Evaluating Essential Chemistry Laboratory Skills Utilizing Shimadzu Instruments: A Novel Partnership Driving Student Success at Walsh University

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Assessment Design

Our Mission & Our Focus: Our main priority is to ensure that our goals for undergraduate students align well with our Walsh mission: Students become responsible scientists and leaders in chemistry.

Our Challenge: To design a meaningful assessment plan to evaluate student success focusing on our collaboration with Shimadzu USA in the following areas:

1) Utilization of new instruments in the Integrated Laboratory Experience to enhance student learning
2) Evaluation of students' competency in discipline-specific skills

Assessment Design (cont.)

Our Goals:

1) Enhance the education of Walsh University's chemistry majors including Honors students.
2) Evaluate student success in unique laboratory skills, rarely found at the undergraduate level

Our Focus: To evaluate program student learning outcomes (PSLOs) and, ultimately, gain a greater insight regarding their preparedness for future courses and careers.

- Assessment focused on two PSLOs: Demonstrating knowledge and using critical thinking.

Key PSLOs for This Study

- Specifically, the following outcomes served as key determinants for this study:
- PSLO #1: Demonstrate knowledge of thermodynamics, kinetics, equilibrium, structure of materials, quantum mechanics, synthesis, reactivity of substances, and green chemistry

- PSLO #2: Use critical thinking by demonstrating the ability to recognize the components of a problem, formulate a strategy to solve the problem, apply comprehensive scientific knowledge to execute a solution and, then, evaluate the effectiveness of the solution
- Assessment utilized a 0-3 scale

Assessment Focus

- The assessment results were acquired from laboratory activities.
- More specifically, the students were evaluated on their ability to demonstrate knowledge of these Shimadzu instruments and their successful operation:

1) Pyrolysis GC-MS: Pyrolysis gas chromatography mass spectrometry
2) FTIR: Fourier Transform Infrared Spectrophotometer
3) ICP: Inductively Coupled Plasma Emission Spectroscopy
4) DSC: Differential Scanning Calorimeter

Collectively, these instruments help us characterize most materials including insoluble and complex materials

Rubric Design

- This rubric was designed having the following categories:

1) *Proper startup*: checks all valves, pressure gauges, allows instrument to warm up prior to starting
2) *Follows Standard Operating Procedure (SOP)*: follows protocol outlines in the SOP, complete steps in correct sequence
3) *Saves and Files Data:* saves in proper format with details completed in proper folder, work is easily accessible
4) *Proper Disposal of Waste*: disposes waste in proper container and completes necessary paperwork

Rubric Design(cont.)

5) *Shut down machine properly*: uses proper sequence and logs all information, leaves work area clean and ready for next person
6) *Technique*: demonstrates flawless technique
7) *Maintenance*: checks for maintenance reminders and takes appropriate action
8) *Troubleshooting*: possesses troubleshooting skills, looks independently for answers
9) Documented work properly: includes works cited, both text and visual

Assessment Results

- Results were generated from the assessment of student responses from a problem set concentrating on unknowns.
- Data reported on a 0-3 scale:
- 5 students scored 3: exceeding the standard
- 2 students scored 2: meeting the standard
- Mean = 2.81
- Results indicated that these ambitious students demonstrated knowledge of the correct utilization of the Shimadzu instruments for structural, material, or trace element analysis
- And, showed that students have proficient laboratory techniques in this chemistry laboratory, which are critical for their future careers

Assessment Results (cont.)

- Trends from this assessment:
- Overall, students performed exceptionally well in the areas of following the SOP, technique, maintenance, and troubleshooting.
- This shows significant strengths as they prepare for the workplace and/or graduate programs.
- We plan to continue to conduct this type of assessment for this laboratory course.
- We can build on this assessment and compare data to that collected in upcoming 16-week terms.
- A multi-year report of this data would be helpful to identify any areas for improvement.

Assessment Summary

- Additionally, these experiences allowed for these opportunities:

1) personal growth as future scientists: reinforcing chemistry concepts from previous courses and students now show appreciation for critical nature of operating procedures
2) increased curiosity chemistry: asking questions and making proposals for new experiments
3) student collaborations: learning techniques in a group and applying the skills for their own activities
4) new insights regarding real-life situations: gaining problem-solving strategies for group projects/activities with realistic timelines
5) increased student self-efficacy in the use of Shimadzu instrumentation: preparing students for their future careers or graduate programs in chemistry

Conclusions & Future Work

- Due to these findings, we will continue to utilize these effective teaching tools and collaborations with Shimadzu in order to enhance students' success in this laboratory course.

- Look for new ways to engage students in answering their own questions and applying their own knowledge to solve problems.

- Continue to emphasize the importance of following safety protocols and limiting chemical waste.

Conclusions & Future Work

- Assess students' abilities focusing on the global impact as related to the topics covered in this course.
- Find ways to incorporate these effective teaching tools for individual research projects and Honors projects.
- Continue to include this data in our 5-year assessment plan for chemistry as part of the Annual Program Assessment Report (APAR) for the Division of Math and Science at Walsh University.

Audience Activity: What is Your “So That”?

- Thoughts and questions that you might consider:
- 1) I am designing my assessment plan So That: _____
- Amy and Tim- ”So That we can identify areas for improvements for next year”.

- 2) This assessment data is meaningful because we can make improvements to the course So That: _____
- Amy and Tim- ”So That junior students will be better prepared for the next course and senior students have a unique set of skills to bring to the workforce, advancing STEM projects”.

- 3) Overall, the students will benefit from this course, achieving the given competencies So That: _____
- Amy and Tim-”So That they do work they love, producing meaningful results, and making a positive impact to society”.

- 4) Students will gain new perspectives in chemistry So That: _____
- Amy and Tim- “So That they continue to be curious, leading to self-determination and motivation

Looking Ahead: More Findings to Share

- Additional findings for this course provide us with a greater picture of the students' abilities. Assessment and categories for the rubric were as follows:
- **Oral Presentation**

1) *Language Use and Delivery*: makes eye contact, speaks clearly, engages audience, uses proper content language.
2) *Organization and Preparation*: defines a clear topic, makes smooth transitions, ends with logical conclusion.
3) *Content:* clearly defines thesis, supports thesis with analytical data, illustrates ideas to form new insights.
4) *Q & A*: demonstrates extensive knowledge by responding confidently and appropriately to all audience questions and feedback

Results of Oral Presentations

- All 7 students in this course are exceeding or meeting the standard in these areas:

1) Language Use and Delivery:
2) Organization and Preparation:
3) Content
4) Q & A

Results of Oral Presentations (cont.)

- Trends from this assessment:
- Overall, students performed exceptionally well in the areas of communication and explaining processes and scientific findings.
- This shows significant strengths in both delivery and presenting scientific content.
- We plan to continue to require this oral presentation as part of the laboratory course.
- We can build on this assessment and compare data to that collected in upcoming 16-week terms.
- A multi-year report of this data would be helpful to identify any areas for improvement.

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Contact Us

Questions? We would like to hear from you!

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