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Development of the Student Perceptions of the College Instructional Laboratory Survey

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The science laboratory learning environment is an important area in science education and has been examined extensively at the high school level, primarily using the Science Laboratory Environment Inventory (SLEI) (Hofstein & Lunetta, 1982; 2004). The SLEI at one time was also validated for use with college students though college-level studies are much fewer, and now they are quite dated (Fraser, McRobbie, and Giddings, 1993). Moreover, it isn't clear that the SLEI ever represented the interests of college laboratory science instructors given its infrequent use with college students.

In contrast to the SLEI, Bruck and Towns (2013) developed and validated an instrument specifically for use with college chemistry faculty focusing on faculty goals or intentions for laboratory instruction. The Bruck and Towns (2013) instrument is specifically used to assess college chemistry faculty intentions for labs. Our interest is expanding on their work to develop and validate an instrument for use across the sciences to assess college *student* perceptions of the undergraduate, science laboratory with respect to science instructor intentions. In other words, our interest is in student perceptions of faculty intentions for undergraduate science laboratory instruction.

We were interested in developing an instrument that assesses the degree to which students perceive the laboratory as it is generally intended by science instructors, with that instrument being validated at the college level. An examination of the literature indicated that there are no validated and reliable instruments for measuring student perceptions of what science instructors intend for the laboratory. We developed and validated the SPCILS survey to serve this purpose. Potentially, the SPCILS will give college instructors valuable information for revising the instructional laboratory. It is important to identify students' perceptions because one can expect that laboratory instruction will be more effective where student perceptions are aligned with their science instructors' intentions. While this point has not been addressed, other research on attitudes and instructional effectiveness suggests that such a linkage exists (George-Williams, Carroll, Ziebell, Thompson, and Overton, 2018).

The existing instrument closest to our purposes is the Bruck and Towns (2013) instrument, but as noted, that instrument was explicitly designed for chemistry and to be taken by faculty. Nevertheless, the Bruck and Towns (2013) instrument provided a model useful for our purposes. Following their model, we used a bottom-up approach for instrument development (Cobern and Adams, 2020). Drawing on the work of Bruck and Towns (2013), our goal was to develop an idealized model of faculty intentions for college laboratory instruction as the basis for a new instrument measuring students' perception of faculty intentions for laboratory instruction. Thus, our research had two objectives:

1. Develop a new instrument for measuring students' perception of faculty intentions for laboratory instruction.
2. Evaluate the validity and reliability of the new instrument for use at the undergraduate level.

What follows is a description of the development and validation processes.

We developed a conceptual or foundational model for the SPCILS using a bottom-up approach. We then used statistical analysis for item reduction and determining category internal consistency. The bottom-up approach is applicable for the development of the SPCILS since there was no a priori model or theory on which to build the survey. In this case, the model had to be built inductively from expert opinion (Cobern and Adams, 2020). The survey development involved two phases following Human Subjects Institutional Review Board approval.

Phase I: Model and Item development

Using a process similar to that of Bruck and Towns (2013), we recruited an expert panel from biology and physics to draft a list of typical faculty goals or intentions for undergraduate laboratory courses. We did not recruit from chemistry because we had Bruck and Towns (2013) to draw from since their focus was chemistry. The expert panel generated 137 goal statements; this included statements from Bruck and Towns (2013). Subsequently, an independent group of six college science instructors, working in three teams of two, categorized the statements. The teams had similar but not identical categories, and thus they worked together until they reached a consensus set of categories. During this process, five statements were found not to fit in any category and were therefore removed (Table 1).

Table 1

Statements deleted from the initial SPCILS

I am able to change the laboratory curriculum as I please.
I collaborate with other faculty to develop the laboratory curriculum.
I consider how the laboratory connects to the lecture when choosing laboratories.
Collaborating with other faculty members about the laboratory curriculum is cumbersome.
Laboratory experiments are selected with high regard for the safety of the students.

Subsequently, a third group composed of four doctoral students, all experienced teachers of science, examined the grouped statements, and suggested some rearranging. The final step in this phase of development was to take the suggested grouped statements back to the panel of experts. They concurred on the rearrangement of the statements and ranked the statements in each category on what they considered most important to least important. We then reduced each category to ten statements by keeping only the most important statements. These 50-items were placed into a five-point Likert scale (See Appendix A). We checked the survey items for readability using an online readability calculator. All the items were found to be within the 10th-grade readability level.

Phase II: Item Reduction and Reliability Assessment

Item Reduction and Testing

We were concerned that with 50 items, fatigue would create response errors over the last quarter of the survey (Cobern and Adams, 2020). As a precaution, we created five versions, with each version having a different random assortment of items, thus preventing fatigue-based response errors being concentrated in the same items. In fall 2019, these five versions were administered to 557 students in an undergraduate laboratory course, during the fifth week of lab sessions. Indeed, we had a few students complain about the length of the survey and the questions being redundant. We subsequently checked for category internal consistency by calculating Cronbach's alpha for each of the five categories (Table 2). All five categories had acceptable scores (≥0.70).

Table 2

Cronbach Alpha Coefficients for the 20-item Final SPCILS survey

Categories	Cronbach's alpha
Social Relationships	0.725
Future Oriented Outcomes	0.755
Habits of Mind	0.758
Relationship to Content	0.794
Skills	0.804

The next step was to reduce the number of items while maintaining acceptable internal consistency scores for each of the categories. Our target was a total of 20 items. We calculated item-to-item, Pearson correlation coefficients for all of the 50 items, and then reconvened the panel experts. The panel did another ranking of items within the categories (most important to least) and then used those rankings along with the item-to-item correlation coefficients as the basis for deleting items. Thus, the panel reduced each category to four items, for a total of 20 items (Table 3).

Table 3

The 20-Item SPCILS

Social Relationships
In this lab course, I feel comfortable asking the instructor questions.
I work with my lab partners cooperatively and collaboratively in this lab course.
In this lab course, the process of thinking through an experiment is as important as obtaining the correct answer.
I understand the purpose and outcomes for this lab course.
Future Oriented Outcomes
The course lab activities help me develop skills that I can apply to future science courses
This lab course gives me an idea of how science is performed in the real world.
The goal of this lab course is to prepare me for research experiences.
The laboratory experiments of this lab course are applicable to various disciplines.
Habits of Mind
This lab course is designed to foster the development of my scientific reasoning skills
In this lab course, I learn how to present data in a form that is understandable.
In this lab course, I am developing an understanding of the scientific method.
In this lab course, I am learning good lab practices like how to use and organize my lab notebook.
Relationship to content
In this lab course, I gain hands-on experience that reinforces and solidifies content knowledge.

In this lab course, I learn to connect laboratory concepts to quantitative data collection procedures.
In this lab course, laboratory activities help strengthen my understanding of concepts taught in lecture.
In this lab course, laboratory activities help me develop a deeper understanding of science concepts.
Skills
In this lab course, I am developing an understanding of the accuracy of measurements, calculations and data analysis methods.
In this lab course, I am gaining skills in presenting the findings of my experiments in tables and graphs.
In this lab course, I am developing skills in using scientific instruments.
This lab course is helping me develop practical laboratory skills.

Cronbach's alpha was recalculated for each category finding the scores for all five categories to be acceptable. The panel then wrote descriptions for each category (Table 4).

Table 4

Student Perceptions of the College Instructional Laboratory Survey (SPCILS) Categories and Description of Each Category

Categories	**Category Descriptions**
Social Relationships	Social interaction is an important aspect of the classroom environment and lab activities foster interactive learning.
Future Oriented Outcomes	The laboratory curriculum includes knowledge and skills students might need for future laboratory experiences.
Habits of Mind	Students are regularly engaged with a range of practices that reflect the broader methods of science.
Relationship to Content	Content depth and practical experiences in the laboratory go beyond, but are directly related to, what is covered in lecture settings.
Skills	A priority is placed on developing the fundamental skills and techniques students need to appropriately engage in the general laboratory setting.

Reliability Assessment

Phase II concluded with a second pilot study (Fall 2019) used to assess the reliability of the 20-item SPCILS and also to recheck category internal consistency. A new sample of 40 students, who were midway through undergraduate science laboratory courses, were the participants. The students completed the 20-item SPCILS and then ten days later took the same instrument again. To determine whether the reduced item set still had category internal consistency, we calculated Cronbach's alpha for each category.

Most researchers use Cronbach's alpha to measure the reliability of a group of variables. However, Cronbach's alpha is actually an indicator of internal consistency amongst a group of items (see Taber, 2018; Cobern and Adams, 2020). Therefore, for this study, to check for reliability, we calculated Pearson correlation coefficients between the test and retest data. In the test-retest procedure, the same survey is administered twice to the same group of people and the test/retest, item-to-item correlation coefficients calculated; scores from the first test are correlated with scores from the retest (Cobern and Adams, 2020). The time between the two tests is critical. If the time is too short, responses on the retest may be affected by participants' memory of individual items. If the time is too long, participant responses may change due to events occurring during the intervening interval. Either situation potentially distorts the estimate of instrument reliability (Mueller, 1986; Cobern and Adams, 2020; Taber, 2013; Taber, 2018). The time in between the test-retest should not be more than 10-14 days.

Results

Table 5 below shows the category Cronbach alpha coefficients for the initial 50-item SPCILS. Reducing to 20 items actually improved the internal consistency. Table 5 shows the Cronbach alpha coefficients for both the test and retest using the 20-item instrument. Cronbach's alpha for each of the five categories for the test/retest are consistent across time (test/retest), which indicates category reliability.

Table 5

Correlation Coefficients for the Test-Retest Final SPCILS survey

Categories	50-items	20-items	
	Test	Test	Retest
	Cronbach's alpha	Cronbach's alpha	Cronbach's alpha
Social Relationships	0.725	0.859	0.877
Future Oriented Outcomes	0.755	0.839	0.891
Habits of Mind	0.758	0.846	0.822
Relationship of Content	0.794	0.847	0.875
Skills	0.804	0.913	0.894

As a further test of category reliability, we calculated test/retest category correlation coefficients and found them acceptable, ranging from 0.746 to 0.837 (Table 6).

Table 6
Correlation coefficients for test retest of the Final SPCILS survey categories

Categories	Correlation coefficient
Social Relationships	0.837
Future Oriented Outcomes	0.824
Habits of Mind	0.746
Relationship of Content	0.768
Skills	0.790

Finally, we calculated test/retest correlation coefficients at the item-level and found all greater than or equal to 0.725, and thus having acceptable reliability (Appendix C).

Summary

We developed the Student Perceptions of the College Instructional Laboratory Survey (SPCILS) using a foundational model and a bottom-up approach. The bottom-up approach is applicable for the development of the SPCILS since there was no *a priori* model on which to build the survey. In this case, the model had to be built inductively from expert opinion (Cobern and Adams, 2020). We convened a panel of undergraduate science laboratory experts to develop valid statements. We believe the categories are valid because they came from this panel of experts. We then used statistical analysis for item reduction and determining category internal consistency. The item reduction was accomplished by item to item correlation and expert opinion. Cronbach's alpha and expert opinion were used to determine category internal consistency and validity; reliability was established by Pearson correlations coefficients between the test and retest data.

The SPCILS is an easy-to-use, quantitative indicator of student perceptions of the laboratory with respect to science instructors' intentions. It is neither course-specific nor discipline-specific, but rather constitutes student perceptions of the laboratory with respect to science instructors' general intentions for laboratories. The SPCILS has students rate their agreement with statements and can be directly compared with science instructors' intentions for laboratories. Thus, instructors should find the SPCILS to be a useful tool for evaluating introductory science laboratory course design for the purpose of improving laboratory instruction.

References

Bruck, A. D., & Towns, M. (2013). Development, implementation, and analysis of a national survey of faculty goals for undergraduate chemistry laboratory. *Journal of Chemical Education*, 90(6), 685-693.

Cobern, W. W., & Adams, B. A. (2020). When interviewing: how many is enough? *International Journal of Assessment Tools in Education*, 7(1), 73-79.

Fraser, B. J., McRobbie, C. J., & Giddings, G. J. (1993). Development and cross-national validation of a laboratory classroom environment instrument for senior high school science. Science Education, 77(1), 1-24.

Fraser, B. J., McRobbie, C. J., & Giddings, G. J. (1993). Development and cross-national validation of a laboratory classroom environment instrument for senior high school science. *Science Education*, *77*(1), 1-24.

George-Williams, S., Carroll, M. R., Ziebell, A., Thompson, C., & Overton, T. (2018). Curtailing marking variation and enhancing feedback in large scale undergraduate chemistry courses through reducing academic judgement: a case study. *Assessment & Evaluation in Higher Education*, 1-13.

Hofstein, A., and V. N Lunetta. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science Education* 88 (1): 28-54.

Hofstein, A., and V. N. Lunetta. (1982). The role of the laboratory in science teaching: Neglected aspects of research. *Review of Educational Research* 52 (2): 201-217.

Mueller, D. J. (1986). *Measuring social attitudes: A handbook for researchers and practitioners*. New York: Teachers College Press..

Taber, K. S. (2013a). *Classroom-based research and evidence-based practice: an introduction* (2nd ed.). London: Sage

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273- 1296.

Appendix A

Initial Version of the Student Perceptions College Instructional Laboratory Survey (SPCILS)

Directions

The following questionnaire contains 50 statements about goals that laboratory instructors have for your science laboratory course.

We would like your opinion on whether the lab course you are now in is meeting these goals. For each item, please choose an option that best describes your level of agreement or disagreement with the laboratory goal.

Indicate your opinion by filling in one bubble per item according to the following scale.

Only fill one bubble per item.

STRONGLY DISAGREE with the statement.	●	○	○	○	○
DISAGREE with the statement.	○	●	○	○	○
NO OPINION about the statement	○	○	●	○	○
AGREE with the statement.	○	○	○	●	○
STRONGLY AGREE with the statement	○	○	○	○	●

SOCIAL RELATIONSHIPS		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	In this lab course, I feel comfortable asking the instructor questions.	☐	☐	☐	☐	☐
2	I work with my lab partners cooperatively and collaboratively in this lab course.	☐	☐	☐	☐	☐
3	The classroom for this lab course is a safe environment.	☐	☐	☐	☐	☐
4	I understand the purpose and outcomes for this lab course.	☐	☐	☐	☐	☐
5	In this lab course, I feel confident that I know how to properly use equipment and materials.	☐	☐	☐	☐	☐

6	I feel mentally and emotionally engaged during this lab course.	☐	☐	☐	☐	☐
7	Group work, in this lab course, helps me to learn to collaborate.	☐	☐	☐	☐	☐
8	In this lab course, I feel like I know what I am supposed to do.	☐	☐	☐	☐	☐
9	Because of this lab course, I feel confident in my ability to learn science.	☐	☐	☐	☐	☐
10	The course lab activities help me develop skills that I can apply to future science courses.	☐	☐	☐	☐	☐
FUTURE ORIENTED OUTCOMES		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
11	The laboratory experiments of this lab course are relevant to my career path.	☐	☐	☐	☐	☐
12	This lab course teaches skills that are relevant to my future career.	☐	☐	☐	☐	☐
13	In this lab course, I am introduced to skills that transfer to other courses offered at this university.	☐	☐	☐	☐	☐
14	Group work, in this lab course, helps me to succeed in my future endeavors.	☐	☐	☐	☐	☐
15	This lab course gives me an idea of how science is performed in the real world.	☐	☐	☐	☐	☐
16	The laboratory experiments in this lab course align well with my major at the university.	☐	☐	☐	☐	☐
17	The goal of this lab course is to prepare me for research experiences.	☐	☐	☐	☐	☐
18	The laboratory experiments of this lab course are applicable to various disciplines.	☐	☐	☐	☐	☐
19	The course lab activities foster an appreciation for science.	☐	☐	☐	☐	☐
20	In this lab course, the process of thinking through an experiment is as important as obtaining the correct answer.	☐	☐	☐	☐	☐

HABITS OF MIND		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
21	This lab course is designed to foster the development of my scientific reasoning skills.	☐	☐	☐	☐	☐
22	In this lab course, I learn how to analyze and interpret my data.	☐	☐	☐	☐	☐
23	In this lab course, I learn how to build logical conclusions based on my data.	☐	☐	☐	☐	☐
24	In this lab course, I learn how to present data in a form that is understandable.	☐	☐	☐	☐	☐
25	In this lab course, one of the goals is understanding proper data collection techniques.	☐	☐	☐	☐	☐
26	In this lab course, the experiments allow me to interpret my data.	☐	☐	☐	☐	☐
27	In this lab course, I am developing an understanding of the scientific method.	☐	☐	☐	☐	☐
28	In this lab course, I learn the meaning of uncertainty in measurement procedures.	☐	☐	☐	☐	☐
29	In this lab course, I am developing a better understanding of laboratory techniques.	☐	☐	☐	☐	☐
30	In this lab course, I am learning good lab practices like how to use and organize my lab notebook.	☐	☐	☐	☐	☐
RELATIONSHIP TO CONTENT		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
31	In this lab course, I explore concepts already discussed in lecture.	☐	☐	☐	☐	☐
32	In this lab course, I gain hands-on experience that reinforces and solidifies content knowledge.	☐	☐	☐	☐	☐
33	In this lab course, the instructor asks questions to solidify my understanding of the concepts and meaning of lab results.	☐	☐	☐	☐	☐
34	In this lab course, the lab activities are relevant to lecture content.	☐	☐	☐	☐	☐

35	In this lab course, there is a strong connection between the laboratory and lecture.	☐	☐	☐	☐	☐
36	In this lab course, I learn to connect laboratory concepts to quantitative data collection procedures.	☐	☐	☐	☐	☐
37	In this lab course, laboratory activities help strengthen my understanding of concepts taught in lecture.	☐	☐	☐	☐	☐
38	In this lab course, laboratory activities help me develop a deeper understanding of science concepts.	☐	☐	☐	☐	☐
39	In this lab course, I am learning how to keep a proper laboratory notebook.	☐	☐	☐	☐	☐
40	In this lab course, I am learning how to work collaboratively with another student or students.	☐	☐	☐	☐	☐
SKILLS		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
41	In this lab course, I am developing an understanding of the accuracy of measurements, calculations and data analysis methods.	☐	☐	☐	☐	☐
42	In this lab course, I am gaining skills in presenting the findings of my experiments in tables and graphs.	☐	☐	☐	☐	☐
43	In this lab course, I am developing skills to work safely in a laboratory environment.	☐	☐	☐	☐	☐
44	In this lab course, I am developing skills in using scientific instruments.	☐	☐	☐	☐	☐
45	Understanding the applications specific for laboratory techniques is a goal for this lab course.	☐	☐	☐	☐	☐
46	In this lab course, I present data in multiple formats such as PowerPoint and posters.	☐	☐	☐	☐	☐
47	In this lab course, I am learning how to communicate scientific results by writing laboratory reports.	☐	☐	☐	☐	☐
48	This lab course is helping me develop practical laboratory skills.	☐	☐	☐	☐	☐
49	I feel confident when I have completed my lab work because I understand how to study for the lab exam.	☐	☐	☐	☐	☐

50	In this lab course, I am learning writing skills.	☐	☐	☐	☐	☐

Which question was confusing, or did you have a hard time understanding?

Appendix B

Final Version of the Student Perceptions of the College Instructional Laboratory Survey (SPCILS)

Instructions

There are no "right" or "wrong" answers to the following questions. We are simply interested in your opinion on whether the lab course you are attending is meeting these goals and your interest in science.

Indicate the extent to which you agree or disagree with each the following statements.

Only fill one bubble per item

Social Relationships					
1) In this lab course, I feel comfortable asking the instructor questions.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
2) I work with my lab partners cooperatively and collaboratively in this lab course.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
3) In this lab course, the process of thinking through an experiment is as important as obtaining the correct answer.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
4) I understand the purpose and outcomes for this lab course.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
Future Oriented Outcomes					
5) The course lab activities help me develop skills that I can apply to future science courses.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
6) This lab course gives me an idea of how science is performed in the real world.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
7) The goal of this lab course is to prepare me for research experiences.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
8) The laboratory experiments of this lab course are applicable to various disciplines.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
Habits of Mind					

9) This lab course is designed to foster the development of my scientific reasoning skills.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
10) In this lab course, I learn how to present data in a form that is understandable.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
11) In this lab course, I am developing an understanding of the scientific method.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
12) In this lab course, I am learning good lab practices like how to use and organize my lab notebook.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
Relationship to Content					
13) In this lab course, I gain hands-on experience that reinforces and solidifies content knowledge.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
14) In this lab course, I learn to connect laboratory concepts to quantitative data collection procedures.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
15) In this lab course, laboratory activities help strengthen my understanding of concepts taught in lecture.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
16) In this lab course, laboratory activities help me develop a deeper understanding of science concepts.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
Skills					
17) In this lab course, I am developing an understanding of the accuracy of measurements, calculations and data analysis methods.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
18) In this lab course, I am gaining skills in presenting the findings of my experiments in tables and graphs.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
19) In this lab course, I am developing skills in using scientific instruments.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)
20) This lab course is helping me develop practical laboratory skills.	Strongly disagree (A)	Disagree (B)	Not sure (C)	Agree (D)	Strongly agree (E)

Appendix C

Item level test/retest correlation coefficients

Social Relationships	**Correlations coefficients**
In this lab course, I feel comfortable asking the instructor questions.	0.851
I work with my lab partners cooperatively and collaboratively in this lab course.	0.744
In this lab course, the process of thinking through an experiment is as important as obtaining the correct answer.	0.724
I understand the purpose and outcomes for this lab course.	0.730
Future Oriented Outcomes	
The course lab activities help me develop skills that I can apply to future science courses	0.780
This lab course gives me an idea of how science is performed in the real world.	0.798
The goal of this lab course is to prepare me for research experiences.	0.831
The laboratory experiments of this lab course are applicable to various disciplines.	0.877
Habits of Mind	
This lab course is designed to foster the development of my scientific reasoning skills	0.748
In this lab course, I learn how to present data in a form that is understandable.	0.709
In this lab course, I am developing an understanding of the scientific method.	0.791
In this lab course, I am learning good lab practices like how to use and organize my lab notebook.	0.811
Relationship to content	
In this lab course, I gain hands-on experience that reinforces and solidifies content knowledge.	0.755
In this lab course, I learn to connect laboratory concepts to quantitative data collection procedures.	0.743
In this lab course, laboratory activities help strengthen my understanding of concepts taught in lecture.	0.754
In this lab course, laboratory activities help me develop a deeper understanding of science concepts.	0.735
Skills	
In this lab course, I am developing an understanding of the accuracy of measurements, calculations and data analysis methods.	0.723
In this lab course, I am gaining skills in presenting the findings of my experiments in tables and graphs.	0.749
In this lab course, I am developing skills in using scientific instruments.	0.716
This lab course is helping me develop practical laboratory skills.	0.731