “the next renovation,” not as part of research into how well students learn in the space.



02

STEM Lab Research Study

Study Team

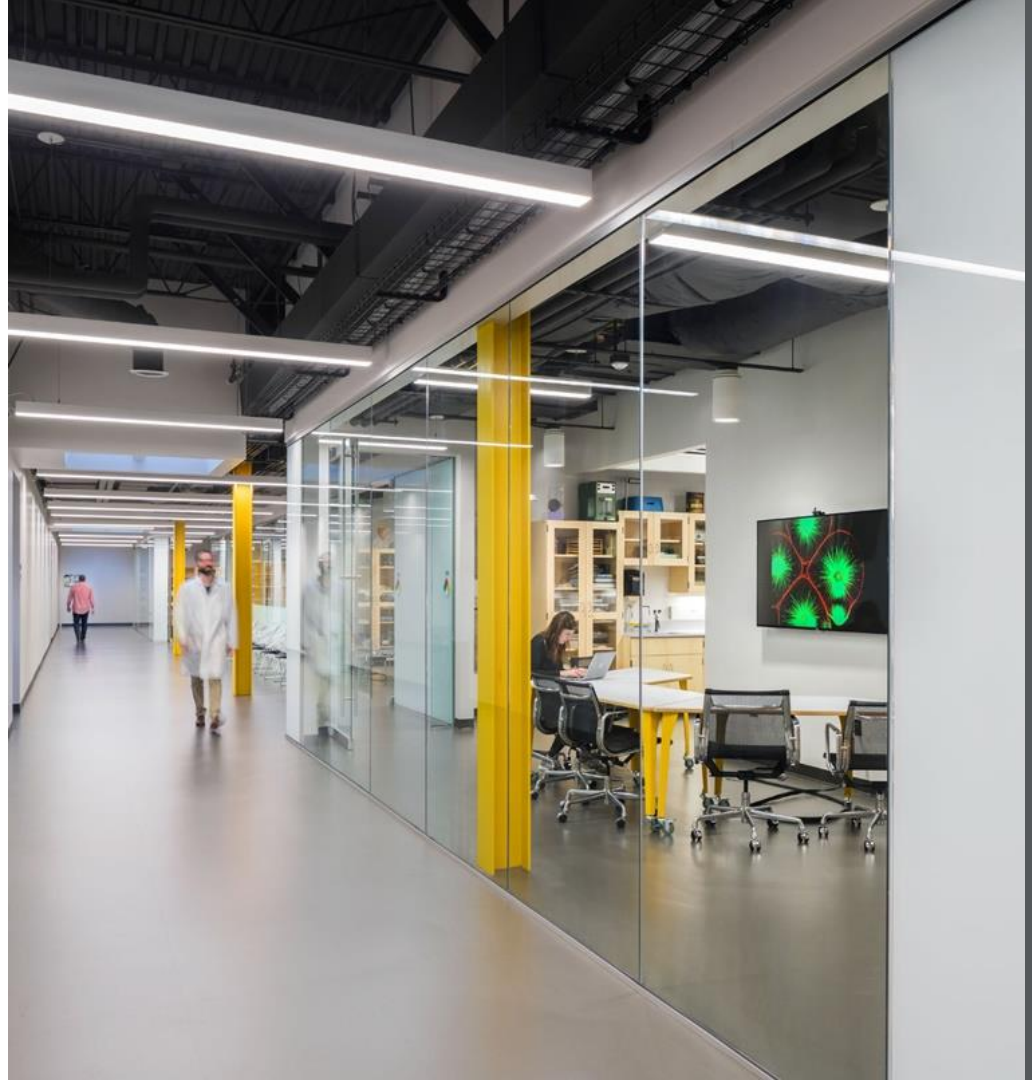
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Acknowledgements

- Diane Dowgielewicz, Strategic Program Manager, Education/Science/Technology, HDR
- John Kyndt, PhD, Associate Professor of Microbiology, Nutrition & Sustainability, Bellevue Univ.
- Eric Malina, PhD, Associate Professor of Practice, Department of Chemistry, UNL
- Mike Hamilton, Design Principal, HDR
- Ed Vidlak, Director, Education, HDR
- Participating Students and Faculty at Bellevue University and University of Nebraska-Lincoln

Research Site

- Bellevue University, Bellevue, Nebraska
- Private, non-profit university
- Enrollment ~9,000





R. Joe Dennis Learning Center

Project Cost: \$2,380,159

Size: 9,800 SF



555



Research Site

- University of Nebraska–Lincoln, Lincoln, Nebraska
- Public research university
- Enrollment ~26,000





UNL Hamilton Hall 4th Floor Renovation

Project Cost : \$1,200,000

Size: 6,780 SF



ACID

ACID

BASE



Design Intentions

- Design for Inquiry-Based Approaches
- Place Science on Display
- Integrate Technology
- Improve Instructor-Student Interaction
- Design for Student Collaboration
- Target Flexibility



Research Questions

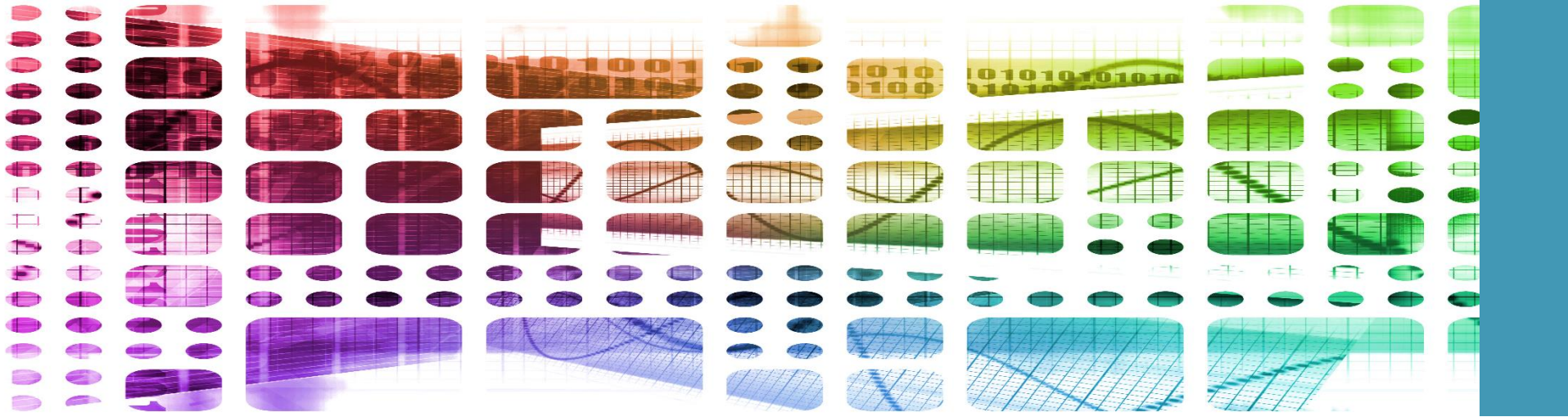
How have architectural design decisions for the STEM laboratory classroom environments...

- Facilitated the development and evolution of curricula, pedagogy and student engagement from a faculty perspective?
- Supported processes that influence positive student learning experience, including engagement and motivation?



Research Methods

- Student Experience was measured quantitatively using an online survey, including validated measures of the following constructs:
 1. Environmental Satisfaction (validated by HDR Research)
 2. Student Engagement (Schaufeli et al. 2002)
 3. Motivated Strategies for Learning (Pintrich and de Groot 1990)
 4. Inspiration (Thrash and Elliot 2003)
 5. Perceptions of the Science Laboratory Environment (Fraser et al. 1986)
- Student qualitative feedback was also captured via survey comment fields.
- Instructor experience was assessed qualitatively using semi-structured interviews.



03

Results: Student Experience

Results

Student Respondent Demographics

- **28 students** participated in the survey at **Bellevue University**
 - 84% Female;
 - 54% 18-24 years old
 - 30% Seniors; 19% Freshman
 - Participants enrolled in a range of science classes including General Chemistry, Zoology, Molecular Biology

- **46 students** participated in the survey at **UNL**
 - 71% Female;
 - 98% 18-24 years old
 - No Seniors; 54% Freshman
 - All participants enrolled in General Chemistry Lab

Environmental Satisfaction

Validated measures of satisfaction with aspects of the built and ambient environments

SPACE & PRIVACY

Bellevue



UNL





I appreciate the amount of open space there is in order to complete my labs. I can walk around with out weaving through tables or running into other students.”

– ***Bellevue Student***



I enjoyed how clean and how well spaced the lab was.”

– ***UNL Student***



The table space is poor. Each table...has a sink in the center of it. This is unfortunately wasted space. Students use sinks along the walls, not the ones at the table. We have our lab notebooks lying all over the place and no one wants to risk getting them wet. With four students at a table, with four notebooks, and four lab guides, we run out of surface space quickly.”

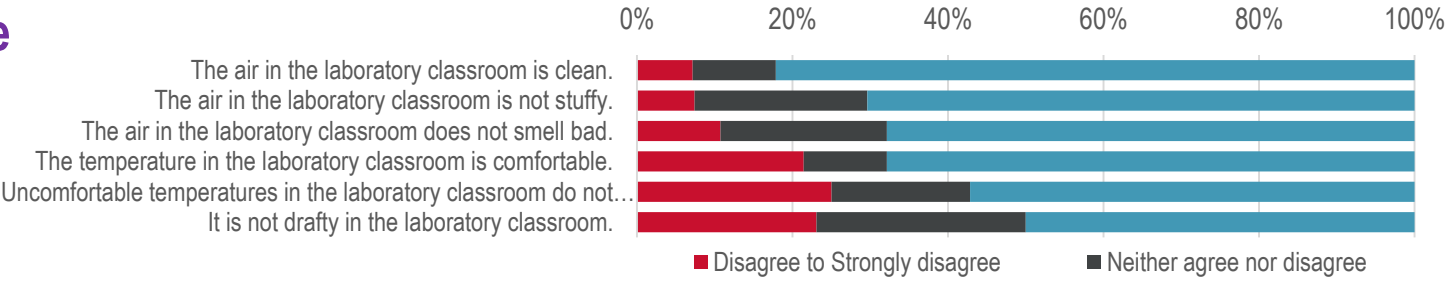
– *Bellevue Student*

Environmental Satisfaction

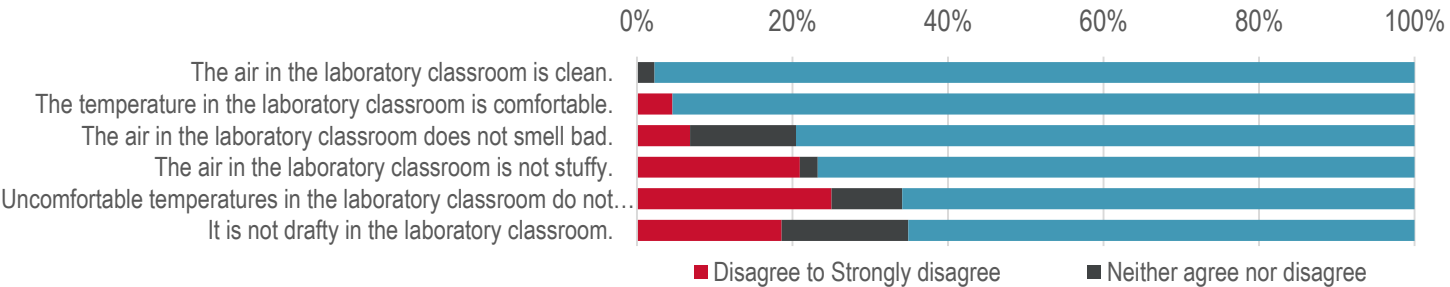
Validated measures of satisfaction with aspects of the built and ambient environments

THERMAL COMFORT

Bellevue



UNL



Note: Some items are reversed to accommodate consistent graphing.



The temperature is usually comfortable and the lighting is good.”

– *UNL Student*

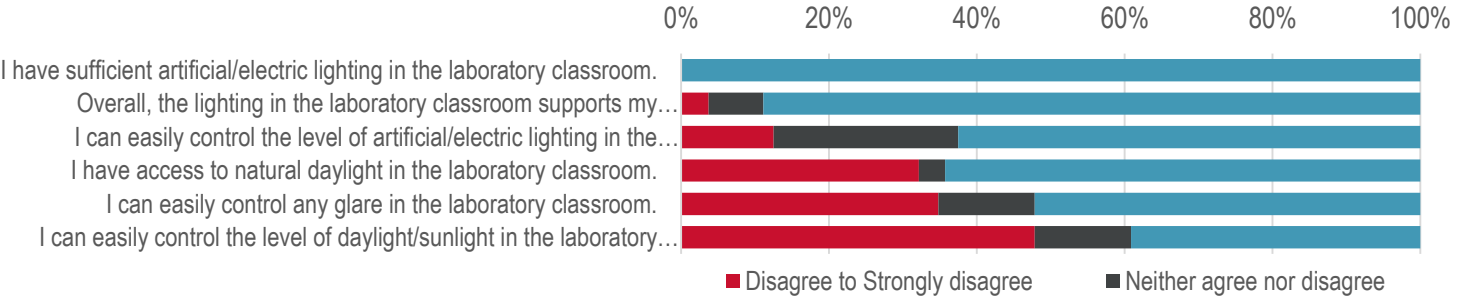


Environmental Satisfaction

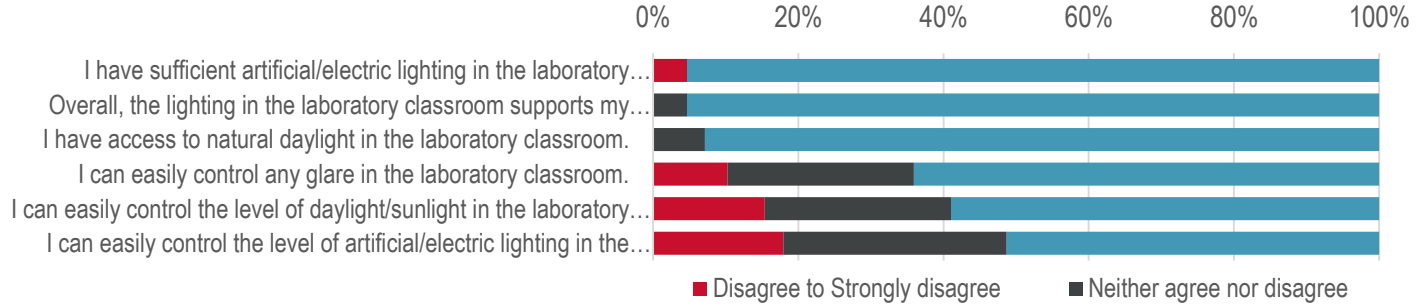
Validated measures of satisfaction with aspects of the built and ambient environments

LIGHTING

Bellevue



UNL



Note: Some items are reversed to accommodate consistent graphing.



I really like the glass windows that are used as a replacement to a wall.”

– ***Bellevue Student***



The labs are very nice and I love the natural lighting and lighting in general.”

– ***UNL Student***



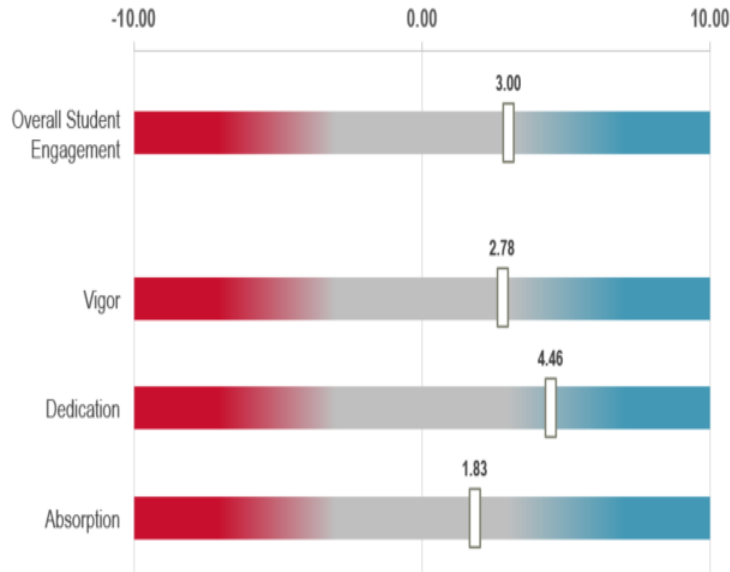
Great Lighting!”

– ***UNL Student***

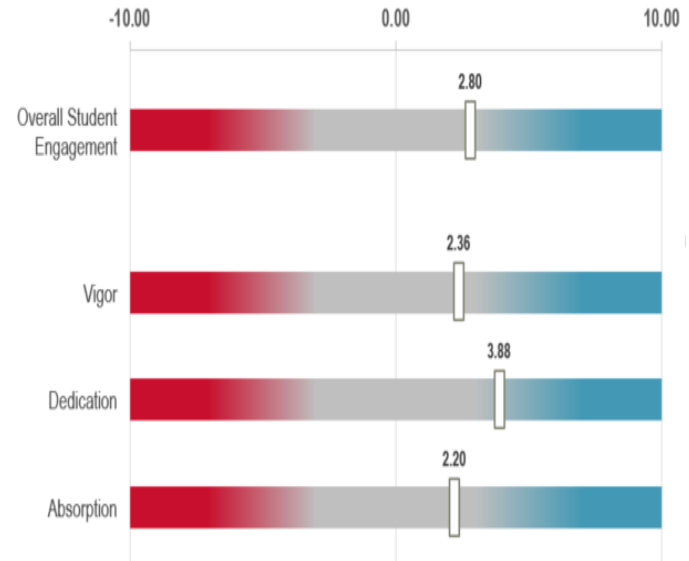
Student Engagement

Utrecht Work Engagement Scale for Students (UWES-S) (Schaufeli et al. 2002) – assessed the degree to which students feel engaged in their studies or classes through examining their dedication, vigor, and absorption.

Bellevue



UNL





It was a great environment to be in, comfortable to do work in and listen to music while doing experiments made it a whole lot better.”

– ***UNL Student***



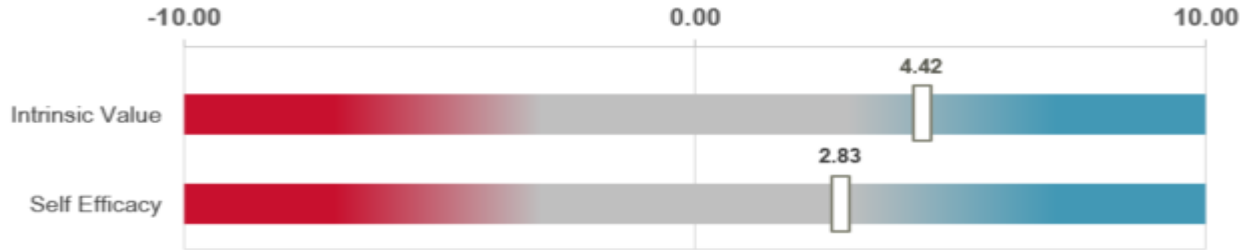
[The lab classroom] is really great and we got an opportunity to work with cells, we learned new experiences during this lab.”

– ***Bellevue Student***

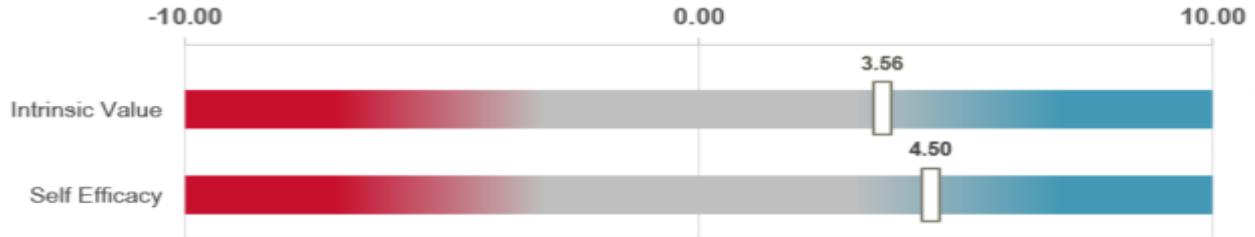
Motivation

Motivated Strategies for Learning Questionnaire (MLSQ) (Pintrich and de Groot 1990) – Used to assess students' willingness to persevere with learning task (Bruinsma & Jansen, 2007). Included subscales measuring students' intrinsic goal orientation and self-efficacy.

Bellevue



UNL





The new labs give students the hands on experience they need to be successful.”

– ***Bellevue Student***



I was able to succeed in this lab.”

– ***UNL Student***



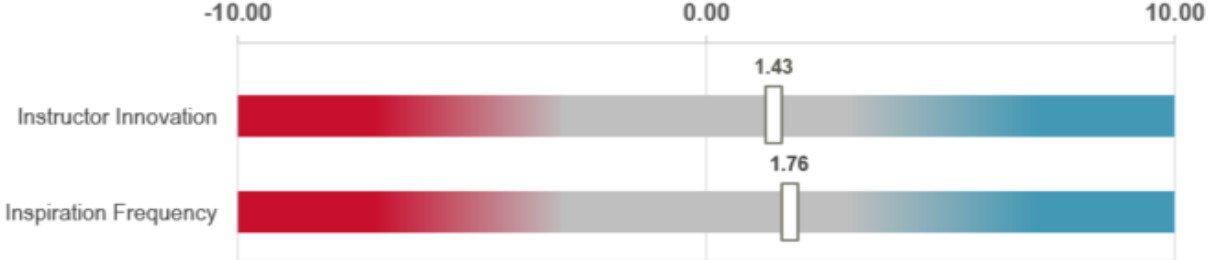
The facilities are very good, and the lab work equips students with basic lab knowledge to prepare us for harder classes and labs.”

– ***UNL Student***

Inspiration

Inspiration Scale (Thrash and Elliot 2003) – Used to measure the frequency and intensity of recalled inspiration experiences in the classroom.

Bellevue



UNL





I loved the appearance of the classroom!”

– *Bellevue Student*



The lab was always clean and [has] a great view, it made me feel like a scientist.”

– *Bellevue Student*



Science Laboratory Environment

Science Laboratory Environment Inventory (SLEI) (Fraser et al. 1986) – Assessed perceptions of five dimensions of an actual or preferred classroom environment. The dimensions include Student Cohesiveness and Material Environment.

Bellevue



UNL





I like the new technologies that are available for us to use during lab times. I like that the professors know what they are doing and are able to teach us how to use the new technology.”

– ***Bellevue Student***



Anyone can understand what is being taught because there are TV screens all around the room that all show the same image that is on the instructor's screen.”

– ***UNL Student***



I feel everything is explained very well and everyone works well as a group to get stuff done.”

– ***UNL Student***



I really love the collaborative setting of this class.”

– ***Bellevue Student***



It’s a good environment and my lab partners helped me a lot.”

– ***Bellevue Student***



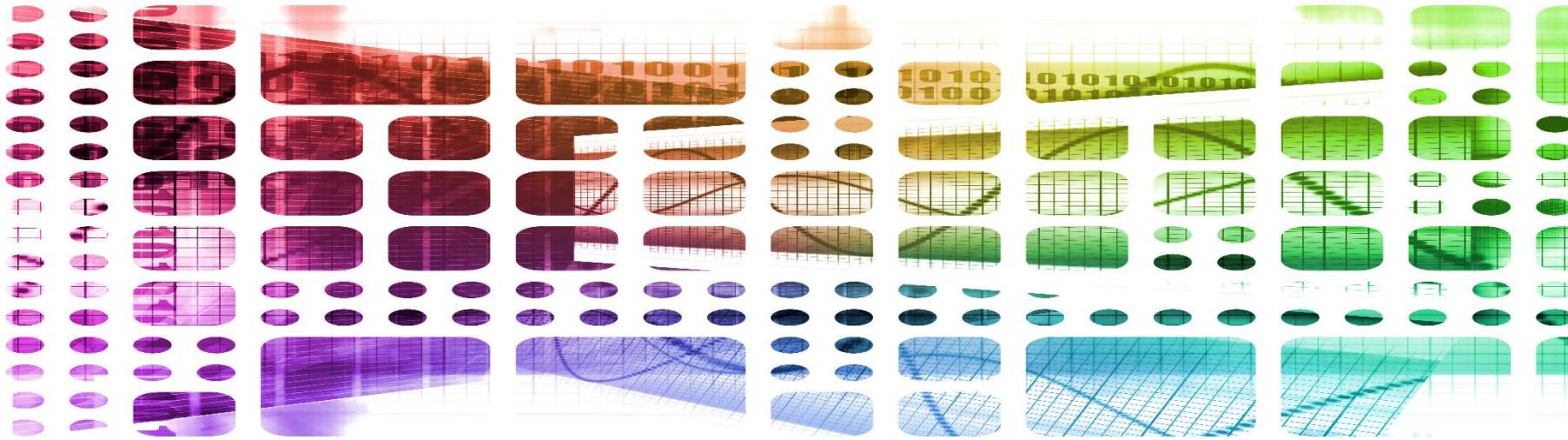
I don't like how half the seats at the tables face away from the front of the room. When I sit there I feel like it is hard to take notes because there is nowhere for me to set my notebook and to write on. I also feel like I can be perceived as not paying attention if my back is always turned to the professor when trying to take notes using the table.”

– ***Bellevue Student***



There are not any chairs, standing for 3 hours straight makes my feet, ankles, and knees hurt.”

– ***UNL Student***



04

Results: Instructor Experience

Instructor Experience

Structured interviews were conducted with four instructors, one from UNL and three from Bellevue University.

Qualitative findings revealed that the lab environment supports the following:

1. Course Goals
2. Student Safety
3. Curriculum Development and Teaching Practice
4. Flexibility

Instructor Experience

COURSE GOALS

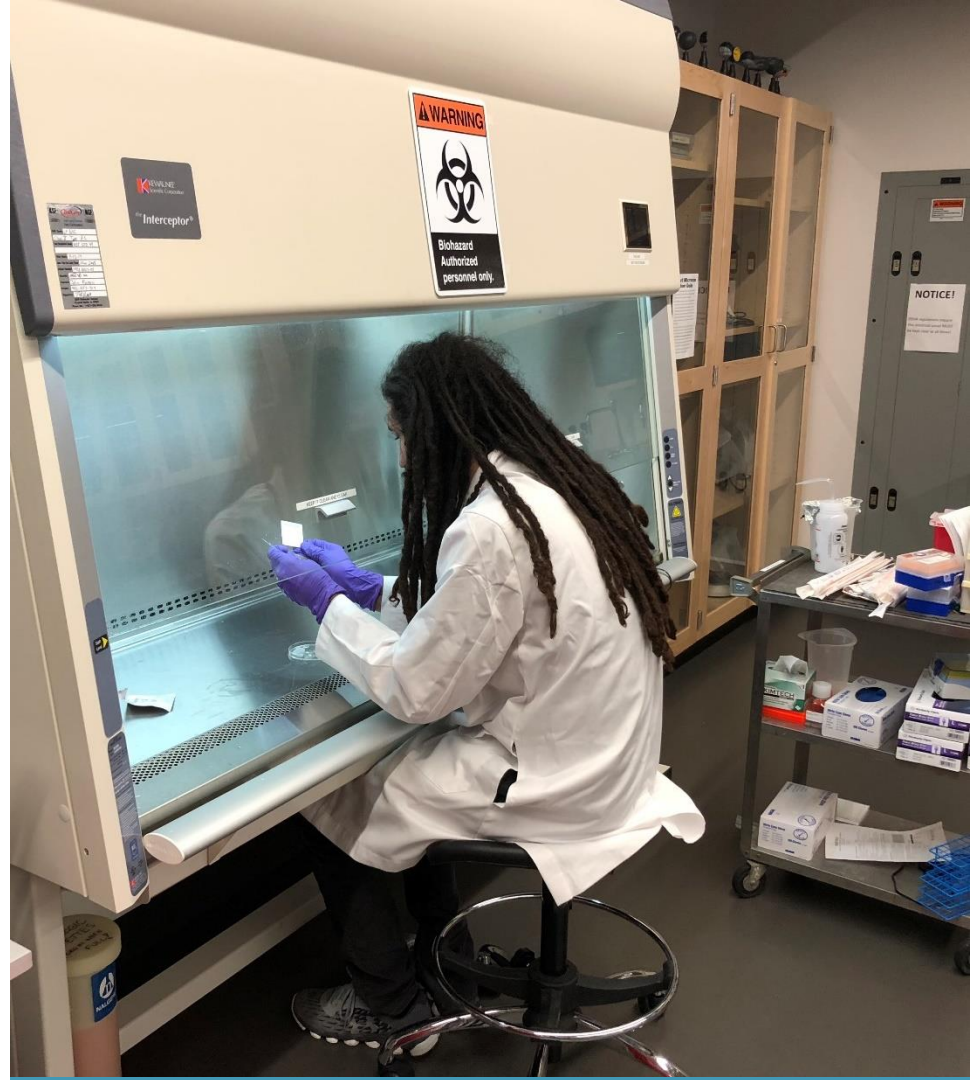
“So, we take 150 years’ worth of chemistry and condense it into 44 lectures. . . I want to get them started on how does chemistry think. It’s a different way of trying to observe and how we classify and explain things.”



Instructor Experience

COURSE GOALS

“[The new laboratory design] has made it a lot more flexible for how we can get to that goal. The spaces are a lot more conducive to collaboration... I have been able to do some things in the new spaces I wasn't able to do in the old spaces.”



Instructor Experience

STUDENT SAFETY

“Number one, there's more space and that's a big plus. The other thing is that there's more safety equipment per area.”



Instructor Experience

CURRICULUM DEVELOPMENT & TEACHING PRACTICE

“It has changed, especially the lab portion has changed...Now, we give students a lot more freedom, in a way, and it is a lot more unknown for us too...So, it has definitely changed the lab portion of the curriculum because of the space, because of the capability that we have to do this, but driven by the desire to do research.”



Instructor Experience

CURRICULUM DEVELOPMENT & TEACHING PRACTICE

“I think the flexibility helps keep me in the nothing’s-impossible mode. I mean it’s not restricting what I can do, or I probably would have backed off a little bit if I knew we didn’t have a lot of that interaction piece.”



Instructor Experience

FLEXIBILITY

“We only had four labs [before], we have four labs now...in the past it wasn't really designed for one or the other, it was just a room and you kind of had to adapt yourself to the way it is. Now, it is a lot more flexible when you step in the room.”



Instructor Experience

FLEXIBILITY

“My ultimate goal is if they can pull some of the concepts and be able to think scientifically, that’s ultimately what I’d like them to walk away with. . . it’s hard to finger if there’s a specific thing in the design that achieves that [goal] other than flexibility. . . Having that design where I can come in next year and completely wipe out one lab and put in a different one. And it’s relatively easy for us to implement that.”



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