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.
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.
Acknowledgements

We would like to express our appreciation to:

• 2021 Virtual Assessment Institute hosted by IUPUI
• Shimadzu USA: Chemistry Collaborations
• Dr. Katie Brown: Dean of School of Arts & Sciences
• Dr. Jackie Novak: Chair of Math & Science
• Walsh Undergraduate Students
Contact Us

Questions? We would like to hear from you!

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