CONTEXTUALISED INTEGRATION OF UNIVERSITY-WIDE ESD INTO CHEMISTRY DEGREES AT NTU

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Overview

1. University-wide ESD (Sustainability in Practice Certificate, SiP)

2. Chemistry modules integrated with SiP

Conclusions

University-wide ESD at NTU

Sustainability in Practice Certificate (SiP) Additional award: HEAR

Open to all 25000+ undergraduates, postgraduates and staff at NTU

Concept: apply a common theme to individual's own specific discipline

Theme: "Food for Thought" – developed later with other themes

Promoted to students at induction with Student Union support. Open to students at any level of study.

NTSU
NOTTINGHAM TRENT STUDENTS' UNION

Five stages to SiP Award

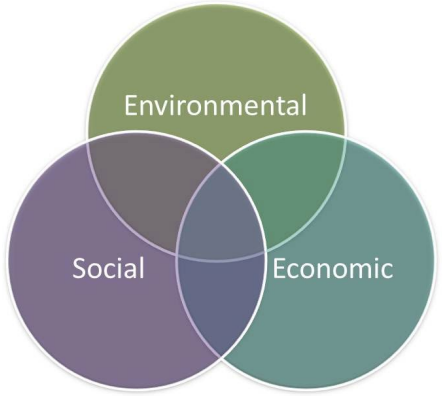
1. Introduction to sustainability concepts
   - Brief post on (food) sustainability issue

2. Links between food, sustainability & discipline
   - Reply to peer's post with reference to own subject

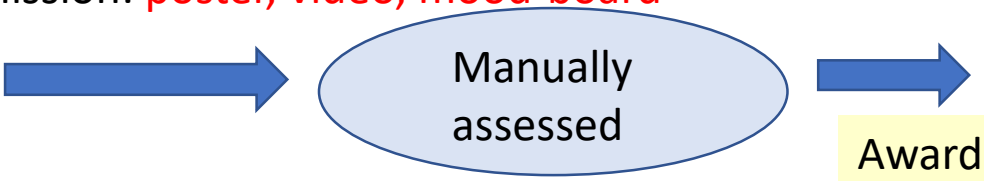
3. Quiz – video followed by MCQ quiz

4. Solutions to the food sustainability challenges
   - Research & post on potential solutions to (food) sustainability issue

Sessions 1-4 online, automated assessment, staged progress



5. Individual submission: poster, video, mood-board



Award ceremony
Best submission winners

1. University-wide ESD (Sustainability in Practice Certificate)

2. Chemistry module integrated with SiP

Conclusions

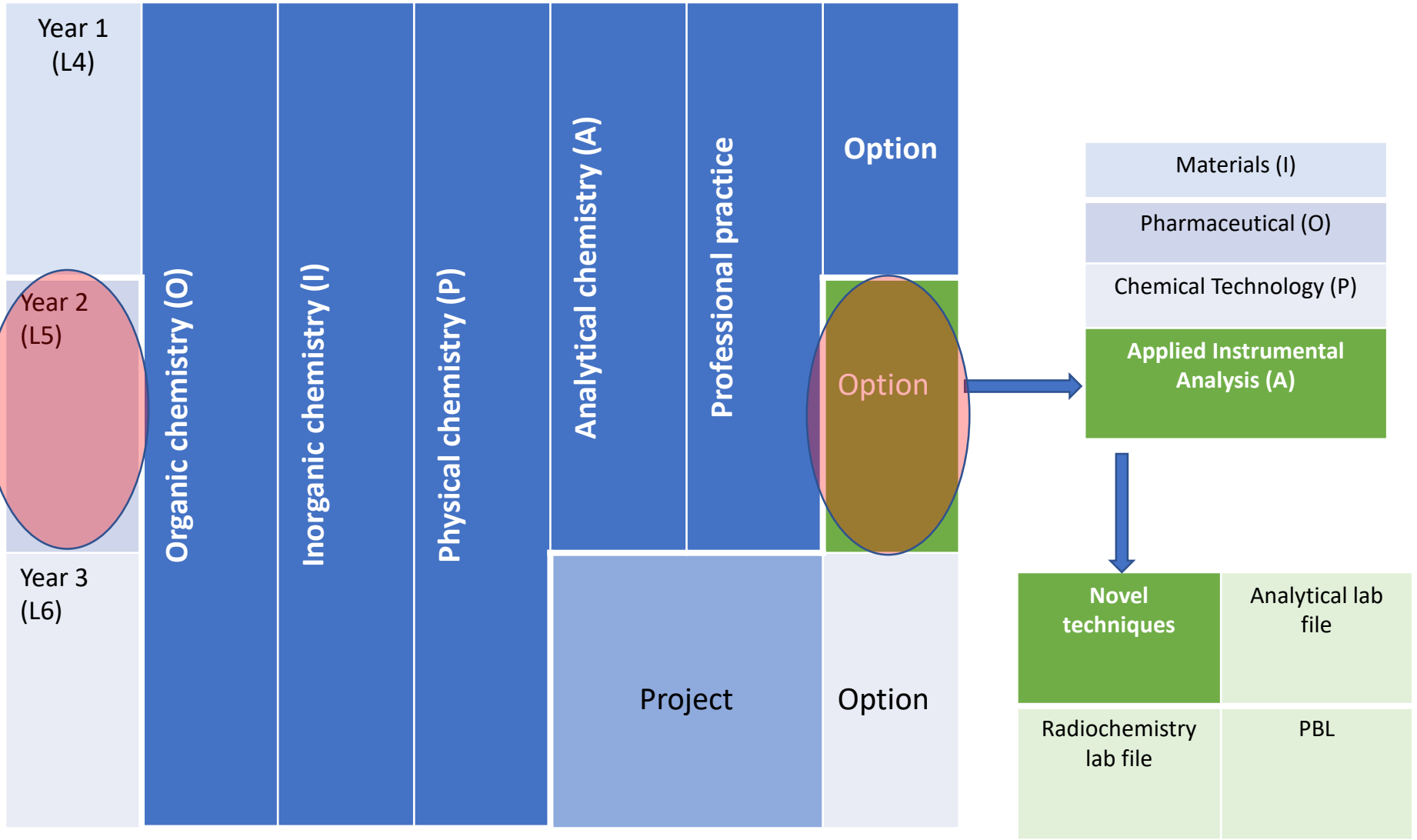
Why the need for direct integration of SiP in Chemistry degrees?

Chemistry students find difficulty in seeing the need to study sustainability:

- Unpopular “Sustainable Chemistry” optional module (2014)
- Discussions at staff-student consultative committee -relevance to subject of chemistry questioned by students

CONTEXTUALISE FOR THE CHEMISTRY STUDENTS

Where to fit the SiP? (2015 – 2019)



Integrating SiP in Applied Instrumental Analysis module

1. Align module coursework directly with two of the more time-consuming SiP stages (sessions)

2. SiP Quiz (Session 3) replaced by **comprehension test on primary literature** related to instrumental analysis of food
   - MCQ - automatically marked;
   - Open answer manually assessed

SiP final submission replaced by **poster submission** for module – manually graded

Applied Instrumental Analysis	SiP
	Session 1
	Session 2
Journal comprehension test	Session 3
	Session 4
Poster	Session 5

"Create a poster explaining your studied technique(s) to a non-specialist audience and include the context of how analysis can apply to a wider context of food supply, safety or sustainability."

Kept **optional** – some additional work required for SiP

Student view

Direct relevance to chemistry

Graduate skill development alongside sustainability awareness being raised

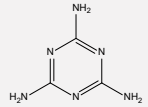
NMR Spectroscopy for control of protein Adulteration by Melamine in Foods, especially infant formulas.

NOTTINGHAM TRENT UNIVERSITY

Full Paper Here

Aim

Explain the potential of the Nuclear Magnetic Resonance (NMR) for Non-targeted screening and Quantitative analysis as well as the importance of adulteration control in the world.



Melamine
(1,3,5-Triazine-2,4,6-triamine)

Introduction

- Melamine is an organic compound (CAS # 108-78-1) used as fire-retardant or for production of melamine-formaldehyde resins (thermoset) for many industrial applications.
- Because of its 67% nitrogen by mass content, it is used as Adulterant in Milk, Infant formulas, candies and other food products(**Figure** 1).[1,2] Addition of 1% of melamine can falsely increase protein content by 4.16%.[1]
- Although short-term lethal dose is comparable to table salt, it can cause urinary tract stones[4] and be fatal for infants in some cases. In 2008, nearly 50 000 people were hospitalized in China during a safety incident of adulteration in infant formulas.[1,2]
- Adulteration of food should be stopped with regards to Sustainability Development Goals (**2, 3**) and this will be only possible with global partnership (**17**) based on **Figure 3**.
- WHO pressures for new methods for food control[5], therefore, ^{1}H NMR at 400 MHz method provided on this poster was developed and it can straightforwardly distinguish melamine-contaminated foods and provide quantitate measurements using integration.

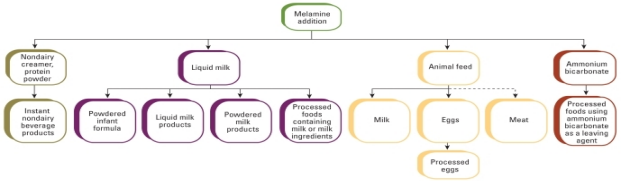


Figure 1-Melamine contamination chain from Adulteration. Solid line indicates contaminated products, dashed line indicates possible contamination.[2]

Method

Sample: Authentic Chinese infant formulas (n=9) and German infant formulas (n=13) were sampled.

1. **Sample preparation:**
20±0.4 grams of infant powder was dissolved in 2mL 99.8% DMSO-d_6 to obtain a concentration of 10±0.2 g/L. The solution was homogenized using ultrasonic homogenizer and vortex mixer.

2. **Measurement:**
Measurements were performed on Bruker Avance 400 at 300 K using 1D Nuclear Overhause enhancement spectroscopy (NOESY). In addition, low –power continuous wave presaturation was used during relaxation delay and mixing time. Data were acquired at speed of 12 min per sample automatically using ICON-NMR control.

3. **Data Analysis:**
Spectra were analysed using MatLab routines developed in-house. For the quantitation of melamine, the NH2 group singlet at 5.93 ppm (**Figure 1**) was integrated.

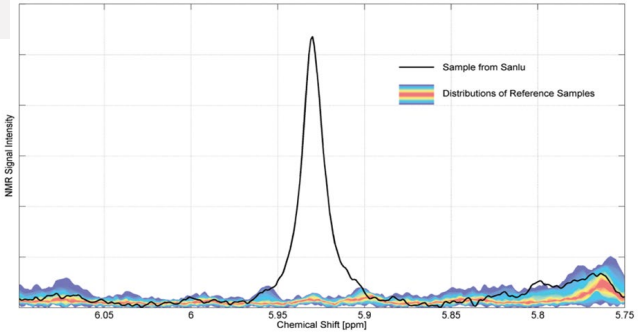


Figure 2-Comparison of melamine-contaminated sample from Sanlu (China) with the reference distribution of collection of infant formulas (measured in DMSO-d_6 at 400MHz). The signal at 5.93 ppm derives from the NH_2- groups of melamine

Results and Discussion

Melamine recommendation of the WHO for infant formulas was set to 1mg/Kg in 2010.[5] After evaluation of the method, its sensitivity was sufficient for screening purposes(**Figure 2**). However, it could have been improved by optimized sample extraction or preconcentration. Melamine concentration in contaminated infant formula was determined to be 412 mg/kg, this was a lower result than measured by the reference method (SPE-LC/MS/MS). The precision of the method showed a 3.2% variation (n=9).

In addition, richness of data made it possible to determine higher sucrose content or lactose free infant formulas from the screening measurement.

Considering all facts, 400 MHz NMR in the current form has sufficient results to be used as a screening method for Melamine contamination as a very low amount of melamine is admissible.

Comparison with other techniques

In comparison with Near IR spectroscopy, NMR can provide much richer information, selectivity and sensitivity is more advance too.[1,3] Although, 400 MHz NMR has sufficient Limit of Detection (LOD), more expensive 700 MHz NMR (HRMAS), have LOD of nearly 0.69 mg/kg in the matrix, this is exceptional in comparison with 400 MHz NMR's LOD of 33.26 mg/kg. However, SPE-LC/MS/MS has even better LOD of 0.005 mg/kg, but more laborious sample preparation is necessary.[1]

Conclusion

In conclusion, the 400 MHz NMR method was developed and used for non-targeted screening and quantification of infant formulas. Obtained results of melamine were much higher than safety recommendations of WHO.[5] Method required only simple sample pre-treatment. Analysis of abnormal peaks in spectra and overall quality of infant formula was also possible using this method. Therefore, to protect the health of the people and safety of the food, World Health Organization urges for the global control system which should be developed against intentional

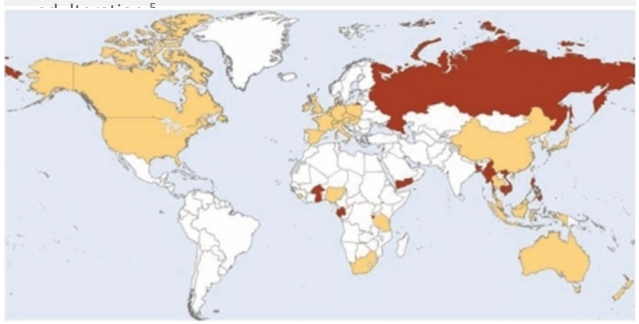


Figure 3-Global distribution of melamine-contaminated products as published on national official web sites. Light shading indicates countries that reported melamine findings in products. Dark shading indicates countries to which import of contaminated products occurred.[2]

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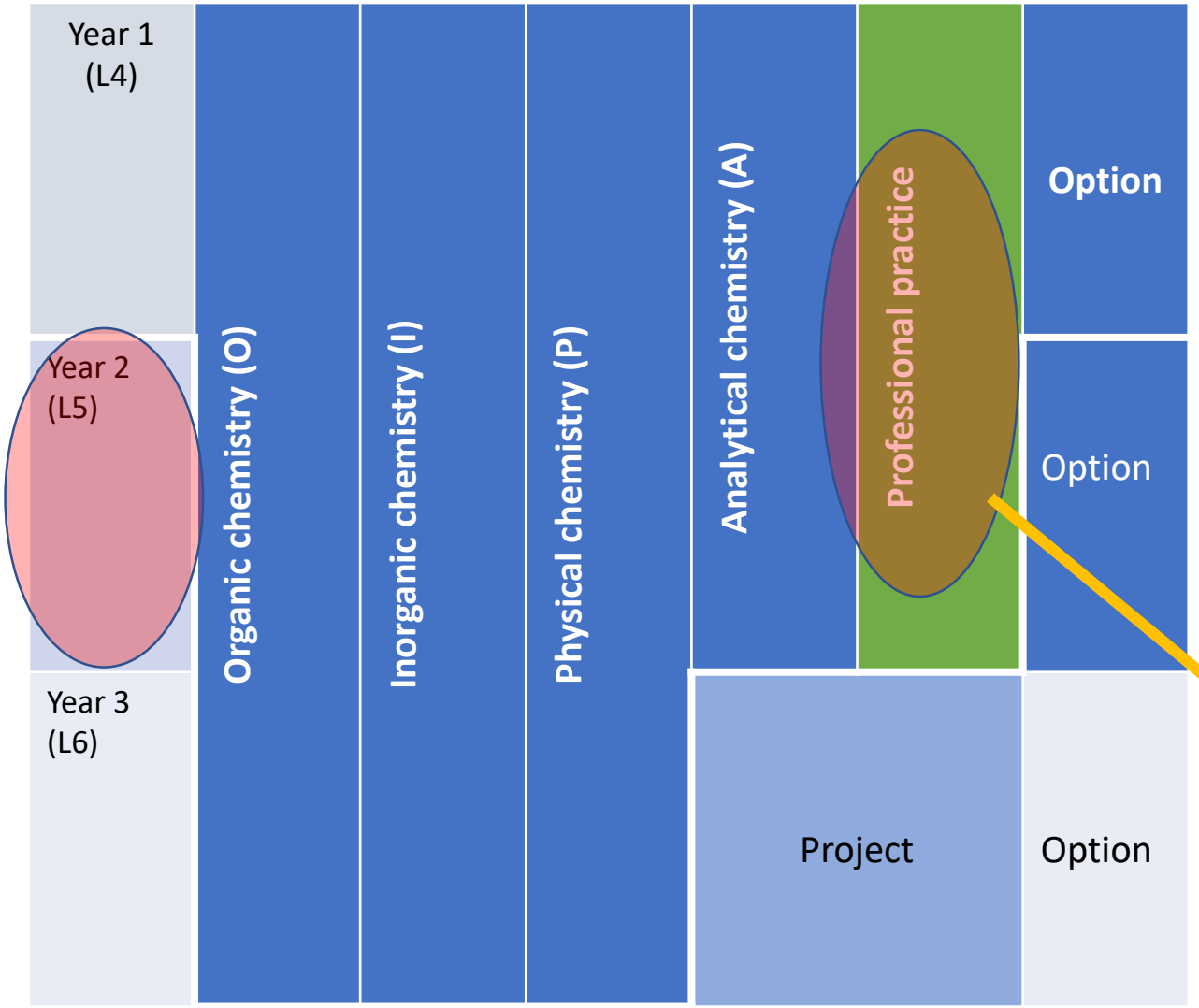
Where to fit the SiP? (2020-present)



Materials (I)

Pharmaceutical (O)

Chemical Technology (P)

Applied Instrumental Analysis (A)

Compulsory module:

2020-21 Optional SiP

2022 Compulsory SiP

Conclusions

1. NTU-wide supplementary award focussing on ESD (SiP certificate)
   - to facilitate student engagement with sustainability issues within their discipline and to appreciate cross-disciplinary aspects of ESD

2. NTU chemistry students lukewarm to ESD (<5 SiP awards for Chemistry students/yr):

   SiP integrated and contextualised, and kept optional
   - better engagement with contextualised SiP (ca. 20-25 Chemistry students/yr), but room for improvement

<u>Current situation</u>

1. Development of chemistry contextualised SiP broadened to be taken by all chemistry undergraduates (ca. 100/yr):
   - contextualised with chemistry content and couched in terms of discipline development and development of study skills

Chemistry student "buy-in" to ESD now good

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