

Supplementary Information (SI) for Chemistry Education Research and Practice.
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Electronic Supplementary Information

for

Formulation of a Theory of Equity in Chemistry Instruction

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Preliminary Observation Protocol

This is the protocol which was used at the beginning of the study to inform the creation of the interview guide. The first author would fill out the form in a word processor while sitting in the classrooms being observed.

Observation number:

Observer:

Instructor:

Class:

Date:

Time:

NOTES:

Noteworthy verbal interactions: Record any significant exchanges between the instructor and students. Use quotation marks for verbatim statements. Note any students who may need to sign consent forms for data use.

Gender-neutral language: Did the instructor use gender-neutral terms? Record any relevant examples.

Student participation: Did the instructor call on students for answers? Note the diversity of students called on.

Positive reinforcement: Record any instances of praise and indicate whom it was directed toward.

Negative reinforcement or criticism: Record any instances and indicate whom it was directed toward.

Time	Tally		Approx. % of students on task
	On task	Off task	
Class start time			
Start time + 20 minutes			
Start time + 40 minutes			
Start time + 60 minutes			
...			

Auditory learning: Were there opportunities for students to engage through auditory learning?

Visual learning: Were there opportunities for students to engage through visual learning (e.g., diagrams, slides, demonstrations)?

Verbal learning: Were there opportunities for students to engage through verbal learning?

Kinesthetic learning: Were there opportunities for students to engage through hands-on activities or movement?

Classroom layout and movement: Sketch the classroom below and note how the instructor moved throughout the space.

Interview Guide

The following are examples of questions posed to participants.

When asked about underrepresented students, if the interviewee requested, they were provided with a definition and examples. Some examples of underrepresented identities are sexual and gender minority identities and disabled identities. Interviewees were also told that their answers to these questions can differ for different groups of underrepresented students. They were asked to be specific in which students they are talking about in their answers.

I. Background and Professional Experience

1. What is your experience in chemistry instruction?
2. How did you get to your current position?
3. What is your experience in chemical education research?
4. Have you been involved in teacher training? About how many/how often?
5. Do you feel comfortable with your amount of training?

II. Survey Follow-Up

6. What did you think of the survey?
 - Did you have any issues answering any of the questions?
 - Do you want to clarify any of these responses?

III. Equity and Pedagogical Practice

7. Have you been trained for equity or equality in the classroom? What did you learn?
8. What pedagogical methods do you use in your teaching?
 - Do you consider equity or equality when determining your pedagogical methods?
 - Why did you choose your pedagogical method instead of another?

9. Do you / How do you treat all your students equally?
10. Do you / How do you treat your students with equity?
11. What do you think about fairness in the classroom?
 - Do you / How do you make things fair in the classroom?

IV. Student Engagement and Support

12. How do you learn about your students at the beginning of each semester?
13. What would you do in a situation where a student asks to take an exam at a different time due to circumstances beyond their control, but not considered “excused” under university policy?
14. Have you ever recommended to a student that they change their major?
 - Please describe the context and the reason for your recommendation.
15. How can students learn about financial aid?
16. How can students balance work, school, and social life?

V. Vision for Equity in Chemistry Education

17. How do you think chemistry instruction can become more equitable?
18. How can concepts related to equity be incorporated into the content and delivery of chemistry courses at this university?
 - What concepts?
 - Do you think this would be valuable?
19. Do you identify with the term "equity practitioner"?
 - How do you practice equity?

Table 1: Carnegie and Hispanic Serving Institution Classifications of the Five Institutions where Data Were Collected

Institution	Description
A	<ul style="list-style-type: none"> • Medium, primarily residential, community engaged university • Doctoral/professional university • Undergraduate profile: full-time, inclusive, higher transfer-in
B	<ul style="list-style-type: none"> • Large, primarily nonresidential • Doctoral university, very high research activity • Undergraduate profile: medium full-time, selective, higher transfer-in
C	<ul style="list-style-type: none"> • Large, primarily residential • Doctoral university, very high research activity • Undergraduate profile: full-time, more selective, lower transfer-in
D	<ul style="list-style-type: none"> • Large, primarily nonresidential • Master's colleges and university • Undergraduate profile: medium full-time, inclusive, higher transfer-in • Hispanic Serving Institution
E	<ul style="list-style-type: none"> • Large, primarily residential, community engaged university • Doctoral university, very high research activity • Undergraduate profile: full-time, selective, lower transfer-in

Table 2: Summary of Student Participant Demographics

Pseudonym	Race	Ethnicity	Age	Gender Identity	Sexual Orientation	Disability
Crimson	Caucasian	NR	35	Female	Heterosexual	NR
Teal	White	NR	18	Non-Binary	Asexual	NR
Aqua	Black	African American	20	Female	Straight	None
Lime	Indian	Indian American	19	Male	Heterosexual	NR
Salmon	Hispanic	Hispanic	18	Female	Straight	None
Lilac	Black	African	21	Female	Straight	None

Silver	Mexican	NR	24	Female	Straight	Turner Syndrome
Mauve	Caucasian	White	18	Transmasculine	Gay/Demisexual	Depression
Chartreuse	White	NR	19	Female	Straight	None
Indigo	White	White	29	Male	Heterosexual	None
Citrine	Asian	Asian	19	Female	Straight	None
Plum	Asian	Punjabi	26	Male	Bisexual	None

Note. NR = Not reported.

Table 3: Summary of Chemistry Instructor Participant Demographics

Pseudonym	Job Title	Ethnicity	Gender Identity	Sexual Orientation	Other Reported Identities
Mustard	Lecturer	White/Caucasian	Cis-gender female	Heterosexual	Not reported
Fuchsia	Research assistant	European	Female	Straight	Not reported
Lavender	Associate Professor	Caucasian	Female	Heterosexual	Liberal, feminist, European
Magenta	Full-time researcher	European	Slightly femme of center	Queer	Agnostic
Platinum	Graduate student research assistant	White	Female	Bisexual	Jewish
Steel	Instructor	White European	Female	Straight	Dual citizenship, globalist, runner
Sapphire	Graduate Student	European American	Male	Heterosexual	Jewish, tall, leftist, atheist
Mint	Associate Professor	Polish	Female	Heterosexual	Political refugee
Periwinkle	Teaching Professor, Senior Instructor	Non-Hispanic	Female	Straight	Episcopalian

Note. All chemistry instructors in the study reported White as their race and none reported any disabilities.

Table 4: Summary of Equity Practitioner Participants

Pseudonym	Job Title	Race / Ethnicity	Gender Identity	Other Reported Identities
Moss	Graduate Teaching Assistant	Mexican/ Latinx/ Hispanic	Woman	Raised low income in an area of high crime. Child of an immigrant. First-generation student. Bisexual. Has anxiety and depression.
Mango	Graduate Teaching Assistant	White/ American	Cis Female	Southerner, raised Christian, woman scientist, US citizen, part of an interracial marriage. Heterosexual.
Amethyst	Graduate Teaching Assistant	White/ White	Female	Heterosexual
Tangerine	Director of Student Affairs	White/ Non-Hispanic	Cis-Gender Female	Agnostic, Heterosexual.
Gold	Professor; Interim Director of Center for Teaching	White/ Mexican	Female	NR
Denim	Director of the Center for Learning	White/ German American	Female	First-Generation College Student. Has chemical sensitivity. Fluid sexuality. Practices Mindfulness.
Hibiscus	Graduate Researcher	White/ White	Female	Thin, upper middle class, Jewish, Bisexual. Has anxiety and depression.
Turquoise	Director of Hispanic Serving Institution Initiatives	NR/ Chicano/ Latino	Cis Male	Catholic, Gay.
Canary	Assistant Dean of Center of Equity and Director of Student Support	Native American /Hispanic	Woman	Catholic, straight, cisgender. Has disability.

Note. NR = not reported.

Table 5: Number of Interview Participants per Institution.

Institution	Participant Type		
	Student	Chemistry Instructor	Equity Practitioner
A	5	2	5
B	0	2	0
C	6.5*	5	1
D	0.5*	0	2
E	0	0	1

Note. One student participant attended classes at two of the institutions included in this study (C and D). To account for this in the table, the student was split between the two institutions.

Equity Observation Protocol

The following table is an example of a rubric that connects the theoretical elements to behavioral indicators and proficiency scale by which the behavior could be assessed. This rubric could help educators and institutions reflect on and evaluate practices that support equity in education. Each theoretical element is paired with specific behavioral indicators. The 1-4 proficiency rating scale could be used to assess how consistently each practice is integrated.

Table 6: Equity Observation Protocol

Theoretical Element	Behavioral Indicators	Rating (1-4)*
Fostering awareness and education around the challenges students face	<ul style="list-style-type: none"> • Reflects on systemic barriers • Attends equity Professional Development regularly • Gathers student input 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Empathizing and sympathizing	<ul style="list-style-type: none"> • Checks in on students' well-being • Responds with compassion • Uses open communication practices 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Practicing flexibility	<ul style="list-style-type: none"> • Provides deadline flexibility • Uses alternative assessments • Adjusts for students' diverse needs 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Using evidence-based equitable practices	<ul style="list-style-type: none"> • Applies UDL and active learning • Analyzes disaggregated student data • Uses culturally responsive pedagogy 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Including many perspectives	<ul style="list-style-type: none"> • Includes diverse authors/scientists and content • Invites student cultural connections • Facilitates critical discussions on perspectives 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Institutional accountability	<ul style="list-style-type: none"> • Shares equity metrics • Integrates equity into evaluations • Has structures for feedback and reporting 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Providing support and resources	<ul style="list-style-type: none"> • Regularly refers students to support resources • Shares academic and wellness resources • Tracks support access and follow-up 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Practicing reflexivity	<ul style="list-style-type: none"> • Reflects on teaching impact • Reviews student feedback • Discusses equity in teaching groups 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Building welcoming environments	<ul style="list-style-type: none"> • Affirms student identities • Uses co-created classroom norms • Creates inclusive classroom culture 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4
Working with the Community	<ul style="list-style-type: none"> • Includes community-based learning • Invites local speakers/partners • Builds reciprocal partnerships 	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4

*Rating Scale:

1 = Not evident (the behavior, skill, or concept is absent or not observable)

2 = Emerging (some early signs are present, but inconsistent or limited)

3 = Practiced (regularly demonstrated but may still need refinement or consistency)

4 = Consistently integrated (fully embedded and applied with confidence and regularity)