

Disciplinary Excellence in First Year Chemistry



Ollscoil
Teicneolaíochta
an Atlantaigh

Atlantic
Technological
University



Pictured at the awards ceremony are some members of the First Year Chemistry team with HEA staff, after winning the National Forum's Disciplinary Excellence in Learning, Teaching and Assessment (DELTA) Award, November 2022

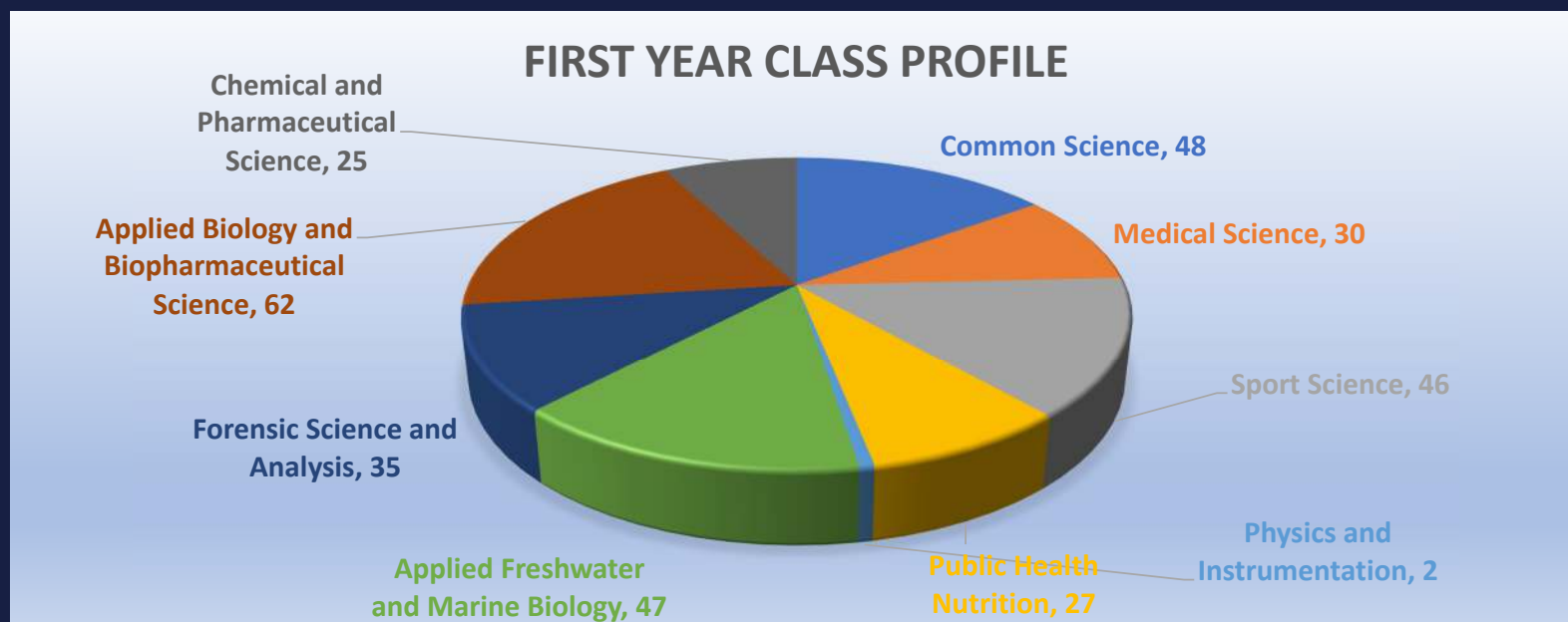


L to R: Tim Conlon, Head of Policy and Strategic Planning at the Higher Education Authority, Anne Downes, ATU, Dr Aisling Crowley, ATU; Dr Cormac Quigley, ATU, Dr Lynn Ramsey, Chair – National Forum, Dr Etain Kiely, ATU, Dr Eugene McCarthy, ATU, and Dr Michelle Glacken, ATU.



Additional members of the team: Judith Wurmel, John Graham, Philip White, Siobhan Wall, and Moira Schlingermann.

Profile of the First Year Chemistry Lab



- Two hours per week practical class embedded in year long modules
- Approximately 300 students annually
- 8 destination programmes

DELTA Action Plan

Breakdown:

Component 1
Leadership, Policy Development, and Professional Development of Staff

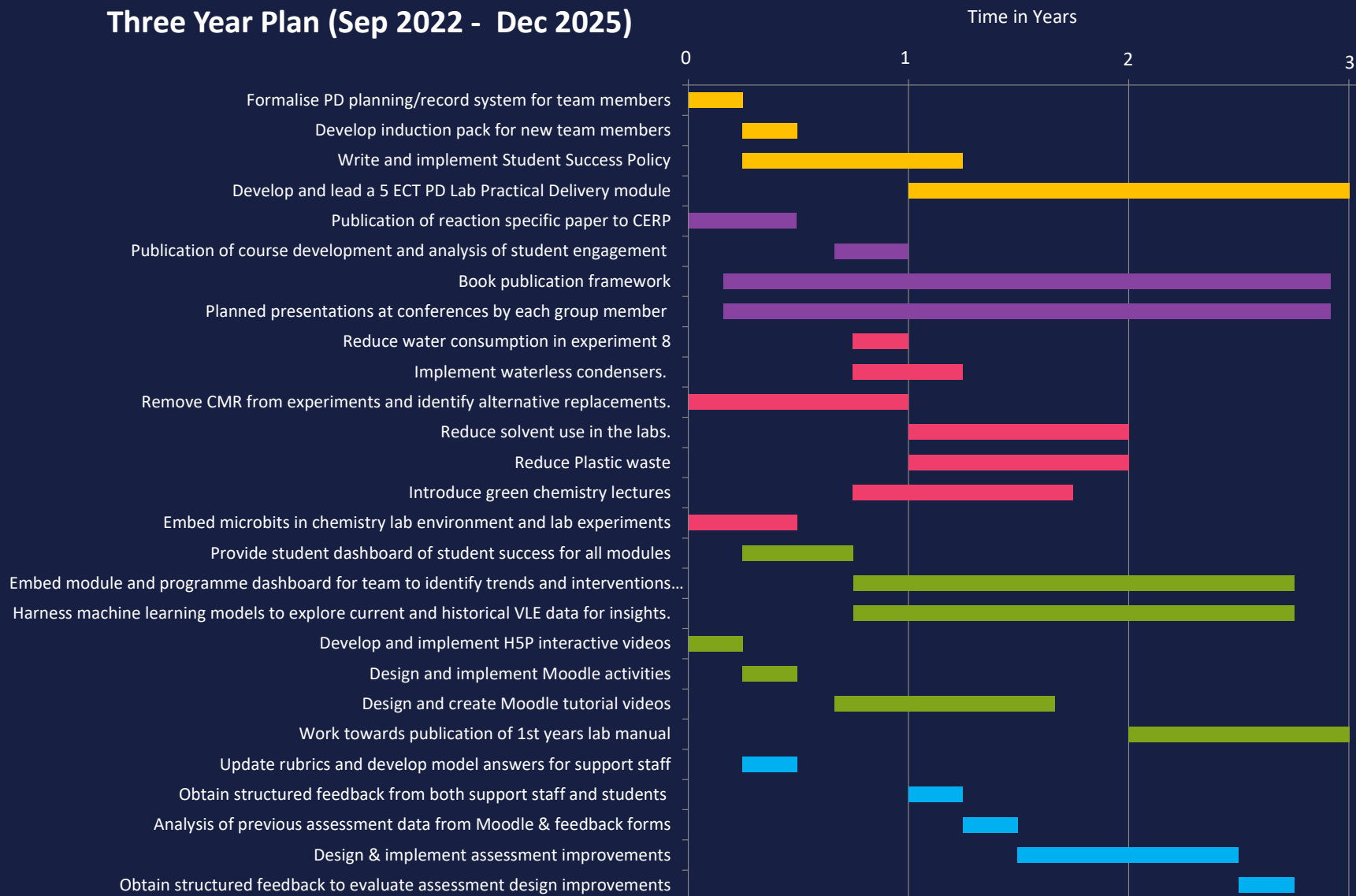
Component 2
Evaluation, Scholarship of Teaching and Research-Informed Teaching

Component 3
Designing Curriculum, Connections and Collaboration; Learning Environment

Component 4
Engaging Teaching/Learning Approaches, Supporting Students in Transition, and Blended/Online Approaches

Component 5
Assessment Purposes and their Rationale

Three Year Plan (Sep 2022 - Dec 2025)



Embracing the Sustainable Development Goals

Aim: To help our students become sustainability-literate and conscious scientists.



Actions:

- Introduction of Green Chemistry to First Year LIS module
- Revision of experiments to reduce volume size/solvent use.
- Revision of lab manual to reduce plastic cuvette usage and eliminate use plastic weigh boats.
- Design of new experiments to include waterless condensers.
- Replacement of CMRs with safer alternatives.

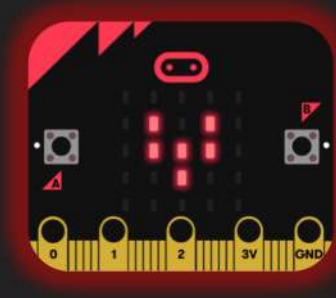
Students as Partners in Teaching and Learning

Student Partner in Development of PIRATE Funded Micro:bit Project

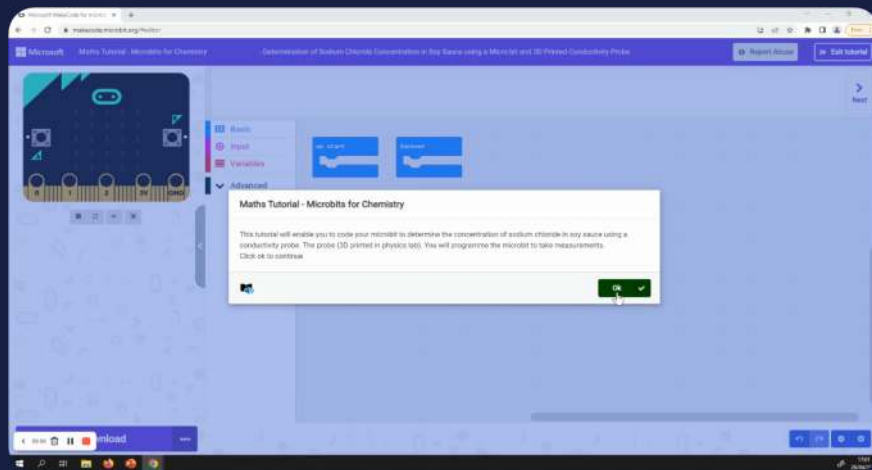
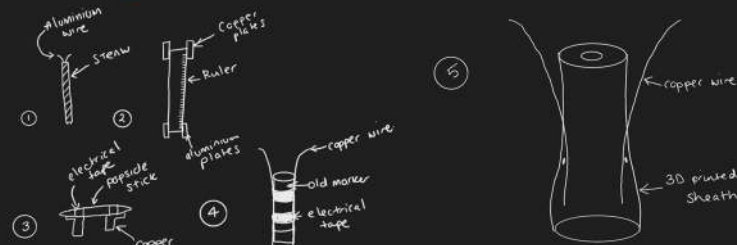


Cliona Flanagan

Final Year
Physics Student



DEVELOPMENT OF A NEW CHEMISTRY LAB PRACTICAL: EVOLUTION OF THE CONDUCTIVITY PROBE



- The Micro:bit experiment has now been integrated into Common Science Year 1 Maths tutorials.
- It is available as a lab practical for Year 1 Common Science students.
- It has been improved based on staff & student feedback and will run again next year.

Students as Partners in Teaching and Learning

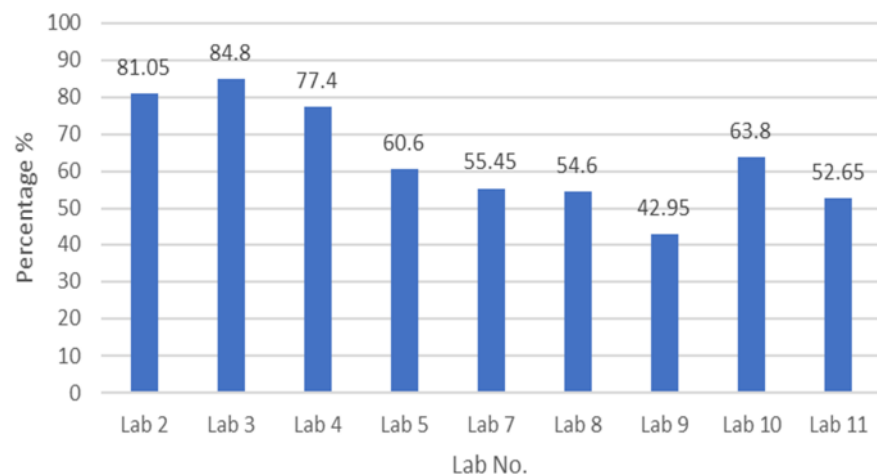
- Postgraduate students are key partners in delivering and developing the first year labs
- Four post graduate demonstrators
(YuanTing Low, Moira Schlingermann, Ryan McGowan, Aine Sally)
- Two postgraduates working in Learning Analytics
(pictured)

Supervisor: Dr Etain Kiely, Ikechukwu Ogbuchi, Ontiretse Ishmael

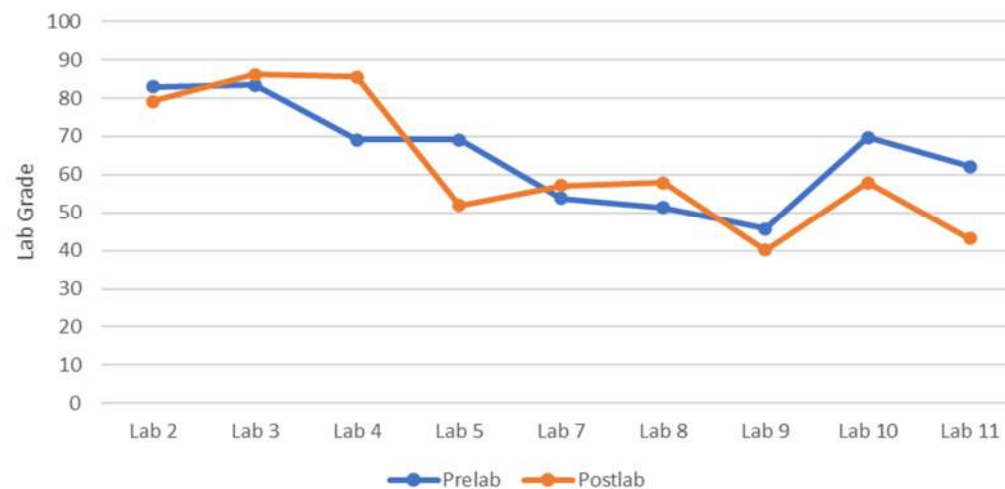


Investigating Reduced Engagement & Grades in Semester 1

Average Grade for Pre and Post Lab Activities



Grades for Semester 1 2022/2023



Investigating Reduced Engagement & Grades 1

7. How long does it take you to complete the **Post** lab videos and quizzes? *

- 0 - 10 minutes
- 10 - 20 minutes
- 20 - 30 minutes
- 30 - 40 minutes
- 40 - 50 minutes
- Longer than 50 minutes

8. Do you feel the **Pre** lab activities prepare you for the lab practical? *

- Yes
- No
- Sometimes

14. How would you like to see the first year chemistry labs improved. *

Refrain from personal comments or naming individuals.


Enter your answer

15. How would you like to see the first year chemistry online activities improved. *

Enter your answer

Investigating Reduced Engagement & Grades in Semester 1

Use Stock Solution to Create Standards



Remove the required volume of standard from the stock solution of known concentration.

Transfer the volume of stock solution to a second volumetric flask.

Dilute the solution by filling to the mark with solvent.

Standard 2

$C_1V_1 = C_2V_2$

Fill in the Formula

C1 = 0.5 ✓ g/cm³

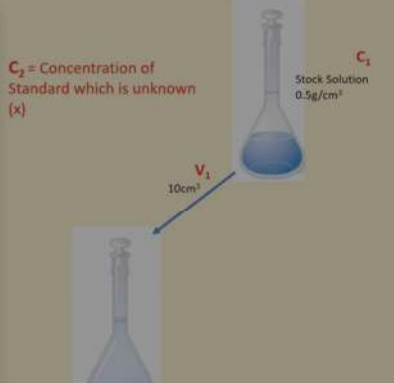
V1 = 10 ✓ cm³

C2 = x ✓

V2 = 100 ✓ cm³

4/4

Continue



Digital Transformation in Teaching & Learning

The First Year Chemistry Moodle Page:



Bank of over 600 questions

21 Pre-Lab & Post-Lab Quizzes

36 Video Tutorials

Improving Feedback on Moodle Quizzes

QUESTION TEMPLATE

In the following **titration experiment**, calculate the concentration of the acetic acid solution.

35.00 ml of 1.000M LiOH solution is titrated against a solution of acetic acid (CH_3COOH) of unknown concentration (xM). of acetic acid solution is required to reach the endpoint.

The equation for the reaction is



Answers should be given to three decimal places.

WHAT THE STUDENT SEES

In the following **titration experiment**, calculate the concentration of the acetic acid solution in the following experiment?

35.00 ml of 1.000M lithium hydroxide (LiOH) solution is titrated against a solution of acetic acid of unknown concentration (xM). 19.32 ml of acetic acid solution is required to reach the endpoint.

The equation for the reaction is $\text{LiOH} + \text{CH}_3\text{COOH} \rightarrow \text{CH}_3\text{COOLi} + \text{H}_2\text{O}$

Answers should be given to three decimal places.

Answer: ✘

OLD FEEDBACK



NEW FEEDBACK

First get the number of moles of LiOH. Remember to change volume to litres 35ml = 0.035L

No. of moles = M x V

LiOH + CH_3COOH react in a 1:1 ratio therefore the number of moles of CH_3COOH is equal to the number of moles of LiOH.

Molarity (concentration) of CH_3COOH = Moles/ volume (titration endpoint in litres).

The correct answer is: 1.812

Streamlining Pre-Lab Engagement & Assessment

NOW



+

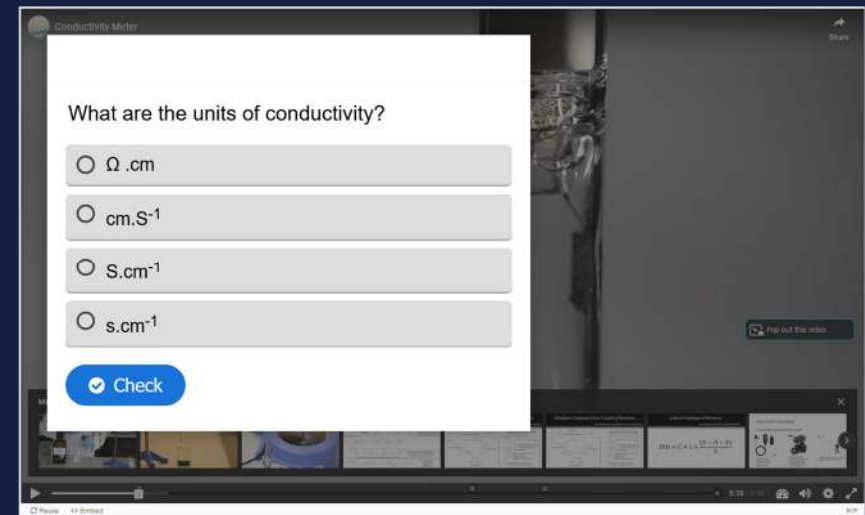
Question 3
Not yet answered
Marked out of 4.00
Flag question
Edit question

The SI unit of conductivity is

Select one:

- a. Siemens per metre
- b. Ohm metre
- c. Molecule
- d. Volt
- e. Electron

SEPTEMBER 2023



Benefits of H5P:

- Increases active engagement with video.
- Reduces friction in learning by synchronising theory and assessment.

QQI funded assessment development and analysis

- REAL Assessment Strategies for NFQ standards
- QQI Anniversary grant call funding (€59,651)
- Recruitment of postdoctoral researcher underway
- Designing new robust question types and leveraging analytics

ASSESSMENT AND CONFIDENCE
IN HE QUALIFICATIONS

INCLUDED IN THE NATIONAL
FRAMEWORK OF QUALIFICATIONS

BURSARY RECIPIENTS



Quiz: 1 lab week 9 Postlab quiz (experiment 8)

Question: Part 1 - grams to molarity

Attempts: 1, 2, 3

Completed on: Friday, 1 December 2017, 12:32 PM

Question 1

Part 1 - Grams to Molarity, making the standard

Correct

Mark: 1.00 out of 1.00

How many grams of Sodium Carbonate did you weigh out? g

Using the periodic table in the lab manual, what is the molar mass of Sodium Carbonate to three decimal places? g.mol⁻¹

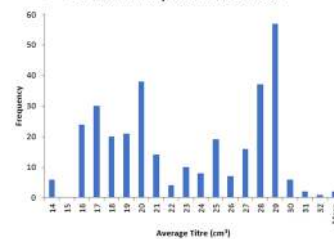
Therefore how many moles of Sodium Carbonate did you weigh out? moles (4 significant figures)

What volume of liquid did you dissolve this material into? ml = l

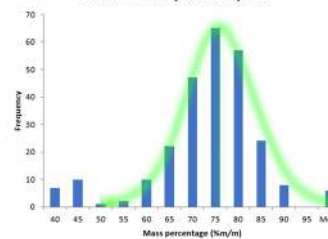
Therefore the concentration of the standard you have made up is M

Lab activity data analysis enabled by Formula Type questions

a) Student Analysis of Acetic Acid



b) Student Analysis of Aspirin



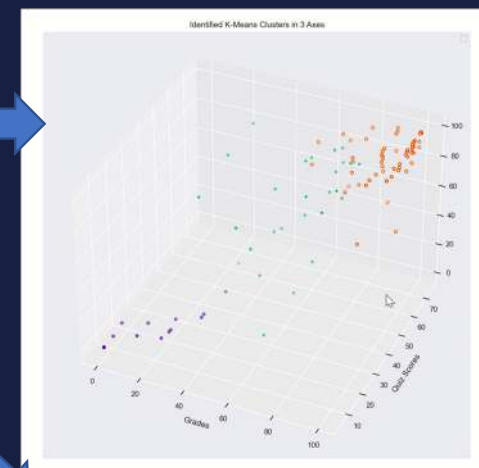
REAL EXPLORATION OF
ASSESSMENT AND LEARNING (REAL)

USING SOPHISTICATED TOOLKITS
ACROSS NFQ LEVELS

DR CORMAC QUIGLEY & DR ETAIN KIELY
ATLANTIC TECHNOLOGICAL UNIVERSITY

Academic Integrity and Artificial Intelligence

- AI and first year chemistry:
 - Machine Learning vs Artificial intelligence
 - ML used to model student success probability
-
- Creating assessment that is robust to AI:



Quiz: Lab week 9 Practical quiz (experiment 8)

Question: Part 1: grams to molarity

Attempts: 1, 2, 3

Completed on: Friday, 1 December 2017, 12:32 PM

Question 1

Correct

Marked 1.00 out of 1.00

✓

Part 1: Grams to Molarity: making the standard

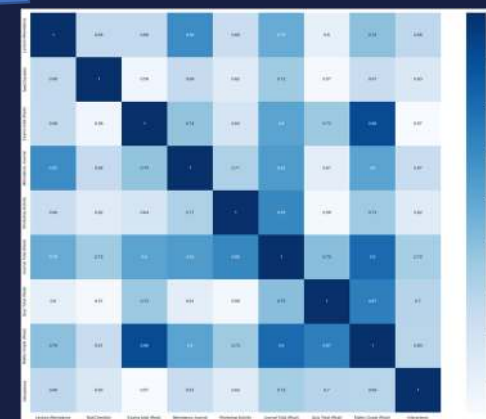
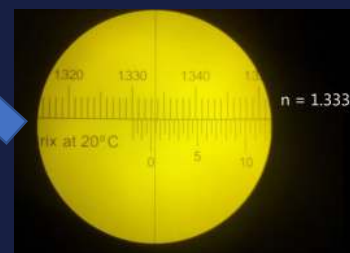
How many grams of Sodium Carbonate did you weigh out? g

Using the periodic table in the lab manual, what is the molar mass of Sodium Carbonate to three decimal places? g/mol

Therefore how many moles of Sodium Carbonate did you weigh out? moles (4 significant figures)

What volume of liquid did you dissolve this material into? ml = L

Therefore the concentration of the standard you have made up is M



Project Outputs to Date

First Year Chemistry Lab Induction Pack
Including Lecturers Handbook and
Manual with Sample Data

What is the pH for a 0.0068 molar solution of KOH?

Answers should be given to two decimal places.

Answer: ✖

If Acid with 1 hydrogen (ex: 0.01M HCl) then use the formula:

$$\text{pH} = -\log[\text{H}^+] \\ = -\log[0.01] = 1$$

If Acid with 2 Hydrogens (ex: 0.01M H₂SO₄) then multiply the concentration by 2:

$$\text{pH} = -\log[\text{H}^+ \times 2] \\ = -\log[0.01 \times 2] = 0.699$$

If Base with 1 OH group (ex: 0.01 M NaOH) then use the formula:

$$\text{pH} = 14 - (-\log[\text{H}^+]) \\ = 14 - (-\log[0.01]) = 13$$

If Base with 2 OH group (ex: 0.01 M Ba(OH)₂) then multiply the concentration by 2:

$$\text{pH} = 14 - (-\log[\text{H}^+ \times 2]) \\ = 14 - (-\log[0.01 \times 2]) = 13.30$$

Improved
Feedback
for over
600
Moodle
Questions

Preparation & Standardisation of a Sodium Hydroxide Solution

Notes specific to this lab practical:

Students will work individually and will need their pipette filler. As we are midway through the semester, ensure you are monitoring students' progress on Moodle and email any students who are not engaging.

Titrations are often included in the Christmas practical exam so it's important that students pick up good habits from the beginning: They should always lower their burette below eye level before filling, they should never pipette directly from the stock bottle, and they should always remove their funnel before beginning each titration.

It's worth noting that students often struggle with the concept of "consistent values" and reading the burette to two decimal places. This is something you may have to emphasise in the first few titration labs. It's also a good idea to explain the terms "indicator", "analyte", and "standard".

This may be the first time students have encountered molarity calculations, so do take the time to walk them through it step-by-step. Encourage the students to write all their calculations step-by-step in their lab manual, as this will help them in future weeks as they begin to work more independently.

Safety:

- Sodium hydroxide can cause burns and is damaging to the eyes - make students aware of this. Students should use a wooden spatula to handle the pellets.
- Dissolution of sodium hydroxide in water is exothermic so make sure students add at least 100 mL water to the pellets before mixing.
- Ensure students hold pipettes correctly when attaching pipette fillers.
- Students should not fill the burette from above eye level.

By the end of this lab, students should be able to:

- Correctly perform a quantitative transfer into a volumetric flask.
- Correctly perform a titration.
- Correctly use a burette, removing the funnel after filling and operating the tap and swirling the conical flask at the same time.
- Obtain a minimum of three consistent titres within 0.1 mL.
- Understand what an indicator is and its function.
- Perform simple titration calculations to obtain the concentration of the analyte.

RESULTS

Vol. HNO ₃ (cm ³)	Burette Readings		Vol. NaOH (cm ³)
	Initial reading (cm ³)	Final reading (cm ³)	
25.00	0.03	15.02	15.01
25.00	15.02	28.17	13.15*
25.00	28.17	41.37	13.20*
25.00	0.05	13.21	13.16*

Don't forget the rules for taking measurements when reading the burette!

Mean titre (NaOH) 13.17 cm³ 0.01317 l

Molarity HNO₃ (from label) 0.1 mol L⁻¹

Volume HNO₃ 25 cm³ 0.0250 l

$$\text{Amount (mol)} = \text{Molarity (mol L}^{-1}\text{)} \times \text{Volume (l)}$$

Calculations

$$\text{HNO}_3 \text{ moles} = 0.1 \text{ mol/L} \times 0.025 \text{ L} = 0.0025 \text{ mol}$$

Amount HNO₃ (mol) 0.0025 mol

Amount NaOH (mol) 0.0025 mol (1:1 reaction ratio)

$$\text{Molarity} = \text{Amount (mol)} / \text{Volume (l)}$$

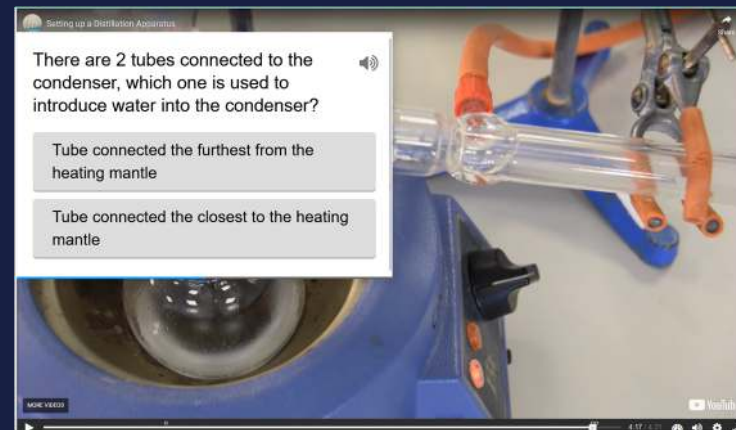
Calculations

$$\text{NaOH molarity} = \frac{0.0025 \text{ mol}}{0.01317 \text{ L}} = 0.1898 \text{ mol/L}$$

Molarity NaOH 0.1898 mol L⁻¹ (4 significant figures)

36

Eight New
H5P
Videos
Created



Project Outputs and Dissemination

A statistical analysis of videos as a means of pre-practical class instruction in the undergraduate setting CASI 2023

Dr. Doreen Lohmeyer, Dr. Elaine Kelly, Dr. Cormac Dunne, and Daniel McElroy
Department of Computer Science & Applied Physics, Department of Analytical, Biopharmaceutical, Computing Services, Atlantic Technological University, Galway.

Abstract
This study investigates the use of videos and short quizzes as a means of instruction prior to practical classes in a first-year undergraduate setting. A stratified randomised controlled trial was undertaken with 288 participants to investigate the hypothesis that the approach provided an improvement in student experiences and achievements. The control groups were given written material in lieu of video content. The use of video and interactive quiz technology allows students to observe phenomena explained in detail with visual aids in a manner which is not possible during a two-hour chemistry practical where there are up to 16 students per session (1). (2) Statistical analysis shows an improvement in student experience and achievement for those receiving video instruction. Lastly, Natural Language Processing (NLP) was used to extract sentiments from students on how chemistry learning experiences can be improved.

Introduction
There is a growing body of research that support the influence of technology-enhanced teaching interventions with student learning (3), (4). A first-year cohort of 288 students was divided into two groups, with 114 in the control group and 110 in the test group (120). The stratification was based on course and assigned lecturer. Figure 1, shows a stacked column graph of subjects assigned to control and non control group.

Methodology
Several hypotheses were tested to evaluate the effects on student achievements.
 > The null hypothesis (H0) was that there is no significant difference in the performance of students who watch pre-practical videos and those who use written instruction.
 > Hypothesis (H1) was that students who watch pre-practical videos perform significantly better in chemistry practical than those who do not.
 > Quantitative data relating to achievement was taken from student grades, attendance, and interactions with the virtual learning environment (VLE), Moodle.
 > Quantitative data relating to student experience was obtained by means of a survey using a Likert scale (18 objects).
 > Qualitative data was obtained by means of free response questions which were analysed using NLP.
 > Student experience and competence was also assessed by means of a lecturer focus group.

Workflow for Students- Videos and Quizzes
If videos with interactive quizzes were provided as pre-lab instruction such as in Figure 2 Phenomena: investigation of copper content of brass

Results and Analysis
The study showed that students experienced a statistically significant difference, and the study rejects the null hypothesis. Analysis included basic statistical tests such as ANOVA, two sample t-tests, chi-squared and non-parametric tests. Figure 3 shows student preparedness for the lab, while Figure 4 seeks to determine if pre-lab material supported learning.
 Figure 5 shows student engagement, Figure 6 shows a significant number of students revisiting videos with 10 videos watched over 6 weeks.
 Figure 7 shows quizzes completed per term. NLP was conducted on suggestions to improve chemistry performance course (ICPC). Average ICPC score sentiment scores. Illustrated in Figure 8 it was higher for Test (5.76) than Control (2.18).
 Figure 9: Student sentiment scores. Figure 10: Student sentiment scores.

Conclusion and Future Work
Pre-lab materials improve student preparedness, technical proficiency and confidence for students, enabling more focused teaching while visible aids reduce repetitive demonstrations. More qualitative analysis will be conducted on this study using NLP to further investigate learners' experiences and suggestions.

References



• Case Study: Seminars: Conferences/ Workshops: Book Chapter:

Moodle Analytics Sandbox

RAISE Sheffield Hallam Uni

Nation Seminar 2019-20

VIT&L

ILIA

DCU MoodleMunch

15th Nov Learning A Possibility Learning

12th March 2021 Creating Learning Analytics to Understand and Describe Student Activity

SOPs/Policy

Technology-Enabled Blended Learning Experiences for Chemistry Education and Outreach

99901 - Moodle Analytics Sandbox

What's Next?

Short-Term Goals

- Improved lab manual.
- Design of a new esterification experiment which utilises UDL principles and use waterless condensers
- QQI funded assessment development and analysis.
- Publication of undergraduate experiments in CERP.

Mid-Term Goals

- Student feedback and focus groups on engagement and assessment in Semester 1.
 - Development of new tutorial videos.
- Publication of course development and analysis of student engagement.

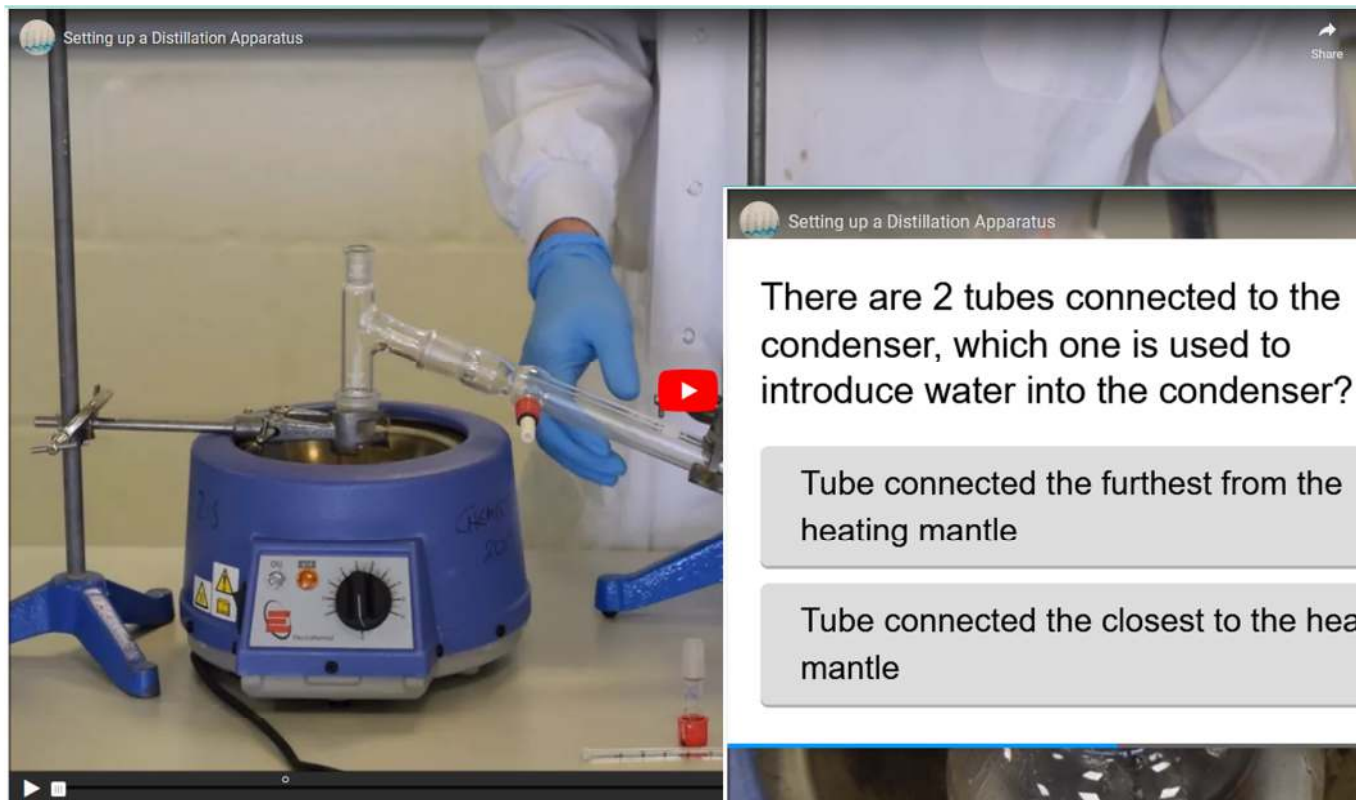
Long-Term Goals

- Design of a 5 ECT CPD Lab Practical Delivery module.
 - Publication of First Year Lab Manual.

THANK YOU



Example of H5P video



There are 2 tubes connected to the condenser, which one is used to introduce water into the condenser?

Tube connected the furthest from the heating mantle

Tube connected the closest to the heating mantle

MORE VIDEOS

YouTube

4:17 / 4:31

Example Moodle p

What is the pH for a 0.0068 molar solution of KOH?

Answers should be given to two decimal places.

Answer:

In the following **titration experiment**, calculate the concentration of the acetic acid solution in the following experiment?

35.00 ml of 1.000M lithium hydroxide (LiOH) solution is titrated against a solution of acetic acid of unknown concentration (xM). 19.32 ml of acetic acid solution is required to reach the endpoint.

The equation for the reaction is $\text{LiOH} + \text{CH}_3\text{COOH} \rightarrow \text{CH}_3\text{COOLi} + \text{H}_2\text{O}$

Answers should be given to three decimal places.

Answer: 1.865 M ✘

First get the number of moles of LiOH. Remember to change volume to litres 35ml = 0.035L

No. of moles = M x V

LiOH + CH₃COOH react in a 1:1 ratio therefore the number of moles of CH₃COOH is equal to the number of moles of LiOH.

Molarity (concentration) of CH₃COOH = Moles/ volume (titration endpoint in litres).

The correct answer is: 1.812

What is the pH for a 0.0068 molar solution of KOH?

Answers should be given to two decimal places.

Answer: 2.1756 ✘

If Acid with 1 hydrogen (ex: 0.01M HCl) then use the formula:

$$\begin{aligned} \text{pH} &= -\log[\text{H}^+] \\ &= -\log[0.01] = 1 \end{aligned}$$

If Acid with 2 Hydrogens (ex: 0.01M H₂SO₄) then multiply the concentration by 2.

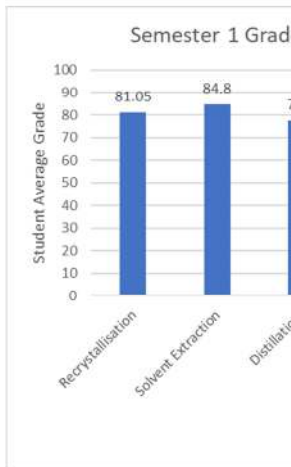
$$\begin{aligned} \text{pH} &= -\log[\text{H}^+ \times 2] \\ &= -\log[0.01 \times 2] = 0.699 \end{aligned}$$

If Base with 1 OH group (ex: 0.01 M NaOH) then use the formula:

$$\begin{aligned} \text{pH} &= 14 - (-\log[\text{H}^+]) \\ &= 14 - (-\log[0.01]) = 13 \end{aligned}$$

If Base with 2 OH group (ex: 0.01 M Ba(OH)₂) then multiply the concentration by 2.

$$\begin{aligned} \text{pH} &= 14 - (-\log[\text{H}^+ \times 2]) \\ &= 14 - (-\log[0.01 \times 2]) = 13.30 \end{aligned}$$



S C1V1 C2V2 dilutions Cognifink

Standard 2

$C_1V_1 = C_2V_2$

Fill in the Formula

C1 = g/cm³

V1 = cm³

C2 =

V2 = cm³

✔ Check

$C_2 =$ Concentration of Standard which is unknown (x)

C_1
Stock Solution
0.5g/cm³

V_1
10cm³

More videos ✕