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Navigating new waters: My journey in leading a Physics lesson study

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Abstract: This study explores the process of leading a lesson study, a collaborative teaching approach that involves choosing a team of teachers and a research focus, planning a research lesson, delivering it, followed by a debriefing session aimed to create new knowledge. Originating in Japan, lesson study has gained popularity because of its reported effectiveness to promote reflective teaching and continuous improvement. In leading the lesson study reported in this paper, which focused on facilitating connections with students through group work and discussion, the team included three teachers and a knowledgeable other. Guided by Vygotsky's concept of the Zone of Proximal Development, the lesson study team aimed to build on students' existing knowledge with carefully planned tasks and questions. This lesson study left a profound impact on both educator development and student learning, highlighting the benefits of lesson study as an approach to collaborative teaching. This experience enhanced Physics teachers' opportunities to explore inquiry-based teaching strategies by researching, sharing, and implementing their ideas. Meanwhile, the Year 11 students with whom the lesson was taught, were introduced to the topic in an interactive manner, and this fostered active engagement and curiosity.

Keywords: Collaborative teaching; lesson study; reflective practice; student engagement; teaching Physics

Introduction

Lesson Study is a professional development (PD) model in which a group of teachers collaboratively plan, deliver, observe, and discuss lessons (Bush, 2009). These lessons typically focus on challenging aspects of the curriculum and are tailored to the learning needs of specific students. Lesson Study, developed in Japan and now used widely worldwide, involves teachers collaboratively examining and improving teaching practices. Lesson study involves cycles of instructional improvement where teachers collaboratively set goals for student learning and development, plan a research lesson to achieve these goals, conduct the lesson where one teacher teaches while others observe and gather evidence. At the end of the lesson, teachers reflect on the evidence of learning collected to enhance the lesson and overall teaching and, optionally, repeat the process in other classrooms for further refinement (Lewis, 2009). By studying classroom practices, teachers aim to refine specific techniques, thereby improving student learning. Stepanek et al. (2009) describe lesson study as a means for teachers to enhance their own understanding of the content and to learn how to effectively translate this knowledge into student experiences. Overall, lesson study is a cognitively demanding endeavour that engages teachers in an in-depth investigation as expert practitioners.

My role in the lesson study reported here was to lead a group of educators. To do so, I invited my Physics teacher-colleagues via email and eventually worked with the two teachers who showed interest. Due to his vast experience in teaching Physics and in leading curriculum development processes, we invited the head of school to join our meetings and act as our knowledgeable other. This lesson study experience was positive for us and, hence, I chose to disseminate it with the hope of motivating others to engage in this process. Moreover, of all the PD initiatives that I participated in during my teaching career, lesson study was the most meaningful to me as a Physics teacher because it was an ongoing collaborative and unique subject-specific endeavour. Indeed, Stepanek et al. (2009) state that PD is more effective when it is collaborative, ongoing, focused on subject matter, centred around teachers' work with their students, is hands on, and focused on student outcomes.

The lesson was meticulously planned to foster higher-order thinking, rather than simply presenting facts for rote memorization. To achieve this, we incorporated a group work activity where, split in four groups, students were invited to discuss various aspects of radioactivity. These discussions stimulated critical thinking about the dangers of radioactivity, protective measures, and its natural decay process. One of the strengths of the lesson study was the necessity to connect the four groups' discussions and anticipate students’ responses to achieve our lesson objectives. As the lesson study leader, my role was to keep the team focused and motivated throughout this extensive preparation process. The culmination of all this preparation was the research lesson itself. Teaching, observing and collecting data about the research lesson served as an opportunity to exhibit our own work and learn from the responses of students and the comments that observers provided.

The research lesson

The research lesson entitled "What is Radiation?” was an introduction to the Year 11 topic of Radioactivity. This is an abstract topic, and students usually have difficulty understanding concepts such as invisible subatomic particles and nuclei and their half-life. Being the last topic taught before the Year 11’s final exam, lessons usually involve showing the students some videos on the subject and passing on information, usually in a rush. With this in mind, and the fact that all three teachers had a Year 11 group, we opted for this research lesson. The lesson study team (see Table 1) decided that I would be the one teaching the lesson with my Year 11 class while the others would act as observers.

Professional role	Role in lesson study
Year 11 Physics teacher	Leader and teacher delivering the lesson
Year 11 Physics teacher	Team member and observer
Year 11 Physics teacher	Team member and observer
Head of school	Knowledgeable other and observer
Research academic and expert in lesson study	Course lecturer, mentor and invited observer

Table 1: The lesson study team members and their role

After the first two meetings, which involved a brainstorming activity to identify key issues in the teaching and learning of Physics at Year 11, we came up with the research theme of introducing students to the topic of radioactivity. In our planning, we sought to prepare a lesson where students engaged in collaboration and inquiry with the aim of building new knowledge at the introductory stage of the topic. This, we thought, would facilitate students' understanding of concepts in the lessons that would then follow. Pedaste et al. (2015) state that inquiry-based learning (IBL) places an emphasis on active participation and a responsibility on the learner for the co-creation of new knowledge. In planning this lesson, we followed Pedaste et al's (2015) suggestion to start from more open questions that could guide students to the exploration of radioactivity. The lesson goals and objectives were therefore planned to provide realistic events and experiences of scientists during their discovery of radioactivity. We sought to engage students in group work to answer questions with the intention of leading them to three basic concepts that we needed to cover in the topic. The questions used in the "neriage" phase, that is, in the concluding part of the lesson, set students thinking about:

1. What radioactivity is and how they can describe it
2. The use of lead as a protective material against radioactive elements, and
3. Different decay rates of radioactive elements and the concept of half-life.

Through this lesson we also sought to learn how to implement group work in such a way that students could benefit from it. Hammar Chiriac (2014) indicates that group work helps students develop inquiry skills, share ideas, clarify differences, solve problems, and construct new understandings. Also, within a small group setting, students tend to be more motivated to engage and achieve than when working individually. Group work, hence, was not only intended to enhance knowledge development but to help students build interpersonal skills. In the context of our lesson study, we used group work to serve both as a means through which students could make sense of the tasks and negotiate their understandings, and as a method for collaborative knowledge acquisition.

The lesson study context

The lesson study was held at a state secondary school in Malta. The school context included a diverse population of students. Situated in the north of Malta, the school has a high population density of about 550 students where Physics is a compulsory subject. This scenario presents challenges for educators (teachers and learning support educators) as the subject needs to be adapted at various levels. Unfortunately, there are limited teacher PD opportunities offered by the school to support educators to develop effective teaching strategies that address the needs of all students. Luckily, I was introduced to lesson study while reading for my master's in educational leadership and management course at the University of Malta (2022-2025). The two teachers collaborating with me on this lesson study showed interest because they recognised lesson study as a unique opportunity for professional collaboration and their professional growth.

The class chosen consisted of high ability and motivated students. However, some students lacked collaborative skills and, as a result, they remained very quiet and passive during discussions. While engaging students in more active participation was a key focus, logistically it made sense to choose this group because they had a lesson after the mid-day break and all the teachers involved in the lesson study were free after the lesson and could attend the post-lesson discussion. In lesson study a knowledgeable other, who is often an expert in the field (Stepanek et al., 2007), provides valuable insights and guidance throughout the lesson study cycle. This role was taken up by our head of school who was a former Physics teacher, Physics head of department and education officer. His teaching and leadership career within the Physics and the curriculum department made him an asset in this lesson study. The Physics teachers involved, each had over 10 years of teaching experience and all actively contributed to designing the teaching resources and planning the lesson. The table below provides information about the role of the lesson study team members.

The lesson study process

In this section I explain the phases of our lesson study and how this developed during the six-week period (November 2023 to January 2024). During the University course, we were introduced to the lesson study cycle as proposed by Takahashi and McDougal (2016), and which we followed (see Figure 1).

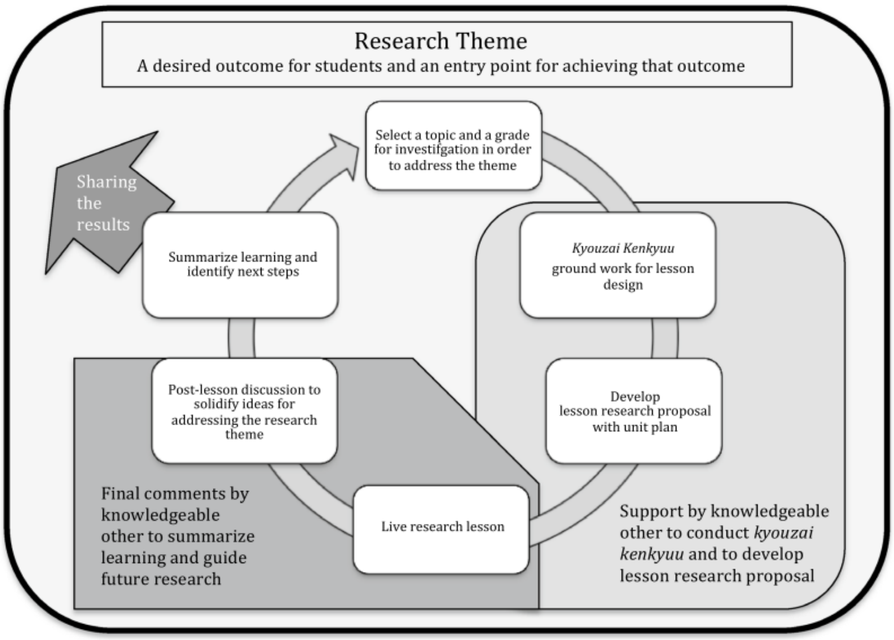

Figure 1: The lesson study cycle adopted from Takahashi and McDougal (2016)

Table 2 below highlights the process that the lesson study team went through. This process encompassed several distinct phases, each of which contributed towards achieving the intended teaching and learning outcomes. Going through these phases not only enhanced the quality of our lesson but fostered a culture of continuous professional growth and collaboration among all those involved (Lewis & Perry, 2009).

Phases and timeline	**Work done by the team**
4th November 2023	As the lesson study leader, I invited the physics teachers to take part in the lesson study by email. Two accepted the invitation.
Week 1: 6th -10th November 2023 Introduction and goal setting.	• Explained the process and phases of lesson study. • Selected a topic and then agreed on the research theme. • Decided to plan for student collaboration and inquiry so that students could build new knowledge at the introductory stage of the topic.

Week 2 and 3: 13th - 24th November 2023 The 'kyozaikenkyu' phase involves teachers researching and deepening their understanding of the content, as well as exploring various teaching materials and strategies. During this phase, educators thoroughly anticipate student responses and prepare instructional resources to ensure the lesson is both engaging and educationally sound. This phase is crucial for setting a solid foundation for the subsequent planning and teaching stages of lesson study (Lewis, 2002).	• Discussed the choice of a knowledgeable other and chose one. • Discussed how each member usually introduced radioactivity to students. Keeping in mind an inquiry approach, we researched how we could make changes to what we usually do to promote critical thinking. • Decided to use facts and anecdotes from the lives of scientists involved in the field to build a set of resources. A set of questions on each text were prepared to guide the students' discussions and lead them towards the learning objectives that we had in mind.
Week 4: 27th November - 1st December 2023 Getting feedback from our knowledgeable others.	• Presented what we found through our research. • Discussed what we thought would be appropriate and what could be challenging. • Sought feedback to improve our research lesson.
Week 5: 4th - 8th December 2023 Discussing the "neriage" phase (the conclusion of the lesson), the observation and the feedback sheets.	• Decided how students could summarise the learning such that they construct new knowledge. • Planned to find the link between each task such that we facilitate the flow of the class discussion and to deepen students' understanding and enhance their ways of thinking (Fujii, 2016).
Week 6: 11th - 15th December 2023 Finalising the lesson plan and resources.	Two meetings were held. • Did a PowerPoint presentation to help with the flow of the lesson. • Designed a student observation sheet for observers. • Sought the support of the administration with regards to logistics. • Contacted the invited observer to be present for the lesson and the post-lesson discussion.

Live lesson week: 9th January 2024 (20-minute meeting)	• A run through of the observation sheets and a discussion on the key students to be observed. • A quick run through of the logistics and last-minute preparations for the day of the teaching of the lesson.
10th January 2024 The teaching of the lesson.	I taught the lesson and the team members together with the invited observer were present. They were assigned different students (one from each of the four groups) and their role was to observe and take notes on student learning.
The post-lesson discussion.	• Discussed the lesson in general and how students interacted. • Feedback was given by each member and observer on their identified student. • Areas for improvement were identified and discussed further.
February 2024 Sharing our findings.	• Findings of this lesson study were shared with the other Physics teachers during one of our departmental meetings. • Presented the findings in an international online conference on leading lesson study organised by Collaborative Lesson Study Malta (see https://www.um.edu.mt/newspoint/events/um/2024/02/clestums-2nd-international-online-seminar)

Table 2: The lesson study phases, activities and timeline

Key instructional decisions within the research lesson

The lesson plan targeted students' understanding of the fundamental concepts of radioactivity through small-group, whole-class discussions and hands-on activities. Our aim was to foster deeper understandings and connections between historical knowledge and scientific principles related to radioactivity.

Hence, the lesson objectives (Appendix 1) were formulated, and we designed the activities to help us target these objectives. Since we wished to work on group work skills, we dedicated the main part of the lesson for a group work activity. We also prepared different activities such that each group was working on a different task. This was important because since we wished to elicit as much knowledge as possible from students, we aimed to provide them with a short reading task followed by a set of questions. After the group work task was done, a whole class discussion was done to link the knowledge that emerged from individual groups. To have flow in the discussion we added questions to each group that were similar, such that during the "neriage phase", which is the concluding part of the lesson, the teacher would take aspects from what each group answered to highlight the lesson objectives and support students with the learning outcomes.

For example, the discussion started by eliciting a description of radioactivity and its main uses. Hence, the teacher asked Group 3 to discuss historical uses of radioactive materials (for example, glow-in-the-dark watches, makeup and energy drinks) and describe radioactivity. Then the teacher turned to Group 1 and asked them to compare their description of radioactivity to Group 3's. Following that, the teacher asked Group 4 to relate radioactive elements to their use in Chernobyl, such that it could become clearer to everyone that these elements are a form of energy (see Appendix 1 and Appendix 2 for the lesson plan and the four learning tasks).

In this lesson, the students were introduced to the lesson objectives at the end of the lesson. Hence, in the conclusion, the teacher used a slide of the PowerPoint presentation to show them the objectives and went over them while checking with the students that the objectives were reached. Finally, the team decided to use a feedback sheet for the students. The students appreciated that the teacher wanted their opinion on the lesson, and this sheet served as a tool for the lesson study team to collect data and gauge the effectiveness of the lesson vis-à-vis student engagement and learning.

Main takeaways from leading and teaching the research lesson

Leading this lesson study has been a unique journey and a significant learning experience for me. Initially, stepping out of my comfort zone to collaborate with colleagues was challenging as everyone is busy at school and I thought that teachers would consider lesson study as an extra piece of work. Notwithstanding my initial dilemmas, since lesson study is a very different approach to traditional teacher PD, I was determined to make it happen because I believe in collaboration, research, observation and reflection which are at the core of lesson study. Indeed, although the process was challenging for all, it was immensely satisfying every time teachers expressed that they enjoyed and learned from their engagement in this process.

Understanding the benefits of IBL in promoting critical thinking and real-world relevance, and in sparking curiosity and interest (Hmelo-Silver et al., 2007), the team seized the opportunity to explore this aspect through lesson study. Moreover, since the lesson study team members had mentioned that they struggled to incorporate IBL in lessons, we agreed to take this up within this lesson study. The benefits of taking up this challenge collaboratively were experienced not only during the lesson study process itself, but also afterwards. In the days following the lesson, students approached me with positive comments, further questions, and additional examples. This indicated that students benefited from the inquiry experience as it stimulated them to continue with their research after the lesson.

Moreover, the students benefited from the fact that the teacher was also learning new ways of teaching and assessing their learning. Pollock et al. (2021) state that many student assignments focus on rote memorization rather than higher-order thinking skills like comparing, analysing, or making connections. To encourage deep thinking, students need to develop these skills and have knowledge about the topics. In this lesson study, teachers sought to foster innovation by planning and teaching a lesson that engaged students in discussion, critical thinking, exploration and communication. When students regularly apply thinking skills to create and explore, they become more independent learners and are in a better position to co-create scientific knowledge while working with others.

Brookhart and Rasooli (2021) suggest that teachers use group work to promote active and deep learning while fostering collaborative skills. We experimented with a different classroom setup and carefully planned group members to complement each other by including various abilities in each group. However, this did not ensure all students participated in group discussions. Lewis (2009) encountered the same problem with introverted students and one of the innovative ways chosen was to have students perform an individual task and gather data from it before they moved to working in groups. The advantage of lesson study is the opportunity to discuss such issues in the post-lesson discussion and to then reflect and plan for improvement in the future.

According to Lewis (2016), teachers' discussions about professional learning emphasise the value of teaching experience and the opportunity to observe and converse with others. Lesson study provides these opportunities, which are quite rare for teachers in my school. In Japan, where lesson study is standard practice, teachers engage in this process throughout their career, whether they are novice, experienced, or expert teachers. Consequently, professional learning is a continuous experience at every career stage.

Lesson study, being practice-driven, effectively bridges the gap between theory and practice. It addresses current classroom dynamics, allowing teachers to set the agenda based on their students' needs. Lewis (2016) asserts that lesson study is deeply rooted in experience. Since it is driven by the interests and needs of the teachers, the lesson study leader and teachers collaboratively develop their skills as they progress together. In our case, the more experienced teacher was new to IBL whereas I had attended courses promoting IBL. Following this lesson study, the more experienced teacher approached me with the idea of using IBL to teach the topic of "Pressure" with her Year 9 group of students. Indeed, our collaboration did not stop with this lesson study. In other words, our PD and professional growth has been sustained through and because of lesson study. We feel that the insights gained from our collaborative practice and the research that we did have laid the groundwork and foundations for our continued professional improvement.

Conclusion

Reflecting on the lesson study process and my role as a leader, I found that leading the lesson study was both challenging and rewarding. Stepanek et al. (2009) describe the leader as the person responsible for driving the lesson study process, encouraging teachers to delve deeper and reconsider their teaching methods. This role involves understanding the core elements of lesson study, seeking feedback, and organising the meetings and agendas.

During my postgraduate course in educational leadership and management, I attended lectures and reviewed literature to effectively lead a lesson study. With strong administrative support at school, handling logistics such as scheduling meetings, arranging facilities, and communicating with the administration was more straightforward. According to Stepanek et al. (2009), the leader is also responsible for finding knowledgeable others to participate in observation and debriefing sessions. Towards this end, I invited one of my university lecturers, who collaborates with schools on lesson study initiatives, and another knowledgeable other (the head of school) was chosen by the team and was present during the entire lesson study process. Our experience shows that knowledgeable others add value to the lesson study process and their insights contribute to teacher learning. In the case of our lesson study, the head of school and invited observer provided content expertise and drove teachers to think more deeply about pedagogy without instructing or directing our work (Stepanek et al., 2009). Indeed, throughout this PD experience, the lesson study team members felt an ongoing sense of ownership and agency that drove our learning – something which no other PD experience had ever given us.

Lesson study not only helped us teachers develop our understanding of content but also provided a platform through which we could learn about effective teaching practices. As highlighted by Fernandez (2005), learning within lesson study revolves around creating a lesson plan and reconsidering teachers' practices around a unit of teaching – in our case radioactivity. Through this process, teachers are constantly thinking about lesson planning and, hence, lesson study is very practical.

Stepanek et al. (2009) contend that lesson study is a process that needs to be sustained. Teachers find the collaborative aspects of planning and analysing the research lesson to be the most valuable (Lewis, 2016), yet these PD experiences are rare for teachers locally (Calleja 2018; Calleja & Formosa, 2020). To be sustainable, lesson study requires a collaborative culture that embraces trust and a commitment to ongoing teacher development and improvement of student learning. Looking ahead, in my new role as a middle leader, I hope to conduct more lesson studies and provide teachers with time and targeted support so that they are able engage in and benefit from such a collaborative PD opportunity.

Acknowledgment

I would like to thank the teachers working with me on this project. Without their involvement, the lesson study could not have been possible. I would also like to thank the Head of School, who not only facilitated the process and supported it, but he was also our knowledgeable other and part of the lesson study team. Finally, my mentors who guided me, step by step, during the lesson study process.

Appendices

Appendix 1: The Lesson Plan

Date: 10th January 2024

Lesson Objectives

By the end of the lesson, students will be able to:

- Refer to radioactivity as a form of energy
- Use some words to describe radiation such as penetrative, dangerous, useful, harmful
- Identify lead as a material that blocks radiation
- Give a brief description of half-life.

Setting of the class

- 4 tables to fit 4 students each
- Power point presentation on the Interactive with the title: What is Radiation?

Introduction (PowerPoint slide 1)

Teacher: *Today we are going to start the topic Radioactivity. During the topic, we need to understand certain concepts and learn new terminology. My aim for this lesson is to set you off thinking and connecting past knowledge with new knowledge.*
Together with us today we have: (Introduce observers)
They are here to observe the lesson so that we can learn how to plan and prepare better lessons for our students.
Explain: *The main task of this lesson is to read a piece of text inspired from the people who sacrificed their life studying and discovering radioactivity and then engage in discussion to answer the questions that follow. You have 15 minutes to do so. On the table you have a button file with the text and questions. You also have a piece of Lead. This material is mentioned a lot in your readings.*
When we are done, we will discuss in groups to share what we learned.

Resources

Each group will have a pack with a piece of text (a different one for each group) and a set of questions to discuss, a highlighter, some paper and a lead cube. (Observers: Take note of the discussions that the target students are or are not engaging in. Do not enter discussion with students and jot down any notes you feel might help us understand the process of student learning.)

The Neriage phase

Neriage is an activity that goes beyond "show and tell". In this section of the lesson the teacher must facilitate extensive discussion with students. By comparing and highlighting the similarities and differences among students' solutions, the students should make connections. Teacher needs to ask students to reflect on what they have learned. The neriage phase includes three discussion sections.

1. Discussion about description of radioactivity
2. Discussion about lead as a protective material
3. Discussion about radioactive decay and half life

Next: Put up on the board a snippet of what each group read and discussed. Give students 3 minutes to go through them briefly (PowerPoint slide 2).

Discussion about description of radioactivity

Group 1: How is their answer like your description of radioactivity? (PowerPoint slide 3)

Group 3: You read about how in the early 1900's people were using radioactive sources in glow-in-the-dark watches, make-up and even energy drinks. People who consumed them suffered the same faith as the Curies. What words did you use to describe Radioactivity?

Group 4: In question 1, you were told that Chernobyl was a nuclear power plant. How did you describe radioactive elements in relation (in the light of) to their use?

Discussion about Lead as a protective material? (PowerPoint slide 4)

Group 1: It is said that Marie Curie was buried in a lead Coffin. Why lead? Why was the lead 1 inch thick? (expect that they say that lead has to be thick to stop radiation from passing)

Group 2: You had to design protective clothing for radiation workers. Can you tell us about the clothes you designed? (Did they mention lead? If yes, link to the coffin. If no, ask them that after hearing what group 1 said, what material should they have included?)

Group 3: Do you think the lead lined clothes would have helped Radium girls, Radioactive make-up or Eben Byres? (Expect no, because they ingested it? Joke: they needed to line their digestive system!!)

Discussion about radioactive decay and half-life (PowerPoint slide 5)

Ask: But in medicine, sometimes we make people drink a radioactive substance as part of a medical test. Briefly explain the slide.

Which group has evidence that this will wear off?

Prompts 1: group 1, in one of the questions you read that after seeing how her husband died of cancer because he was handling radioactive materials, she limited her exposure. What did you say in question 3 which asked: What happens to the levels of radioactivity present as time passes? (Link to the idea that radioactive elements decay over time)
Group 2: You read that the Curie's belongings will be radioactive for another 1500 years. If radioactivity decreases over time as group 1 said…. How are the Curie's belongings still radioactive after 100 years? (See what they say…. Slow decay……)

PowerPoint slide 6
Group 4: You read about the explosion at Chernobyl's nuclear power station that released radioactive material. It says that Cesium (one of the fuels used) has a half-life of 30 years. How did you describe half-life? Does it link to this decay? Refer to the diagram on PowerPoint.
Expected answer—that if you have a 100%, this will become 50% after the first half life and 25% after the second half life and so on.
PowerPoint slide 7

Conclusion:
Tell students that the lesson had four aims. Check that the objectives were reached.
By the end of the lesson, we wish to see if you can:

1. Refer to radioactivity as a form of energy.
2. Use some words to describe radiation such as penetrative, dangerous, useful, harmful…
3. Identify lead as a material that blocks radiation.
4. Acknowledge that radioactive elements decay

Finally, provide student with the feedback sheet.

Appendix 2: Group tasks

Each group of students was given a sheet with some radioactivity facts and a set of questions as prompts for their small-group discussion. The four tasks developed for the lesson study are illustrated below.

Group Task 1

Read about Marie Curie and the fact that her coffin was made of lead.

THE REASON MARIE CURIE'S CASKET IS MADE OF LEAD

Marie Curie was a brilliant scientist who helped expand our knowledge of radioactivity. Since she and her husband Pierre were still trying to understand radioactivity, **they didn't take the same precautions used today.** So when Curie died, her body, still riddled with radioactive atoms, had to be buried safely.

Curie is buried in a casket made of lead to contain the radiation, but according to The Journal of the British Society for the History of Radiology, people didn't know Curie's coffin was made of lead until her body was exhumed in 1995.

Questions

Discuss what you read and try to answer the following

1) Why was Marie Curie buried in a lead coffin?

____

____

2) Why do you think the lead of the coffin was 1 inch thick?

____

3) Pierre Curie died young and the level of radiation in his body was very high, however, he was not buried in a lead box because at the time they had less information. After that, Marie Curie limited her exposure to the radioactive elements so her levels of radiation were less. So what do you think happens to the level of radioactivity present in sources of radiation as time passes?

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4) After reading this, how would you describe radioactivity?

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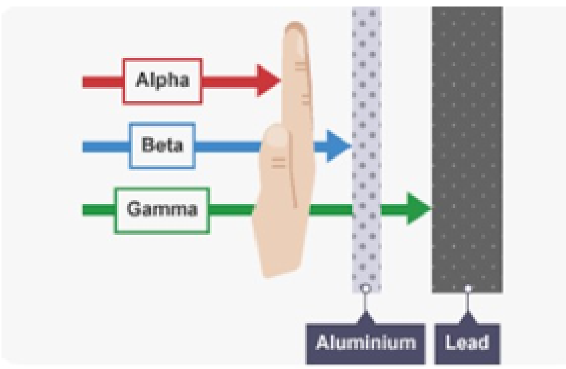
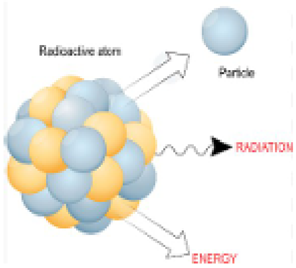




Group Task 2

Read about the effects of being exposed to radioactivity and the decay process. Discuss protective measures against radioactivity.

Marie Curie's Belongings Will Be Radioactive For Another 1,500 Years

27 August 2015 By BARBARA TASCH, BUSINESS INSIDER

Marie and Pierre Curie. Credit: Atmoic Heritage Fund

Marie Curie died of cancer caused by her exposure to radioactive elements, Radium and Polonium. When she died, her body had some radiation, but she lived long enough for most of it to pass through because she limited her exposure to radiation after her husband died. Nonetheless, she was still buried in a lead casket.

On the other hand, her husband died young, so his remains were more radioactive. He wasn't buried in a lead casket because protective measures against radiation were not yet developed.

However, Marie and Pierre Curie's notes and personal belongings, from scientific records to furniture and cookbooks, are still radioactive over a hundred years later. The National Library of France keeps Curie's notes in lead-lined boxes, and if you want to handle their possessions, you need to wear protective clothing.

Questions

Discuss what you read and try to answer the following questions.

1) Why do you think that protective clothing is needed when handling radioactive materials?

____

____

2) How would you design radioactive protective clothing…. What material would you use and why?

____

____

3) Which professions would require the use of such protective clothing?

____

____

4) Why do you think that the Curie's belongings are still radioactive after a hundred years?

____

____

5) How do you think scientists can predict that their belongings would remain radioactive for another 1500 years?

____

____

____

<u>Group Task 3</u>

Read about the effects of radioactive material on humans and how humans got to know about them the hard way. Discuss the effect of radioactivity on human health.

When we didn't know!

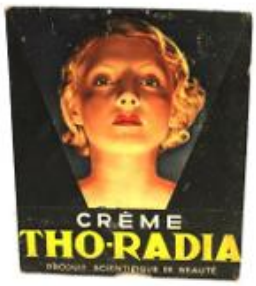
Women painting alarm clock faces with Radium in 1932, Ingersoll factory, January 1932. Workers would often lick the paintbrush to achieve a finer point – directly ingesting the Radium. (Daily Herald Archive/SSPL/Getty Images)

In the mid-1920s, radium watches became a style marker – "the iPhones of the age."

Wearing the watches didn't carry much risk, but the factory workers who made them glow suffered terrible health effects.

Applying radioactive paint to the watch dials was a delicate but painstaking task that was considered women's work. These "radium girls," as the workers came to be known, were instructed to keep the brushes pointed using their lips. Over time, they started to suffer from a condition called "radium jaw," as repeatedly ingesting small amounts of radium caused necrosis of their bones.

When beauty products were radioactive



A miracle cream was launched in Paris in 1933. Billed as a "scientific beauty product," it promised to improve circulation, firm muscle tissue, reduce fat and smooth wrinkles. It was part of a line of cosmetics called Tho-Radia – after thorium and radium, the radioactive elements it contained.

Today, no one would intentionally smear radioactive materials on their face, but in 1933, **the dangers of radioactivity were not yet fully understood.** This mysterious new form of energy, discovered by French physicist Henri Becquerel in 1896, had become imbued with mythical powers.

So much so that Radithor was an energy drink claiming to be the secret to good health until it killed the famous athlete **Eben Byers**. He had become famous for drinking up to three bottles of Radithor every day for years. He did from it in 1932, and the Wall Street Journal ran the headline: "The radium water worked fine until his jaw came off."

https://edition.cnn.com/style/article/when-beauty-products-were-radioactive/index.

1) After reading this text, can you name a few adjectives to describe radioactivity?

____

____

2) What health effects did the radium girls experience and how were these effects connected to their work?

____

____

3) How did the death of Eben Byers effect the way people thought about Radioactivity?

____

____

4) Do you think that the way people thought about radioactivity in their time changed after the events you read about?

____

____

Group Task 4

Read about the Chernobyl accident and the fact that the decay process is long and the place is still contaminated to this day. Discuss how radioactive isotopes are used as a form of energy in power plants and the concept of half life.

Disaster in Chernobyl

On April 26, 1986, a power output surged during a systems test. An emergency shutdown was attempted, but the power output spiked even more, which led to an explosion at reactor No. 4 at 1:23am. Two workers died instantly. Further explosions and **a fire released highly radioactive material into the atmosphere.** The release of nuclear fallout at Chernobyl was 400 hundred times higher than that of the atomic bombing of Hiroshima.

Can Chernobyl, Ukraine ever be restored?

Some radioactive elements in nuclear fuel **decay** quickly, however Cesium has a **half-life of 30 years, and strontium has a half-life of 29 years.** According to scientific estimates, it takes 10 to 13 half-lives before economic activity and life can return to a contaminated area. This means that the total area will be contaminated by the Chernobyl disaster for the next 300 years!

www.history.com

Chernobyl: Disaster, Response & Fallout ...

Abandoned Town

Questions

1) Chernobyl was a nuclear power plant? What does that tell us about Radioactive elements?

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2) Could you draw an energy flow diagram to describe the energy changes in a nuclear power station?

3) What do you think is the meaning of radioactive decay?

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4) In the passage you read that certain elements have a very long half-life? What do you understand by it? (The picture below is there to help you)

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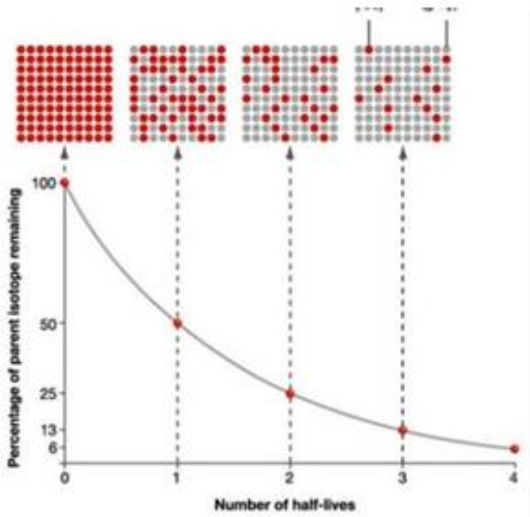

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