Validation of the Student Inclusive Teaching Strategies Inventory (ITSI-S) for instructional STEM laboratory settings

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Access and inclusion in instructional laboratory settings is an important topic in our modern age. Student perceptions of inclusivity are paramount for understanding access needs in classroom settings. The Inclusive Teaching Strategies Inventory - Student (ITSI-S) is an instrument for measuring students' perceptions of the inclusivity of various classroom practices. The instructor component, the ITSI, has been validated for STEM classrooms and for laboratory instructors and significant changes were made by our study team members in previous years. In this paper we describe our validation of the ITSI-S. Data were collected through interviews with students in laboratory courses. Then, we utilized content analysis to uncover areas where students misunderstood the question or needed further clarification. The ITSI-S could be a valuable tool to help investigate inclusivity in labs from the student perspective and could in particular give voice to disabled students.

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I. INTRODUCTION

In this paper, we describe our investigation into the validity of the Student Inclusive Teaching Strategies Inventory (ITSI-S), a survey for eliciting postsecondary students' perspectives of inclusive teaching practices across a range of disciplines, for postsecondary STEM laboratory settings [1]. The ITSI-S is a counterpart to the Inclusive Teaching Strategies Inventory (ITSI), which measures instructors' views on inclusive teaching strategies [2]. Being able to measure the accessibility and inclusivity of courses is an important step to understanding the current state of accessibility within STEM courses.

When implementing the ITSI with STEM faculty and graduate teaching assistants, our group found it was necessary to modify the survey to enhance the validity of responses [9]. The ITSI-S was not modified at this time as the project focused on instructor perspectives. Here, we report our process for identifying changes necessary to implement the ITSI-S in postsecondary STEM lab courses.

II. BACKGROUND

A. Disability and STEM

Educational representation and outcomes for people with disabilities are still behind those of non-disabled people. Disabled workers in STEM hold bachelor's degrees at lower rates than non-disabled workers [3,4]. Universal design education models are one way of increasing access to education for people with a range of abilities [5]. However, research shows that many current curricula in physics and chemistry do not frequently enact UD principles [6,7].

In addition to broader curricula not enacting UD principles, STEM laboratory sections are also behind in enacting inclusive practices. It was only in 2022 that the American Association of Physics Teachers (AAPT) board endorsed a report calling the physics education community to action to increase accessibility in educational laboratory settings [8]. This report includes motivations for change, recommendations for various levels of changemakers, testimonials from disabled students, and information on disabled learners.

B. ITSI and ITSI-S

The ITSI is designed to measure the attitudes and actions of faculty regarding inclusive instructional practices, centered around universal design principles [2]. Similarly, the ITSI-S is designed to measure the attitudes of students and the actions they see their instructors take in the classroom regarding inclusive instructional practices [1]. The ITSI-S is the only known instrument that focuses explicitly on inclusivity for disabilities within classrooms [9].

The ITSI-S is composed of two sections: the actions section and the attitudes section; each section has its own response stem, "I believe it's important for my instructor to…" for the attitudes section and "My instructor…" for the actions section [1]. Each stem has 33 prompts that attach to the stem, forming a full sentence. For example, the prompt "allows students to express knowledge in multiple ways" forms the sentences "I believe it's important for my instructor to allow students to express knowledge in multiple ways" and "My instructor allows students to express knowledge in multiple ways." These 33 prompts are divided into six subscales: accommodations, accessible course materials, course modifications, inclusive lecture strategies, inclusive classroom, and inclusive assessment [1]. The subscales and their associated prompts (after the changes made by our research team, as described in this paper) can be seen in Table I.

C. Prior modification to the ITSI

The ITSI was modified by Scanlon and Chini in 2019, where interviews with physics faculty and graduate students found that they were confused on how to respond to some of the prompts [10]. The largest change made to the ITSI included the addition of a population section, which added an additional stem to some of the questions in order to ask respondents which population they would do certain instructional practices for. Because the ITSI and the ITSI-S were designed with similar prompts, our study team decided to utilize validation interviews to see if the ITSI-S garnered similar responses from students as the ITSI did from faculty.

D. Positionality and language

The research team for this paper is composed of a variety of disabled and non-disabled people. Within disability communities, there are a variety of language preferences, including person-first and identity-first language. The first author of this paper identifies as disabled but does not have a particular preference for specific language surrounding disability. In this paper, we utilize both person-first and identify-first language, while in the ITSI-S itself, person-first language is used, as it was used in the original iteration of the ITSI-S. We value this conscious choice made by the original authors of the ITSI-S and have kept it intact.

III. VALIDATION PROCESS

A. Interviews

Interview participants were current undergraduate general chemistry laboratory students who responded to a participant interest survey. The participants all attended a four-year doctoral-granting, research-intensive Hispanic

TABLE I: Summary of changes made to the Inclusive Teaching Strategies Inventory

Subscale	Prompt	Change
Accommodations	Allows students to use technology (e.g. laptop, calculator, spell checker) to complete tests.	*
	Provide copies of lecture notes or outlines.	*
	Provide copies of PowerPoint presentations	* Removed "overhead"
	Allow flexible response options on exams (e.g. change from written to oral)	*
	Allow digital recording of class sessions (audio or visual).	*
	Make individual accommodations.	*
	Arrange extended time on exams.	*
	Extend the due dates of assignments to accommodate the needs of students.	*
Course Modifications	Allow students to complete extra credit assignments.	* Remove redundancies due to population section
	Reduce the course reading load.	* Remove redundancies due to population section
Accessible Course Materials	Allow flexibility in submitting assignments electronically (e.g. mail attachment, digital drop box)	*
	Use a course website (e.g., Webcourses, or faculty web page.)	
	Post electronic versions of course handouts.	
Inclusive Lecture Strategies	Repeat the question back to the class before answering when a question is asked during a class session.	
	Begin each class session with an outline/agenda of the topics that will be covered.	
	Summarize key points throughout each class session.	
	Connect key points with larger course objectives during class sessions.	
Inclusive Assessment	Allow students to demonstrate the knowledge and skills in ways other than traditional tests and exams (e.g., written essays, portfolios, journals.)	
	Allow students to express knowledge in multiple ways.	
Inclusive Classroom	Use technology so that course material can be available in a variety of formats (e.g., podcast of lecture available for download, course readings available as mp3 files.)	
	Use interactive technology to facilitate class communication and participation (e.g., Discussion Board.)	
	Present course information in multiple formats (e.g., lecture, text, graphics, audio, video, hands-on exercises.)	
	Create multiple opportunities for engagement.	
	Survey the classroom in advance to anticipate any physical barriers.	
	Include a statement in the syllabus inviting students with disabilities to discuss their needs with them.	
	Make a verbal statement in class inviting students with disabilities to discuss their needs with them.	
	Use a variety of instructional formats in addition to lecture, such as small groups, peer assisted learning, and hands on	
	Supplement class sessions and reading assignments with visual aids (e.g., photographs, videos, diagrams, interactive simulations.)	

* Indicates addition of population section

Serving Institution (HSI). Seven students were selected for the interviews, and five interviews were completed. Two students did not respond to interview requests despite responding to the participant interest form. The participant interest form requested students give their level of experience with disability with responses options: I have a disability; family member, friend, or other personal contact has a disability; I have worked with or taught students with disabilities; and no, I have not had any personal experiences with disability. No participants selected "I have worked with or taught students with disabilities." Interviews were ultimately conducted with two students who said they have a disability; one student who said they have a family member, friend, or other personal contact with a disability; and two students who said they have no personal experiences with disability. Two respondents were Black, one was white, and two were Hispanic/Latino/a. One limitation of

TABLE II: Example of analysis Excel sheet

Question	I believe it's important for my instructor to provide copies of overhead and/or PowerPoint presentations to students with documented disabilities.
Participant	Participant 1
Quote	What does it mean by over overhead?
Inference Level	Low
Potential Changes	Remove or change language of "overhead"

this study is that we did not collect gender identity information for participants.

The interview protocol was based on the think-aloud interview method [11]. This method allows for respondents to discuss their thoughts while they are answering questions [11]. The interview questions were mainly the questions of the survey, with a few clarifying questions added in, particularly for participants to discuss their definitions of key words in the survey. For example, students were asked what the term "documented disability" means to them. During the interviews, probing questions were added. These ranged from clarifying questions to requests for the student to think-aloud when they simply answered the question without discussing their thought process.

B. Analysis

The methods used were based on methods by authors Scanlon and Chini to validate the ITSI for STEM courses [10]. Zoom's AI transcriptions of the interviews were used as a base for the transcription and cleaned by Willison. An Excel spreadsheet was used for analysis, which can be seen in Table II with an example of one change. Lead author Willison carefully reviewed each transcript, looking for places in which a participant was confused or did not understand the question, whether they were aware of their misunderstanding or not. For each place of confusion, a quote of the confusion with timestamps was pulled from the transcript and placed in a row with the question the confusion pertained to.

After all the areas of confusion were pulled from the transcripts, the spreadsheet was arranged by question and a researcher went through and suggested changes to each question or the survey based on the areas of confusion and misunderstanding. For trustworthiness, the changes were then reviewed by the remaining authors and any disagreements were discussed. There were two disagreements, out of 29 changes. Both disagreements were resolved after discussion among the research team.

IV. VALIDATION FINDINGS

A. Changes to the ITSI-S

Three primary changes were made to the ITSI-S which mirror changes that were previously made to the ITSI. In order of magnitude from smallest to largest, they are:

1. Updates to technology-related questions
2. Addition of language to ensure students are thinking about the focal laboratory course (in this case, a chemistry laboratory)
3. Addition of the population section

A summary of the changes can be found in Table I.

The smallest change was the updates on technology-related questions. Since the ITSI-S was developed in 2014, significant technological advances have happened, and technology is used in the classroom more now than ever. In particular, the COVID-19 pandemic adjusted student expectations of classroom technology use. Some words, like the inclusion of "overheads" were confusing to students, and thus were removed and/or changed to match the current standards of university-level classroom technology.

The next change was the addition of a section at the beginning of the survey which reminds students to think about their recent chemistry laboratory course. It also reminds students that the term "instructor" could mean either the TA or the professor in their laboratory course. We want to ensure that students are thinking about the TAs in their laboratory course, but we kept the term instructor to allow for usage in broader contexts. When prompted, multiple students said they were only thinking about the professor in their laboratory course when they saw the term "instructor". Secondly, we want students to be thinking about their chemistry laboratory course specifically, and not the chemistry lecture. This was a question that students brought up multiple times in the validation interviews, unprompted by the interviewer.

The biggest change, the addition of the population section, is motivated by many questions that the participants had during the interview about which population of students the ITSI-S questions were about. For example, a question that stated, "My instructor provides copies of lecture notes or outlines to students with documented disabilities" was responded to by one participant saying, "Those kinds of materials, at least in my course, were provided to everybody, regardless of their disability status." These types of questions from the students were expected, as the ITSI received similar questions from instructors. This section of the survey will ask the same prompts as the ITSI-S but with the addition of two stems. The two additional stems are "My instructor does this for…" and "I believe this is important for…" with four response options for each stem: no students, only students

with disabilities, students who need it, and all students. This allows students to answer about both the regular actions and belief stems, along with the population that coincide with the instructional practice. For example, a student may answer the prompt "Provide copies of PowerPoint presentations" with "My instructor does this for all students," "My instructor does this sometimes," "I believe this is important for all students," and "I strongly believe this is important."

B. Comparison to ITSI

As stated in the previous section, the changes to the ITSI-S mirror the changes made to the ITSI in 2019 [10]. The changes to the ITSI were made after a pilot distribution of the survey to physics and chemistry faculty and physics graduate students, interviews with physicists, and discussion with the ITSI developer. The largest change to the ITSI was the addition of the population section, which informed the addition of the population section to the ITSI-S. The similar responses from students and faculty garnered a similar modification for both surveys. However, while the modified ITSI-S has four stems for each prompt, the modified ITSI only has three stems. This difference is because the ITSI is made for instructors to be respondents, so their responses of "I [as an instructor] would do this for…" and "I believe this is important to do for…" are redundant. In the student survey, this was an important distinction to make, as the students are reporting on what they see their instructor do in "My instructor does this for…" and would not be able to add in who they think the instructional practice is important for without the additional stem. Table III lists and compares the stems in the modified ITSI and modified ITSI-S.

Since the number of stems differs between the ITSI and ITSI-S, there is not a one-to-one correlation. Rather, we suggest the following interpretations:

- There are two possible comparisons for the population prompt. Comparing the ITSI-S responses to "My instructor does this for…" and the ITSI "I would do this for…" provides a comparison of the instructor's stated practice and the students' perceptions. Comparison between the ITSI-S "I believe this important to do for…" and the population ITSI prompt allows comparison of instructor and student goals,
- Comparison of the two attitudes prompts explores alignment between student and instructor perceptions of the practice overall
- Comparison of the two action prompts explores alignment between instructors' self-reported actions and students' perceptions of instructors' actions.

TABLE III: ITSI and ITSI-S prompts and stems

Prompt Type	ITSI	ITSI-S
Population	I would do this for…	My instructor does this for…
		I believe this is important to do for…
Attitudes	I believe it's important to…	I believe it's important for my instructor to…
Actions	I do this…	My instructor…

V. CONCLUSIONS AND FUTURE RESEARCH

In this paper, we reported on our investigation of the validity of the ITSI-S survey for postsecondary STEM laboratory environments. We found several changes were needed to support students' interpretations of the survey prompts, including minor changes, such as an update to descriptions of technology and reminders of the focal course and instructor, as well as a more significant change to include a population prompt. The need for this population prompt mirrors our prior modifications to the ITSI survey.

The changes made to the ITSI-S may help future instrument designers. They may also help those looking to utilize the ITSI-S in their research projects, and instructors looking to utilize the ITSI-S in their classroom to determine the student perceptions of inclusivity. Additionally, the validation process that was used here could be easily replicated for other contexts and populations.

Next steps for this project include investigation of the reliability of the overall survey and of each subscale through a small-scale distribution. Time limitations did not allow a distribution of the survey prior to this publication. Next, a large-scale distribution of the survey is intended. The survey will be distributed to undergraduate chemistry students at four institutions participating in the larger study. The students' TAs will also respond to the ITSI. The students' responses will be compared to the responses of the students' respective TAs to the ITSI survey, as described in the prior section.

As the subscales and items of the ITSI and the ITSI-S correspond, the mean and standard error of the mean of each subscale and each prompt will be used to describe the similarities and differences between the TA responses and their students' responses. The project is looking to ascertain the differences between undergraduate student and TA attitudes towards and perceptions of the accessibility of their classrooms.

Finally, the ITSI-S will be distributed to undergraduate physics students at a four-year doctoral-granting, research-intensive Hispanic Serving Institution (HSI). Similarly to the undergraduate chemistry responses, these responses will be matched to ITSI responses from the students' respective physics teaching assistants. The differences and similarities between the physics students and TA responses will then be compared to those from the chemistry student and TA responses. The goal of this portion of the project is to understand the differences in attitudes and perceptions of inclusive classroom activities between disciplines.

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