Learn Chemistry

Small Materials to Solve Big Problems: Nanochemistry in Innovative Technology

Resource Overview

Developed by Dr. Christine O'Connor and Dr. Michael Seery, Dublin Institute of Technology

This resource was produced as part of the National HE STEM Programme

National HE STEM Programme

RSC | Advancing the Chemical Sciences

www.rsc.org/learn-chemistry

Registered Charity Number 207890

Acknowledgements

The authors of this document would like to thank the following people who contributed to this work: Dr Alan Casey for his assistance with particle size determinations of the nanoparticles; Dr Ann Hopper for supplying us with quantum dots and trialling case studies with students; Dr Luke O'Neill of the FOCAS Institute, DIT (www.focas.dit.ie) for providing the spectral data on the quantum dots and the carbon allotropes and also for his vast knowledge on all of the instrumentation used in nanoparticle characterisation; Dr Anne Shanahan for her assistance with the TEM studies; Mr Damien Synnott for the supplying us with Raman and XRD data on the various forms of TiO_2; Dr. Patricia Ennis for her input on synthetic methods; Dr Claire Mc Donnell and Dr Sarah Rawe of the DIT Chemistry Education Research Team for their input and for many useful discussions; the reviewer and trial teams who provided useful feedback for the development of the final resource; and, last but by no means least, Dr Brigid Lanigan who has prepared all of the material for the nanoparticles activities, experimental data and supporting slides for the tutor guide.

Resource Overview

This resource is designed for year one or two of an undergraduate BSc honours chemistry or physical sciences course. The context of the resource is to examine nanomaterials for the purpose of preparing a commercial product, while giving the students an introduction to the synthesis and characterisation of nanomaterials. Context/Problem Based Learning (C/PBL) is a teaching methodology that aims to increase students' engagement with a subject by delivering courses based upon real-life applications of the principles, techniques and experiments students encounter in their undergraduate courses. These real world contexts are presented in the form of problem scenarios which are ill-defined, and have a number of satisfactory solutions. Learners work collaboratively to solve problems and acquire new knowledge and present the outcomes or product. This approach provides the opportunity to develop valuable transferable skills such as communication, team working and problem solving. Students are encouraged to take control of their learning and real world examples are used as an effective means to promote real learning. Academic staff adopt the role of facilitator or guide during this process. It is recommended that the following review on context and problem based learning be consulted for further information; T.L. Overton, Context and Problem-Based Learning, New Directions, Issue 3, Oct. 2007, pages 7-12.

The resource is a paper based exercise, but will be supported with data previously collected from experiments, which is available electronically. Students will be presented with an introduction to nanochemistry and with self directed exercises to introduce concepts. Characterisation techniques for nanomaterials showing the instrumentation used and the applications of these materials in a real life context will be considered. Figure 1 provides an outline of how this will be achieved. The module has been designed to allow students to build an introductory level knowledge about nanomaterials and their applications during the workshops, which include student presentations and debates as depicted in Figure 1. The case study will allow them as groups to build on their learning to compile their case study material into a wiki format and present it to the class. Introductory support on the synthesis of nanomaterials and the characterisation techniques involved have been supported with electronic resources provided. The tutor guide is also supported with an annotated bibliography for each case study so that the tutor may provide some papers of interest. The synthesis and safety data for some of the nanomaterials are also supplied in the appendix to the tutor guide should you wish to include a demonstration or ‘hands on’ practical.

The workshops have been designed to promote student driven learning. Each workshop should take up to three hours per session. Access to nearby computer facilities throughout the module would be ideal for facilitating the workshops. The staff student ratio recommended for each workshop would be one tutor per thirty students maximum. The assessment has been aligned with the learning outcomes (both for the module and the individual workshops) to address transferable skills in parallel with the scientific context.

The workshops will encompass: student presentations, debates, group wikis, and individual reflective statements.

Guidelines are provided in the student guide appendices on:

- Using a wiki
- Preparing presentations
- Writing a reflective piece
- Plagiarism

Students should be directed to read these and follow them when preparing work.

This resource aligns with the RSC Chemistry for Tomorrow’s World priority areas “Future cities” and “Human health.”

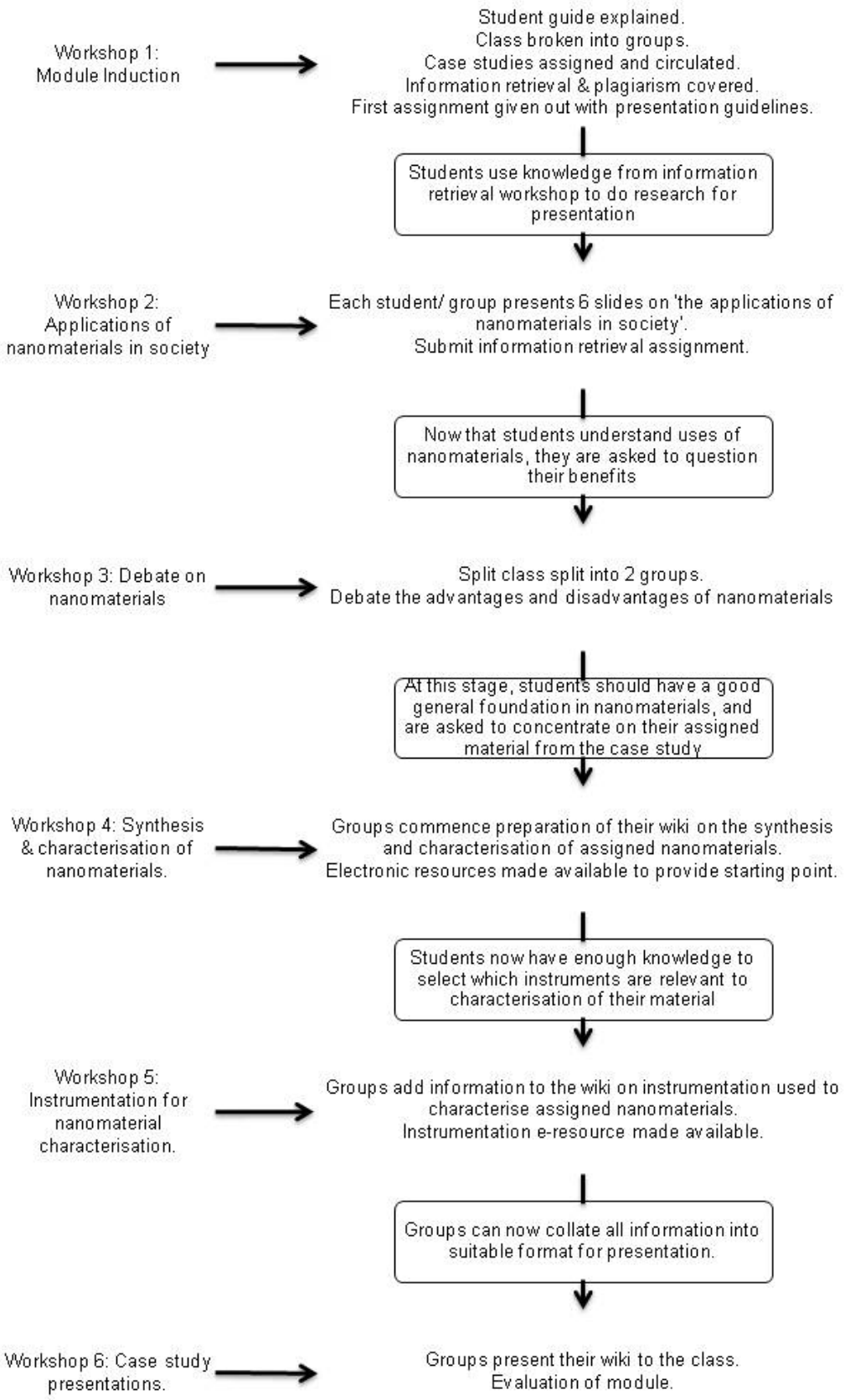

Figure 1: Suggested overview of workshop sessions

Flexibility within Resource

The resource may be altered to suit the needs of the class group. Where students already have an understanding of nanomaterials or the time available is short, workshops 4-6 can easily be run as a standalone resource. If the module tutor wishes to lengthen the module, or to incorporate laboratory sessions, detailed laboratory procedures are provided in Appendix 6.

There are many advantages to using a wiki when collaboration on a group project is required and these are dealt with in more detail in the Appendix. To summarise, it provides an effective and flexible means for learners to work as a team on a report or presentation while generating an archive of all information used and of all previous versions of the final pages. The main benefit to a tutor is that the quality and quantity of contributions made by each student can be tracked relatively easily and that the process as well as the product can be assessed.

Although it is recommended that a wiki be used as a component of this C/PBL activity, an alternative can be adopted if preferred. Some type of online interaction among a group such as a discussion board or online group is very useful, and, if this has been set up by the tutor, there is the advantage that they will be able to monitor progress being made. If this option is not used, the weekly group meeting summaries that are required from each group can be used to monitor progress and to check that all members are making a contribution. To provide a facility similar to the wiki for organisation of the work being undertaken, it would be useful for groups to use a ring binder with sections that correspond to the main parts of the report to which useful documents and draft work can be added. Under these circumstances, it is recommended that the students produce a final printed report with this draft work and supporting information is submitted as an appendix.

Module Learning Outcomes

On completion of the resource, the learner will be able to do the following within the context provided:

- Describe nanomaterials and the difference between their properties and those of the bulk material.
- Explain the applications of nanomaterials and discuss the advantages and disadvantages of using them.
- Identify instruments suitable for the characterisation of nanomaterials.
- Suggest which instruments and techniques will be suitable for the identification of particular nanomaterials.
- Prepare group reports on their research of the subject area and support their work with individual reflective statements.

Transferable skills

This resource allows the learner to further develop the following transferable skills:

- Problem solving: learners work in groups to address the brief presented in the contextualised scenario.
- Analytical and critical thinking: using their background knowledge to inform opinion in the debate, deciding on synthetic protocols and characterisation methods.
- Team work: learners work in groups to complete the task assigned, use a wiki to facilitate collaboration and meet between sessions to review progress.

- Communication skills: Learners present (oral presentation) and report (wiki) on the scientific work performed in keeping with the context.
- Independent learning: learners can justify decisions, assumptions and conclusions made with reference to supporting documents and literature in order to produce a logical and clearly reasoned scientific proposal.
- Information technology skills: learners use a wiki to collaborate and develop their ability to use word-processing, spreadsheet, presentation, chemical drawing and library database software.
- Metacognition: learners reflect on the process involved in working on the brief given, the extent to which the stated learning outcomes were met and to which their transferable skills were developed.

Assessment

Table 1 provides an outline for the assessment of this module. For certain workshops, additional detail is given on assessment of specific tasks driving the session, but in general, this can be used as a guideline for the module. A peer assessment form is provided in workshop 6 to give the students and tutor an opportunity to give immediate anonymous feedback during the presentations.

Table 1: Overall assessment of module

Assessment Component	Mark Allocation	Assessment mark
Information retrieval (Workshop 1)	Individual	10%
PowerPoint presentation (Workshop 2)	Individual	20%
Debate (Workshop 3)	Individual	20%
Case Study		**50%**
Breakdown:		
Attendance and contribution at workshop 4	Individual	(5%)
Attendance and contribution at workshop 5	Individual	(5%)
Attendance and contribution at workshop 6	Individual	(5%)
Group wiki	Group	(20%)
Peer assessment mark for wiki presentation	Group	(5%)
Final individual reflective piece	Individual	(10%)

Since this module is continuously assessed, the student should submit an assignment or present/prepare work each week by the deadlines shown in Table 2. It is very important that they submit assignments on or before the deadline, and that they check the timetable below carefully. All assignments should be prepared/submitted on a weekly basis as shown below during the workshop session unless otherwise indicated by you. It is expected that the tutor should aim to return material within a week so that feedback can be acted on.

The student will be required to submit an individual reflective piece on their engagement with the module, which will receive an individual mark. This should be submitted the week after the module has ended.

Table 2: Outline of module assessment submission/presentation dates

Module Week	Outline of Assessment Description
Week 2 Date:	Submit a library information assignment from week 1. Present a six slide presentation per individual on 'the applications of nanomaterials in society'.
Week 3 Date:	Submit debate points to module tutor in advance of the debate. Attend and participate in the debate.
Week 4 Date:	Prepare material for wiki on the preparation of nanomaterials and characterisation for case study.
Week 5 Date:	Prepare material for wiki on instrumentation for case study. Finalise material for the project description template.
Week 6 Date:	Present as a group the case study wiki and submit a compilation of individual work.