Supplementary Information

Embedding UN SDGs in Chemistry Education through Project-Based Learning: Insights from Case Studies in the UK and USA

Yalinu Poya*[a]

The University of the West of Scotland (UK)

Project Design

The following sections outline the key components of the project along with the rationale supporting each element.

1. *Group Collaboration:* Students worked in teams to select and address one UN SDG-related challenge.

The author designed the 10 UN SDG-related challenges to engage students to use undergraduate-level chemistry concepts to solve real-world problems that intersect with global issues, such as climate change, sustainability, public health, resource management, and more. Each challenge presented a pressing concern and encouraged innovative thinking and practical solutions. The author framed these challenges in diverse geographic and social contexts to promote global awareness, critical thinking, and creativity in addressing societal problems.

2. *Structured Planning:* Each group completed a detailed project plan consisting of:
   A. A *Personal SWOT Analysis* to reflect on individual contributions.

A SWOT analysis is a planning tool that strategically evaluates a project by its internal Strengths and Weaknesses, and its external Opportunities and Threats. For this project, the author included a SWOT analysis to encourage students to reflect on their work together as a group, resources, and a strategic approach to solving the challenges. Through the SWOT analysis, students identified their individual strengths, for example, current knowledge in chemistry, collaborating with others, or accessing resources. Acknowledging weaknesses in the SWOT analysis helped students to reflect on their personal proficiencies and actively address potential obstacles. Examples included barriers of communication, time management, and others. The external components, such as opportunities, determine avenues of assistance students can seek, such as information sources, interviewing field experts, and many others. Threats are helpful for students to predict unforeseen circumstances such as misinformation, unavailability of team members, and others. The SWOT analysis tool not only enhanced project planning but also cultivated meta-skills like time management, critical thinking, strategic decision-making, problem-solving, research skills, self-awareness, collaboration, and many others, which are essential for STEM students in their studies and later in their careers.

   B. A *Five-part Project Plan* covering:
      - Overview of the UN SDGs
      - Justification for the chosen challenge
      - Proposed solutions
      - Alignment with specific UN SDGs
      - Anticipated risks and mitigation strategies

For any learning experience where students work in groups, a project plan is important for the success of the work. The project plan acted as a framework to guide students to focus on the challenge at hand, brainstorm ideas to solve the challenge, and finally implement their ideas. The author designed the project plan template into five main sections, purposely as a guide for students to think methodically and logically organize their work. This promoted critical thinking, collaboration, communication, teamwork, time management, research, innovation, adaptability, and systems thinking. The project plan also enforced setting timelines, accountability through equitable participation by assigning roles and responsibilities, so that problems like shifting the blame on underperforming group members can be avoided.

   C. *Presentation Component*: Groups presented their findings through a PowerPoint presentation.

The presentation component allowed students to effectively communicate their proposed solutions to their selected UN SDG-related challenge to other students in a seminar presentation. Through preparing and presenting their work, students built skills in communication, public engagement, digital literacy, and collaboration. The seminar presentation encouraged students to build confidence in articulating their ideas to an audience, and also to portray their understanding of global sustainability and the strategies they took to solve their chosen challenge.

   D. *Meta-Skills Reflection:* Students documented and reflected on the 12 selected meta-skills that they developed during the module.

Meta-skills are high-level cognitive and interpersonal skills that enable learners to adapt, think critically, and solve problems across many settings. In this project, meta-skills were not complementary but essential. These challenges

required students to solve real-world issues, so embedding meta-skills that enforced collaboration, communicating scientific ideas, critical thinking, scientific writing, data handling, teamwork, and global citizenship was necessary.

Measuring Learning Outcomes

The ASPIRE Level 8 module learning outcomes can be divided into two distinct categories: the ASPIRE Level 8 Learning Outcomes and the UN SDG Group Project Learning Outcomes. While distinct in focus, both sets of learning outcomes ultimately aim to cultivate systems-thinking, strengthen meta-skills, and promote active engagement with the UN SDGs. These capabilities are especially vital for learners navigating complex global challenges and interdisciplinary futures.

A. ASPIRE Level 8 Learning Outcomes: These learning outcomes focused on the primary goals of Academic, Professional, and Personal Development (APPD), which include reflective thinking and meta-skills development.

- *Reflective Thinking and Self-Awareness:* Students developed the ability to reflect critically on their values, motivations, actions, and goals in the context of their academic and professional journey.
- *Academic, Professional, and Personal Development:* Students enhanced their understanding of themselves when exploring career opportunities and identified the relevant skills, knowledge, and experiences needed.
- *Collaborative Problem-Solving:* Through the project, students worked in groups and applied combined knowledge to address real-world challenges that aligned with the UN SDGs.
- *Critical Thinking and Innovation:* Students were supported to think creatively and critically when developing innovative solutions to global issues.
- *Communication and Presentation Skills:* Students gained skills and improved their ability to communicate their ideas effectively through written project plans and oral presentations.
- *Meta-Skills Development*: Students cultivated their 12 chosen meta-skills to build lifelong skills for success.
- *Portfolio Creation and Documentation:* Each student produced an e-portfolio to showcase their work by capturing their learning journey, engaging in reflective thinking, and documenting their meta-skill development. Additionally, the portfolio was used as a tool to demonstrate each student's growth and journey in the ASPIRE Level 8 module.

B. UN SDG Group Project Learning Outcomes: These learning outcomes are related directly to the UN SDG group project, which underlined global sustainability awareness, problem-solving, teamwork, and innovation.

- *Understand Global Sustainability Frameworks:* Students were required to demonstrate a clear understanding of the 2030 United Nations Sustainable Development Goals, along with their interconnectivity and relevance to current and pressing global challenges.
- *Challenge Identification and Justification:* Students selected a real-world challenge that aligned with the UN SDGs, conveyed its significance and relevance to societal, environmental, or economic sustainability in the world.
- *Solution Design and Innovation:* Students worked collaboratively and developed innovative, feasible, and sustainable solutions that addressed the chosen challenge through integrated interdisciplinary knowledge, innovation, and creative thinking.
- *Strategic Planning and Implementation:* Students constructed a structured project plan that outlined objectives, methodologies, resources, and timelines to implement their proposed solution.
- *Impact Analysis and Goal Alignment:* Students assessed how their proposed solution aligned with specific UN SDGs, demonstrating their awareness of global citizenship and ethical responsibility.
- *Contingency Planning and Risk Evaluation:* Students identified potential risks and barriers towards the implementation of the proposed mitigation strategies to ensure project feasibility and resilience.
- *Communication and Collaboration:* Students had the opportunity to enhance their capability to work effectively in teams, communicate ideas successfully, and present their findings through written work and oral presentations

Assessment Strategy

The ASPIRE Level 8 module was a pilot module and was made into a *Pass/Fail module*. Level 8 introduced a percentage-based grading system to enhance transparency and reduce the number of resits for students who may have failed. A minimum overall score of 40% is required to pass.

The assessment of ASPIRE Level 8 was based entirely on the UN SDG project. The assessment was submitted on PebblePad, a web-based platform for personal learning and e-portfolios. The e-portfolio comprises of the following components:

- *Group Project Plan* – 46%
- *Project Presentation* – 18%
- *Meta-Skills Record and Reflection* – 36%

Assessment Criteria and Tools

This rubric outlines how the work was assessed across three main components: Group Project Plan, Project Presentation, and Meta-Skills. Each section includes clear criteria and percentage weightings shown in Table S1. Students used this guide to understand the expectations required for quality work.

Table S1: Assessment Criteria for the Applying UN SDGs to Solve Global Challenges project.

Component	Criteria	Excellent	Good	Basic	Needs Work
Group Project Plan (46%)	SWOT Analysis (16%)	16% -13% All sections complete, insightful, realistic strategies	13%-11% All sections complete, mostly clear	10%-8% Sections are complete but lack depth	7%-0% Missing sections or unclear
	Project Plan (30%)	30%-25% Logical structure, clear roles, timelines, innovative ideas	24%-21% Mostly clear structure, minor gaps	20%-16% Basic structure, lacks detail	15%-0% Poor structure, missing key elements
Project Presentation (18%)	Class Presentation (15%)	15%-13% Engaging, clear visuals, confident delivery	12%-10% Clear visuals, minor delivery issues	9%-7% Basic visuals, limited engagement	7%-0% Unclear or incomplete
	Upload to PebblePad (3%)	3% Uploaded correctly, on time	2% Uploaded with minor issues	1% Late upload	0% Not uploaded
Meta-Skills (36%)	Each Meta-Skill (3%)	3% Clear explanation and justification, with examples	2% Explanation with some detail	1% Minimal explanation	0% Missing or incomplete

Table S2 outlines the assessment tools used in the UN SDG Project at the University of the West of Scotland. Each tool is designed to evaluate specific student skills and contributions, aligned with the learning outcomes and project goals.

Table S2: Assessment tools used in the Applying UN SDGs to Solve Global Challenges project.

Assessment Tool	Purpose	Skills Assessed
Group Project Plan Template (46%)	Evaluates students' ability to plan, organize, and strategize collaboratively.	Planning, organization
Project Presentation (18%)	Tests students' ability to communicate scientific ideas effectively.	Communication, Presentation
Record of 12 Meta-Skills (36%)	Encourages self-awareness, reflection, and documentation of transferable skills.	Self-Awareness

Project Methodology

Below are 10 challenges that are directly related to the 2030 United Nations Sustainable Development Goals. These challenges were designed by the author to represent real-world scenarios that are trending in the world today. Students were to work in groups and choose one challenge to address and solve.

Challenge 1: Knocking the Wind Out of the UK

The United Kingdom has non-renewable energy resources such as oil, gas, and coal. Although these resources could be converted into electricity, the UK has decided not to use them due to its commitment to addressing climate change and its impacts. The country mainly generates electricity from wind farms, which are cleaner than oil, gas, and coal because wind energy is classified as a renewable resource. Despite this, electricity remains a concern for many people. The cost of electricity has increased significantly in recent years, leading to higher energy bills for many households. What green, sustainable, and affordable solution would you suggest to the UK government to supply electricity to its people?

Challenge 2: Wave Goodbye to Fresh Water

The Pacific Islands are facing severe problems with the rise of sea levels due to climate change. Problems that Pacific Islands face may include sinking of their islands, infrastructure damage, and local food security threats due to salination of arable farming lands. One major problem that small island nations face is the loss of fresh and clean water. Fresh water supplies are affected because of limited land area (islands sinking) to capture precipitation, and due to groundwater supplies being exposed to saline intrusion from rising sea levels. What innovative idea can you offer to the small islands that face this issue?

Challenge 3: Putting the "Hydrogen" in Hydrogen Powered Vehicles

Countries across the world are thinking of developing substitutes for fossil fuels to power vehicles. Hydrogen-powered vehicles are widely discussed, gaining popularity, and are considered far and wide as the future. Hydrogen-powered vehicle's function uses hydrogen fuel. Hydrogen fuel is much cleaner and more efficient than petrol and diesel, but the

downside of hydrogen is that it is far more expensive. Think of an innovative way that the United Kingdom can produce green hydrogen.

Challenge 4: More Precious than Silver and Gold

Earth's abundant elements are oxygen, silicon, aluminium, iron, calcium, sodium, magnesium, potassium, titanium, and hydrogen. The remainder are rare earth metals. Rare earth metals are highly useful due to their unique physical and chemical properties. They are mostly used in catalysts, ceramics, glass, aviation, defence, metallurgy, consumer electronic products/devices, batteries, and many more. As our world population increases, there is also a proportional increase in consumer demands and the use of rare earth metal elements. How will you solve this problem?

Challenge 5: From Farm to Fork

How can we grow our own food without depending on outside supplies? UWS has decided to grow its own vegetables to supply to the cafés in the University. The UWS Principal Professor James Miller has given folks a plot of land to grow vegetables, but they have found that the crops do not grow too well. How can you identify what is wrong with the plot of land, and what can you suggest to improve it so vegetables can grow?

Challenge 6: Scotland's NHS Nightmare

A recent system malfunction has caused NHS Scotland to lose all its data for its cancer patients in its central system. Data was collected from different sources across Scotland, and the number of people on the system comes to a total of 10,000 people. Data was finally retrieved but did not maintain their original data structure. The patient database that was lost was mainly for the following types of cancer: breast, bowel, cervix, liver, lung, and prostate. People are waiting for treatment, and this needs to be solved quickly. How would you sort this data into categories of cancer type, cancer stage, gender, diagnosis date, and treatment?

Challenge 7: Making your Mark

Scotland has the highest drug-related death rate of any country in Europe. As a result, Police Scotland is going down hard on criminals involved in the drugs trade. The police received a tip from a local source and discovered a shipment container full of drugs. The criminals are nowhere to be found but have left behind only half a fingerprint, some hair follicles, and blood splatter. The police need help to determine who the culprits are. What solution can you offer them?

Challenge 8: Teachers without Borders

You have been selected to go for a student-exchange program in Central Australia. Part of the program is for you to teach at a rural school in Uluru. When you arrive at that school, you have been set a task to teach a basic home experiment to students who are interested in science. The school is small and has very limited resources, but only basic household items. The students are excited to hear from you and have asked you to design an experiment on a STEM topic of your choice. Design a basic experiment and explain what it is about and what you will do.

Challenge 9: Ending Period Poverty

Menstrual hygiene products are much needed in developing countries around the world. Many women and girls suffer from period poverty due to products being expensive or inaccessible. India is the largest banana producer in the world, with millions of tonnes of bananas produced per year. The leading state in the production of bananas in India is Andhra Pradesh. So much banana waste is being produced, and there is a theory that, instead of this banana waste being used as soil compost, it could be used for absorbent products. Think of an innovative process that could convert banana waste into inexpensive and biodegradable menstrual products.

Challenge 10: Show Your True Colours

There is a great movement in the creation of vegan baked goods as a wider solution to climate change. There is an all-vegan local bakery that has just opened in Paisley, and the pastry chef is looking for natural ingredients to bake its products. The main problem that the pastry chef faces is finding suitable natural food colouring for its icings, particularly the colours red, green, and yellow. Think of a clever process that the pastry chef could use to extract these colours from natural sources and turn them into red, green, and yellow food colourings.

The work was presented in 4 parts – Part 1 was the SWOT analysis, which was recorded in the Project Plan template, Part 2 was the Project Plan, which comprises 5 sections. There were prompts provided to help students answer each part. Part 3 was the presentation, and Part 4 was for students to demonstrate the completion of 12 meta-skills activities.

Part 1: SWOT Analysis

A SWOT analysis is a planning tool that identifies the Strengths, Weaknesses, Opportunities, and Threats involved in a project or organisation. The SWOT analysis in this project will mainly focus on each student and what they would bring to their group in the Group Project. Each student were to reflect on the strengths they bring to the project, any weaknesses they struggle with and will need help/support from their group members/others, opportunities for their learning and development that the group project will bring to them, and finally, any threats from external circumstances or barriers, that could hinder them or prevent this project to be completed successfully.

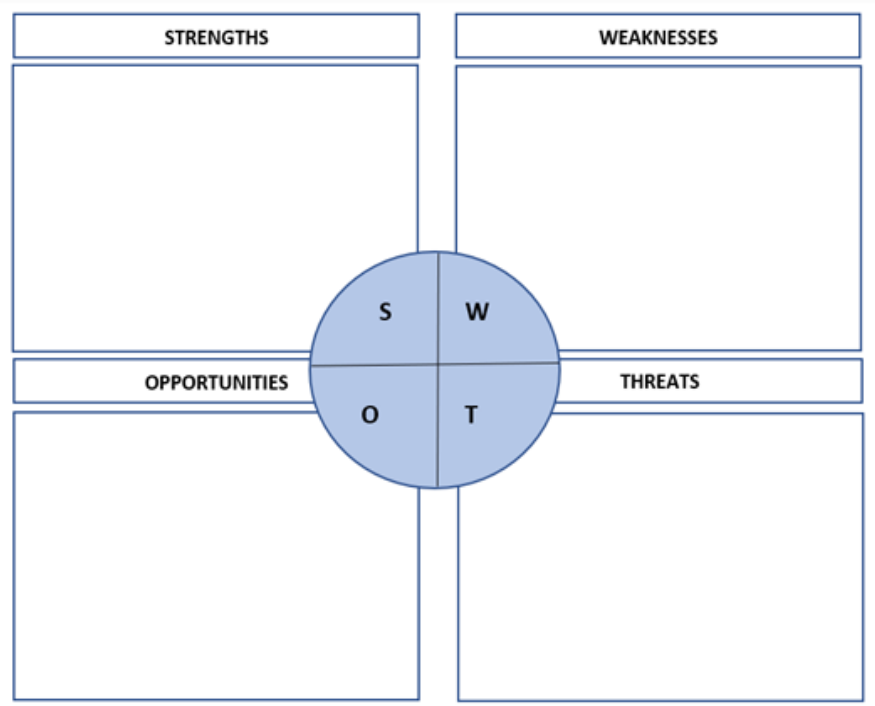

Figure S1: Diagram of the SWOT analysis component taken from the Applying UN SDGs to Solve Global Challenges project.

Part 2: Project Plan

Below is the template for the project plan. There were 5 sections, and students were advised to complete all sections and were welcome to use any diagrams or images. The total word count for the project plan was 2500 words.

- Section 1: Give a brief overview of the UN SDGs and explain why they are important for global sustainability.
  Word Count: 500 words Name(s) of Section Lead(s):

- Section 2: Name the challenge that your group has chosen and explain why you chose this challenge and why you think solving this challenge is important.
  Word Count: 500 words Name(s) of Section Lead(s):

- Section 3: Describe the solutions that your group has suggested and explain how they will be met.
  Word Count: 500 words Name(s) of Section Lead(s):

- Section 4: How will solving this challenge meet the UN SDGs? Name the main UN SDGs goals that your solution meets and explain how?
  Word Count: 600 words Name(s) of Section Lead(s):

- Section 5: Mention and explain any problems that could go wrong in trying to solve this challenge.
  Word Count: 400 words Name(s) of Section Lead(s):

Part 3: Seminar Presentation

Every group was required to present their solutions as a 15-minute presentation during the seminar. They were free to use props, models, and visual aids to support their ideas in solving the challenge.

Part 4: Complete 12 Meta-Skills

Collectively as a group, students decided on the 12 meta-skills that they would do. After selecting the chosen 12 meta-skills, each group member did the meta-skills learning activities independently. Students reported back to their group on what they learnt for each meta-skill, and how these skills will benefit them in their studies and future career. They recorded their findings as a reflective write-up.

Table S3 shows a list of 20 meta-skills and their summaries. Students were to choose 12 meta-skills from this list.

Table S3: Meta-skills developed for the Applying UN SDGs to Solve Global Challenges project.

Meta-Skills	Summary
Critical Reading and Thinking	Students will learn how to read or study different forms of text, understand the author's main idea, and the supporting evidence. Students will be able to conduct in-depth analysis, understanding, and identify the relevant information presented along with its problems or solutions.
Referencing and Citation Skills	Students will learn how to conduct in-depth research with a variety of information sources and acknowledge the work of others through correct referencing and in-text citation.
Data Handling	Students will learn how to protect the integrity of the data, protect and store research data correctly. Students will also learn how to process data into graphs, tables using Microsoft Excel.
Lab Safety	Students will learn how to understand and grasp the importance of lab safety, be able to identify hazards, so you they be able to perform good lab practice.
Abstract Writing	Students will learn how to write an abstract for any piece of work.
Reflective Writing	Students will learn how to build confidence in their academic writing skills, be able to review and summarise information, and better understand the topics they study.
Scientific Writing	Students will build this important aspect of academic writing and communication skills. Students will learn how to confidently produce lab reports, scientific essays in a formal, objective, and concise way.
Research Proposal Writing	Students will build proposal writing skills, which are important for research work. Students will also be able to identify specific research goals and develop clear strategies when meeting research goals.
Science Communication and Presentation	Students will learn how to effectively communicate science in a way that general audiences and area specialists understand. Students will be able to communicate with confidence with colleagues, industrial experts, scientists in other fields, educators, or even the public.
Global Citizenship	Students will learn how to be a global citizen in the 21st century.
Interview Techniques	Students will learn 1) interview questions and how to answer them for job and PhD interviews, and 2) tips for successful interviews.
CV/Resume Writing	Students will learn basic tips on how to write an effective and well-structured CV/resume.
Time Management	Students will be taught how to manage time effectively with tools, identify times where they are the most productive, and how to avoid procrastination.
Financial Literacy	Students will learn how to develop good money management skills to help them better understand their finances and their importance in planning their future, achieving life goals, and managing debt.
Emotional Intelligence	Students will learn emotional intelligence and how it will help them to build relationships, reduce personal stress, defuse conflict in situations, understand the emotions of others, know how to adjust to meet deadlines, take criticism well, improve based on feedback, be open-minded, and adjust to improve their overall workplace and job satisfaction.
Public Engagement	Students will learn how to conduct effective public engagement, understand its importance, and know the different types of activities.
Applying for Funding	Students will learn the basic tips on how to write an effective and well-structured grant application.
STEM Research Ethics	Students will learn basic STEM Research ethics and their importance. Students will explore and evaluate real-life examples, develop knowledge and critical thinking skills, and apply ethics in their work and personal lives.
Social media: LinkedIn and Twitter	Students will learn how to set up and use these social media platforms in an effective way for professional purposes. Students will also explore the pros and cons of these social media platforms and learn to use them responsibly.
Leadership and Teamwork	Students will learn how to become a good leader and how to work effectively with others.

Student Feedback and Reflections

In Table S4, the project outcomes were derived directly from the student presentations and reflect the specific results proposed in each project. While the manuscript contains a similar table with generalized outcomes, the project outcomes presented here specify real student solutions taken from their original work.

Table S4: Mapping of the UN SDG Challenges, Chemistry Topics, and Project Outcomes.

Challenge	UN SDGs	Link to Chemistry Topics	Project Outcomes
Challenge 1: Knocking the Wind Out of the UK	SDG 7, 9, 13	Electrochemistry; Materials Chemistry; Thermodynamics	Proposed hybrid renewable energy strategies (Wind and Solar, Nuclear and Wind); considered electrochemical storage systems and materials for turbine efficiency; aimed to reduce CO_2 emissions using thermodynamic optimization
Challenge 2: Wave Goodbye to Fresh Water	SDG 2, 6, 13	Water Chemistry; Environmental Chemistry; Analytical Chemistry	Mitigation via protective sea walls and land acquisition; emphasized water quality monitoring using analytical techniques and chemical treatment for desalination to sustain agriculture
Challenge 3: Putting the 'Hydrogen' in Hydrogen Powered Vehicles	SDG 7, 9, 13	Catalysis; Physical Chemistry	Transition from steam methane reforming to electrolysis powered by renewables; explored catalyst efficiency for H_2 production, electrochemical cell design, and pipeline material compatibility
Challenge 4: More Precious than Silver and Gold	SDG 8, 9, 12	Inorganic Chemistry; Green Chemistry	Recovery of Au/Ag/Pt from e-waste using selective precipitation and electrochemical methods; material substitution; nanoparticle catalysts to reduce metal load; electroplating for minimal usage
Challenge 5: From Farm to Fork	SDG 2, 3, 12	Organic Chemistry; Environmental Chemistry	Soil pH and nutrient analysis using acid-base titration and spectroscopy; strategies for minimizing pesticide residues; sustainable farming through controlled chemical inputs
Challenge 6: Scotland's NHS Nightmare	SDG 3, 9, 16	Biochemistry; Analytical Chemistry; Medicinal Chemistry	Data integrity solutions, linked to analytical chemistry for drug traceability and biochemical data security for patient diagnostics
Challenge 7: Making your Mark	SDG 3, 10, 16	Forensic Chemistry; Analytical Chemistry; Polymer Chemistry	Advanced fingerprint analysis using polymer-based powders and chemical reagents; DNA profiling through biochemical extraction and PCR
Challenge 8: Teachers without Borders	SDG 4, 9, 10	General Chemistry; Physical Chemistry; Green Chemistry	STEM experiments demonstrating acid-base reactions (Lemon Volcano), non-Newtonian fluid behaviour, and water cycle chemistry using household materials
Challenge 9: Ending Period Poverty	SDG 3, 5, 12	Polymer Chemistry; Organic Chemistry; Green Chemistry	Development of biodegradable polymer-based sanitary products from banana fibres for affordable and accessible menstruation products; reduction of plastic waste through green chemistry approaches
Challenge 10: Show Your True Colours	SDG 3, 12, 13	Organic Chemistry; Food Chemistry	Create safe food colorants using natural pigments and organic extraction methods; reduce synthetic additives; support sustainable food chemistry

Wentworth Institute of Technology (USA)

Project Design

The project was structured around a learning framework that focused on the Environmental Science course and WIT's strategic pillars. The following sections outline the key components of the project along with their rationale.

- Individual Project Work: Students worked individually and chose one of the pre-selected UN SDGs, and worked on the project. The rationale behind students working individually on the project was to foster student autonomy, independent thinking, initiative, and critical engagement with the UN SDGs. By working independently, students selected their UN SDG of their choice from the list of goals, and reflected on how it could be implemented to address some of the challenges faced within WIT, where students tailor their work to their personal interests when analyzing sustainability challenges in higher education.

- Project Work: Students did their project work, which consists of the following project outlines:

A. Knowledge Acquisition on the UN SDGs

Working individually allowed students to fully understand their selected UN SDG. It also gives an avenue to do personal research and read and review a minimum of 6 journal articles based on their chosen UN SDG, and how it can be implemented at WIT.

B. Contextual Application of the UN SDG in the setting of Wentworth Institute of Technology

When students related their chosen UN SDGs global targets to the context of WIT, this gave them scope to critically analyse the university's efforts towards sustainability. Students investigated WIT's academic programs, active research areas, infrastructure, and community partnerships to find any gaps that could be addressed in accordance with the chosen UN SDG. On the contrary, they also identified whether there are any existing contributions.

Contextual application of their UN SDG enabled students to evaluate any connections between WIT's initiatives and the chosen UN SDG. If there were connections, students identified strengths, gaps, and opportunities or reinforcements for student and institutional impact. Evidence collected from literature or research aided students in thinking of strategies where their chosen UN SDG can be implemented in the university.

C. Solution Development of the UN SDG in the setting of Wentworth Institute of Technology

Students proposed actionable, feasible, realistic, and measurable recommendations for the university to incorporate the chosen UN SDG that demonstrated systems thinking. Solution development promoted students to view sustainability challenges not as isolated issues or issues experienced on a grander scale, but as interconnected with the university, society, and environment. Students identified areas where their goal could be implemented in the university to enforce its strategic pillars, such as curriculum design, student engagement, research, campus initiatives, and community partnerships. Students also explained unintended consequences as part of their solutions.

The report required students to write a 2,500-word report on their work. This allowed students to develop their academic writing skills, conduct literature reviews, and synthesize complex information.

D. Communication & Reflection: Work Presentation

The students presented their findings in a class presentation. This was to build the skill of communication and public engagement and show that they understood their work. 10-minute presentations followed by 5-minute questions and answer sessions allowed students to engage in meaningful dialogues, defend their ideas, receive feedback, and reflect on their work. Presenting their work reinforced essential skills in students, such as communication and presentation skills, which are important academically and professionally.

Assessment Strategy

The Environmental Science course was a pilot course and was made into a letter grading system. A minimum overall score of 40% is required to pass the course. This project was worth 15% of the overall grade. The project was worth 100 marks, and the grading breakdown is as follows:

- *Structure of Report* – 20 marks
- *Report Presentation* – 20 marks
- *Subject Knowledge* – 20 marks
- *Presentation Oral Delivery* – 20 marks
- *Presentation Structure* – 10 marks
- *Presentation Oral Delivery Timing – 10 marks*

The assessment criteria shown in Table S5 show how the work was assessed.

Table S5: Assessment Criteria for the Applying UN SDGs to Tackle Sustainability Challenges Across Wentworth Institute of Technology project.

Assessment Area	Criteria	Mark Descriptors
Structure of Report	Clear introduction, logical organization of content, and conclusion, inclusion of recommendations and references.	Excellent (18-20), Very Good (16-17), Good (13-15), Fair (10-12), Poor (1-9), No Submission (0)
Report Presentation	The report is clear and legible, with correct formatting and relevant diagrams.	Excellent (18-20), Very Good (16-17), Good (13-15), Fair (10-12), Poor (1-9), No Submission (0)
Subject Knowledge	Work demonstrates a clear and deep understanding of the topic, with a display of in-depth subject knowledge.	Excellent (18-20), Very Good (16-17), Good (13-15), Fair (10-12), Poor (1-9), No Submission (0)

Presentation Oral Delivery	Maintains audience interest, confident and clear delivery of speech, communicates at an appropriate pace, and regularly makes eye contact with the audience.	Excellent (14-15), Very Good (12-13), Good (10-11), Fair (7-9), Poor (1-6), No Presentation (0)
Questions and Answers	The student can answer the questions asked by the audience.	Excellent (5), Very Good (4), Good (3), Fair (2), Poor (1), Did not Answer any Questions/No Presentation (0)
Oral Presentation Structure	The presentation is clear and easy to follow with decent images and text.	Excellent (9-10), Very Good (8), Good (6-7), Fair (4-5), Poor (1-3), No Presentation (0)
Oral Presentation Timing	Presentation is done within the allocated time frame of 10 minutes.	Excellent (9-10), Very Good (8), Good (6-7), Fair (4-5), Poor (1-3), No Consideration of Time/No Presentation (0)

Table S6 outlines the assessment tools used in the project. Each tool is designed to evaluate specific student skills and contributions, aligned with the project's learning outcomes.

Table S6: Assessment tools used in the Applying UN SDGs to Tackle Sustainability Challenges Across Wentworth Institute of Technology project.

Assessment Tool	Purpose	Skills Gained
Report	To evaluate students' ability to research, analyze, and apply a selected UN SDG within the institutional context.	Research, critical thinking, academic writing, holistic analysis, self-management, subject-knowledge, self-assessment, interdisciplinary thinking, understanding complex information, problem-solving, and referencing.
Oral Presentation	To assess the student's capacity to communicate their work to an audience effectively.	Effective communication, public engagement, time management, and presentation design.
Q & A Interaction	To measure the student's ability to listen and respond to questions, and show depth of understanding on the topic.	Effective communication, public engagement, analytical thinking, logical thinking, and the ability to think quickly under pressure.

Project Methodology

In the project, *Applying UN SDGs to Tackle Sustainability Challenges Across Wentworth Institute of Technology*, students explored how global sustainability efforts can be applied at Wentworth Institute of Technology. Their challenge was to select one of the 2030 United Nations Sustainable Development Goals (UN SDGs) and utilize their chemistry knowledge and interdisciplinary thinking to assess if WIT is currently addressing that goal and/or how it can be improved.

- UN SDG 2: Zero Hunger
- UN SDG 3: Good Health and Well-Being
- UN SDG 4: Quality Education
- UN SDG 5: Gender Equality
- UN SDG 6: Clean Water and Sanitation
- UN SDG 7: Affordable and Clean Energy
- UN SDG 8: Decent Work and Economic Growth
- UN SDG 9: Industry, Innovation and Infrastructure
- UN SDG 12: Responsible Consumption and Production
- UN SDG 13: Climate Action

Students were to choose one UN SDG from the list and answer the following questions:

1. Research your chosen UN SDG. Find and read 6 peer-reviewed journal articles related to their selected goal.
2. Analyze WIT's current efforts. Look into how Wentworth is already working toward your chosen UN SDG.
3. Identify gaps and opportunities. Where is WIT doing well? Where could we improve? What's missing?
4. Develop recommendations. Propose realistic and actionable ways WIT can better support your chosen UN SDG.
5. Create an implementation plan. Outline how your recommendations could be put into action.

Students were required to do a written report and a class presentation. Below is a breakdown of what was expected:

1. Written Report (2,500 words):

- Introduction to your chosen UN SDG
- Analysis of WIT's current alignment with the UN SDG
- Identification of gaps and opportunities
- Recommendations and implementation plan
- APA-style references

2. Class Presentation:
   - 10-minute presentation in class using Microsoft PowerPoint
   - 5-minute Q&A session

This project was worth 15% of the final grade and was out of 100 marks. The following was an assessment breakdown:

- Report Structure 20 marks
- Report Presentation 20 marks
- Subject Knowledge 20 marks
- Oral Delivery 15 marks
- Q&A interaction 5 marks
- Presentation Structure 10 marks
- Presentation Timing 10 marks

Student Feedback and Reflections

Project outcomes were derived directly from the student presentations and reflect the specific results proposed in each project. While the manuscript contains a similar table with generalized outcomes, the project outcomes presented here in Table S7 specify real student solutions taken from their original work.

Table S7: Summary of WIT Student Projects Linking Chemistry Concepts to UN SDGs and Sustainability Outcomes.

UN SDG / Challenge	Link to Chemistry Topics	Project Outcomes
SDG 2 – Zero Hunger	Analytical Chemistry; Food Chemistry	Analyze nutrients in local food; test soil for urban gardens using pH/ion-selective methods; develop biodegradable packaging via polymer chemistry
SDG 3 – Good Health and Well-being	Environmental Chemistry	Monitor air and water quality using spectroscopic/chromatographic techniques; study PFAS and microplastics; design safer biomedical materials
SDG 4 – Quality Education	General Chemistry; Physical Chemistry; Green Chemistry	Expand STEM outreach kits (acid–base and thermochemistry experiments); publish open-access lab manuals; embed green practices in labs; implement virtual/global learning modules and industry partnerships for sustainability
SDG 5 – Gender Equality	Lab Safety and Ethics	Ensure equitable lab participation; track gender representation; mentorship for underrepresented groups
SDG 6 – Clean Water and Sanitation	Analytical Chemistry	Monitor local waterways; develop low-cost electrochemical sensors; improve water treatment methods
SDG 7 – Affordable and Clean Energy	Thermochemistry; Electrochemistry	Research battery materials; explore solar photocatalysis; conduct energy audits; hydrogen project: focus on electrolysis and biomass-derived hydrogen; repurpose pipelines for H_2 transport
SDG 8 – Decent Work and Economic Growth	General Chemistry	Partner with industry for safer processes; train in QA/QC standards; promote green chemistry
SDG 9 – Industry, Innovation, and Infrastructure	Materials Chemistry; Environmental Chemistry; Analytical Chemistry	Prototype sustainable materials; optimize catalytic processes; host innovation hackathons; campus actions for green infrastructure and workforce development
SDG 12 – Responsible Consumption and Production	Green Chemistry; Analytical Chemistry; Environmental Chemistry	Implement green lab programs and circular-campus practices; control chemical inventory; perform lifecycle assessments; reduce packaging waste; campus recommendations: recycling/composting, energy conservation, sustainable food choices, track performance/energy usage, convert food waste to bio-energy
SDG 13 – Climate Action	Analytical Chemistry; Environmental Chemistry	Track campus greenhouse-gas emissions; experiment with carbon capture; research climate-resilient materials