

MEET-CINCH

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High School NRC Teaching Package

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EXECUTIVE SUMMARY

MEET-CINCH aims to mitigate the skills gap in nuclear and radiochemistry (NRC), attract new talent to the field and develop a long-term sustainable strategy for education in NRC. NNL is responsible for the delivery of a “teaching package for high school use” which aims to raise young people’s awareness of the available careers in nuclear and radiochemistry, and attract them to the field. NNL’s overall objective is to develop a standalone teaching package that high school chemistry teachers can confidently use in-class to introduce their students to NRC.

The high school material makes use of remote-operated “RoboLab” experiments that were developed by the Universities of Oslo (UiO) and Hannover (LUH) during CINCH-II. RoboLabs allow students to remotely operate an experiment in a real radiochemical laboratory using modern computer-controlled hardware. In consultation with high school teachers, NNL identified two RoboLabs that seemed suitable for high school students. Following this, teaching material was developed that introduces students to the background theory and context. The teaching material and the two RoboLab experiments were tested with high school chemistry students in five in-class workshops. Based on the feedback received during these initial workshops, NNL down-selected to one RoboLab (Ionlab) for further development. A storyboard surrounding this experiment was subsequently developed and successfully tested in a further five workshops.

The teaching package is now publically available and can be accessed online via the CINCH Moodle. Throughout the project, NNL sought input from the end-users (i.e. high school students and teachers) engaging with a total of 87 students and 11 teachers from six different schools, ensuring that the teaching package is suitable for high school use. Workshop feedback has been extremely positive, with students and teachers showing great interest in the subject of NRC. This task has made significant progress in raising young people’s awareness of the importance of NRC, and the range of careers available in the field.

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1 INTRODUCTION

MEET-CINCH aims to mitigate the skills gap in nuclear and radiochemistry (NRC), attract new talent to the field and develop a long-term sustainable strategy for education in NRC. NNL is responsible for the delivery of a “teaching package for high school use” which is a subtask (T1.3) of Work Package 1 (Nuclear Awareness). This task aims to raise young people’s awareness of the available careers in NRC and encourage them to pursue further education/careers in this area. NNL’s overall objective is to develop a standalone teaching package that high school chemistry teachers can confidently use in-class to introduce their students to NRC. For this reason, NNL acknowledged that the success of this task would be largely dependent on input from school teachers and students. Therefore, at the beginning of the project NNL identified six schools to trial the teaching material as it developed throughout the course of the CINCH project.

NNL decided to build upon existing teaching material that was developed during previous phases of the CINCH project and adapt it for use in high schools. During CINCH-II, remotely operated “RoboLab” experiments were developed at the Universities of Oslo (UiO) and Hannover (LUH) for teaching undergraduate students [1]. RoboLabs allow students to remotely operate an experiment in a real radiochemical laboratory using modern computer-controlled hardware. During the first few months of the project, NNL reviewed the available six RoboLab experiments and, in consultation with high school chemistry teachers, identified two RoboLabs that appeared suitably engaging for high school students and offered learning outcomes that could be applied to the school curriculum.

One of the experiments identified was the “absorption of gamma radiation in matter” exercise (RoboLab #1), developed by UiO. RoboLab #1 allows students to measure the attenuation of gamma radiation by lead, copper and aluminium absorbers of various thicknesses and calculate the corresponding absorption coefficient. The absorbers are mounted on pneumatically operated tracks that move the absorber into position between a caesium-137 gamma source and the detector, as shown in Figure 1.

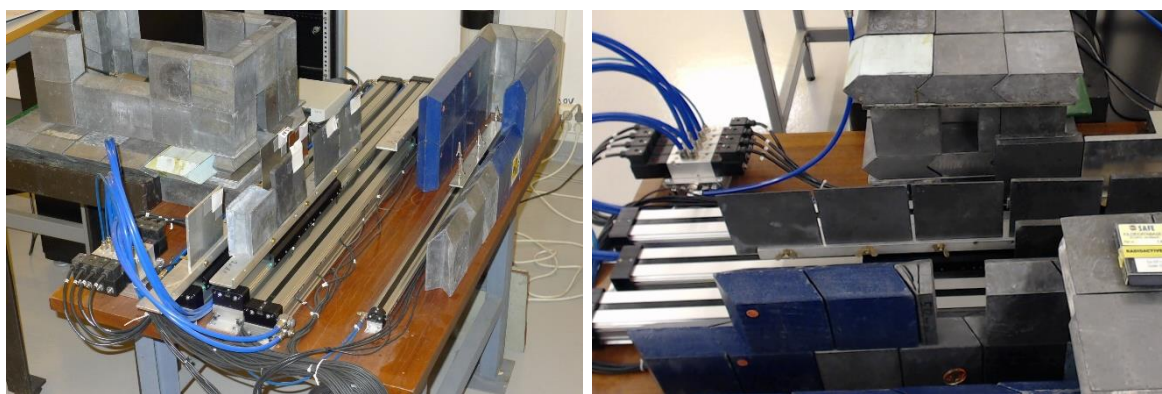


Figure 1: Pictures showing the pneumatically operated tracks to move absorbers in and out of the path between the gamma source and the detector.

Students can control the experiment through a LabView user interface (Figure 2). On the left of the interface, the tracks are diagrammatically presented to the user, together with buttons to control the position of the absorber. In the middle, the Single Channel Analyser (SCA) counter is controlled and read out. Here the user can set a preset time for the desired counting period. On the right-hand panel, a live video feed allows the user to visually check the position of the absorbers and inspect details of the physical system in the laboratory.

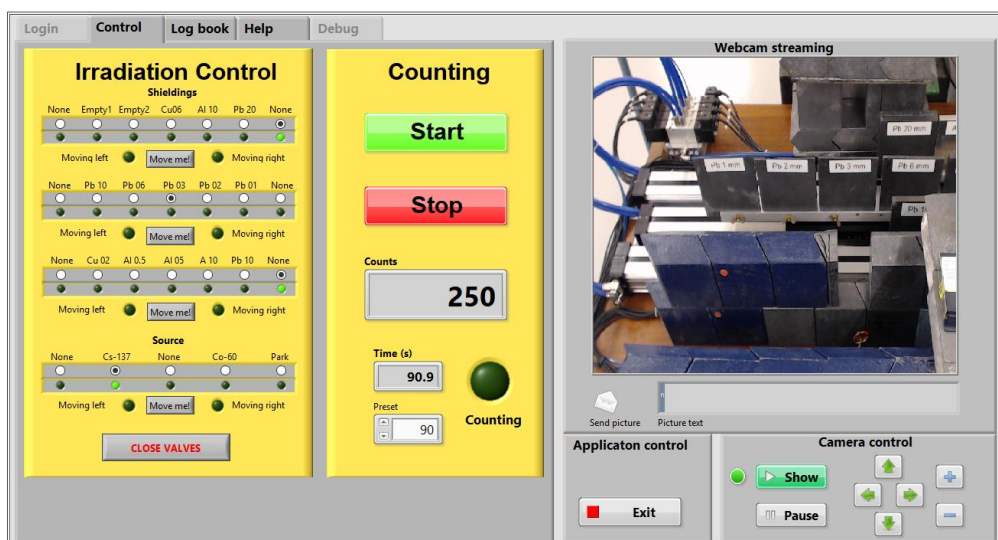


Figure 2: The LabView user interface for RoboLab #1.

The second experiment identified was the “Ionlab” experiment (RoboLab #2), developed by LUH. This remote-controlled experiment shows the chemical separation of radionuclides (strontium-90 and yttrium-90) using extraction chromatography. The aim of the experiment is to allow students to conduct an ion-exchange experiment in real time by controlling the equipment through a web interface. As shown in Figure 3, the set-up consists of

- a syringe pump which injects a radioactive solution containing ^{90}Sr and ^{90}Y onto the column.
- a peristaltic pump which directs the two different solvents to the column.
- two containers, one containing 3M nitric acid (HNO_3) and one containing 0.0001M HNO_3 .
- a Geiger-Müller counter.
- a slide, which slows down the liquid drop so that it stays longer under the detector, allowing the measurement to last longer.
- a waste container.

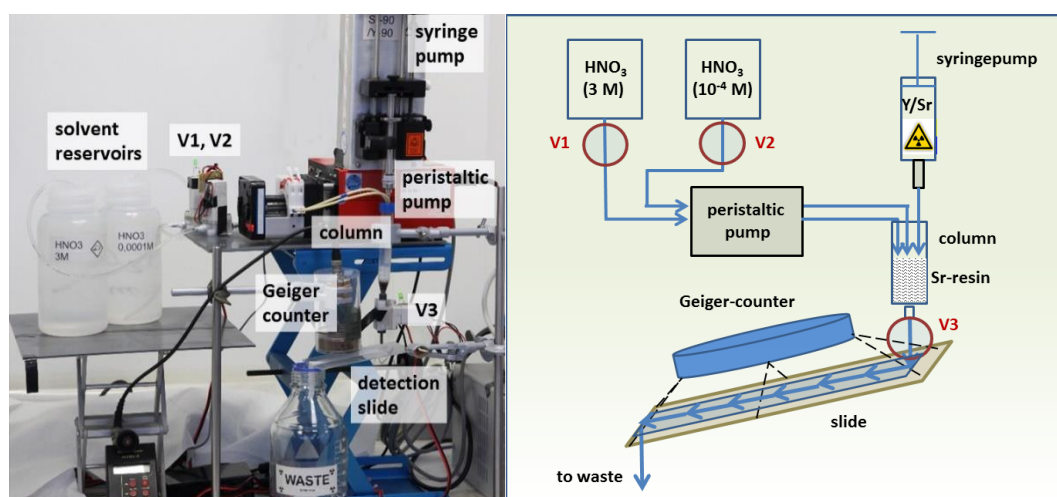


Figure 3: Experimental set-up of Ionlab (RoboLab #2).

As for the other RoboLabs, Ionlab is controlled by LabView and students can access the experiment via the LabView user interface (Figure 4). The interface is divided in three parts: a camera feed in the top left panel where the student can watch the experiment in real time; a chromatogram displaying counts/second in real time (bottom left panel); and an area through

which the user can control the experiment (right-hand panel). The student can move the camera and zoom in on the experiment to check that the pump is rotating and the solvent is exiting the column during operation.

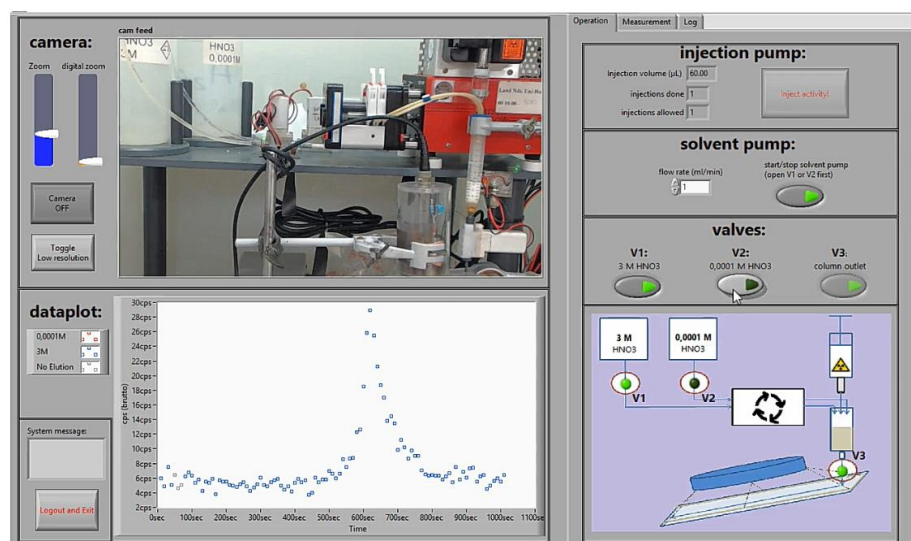


Figure 4: The LabView user interface for RoboLab #2.

During the first 12 months of the project, NNL worked in collaboration with LUH and UIO to extensively test the experiments to ensure that they would work within the classroom trials. NNL also prepared teaching material that would introduce students to the background theory and allow them to test both experiments in a two-hour workshop. The purpose of this workshop was to test the material with high school students in order to down-select to one RoboLab experiment for further development and also to learn about the students preferred learning methods. Feedback from these RoboLab workshops is reported in Section 2 of this report [2].

After reviewing the student and teacher feedback from the RoboLab workshops, the Ionlab experiment was selected for further development. Over the following 12 months, NNL developed a storyboard around Ionlab and the content was made available online (using the CINCH Moodle). This material was tested with students from five different schools during June 2019 and the feedback from these workshops is reported in Section 3 [3]. As the feedback received was generally very positive, only a few modifications to the material have been made. These changes are reported in Section 4, along with some suggestions for improvements that could be made in future work.

2 ROBOLAB WORKSHOP

During June 2018, NNL carried out five RoboLab workshops with AS level chemistry students in Cumbria and the North West of the UK. Unfortunately, a suitable date could not be arranged with one of the colleges. The purpose of the workshop was to identify which RoboLab, if any, should be taken forward into the next phase of development.

During the two-hour workshop, students were introduced to the concept of radiation, decay and half-lives and tested RoboLab #1 and #2. At the end of the session, the students were asked to complete a short survey and participate in a group discussion on how the teaching material could be further developed. The main findings from this survey are reported below.

Table 1 RoboLab workshop dates at participating schools.

School	Location	Workshop Date
Urmston Grammar School	Urmston	6 th June 2018
Priestley College	Warrington	20 th June 2018
St John Rigby College	Wigan	4 th June 2018
Energy Coast UTC	Cumbria	19 th June 2018
St Benedict's Catholic High School	Cumbria	18 th June 2018
West Lakes Academy	Cumbria	Unavailable



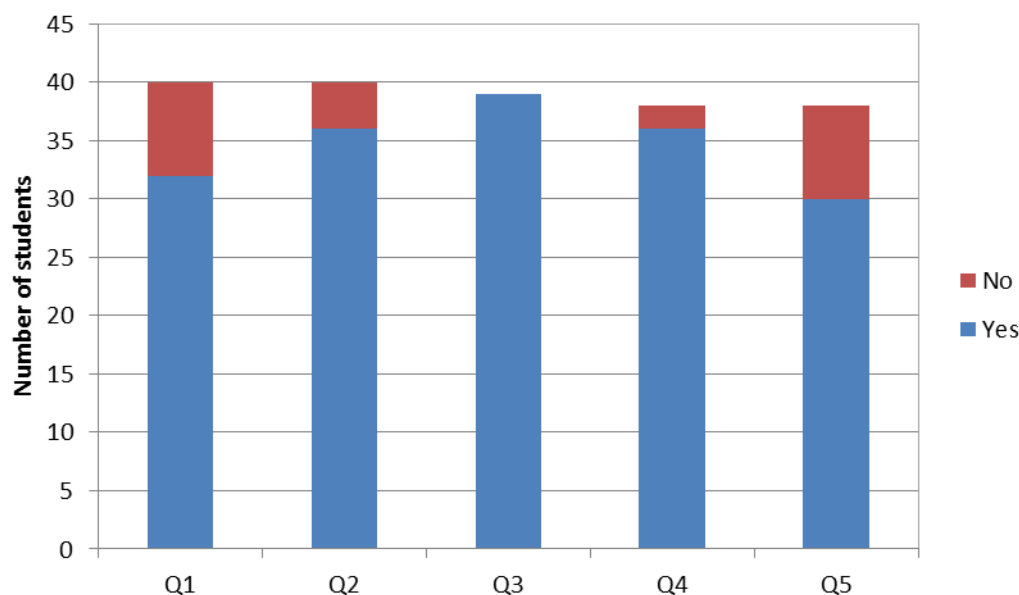
Figure 5 RoboLab workshop at Energy Coast UTC (2018).

2.1 Student Feedback

The first five questions of the feedback form are given in Table 2 and the responses are graphically represented in Figure 6. These questions were designed to assess the student's current understanding of nuclear and radiochemistry and whether the workshop has enhanced their understanding. In total, 40 students took part in the workshops from across 5 different schools. For some questions, the students did not select an answer which has resulted in a total of less than 40.

Table 2 Questions 1-5 of student feedback form.

Q1	Have you already studied nuclear science at school/college?
Q2	Were you aware that chemists/chemical engineers worked in the nuclear industry?
Q3	Has this workshop increased your understanding of the nuclear industry?
Q4	Do you think that RoboLabs are a novel way of learning chemistry?
Q5	Would you like RoboLabs to be used in the classroom?

**Figure 6 Student responses to questions 1-5.**

The responses shown in Figure 6 indicate that the majority (80%) of AS level chemistry students have already come across nuclear science at school, usually during GCSE physics. Most students are also aware that chemists and chemical engineers work in the nuclear industry. Perhaps unsurprisingly, those that were unaware of nuclear chemists / chemical engineers are based in Cheshire and Lancashire, as opposed to Cumbria where a larger proportion of the population work in the nuclear industry. The responses to question 3 indicate that the workshop has increased the students' general understanding of NRC and the role that chemists and chemical engineers play in the industry. Responses to question 4 and 5 show that the majority of students found the concept of RoboLabs novel and 75% of students would like to see them implemented in the classroom. It is worth noting that the majority of students who answered "no" to question 5 experienced technical issues during the workshop.

The purpose of the feedback and discussion was also to identify suitable teaching techniques, in order to create interactive lesson material that will appeal to as many students as possible. Students were asked to circle their preferred methods of learning and to expand further in the comments sections. Figure 7 shows that students like a variety of teaching techniques to be used in the classroom with videos, experiments, lectures, group projects, quizzes and discussions being the most preferred styles. Only one student suggested an "other" method which was the more traditional style of making notes. This feedback highlights the need to incorporate a range of teaching styles as the material develops.

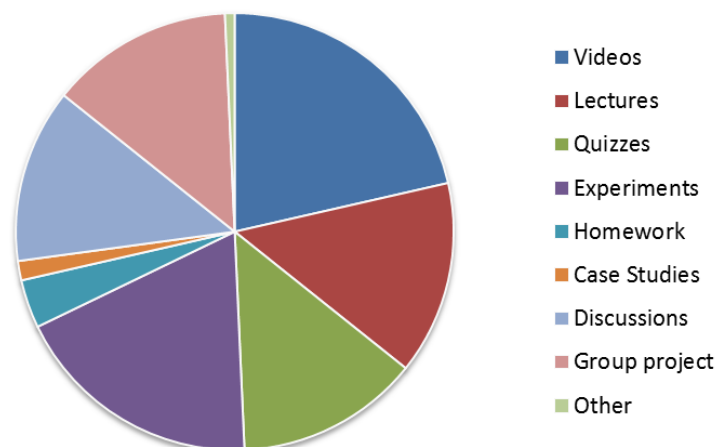


Figure 7 Students' preferred learning methods.

At the end of the workshop, students were asked to choose their preferred RoboLab experiment to take into the next stage of development. Out of 40 students, 36 responded with 64% students selecting RoboLab #1 (Gamma Attenuation). It is assumed that those that did not respond to the question either liked both experiments equally or did not think the RoboLabs should be used in the classroom. Interestingly, all of the chemistry teachers that observed the workshop (8 in total) preferred RoboLab #2 (IonLab $^{90}\text{Sr}/^{90}\text{Y}$ extraction) due to its applicability to the chemistry curriculum. As the feedback forms were more tailored to the students, feedback from the teachers was primarily through discussion at the end of the workshop (see Section 2.2).

The students expanded further on their feedback during the discussion session and in the comments section of the feedback forms. The feedback is summarised in the bullet points below:

- The content of the workshop is interesting and engaging.
- The presentations were clear and concise.
- The majority of students found the content to be pitched at the right level.
- The content of RoboLab #1 was more accessible to the students as the theory had been covered previously in GCSE physics.
- The content of RoboLab #2 was more interesting and applicable to chemistry but some students found the level pitched too high.
- RoboLab #1 is more interactive than RoboLab #2. This is because RoboLab #1 allows students to plan the experiment, record the results in real-time and draw the graph as the experiment is progressing. In its current form, RoboLab #2 is more used for demonstration purposes.
- The students would prefer to carry out the RoboLabs in small groups or on individual laptops to make it more interactive.
- The students would be interested in using simulated experiments which would allow more of them to interact with the experiment at the same time. Many students suggested using individual tablets and simulated experiments.
- The videos helped reinforce the students' understanding and put the theory into context.
- The students would like the class to be more "hands-on" and use quizzes and real-life examples.

2.2 Teacher Feedback

All of the chemistry teachers that observed the workshop preferred RoboLab #2 (IonLab $^{90}\text{Sr}/^{90}\text{Y}$ extraction) due to its applicability to the chemistry curriculum. Currently, A Level chemistry students cover three chromatography techniques; thin-layer, column and gas chromatography. This topic is usually covered towards the end of second year (towards the end of the chemistry qualification) which is an older target age-group than originally anticipated. The advantage of using RoboLab #2 over RoboLab #1 is the higher chance of uptake by chemistry teachers. However, there is the disadvantage that students may have already made their university/career choices prior to the RoboLab lesson. In contrast, RoboLab #1 is accessible to younger students and is more interactive but is unlikely to be used by chemistry teachers.

2.3 Outcome

Based on the feedback received from the RoboLab workshops, NNL decided to further develop the teaching material around RoboLab #2 (IonLab $^{90}\text{Sr}/^{90}\text{Y}$ extraction) due to its applicability to the chemistry curriculum and the higher potential uptake by teachers. Several teachers suggested that chromatography may be covered earlier in the near future, which would allow the RoboLab workshop to reach younger audiences. However, there is the potential that RoboLab #1 could be further developed in future phases of the CINCH project for younger students. Another advantage of using RoboLab #2 is that funding was available to LUH to develop simulated versions of the experiment. At the time of this decision, UIO did not have funding to create simulated experiments of RoboLab #1.

3 IONLAB WORKSHOP

Based on the feedback from the RoboLab workshops, the higher potential uptake by chemistry teachers and the ability for LUH to develop simulated versions of the RoboLab experiments, NNL selected the Ionlab experiment for the high school teaching package.

Ionlab allows students to remotely control an extraction chromatography experiment, separating strontium-90 from yttrium-90 [4]. NNL has developed interactive teaching material on this subject which has been divided into two parts; online e-learning for students to complete before lesson and in-class material for the teacher to use. The teacher and student materials were made accessible on the CINCH Moodle, screenshots of each webpage can be seen in Section 7. The student page is open access to the public, but the teacher page requires a Moodle account and authorisation to access the webpage.

During the e-learning, students are introduced to the concept of radioactive isotopes, medical radioisotopes, chromatography techniques and the experimental procedure for the Ionlab experiment. In-class, teachers can check the students' understanding with quizzes and discussion before starting the Ionlab experiment. Students can also learn about different careers for chemists in the nuclear industry through "a day in the life..." videos. The content has been developed in a "modular" way, giving an indication of time required for each activity. This is to allow teachers the flexibility to build-up a lesson plan based on their students' preferred method of learning and how long the lesson is (lesson duration varies from one school to another). NNL has attempted to include a range of teaching techniques based on student feedback from June 2018 (Figure 7) [2].

To test the latest developments of the teaching material, NNL carried out five workshops with schools based in Cumbria and the North West of the UK. In total, 47 students and 6 chemistry teachers took part in the Ionlab workshops.

Table 3: RoboLab workshop dates at participating schools.

School	Location	Workshop Date
West Lakes Academy	Cumbria	13th June 2019
St Benedict's	Cumbria	17th June 2019
Priestley College	Warrington	18th June 2019
Energy Coast UTC	Cumbria	19th June 2019
St John Rigby	Wigan	20th June 2019

To see how easily the material can be used by someone else (i.e. a teacher or STEM ambassador), seven NNL chemists were trained to carry out the workshops, delivering the teaching material in pairs (Figure 8 and Figure 9). For this reason, the style of delivery varied from one workshop to another as it would in real life. At the end of the workshop, students and teachers were asked to complete a short feedback form. The main findings from these surveys are reported below. It is worth noting that during some workshops, NNL staff experienced technical difficulties in accessing the Ionlab remotely and using the school's IT equipment and this is likely to have influenced the feedback received.



Figure 8 Ionlab workshop at St John Rigby (2019).

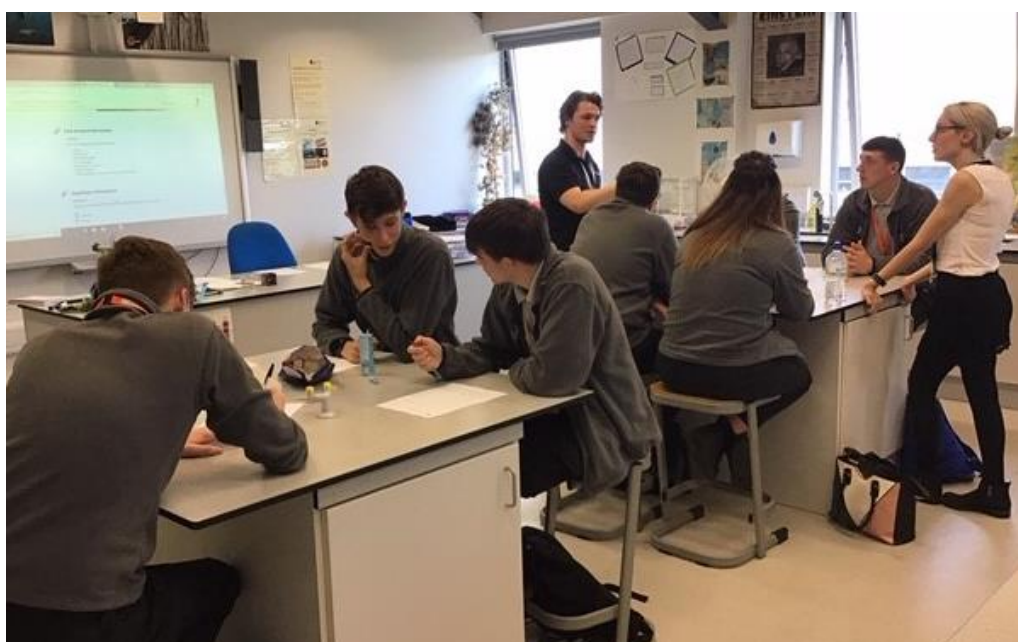


Figure 9 Ionlab workshop at Energy Coast UTC (2019).

3.1 Student Feedback

In total, 47 students took part in the Ionlab workshops and were in the 16-18 age range (Table 4).

Table 4: Age of students participating in Ionlab Workshops.

Age (years)	Number of Students
16	11
17	34
18	1
Unknown	1

All students were studying AS Level chemistry as well as other STEM subjects (Science, Technology, Engineering, Maths). Other popular subjects included maths (72 %) and biology (60 %). A breakdown of the students' subjects is shown in Figure 10 below.

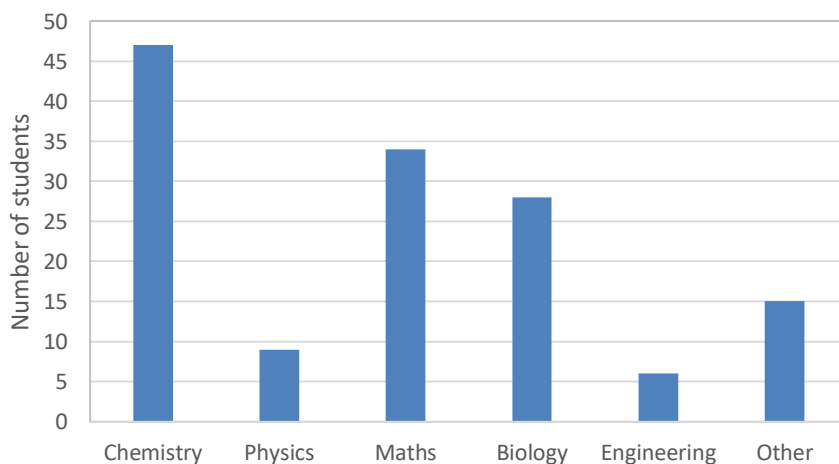


Figure 10: Overview of subjects studied by participating students.

The students were given statements to which they had to respond “Strongly Agree”, “Agree”, “Disagree” or “Strongly Disagree”. Students were also asked to list their “favourite activities” and “least favourite activities”. The questions asked and the replies received are presented in Figure 11 to Figure 20 below.

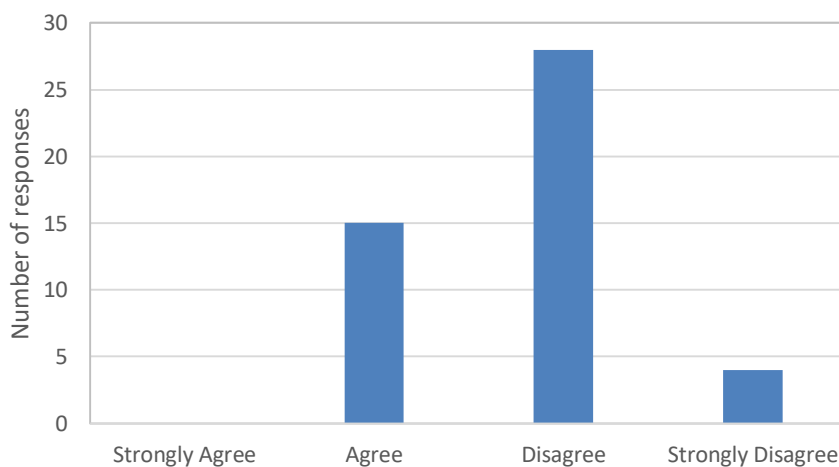


Figure 11: Q1 - Before the workshop - I had a good understanding of radiochemistry and nuclear chemistry.

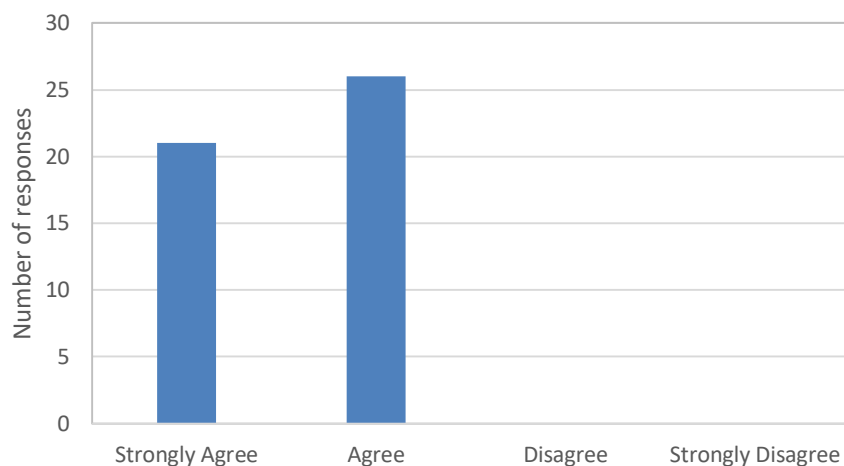


Figure 12: Q2 - After the workshop - I had a good understanding of radiochemistry and nuclear chemistry.

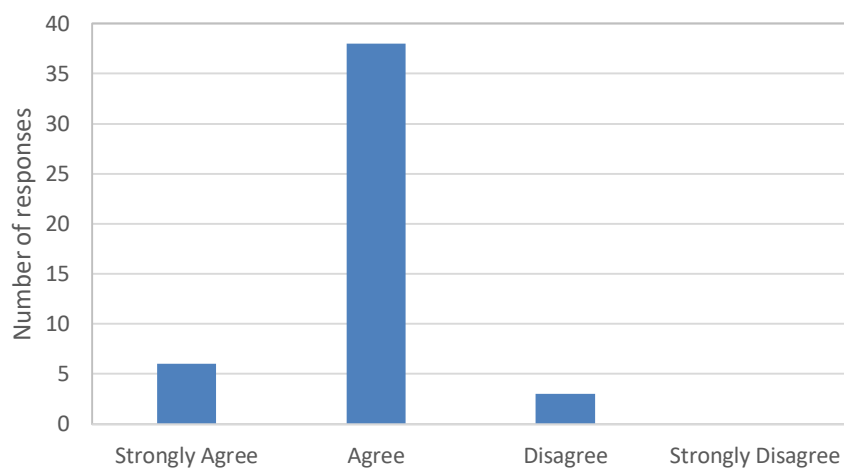


Figure 13: Q3 - The e-learning helped me prepare for the workshop.

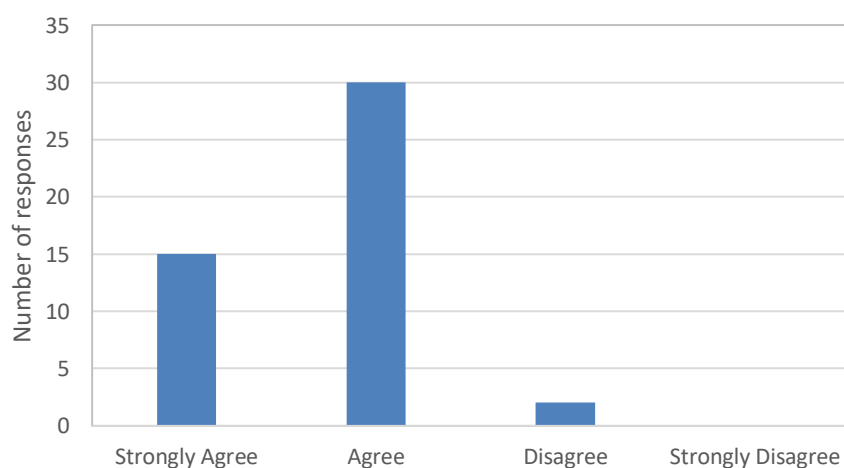


Figure 14: Q4 - I found the workshop interesting and engaging.

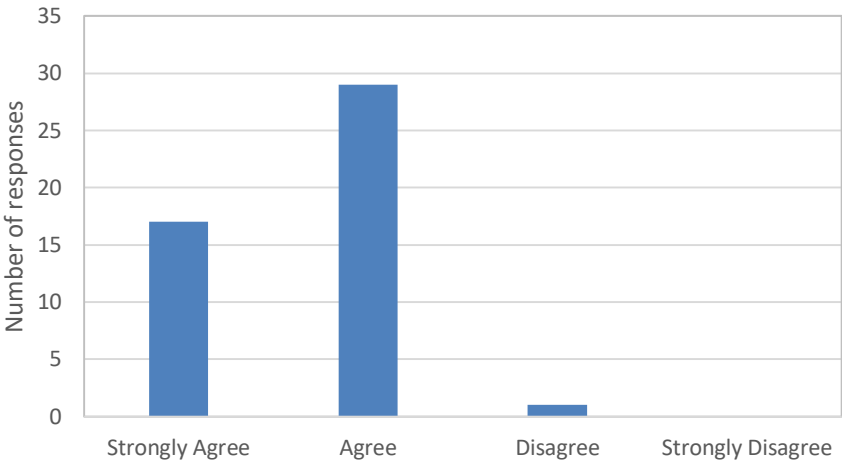


Figure 15: Q5 - I have gained new knowledge/skills from this workshop.

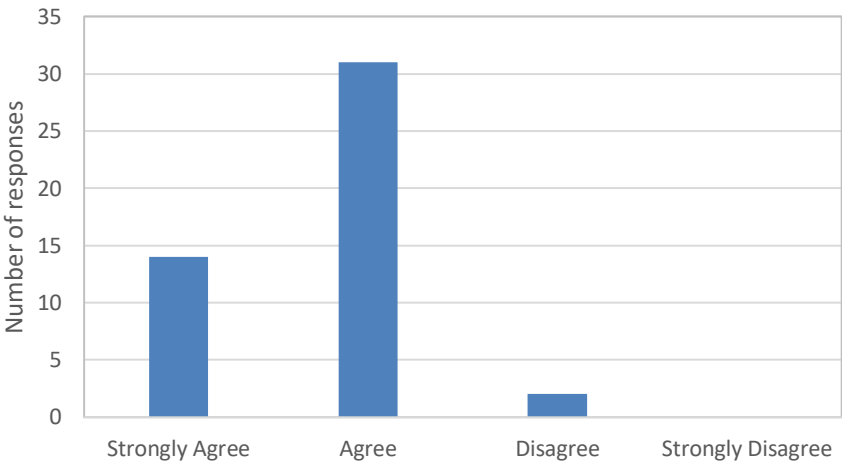


Figure 16: Q6 - I would like to do another activity like this.

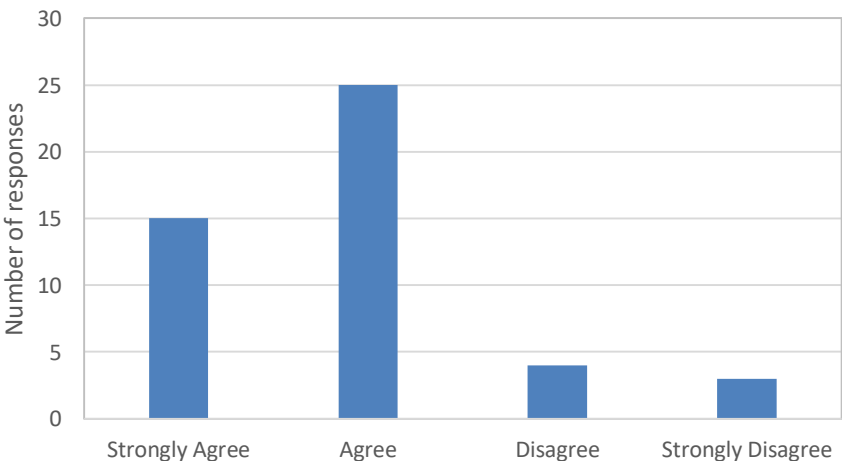


Figure 17: Q7 - I am interested in learning more about the subject covered in this activity.

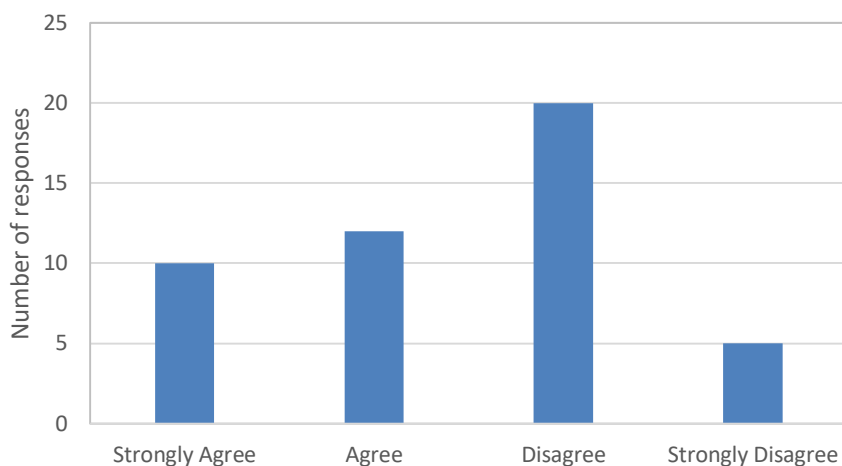


Figure 18: Q8 - This subject has made me consider a career related to chemistry or nuclear.

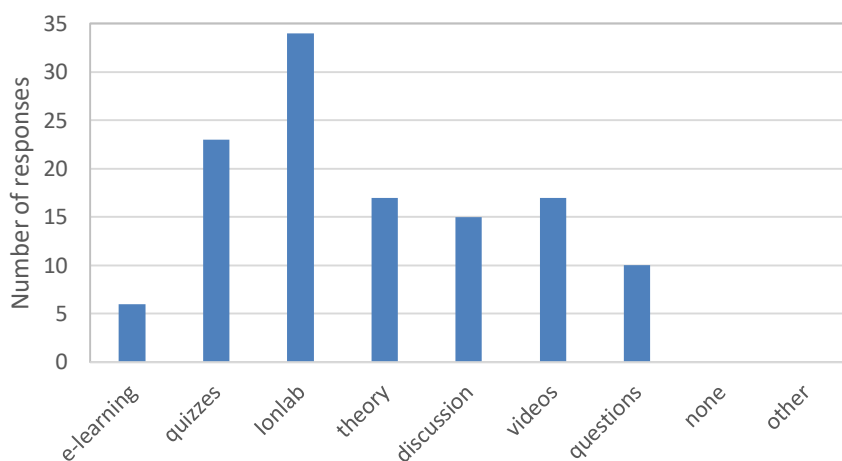


Figure 19: Q9 - My favourite part(s) of the activity is/are.

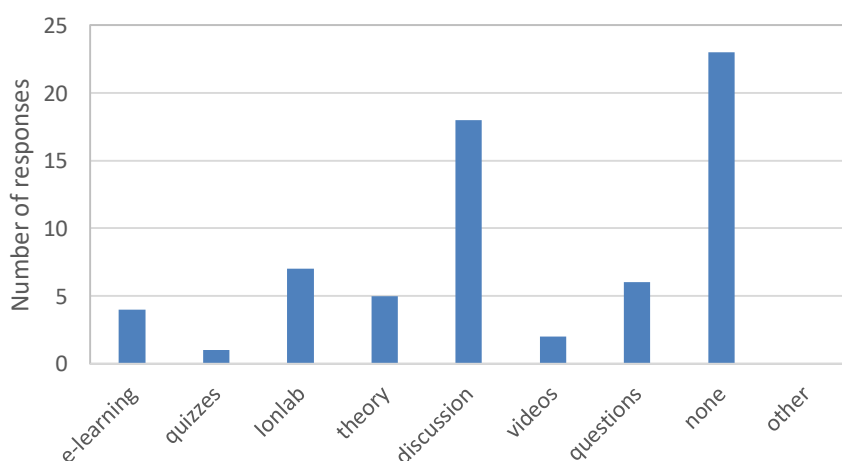


Figure 20: Q10 - My least favourite part(s) of the activity is/are.

Some students gave further written feedback, this has been summarised and is listed below. Written feedback was only received from three out of five schools. It is worth noting that some workshops experienced technical difficulties in accessing the Ionlab experiment and using the school IT equipment.

- Students would like more information on further education and careers (e.g. leaflets, links to websites).
- Students generally liked the “day in the life” video. Students found it useful seeing what a normal day looked like for a chemist in the nuclear industry. Some students would prefer the video to go into more technical depth and some would prefer it to be more relaxed/personal.
- Student handouts could be more in sync with the presentation.
- Links to further information and reading on the subject.
- Some students would prefer a more interactive/hands-on workshop/experiment.
- Students found that there was a lot of repetition between the e-learning material and the in-class material.
- More detailed information on alpha, beta and gamma radiation.
- More information on how medical radioisotopes work in the body.
- Students would like a larger screen to see the experiment more clearly.

Overall, the student feedback is very positive. Before the workshop, 68% students did not have a good understanding of radiochemistry and nuclear chemistry; however, after the workshop all the students felt like they had a good understanding of the subject (55% agree, 45% strongly agree). Grouping “agree” and “strongly agree” responses together, 94% students found the e-learning helpful in preparing for the workshop, 96% found the workshop interesting and engaging, 98% students felt that they had gained new knowledge or skills, and 96% stated that they would like to do another activity like this. 85% students expressed an interest in learning more about the subject but only 47% of students would consider a career related to chemistry or nuclear.

Feedback from the June 2018 workshops showed that students like a range of learning styles (Figure 7). Using this feedback, NNL has tried to incorporate different teaching techniques into the e-learning and workshops (e.g. videos, quizzes) and this seems to have been well received with a relatively even distribution of “favourite activities”. Interestingly, 72% students placed Ionlab amongst their favourite activities which shows that there is a demand for RoboLabs in the classroom. The least favourite activity was “discussion” with 38% voting for this, followed by “questions” (13%), Ionlab (15%) and theory (11%). However, 49% students responded “none” which suggests that the material was generally well received.

Based on the feedback, students find the teaching material interesting and informative. The workshop was successful in making more students aware of careers in nuclear and radiochemistry, whilst covering the school curriculum. There is currently too much repetition between the e-learning and workshop and there are some topics that the students would like to explore in more depth. Although the students enjoy the Ionlab, some students would like the workshop to be more interactive. Students would also like more information on careers and further education.

3.2 Teacher Feedback

Six chemistry teachers were present during the Ionlab workshops. Before the workshop, teachers were asked to review the e-learning material, however a small number of teachers experienced difficulties accessing the content. After the workshop, teachers were asked to respond to the following statements:

Q1 – The e-learning was pitched at the correct level.

Q2 – The content of the workshop was pitched at the correct level.

Q3 – I can see how the content could support the school curriculum.

Q4 – I think robotic experiments are an interesting way to incorporate theories and practicals.

Q5 – I found the moodle (online teaching platform) easy to use.

Q6 – I would be comfortable using the online teaching material to run my own class.

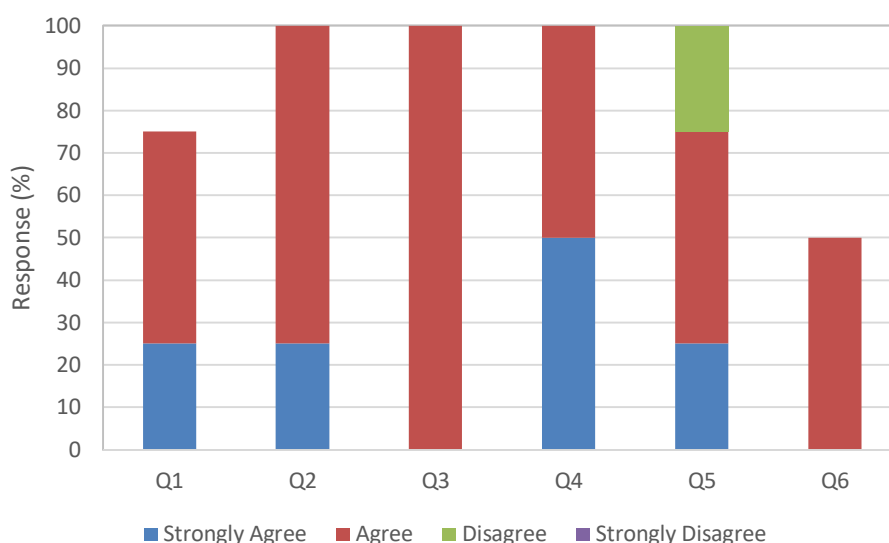


Figure 21: Teachers' responses to e-learning and workshop survey.

The teachers' responses to these questions are shown in Figure 21, please note that not all teachers completed the survey and some questions were not answered. The feedback indicates that all teachers think that the content of the e-learning and workshop was pitched at the correct level and could support the school curriculum. The teachers also found the robotic experiments an interesting way to teach. Most of the teachers found the online teaching platform (Moodle) easy to use; however, one teacher could not access the webpage. The feedback indicates that teachers would feel comfortable using the material themselves although this is only based on two responses.

All of the teachers provided verbal feedback and this is summarised below:

- More activities required to break up the talk.
- The students really enjoyed Kahoot (online quiz).
- Use a “fill in the gaps” activity sheet for the students to complete whilst the content is introduced.
- Liked the careers videos and how the ambassadors talked about their own backgrounds.
- One teacher was familiar with Moodle and thinks it's a great platform but suggested that most teachers use Google Classroom.
- Discussion on video first.
- In case of technical problems affecting the interactive section of the session, it would be good to have a false program of pre-made videos with buttons to control as a “plan B” (i.e. a simulated version).
- Really enjoyed the experiment and the Moodle platform.
- Would like to see more links to paper/TLC which students have already studied at GCSE.
- Ambassadors need to liaise directly with the school's network team as they can assist better with any IT needs.

The written feedback indicates that the teachers are particularly interested in the further education and career information, which can be difficult to cover in class. Some teachers suggested that the workshop needs more activities to break up the presentation. The IT difficulties encountered during some workshops may have been off-putting for some teachers and this risk needs to be removed to ensure uptake by teachers. Some consideration also needs to be given to making the material easy for high school teachers to use.

4 FURTHER DEVELOPMENT

To address the comments received from the Ionlab workshops, some small modifications to the teaching material have been made. These changes are summarised below.

Student Handbook

The student handbook has been modified to be more “in sync” with the e-learning and in-class teaching content, as suggested. This includes “fill-in-the-blank” statements and questions during each “module” to ensure the student is going through the e-learning material in detail and to help them remain focussed during the in-class material.

Teacher Handbook

The teacher handbook (which contains a lesson plan and answers to the student handbook) has been updated, in line with changes to the student handbook.

CINCH Moodle

To stop students accessing the answers to the questions, access to the teacher page on the Moodle is restricted and teachers are required to create an account. Unfortunately, some teachers have experienced difficulties in creating accounts and accessing the material. To provide more clarity to teachers on accessing the material, a new area has been created on the Moodle dedicated to “High School Material”. In this area, a background information page has been created which provides clear instructions on how to access the teacher page and the Ionlab experiment, and who to contact for support.

Following these changes, the teaching package is now in a position where it can be used by high school chemistry teachers. Although there are now clearer instructions on accessing the teaching material, teachers need to go through a number of steps in order to run the session; create a Moodle account, install software to access Ionlab and arrange a timeslot with LUH. This may be off-putting for some teachers and further consideration needs to be given to facilitating teachers’ access to the material in the next phase of the project. One aspect of this is the development of an interactive screen experiment (ISE) version of Ionlab. Although considerable progress was made on this during MEET-CINCH, the ISE is not yet ready for public use, but will be finalized during the next phase of the project (A-CINCH).

Feedback from the school workshops will continue to feed into A-CINCH. This includes the development of more “day in the life...” videos to help students explore the variety of careers available in the field of NRC. Further thought will also be given to minimising repetition between the e-learning and the in-class content. One option is to cover the general principles of NRC in the e-learning, with the possibility to focus on specific areas (e.g. Ionlab) in-class. This would allow the opportunity to develop additional high-school lessons on different topics in the future.

5 CONCLUSIONS

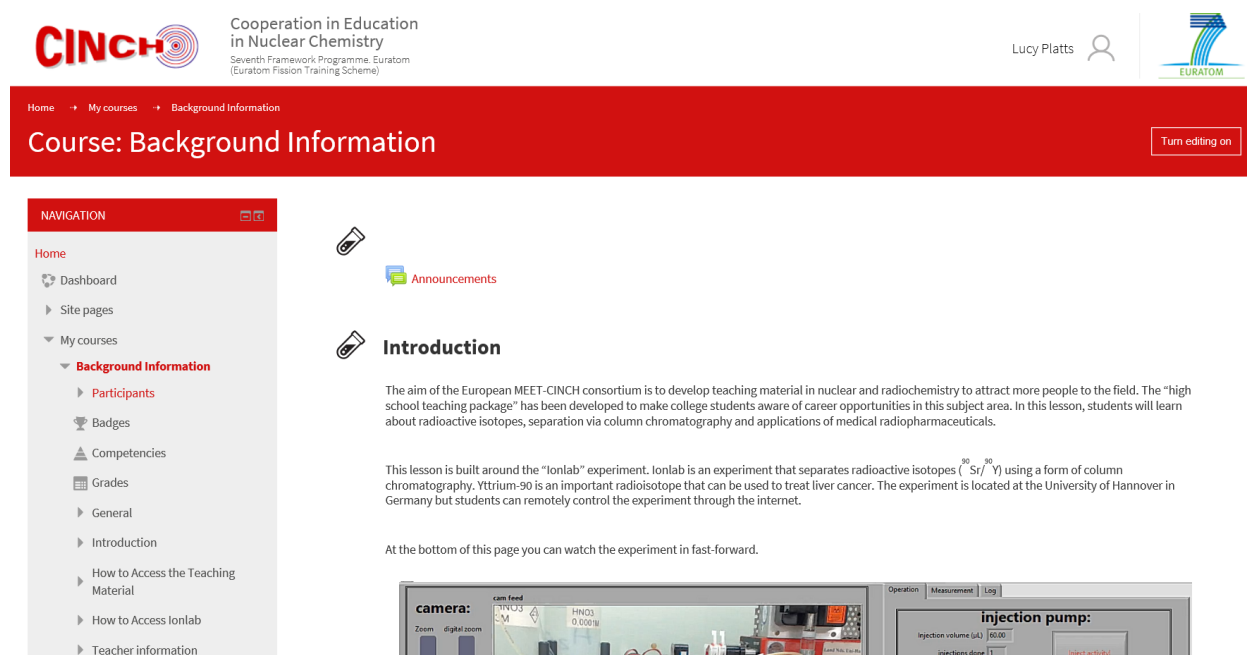
Working in collaboration with UiO, LUH and high school teachers, NNL has successfully developed a NRC teaching package that is suitable for use in high schools and colleges. Throughout the MEET-CINCH project, NNL has sought input from the end-users (i.e. high school students and teachers) engaging with a total of 87 students and 11 teachers from six different schools. This engagement has been achieved through a series of in-class workshops, from which student and teacher feedback has been obtained through surveys and discussions. The purpose of the first five workshops was to test the suitability of RoboLabs #1 and #2 for classroom use and learn about the students' preferred learning methods. Based on the feedback from these workshops, the Ionlab experiment (RoboLab #2) was selected for further development. A further five workshops were carried out the following year to test the latest developments. In addition to testing the content, seven NNL chemists were trained to carry out these workshops to test how easily the material can be used by someone else (i.e. a teacher or STEM ambassador). Feedback from students, teachers and colleagues has now been incorporated into the teaching package.

Throughout the project, workshop feedback has been extremely positive, with both students and teachers showing great interest in the subject of NRC. It is clear that this task has made significant progress in raising young people's awareness of the importance of NRC, and the range of careers available in the field. The teaching package is now publically available and can be accessed on the CINCH Moodle. Although the material is fit for use, a number of recommendations have been made to further improve and expand the high school teaching package in the future.

6 REFERENCES

1. C. Fournier, J-P. Omtvedt, “D3.4 Six nuclear chemistry remote-controlled experiments ready for use”, 14/01/2016.
2. L. Platts, “D1.4 RoboLab School Workshops: Analysis of Student Feedback”, 03/08/2018.
3. L. Platts, “D1.5 School Workshops: Analysis of Student and Teacher Feedback”, 25/10/2019.
4. W. Schulz, C. Fournier, J. Vahlbruch, C. Walther, “IonLab – a remote-controlled experiment for academic and vocational education and training”, *Radiochimica Acta*, Volume 104, Issue 10, Pages 743–748.

7 CINCH MOODLE



CINCH Cooperation in Education in Nuclear Chemistry
Seventh Framework Programme, Euratom (Euratom Fission Training Scheme)

Lucy Platts

Home → My courses → Background Information

Course: Background Information

Turn editing on

NAVIGATION

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Introduction

The aim of the European MEET-CINCH consortium is to develop teaching material in nuclear and radiochemistry to attract more people to the field. The “high school teaching package” has been developed to make college students aware of career opportunities in this subject area. In this lesson, students will learn about radioactive isotopes, separation via column chromatography and applications of medical radiopharmaceuticals.

This lesson is built around the “lonlab” experiment. lonlab is an experiment that separates radioactive isotopes ($^{90}\text{Sr}/^{90}\text{Y}$) using a form of column chromatography. Yttrium-90 is an important radioisotope that can be used to treat liver cancer. The experiment is located at the University of Hannover in Germany but students can remotely control the experiment through the internet.

At the bottom of this page you can watch the experiment in fast-forward.

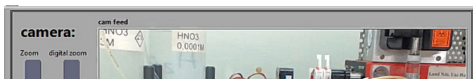
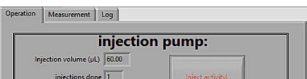
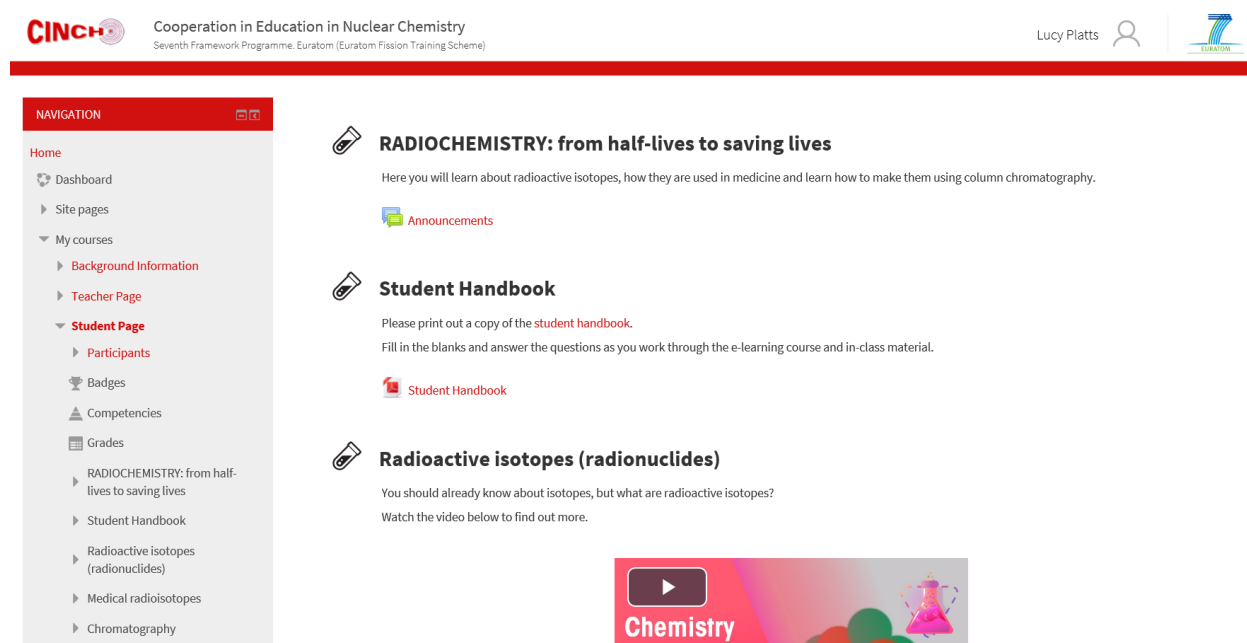
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Figure 22: Screen shot of background information page on CINCH Moodle.



CINCH Cooperation in Education in Nuclear Chemistry
Seventh Framework Programme, Euratom (Euratom Fission Training Scheme)

Lucy Platts

Home → My courses → Student Page

RADIOCHEMISTRY: from half-lives to saving lives

Here you will learn about radioactive isotopes, how they are used in medicine and learn how to make them using column chromatography.

Student Handbook

Please print out a copy of the [student handbook](#).
Fill in the blanks and answer the questions as you work through the e-learning course and in-class material.

[Student Handbook](#)

Radioactive isotopes (radionuclides)

You should already know about isotopes, but what are radioactive isotopes?
Watch the video below to find out more.







Figure 23 Screenshot of Student Page on CINCH Moodle.



Cooperation in Education
in Nuclear Chemistry
Seventh Framework Programme, Euratom
(Euratom Fusion Training Scheme)

Lucy Platts 



Home + My courses + Teacher Page

Course: Teacher Page Turn editing on

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General introduction

This page contains the in-class teaching material for the lesson "radiochemistry: from half-lives to saving lives". Follow the steps below.

 **Announcements**



Teacher Information


Welcome to the MEET-CINCH project! Thank you for taking a look at our teaching material - we hope that you find it helpful and informative. This material is free for you to use and has been developed in a modular way, so that you can tailor the material to your teaching needs.

This page contains the content to be covered "in class". The topics can be taught with a variety of teaching styles (e.g. quiz, presentation, video). This is to help you tailor the material to the preferred learning methods of your students. The estimated time required for each topic is shown in **bold** to help you plan your lesson.

We recommend that the students complete the e-learning before class, this can be found on the "**Student Page**". This is to familiarise them with the **theory** that will be covered in the Ionlab experiment.

The **Student Handbook** contains fill-in-the-blanks and questions for the students to complete whilst working through the e-learning course and in-class material.

The **Teacher Handbook** contains useful information, a lesson plan and answers to the **Student Handbook**.

 **Student Handbook**


 **Teacher Handbook**

Figure 24 Screenshot of Teacher Page on CINCH Moodle.