Materials NOW

Introducing Materials Science

Teachers' Resource Pack

AMBER
Advancing Materials for Impact

Introduction

Materials science is everywhere and, although often taken for granted, it plays an essential role in our lives. From mobile phones and batteries, to water bottles and coffee cups, we use engineered materials every day. The AMBER Education programmes are designed to introduce students to the world of materials science and the scientists that are advancing our understanding of these materials as they work toward making our world a better place through innovation and engineering. We have developed programmes from infants class through 6th class, which support teachers and students as they discover, engage with and investigate materials and their properties in unique and interesting ways. There is much to explore, and we invite you and your pupils to join us in the fascinating world of materials science!

Contents

AMBER's 3rd & 4th class programme

Welcome to AMBER's 3rd and 4th class resources, **MaterialsNOW.** This resource focuses on the material, plastic and is designed to support students' exploration of the role of plastics in society and investigations into the properties of plastic and bioplastics. This programme focuses on integration of science lessons with literacy and numeracy, developing childrens' skills in working scientifically, while also meeting literacy and numeracy objectives. The lessons are designed to guide you as a teacher in supporting your students in **inquiry-based activities**. Each lesson comes with a comprehensive lesson plan, which includes background knowledge for the teacher, learning objectives and pointers towards assessment, all supporting material, including a power point and student handouts, templates and examples.

Any additional materials suggested in this programme are easy to source and safe for children to use.

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Programme Outline

The programme is divided into ten lessons. The lessons are grouped into the three series: Materials, Environmental Awareness and Care, and Working Scientifically. A brief overview of each lesson is given below.

Lesson 1 focuses on vocabulary development. Students develop the words associated with describing materials, and practice sorting materials based on different properties.

Lesson 2–4 in these lessons students work with cornstarch and water to first make Oobleck (slime) and then bioplastic (from cornstarch), it ends with the students meeting a materials scientist and discovering how much they have in common with a scientist. This is very hands-on and activity-oriented, giving students the opportunity to see how materials' properties can be changed while considering solutions and phases of matter.

Lesson 5–7 encourage students to think critically about plastics, the role they play in our lives, and potential solutions to problem plastics. The investigation in this strand involves a sinking and floating activity which allows students to identify different types of plastics. This has real world applications; it is a common method used at recycling centres to sort different types plastics. The students also meet materials scientists who are working on solutions to problem plastic. In the final lesson of this series students are asked to consider, deliberate and make a decision on a real-world research question.

Lessons 8A–8C are an extension investigation on the properties of bioplastic made in class. Students will investigate how to make bioplastic with different properties in the classroom. They will learn about fair-tests and design their own method for testing their prediction. Teachers are provided step-by-step guidance to facilitate this student-led investigation.

Materials NOW: AMBER programme plan

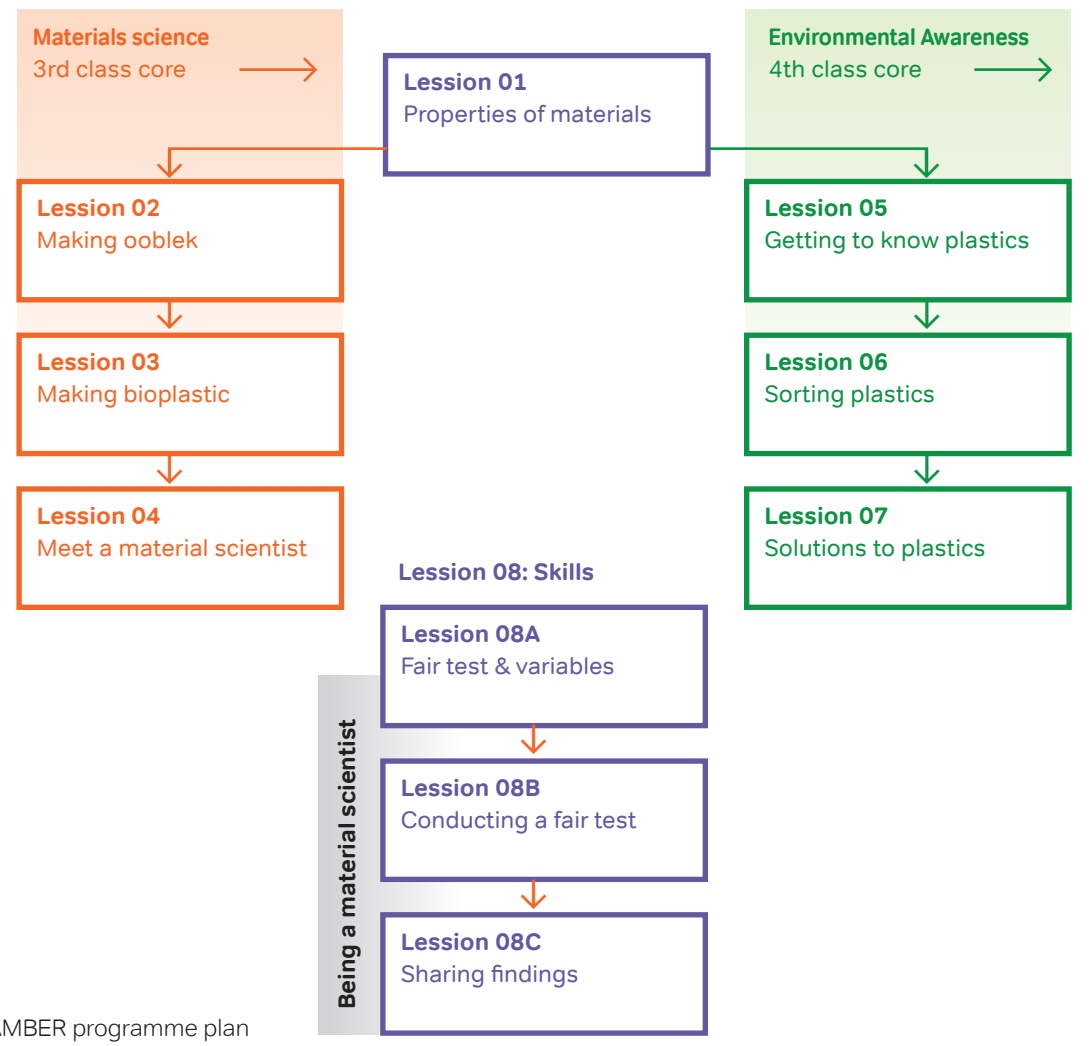


Figure 1: AMBER programme plan

The Resource Roadmap

Teachers have a number of options in how they use this resource.

01. Stand-alone: each lesson has been designed to offer a complete unit of work lasting at least 40 minutes.

02. Materials series: Lessons 1–4 have been designed with 3rd class students in mind. they focus on preliminary science skills.

03. Environmental awareness and care: Lessons 1 & 5–7 have been designed with and for 4th class students due to level of critical thinking required.

04. Science skills development: Lessons 3, 8A–C can be done with either 3rd or 4th class. These lessons build on scientific skills, and bring students through a fair-test.

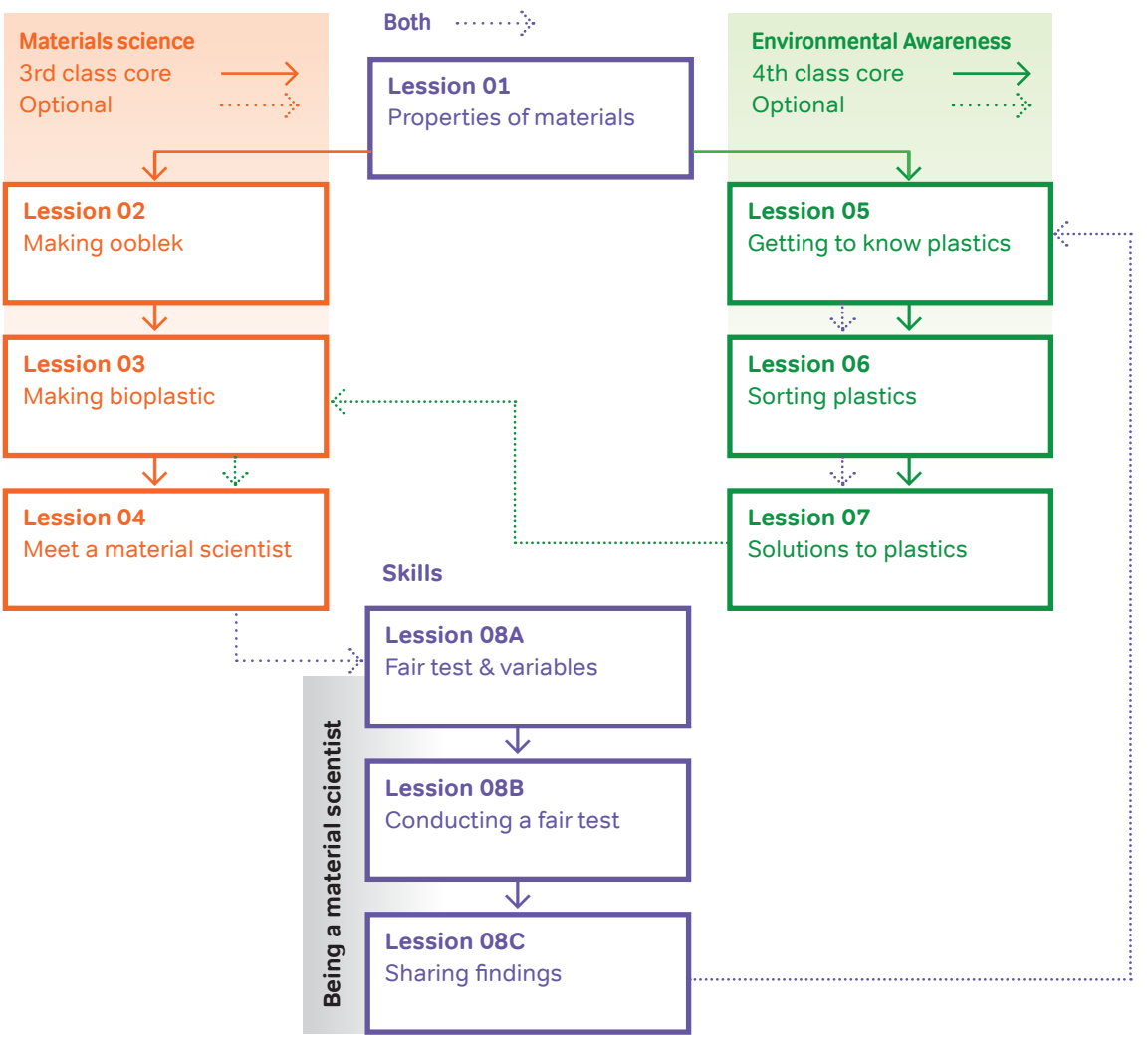


Figure 2: resource road map, recommended pathway for 3rd and 4th classes are outlined in blue and red box, respectively.

Planning – Curriculum Integration

In this section we provide teachers with planning tools to integrate this resource with their class plans. First, we outline the indicative times each lesson delivers on teaching objectives in science, literacy and numeracy – emphasising the cross-curricular and integrated approach this resource follows. Teachers are then provided with the detailed breakdown of each curriculum area addressed through this resource.

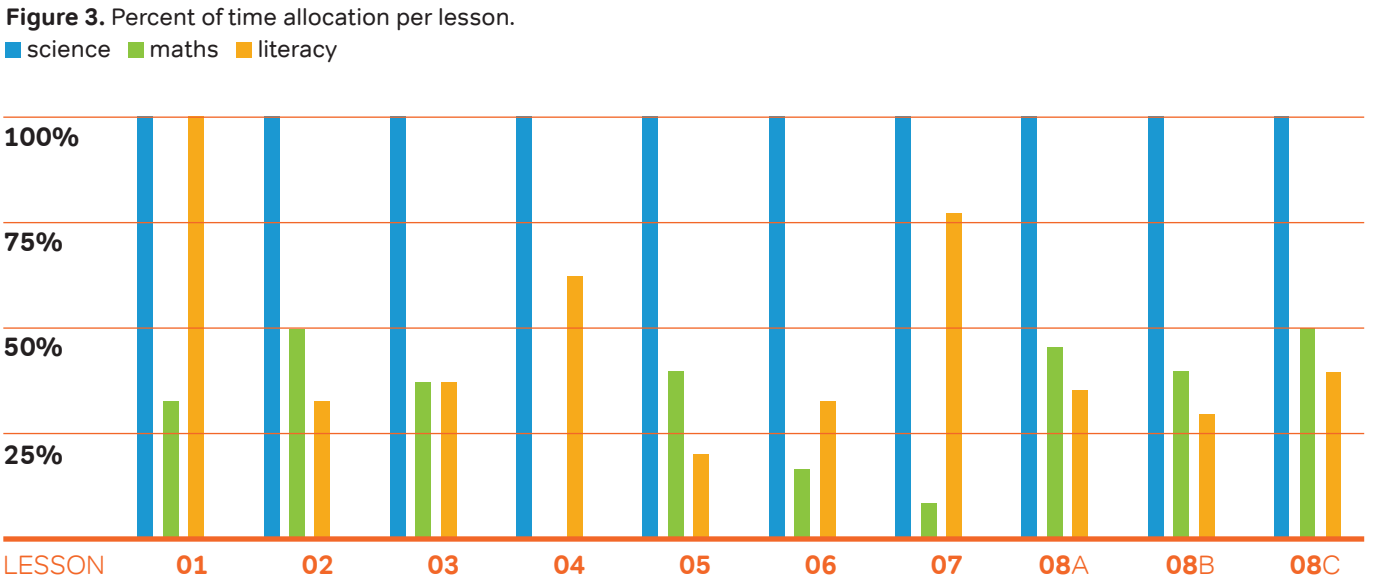
Time allocation

Table 1 indicates the amount of time that can be allotted to science, literacy, and numeracy per lesson. As can be seen in Figure 3, some lessons have a stronger integration with literacy or numeracy, but both subjects are supported throughout the programme.

Table 1: Time allocation per lesson (in minutes). When conducting each lesson – allocate the following time to each subject.

STRAND	LESSON	TOTAL LESSON	SCIENCE	MATHS	LITERACY
Materials	01	60 mins	60 mins	20 mins	60 mins
Materials	02	60 mins	60 mins	30 mins	20 mins
	03	40 mins	40 mins	15 mins	15 mins
	04	40 mins	40 mins	--- --- ---	25 mins
Environmental Awareness & Care	05	50 mins	50 mins	20 mins	10 mins
	06	60 mins	60 mins	10 mins	20 mins
	07	110 mins	110 mins	10 mins	85 mins
Skills	08A	55 mins	55 mins	25 mins	20 mins
	08B	50 mins	50 mins	20 mins	15 mins
	08C	50 mins	50 mins	25 mins	20 mins

Figure 3. Percent of time allocation per lesson.



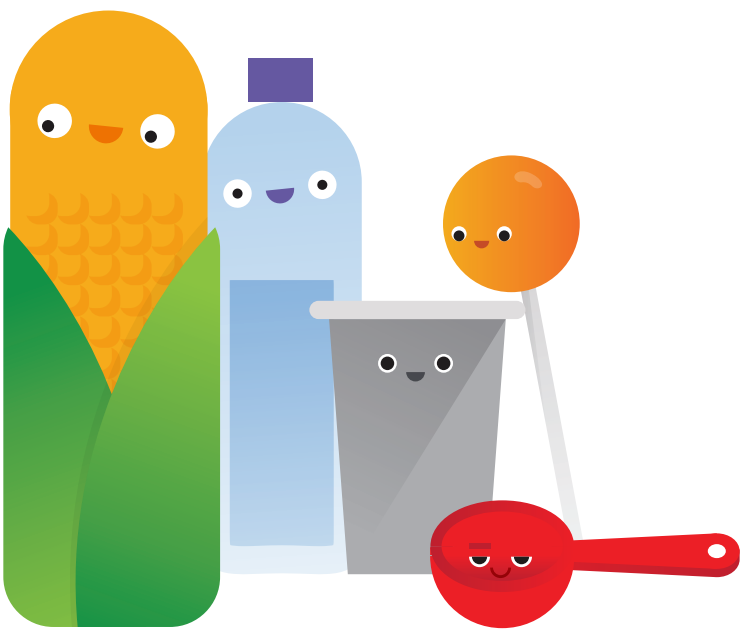
Curriculum areas addressed through this resource.

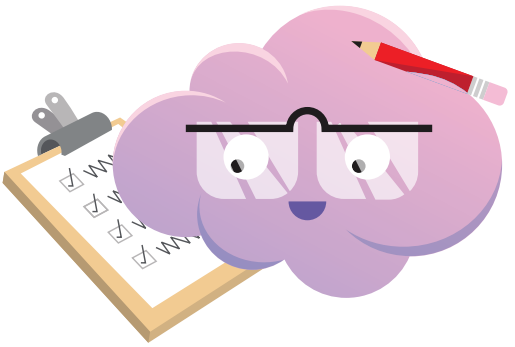
Science

Many Learning Objectives within the 3rd and 4th class science curriculum are met within this programme, specific learning objectives are highlighted within the lesson plans themselves, but an overview is given in Table 2.

Table 2: Science curriculum learning objectives that are covered within AMBER lessons:

STRAND	UNIT	LEARNING OBJECTIVES
Materials	Properties	• recognise that materials can be solid, liquid or gaseous • describe and compare materials, noting the differences in colour, shape and texture • group materials according to their properties: → flexibility, transparency, magnetism, conductivity or insulation properties, strength, shape, ability to muffle sounds, perishable and non-perishable, solubility
	Material Changes	• investigate how materials may be changed by mixing → mixing and dissolving materials in water • investigate the characteristics of different materials when wet and dry • examine the changes that take place in materials when physical forces are applied → when materials are beaten, whisked, mixed, squashed, pulled or bent





STRAND		LEARNING OBJECTIVES
Environmental Awareness & Care	Environmental Awareness	• become aware of the importance of the Earth's renewable and non-renewable resources • recognise how the actions of people may impact upon environments • come to appreciate the need to conserve resources recycling of materials, use of paper packaging in contrast to some plastic packaging, identifying materials which can be used for a variety of purposes
	Science and the Environment	• begin to explore and appreciate the application of science and technology in familiar contexts • identify some ways in which science and • technology contributes positively to society • recognise and investigate human activities which have positive or adverse effects on local and wider environments
	Caring for the Environment	• identify and discuss a local, national or global environmental issue such as: • investigate the causes of the issue • appreciate the roles and different views of people involved • suggest and discuss possible actions and consider the effects of these on people and the environment • realise that there is a personal and community responsibility for taking care of the environment

STRAND	LEARNING OBJECTIVES
Working Scientifically	Questioning → ask questions about animals, plants, objects and events in the immediate environment and their relationships → ask questions that will identify problems to be solved → ask questions that will help in drawing conclusions and interpreting information Observing → observe and describe natural and human elements and processes in the immediate environment, such as effects of heating and cooling on a variety of substances → observe and describe characteristics such as the shape, size, colour, pattern, texture and interrelationships of elements in the local environment Predicting → offer suggestions (hypotheses) based on observations about the likely results of the investigation Investigating & experimenting → collect information and data from a variety of sources → design, plan and carry out simple investigations → identify one or two obvious variables relevant to the investigation → realise that an experiment is unfair if relevant variables are not controlled Estimating & measuring → measure, compare and record mass, weight, capacity, time and temperature using appropriate standard units of measurement and simple equipment Analysing Sorting & classifying → sort and group data on people, events and natural phenomena using a range of appropriate criteria such as test objects that sink or float → sort and present data in sets and subsets Recognising patterns → look for and recognise relationships when making observations → select appropriate observations that fit a pattern Interpreting → interpret information and offer explanations → draw conclusions from suitable aspects of the evidence collected Recording & communicating → record and present findings and conclusions using a variety of methods; oral and written accounts, charts, graphs and diagrams, presentations using information and communication technologies
Design & Make	Through lesson 8, students have an opportunity to design and make an apparatus for testing their hypothesis. → Exploring → Planning → Making → Evaluating

Literacy

Competence in subject literacy and literacy in general is crucial for a student to be successful in science, interpreting texts and science communication are essential in developing science skills. Throughout the AMBER lessons the development of reading, writing, and oral language skills through meaningful integration with science is supported. Within these lesson plans, students will have opportunities to learn new vocabulary, develop their comprehension skills, and discuss the meaning of texts. Students will also engage in note-taking exercises, and develop persuasive writing and report writing skills. Specific learning outcomes are highlighted within the lesson plans themselves, but an overview is given in Table 3.

Table 3: Literacy learning outcomes that are covered in AMBER lessons:

LITERACY	
Oral language	→ Discuss the meaning of new tier 3 vocabulary (low frequency, subject specific words), using context, role-play, visuals and examples. Use this new vocabulary to discuss scientific concepts. → Actively listen and extract meaning from the videos by taking notes → Make predictions and discuss findings
Reading	→ Use comprehension strategies to engage with the texts to develop knowledge of scientific concepts → Discuss the meaning of new tier 3 vocabulary (low frequency, subject specific words), using context, role-play, visuals and examples. Use this new vocabulary to talk about the properties of materials. → Respond to the prompts in the lab book to clarify scientific understanding
Writing	→ Actively listen and extract meaning from the videos by taking notes → Create a poster in the persuasive writing genre using information gleaned from a range of lessons → Write a summary of the experiment using appropriate chronological and scientific vocabulary → Create a poster that outlines a 'fair test' in the report writing genre.

Numeracy

Overall, the curricula of mathematics and science often intersect, and mathematics is integral to the interpretation and understanding of scientific concepts. Maths skills such as problem solving, communicating, connecting and reasoning, overlap with and are essential to the development of science skills.

Within the AMBER lessons, there are many opportunities to meet the maths objectives in a variety of strands and strand units. An overview is highlighted in Table 4, but note that this is not comprehensive and specific learning objectives that may include other strands/strand units are highlighted within the lesson plans themselves.

Strand: Data All the objectives within the strand Data could be covered through the AMBER Lessons. Those highlighted with ** would need focus as described in notes below Table 4.

Strand: Measures - Capacity All content of the Measure curriculum could be contained within the AMBER lessons if:

1. children's attention is drawn to the measuring implements used, and if a variety of measuring implements are used when the quantities differ. How many ml does each teaspoon hold? How could we check? How many ml do we have with 3 teaspoons of vinegar?

2. Children are encouraged to write up their methods, and when doing so to use a variety of ways to refer to e.g. 0.5l as 500 ml, ½l.

Table 4: Numeracy learning outcomes that are covered in AMBER lessons.

	3RD CLASS	4TH CLASS
Data	The child should be enabled to • collect, organise and represent data using pictograms, block graphs and bar charts → collect data from the environment and record in tabular form → represent data in appropriate format → discuss strengths and limitations of the format used → use simple scale in block graphs and bar charts → use computer applications if available to organise and represent data → read and interpret tables, pictograms, block graphs and bar charts** → use data sets to solve and complete practical tasks and problems → solve simple problems using data collected from own environment	The child should be enabled to • collect, organise and represent data using pictograms, block graphs, bar charts and bar-line graphs incorporating the scales 1:2, 1:5, 1:10, and 1:100 → use scales appropriate to the range of numbers for this level • read and interpret bar-line graphs and simple pie charts ** → involving use of ½, ¼, 1/3 • use data sets to solve and complete practical tasks and problems
Measures	• estimate, compare, measure and record the capacity of a wide variety of objects using appropriate metric units (l, ml) → use cartons, spoons, cups, jugs, plastic bottles and other common containers → use litre, 250 ml and 500 ml measuring containers use tall, low, wide and narrow containers → solve and complete practical tasks and problems involving the addition and subtraction of units of capacity (l, ml) • confine to totals that can be readily checked by measuring	• estimate, compare, measure and record capacity using appropriate metric units (l, ml) and selecting suitable instruments of measurement → become familiar with major and minor markings on measuring containers (e.g. 100 ml markings, ½ l, ¼l) • rename units of capacity in l and ml → 1500 ml = 1 l 500 ml • rename units of capacity using decimal and fraction form → 250 ml = 0.25 l = ¼l → 2 l 150 ml = 2150 ml = 2.15 l confine to examples requiring only two places of decimals • solve and complete practical tasks and problems involving the addition, subtraction, multiplication and simple division of units of capacity (l, ml)

1. ** graphs are included that the children needed to read, or if the children read each other's and interpreted them, i.e. asked and answered each other's questions. Ideally the children should be encouraged to always write a couple of sentences to interpret a graph when they present it.
2. ** Simple pie-charts were included with ½s, ¼s, 1/3s. Ideally, this shouldn't be forced so if the structure of the lessons doesn't allow it to emerge through the activities, it could be supplemented.

LESSON 01

Properties of Materials

Lesson 1:
Properties of Materials

Materials NOW

Class Level:
3rd – 4th

Time:
60 Minutes

Strand:
Materials

Strand Unit:
Materials Changes

Safety: All material should be safe and found in your classroom or at home. Avoid selecting sharp items.

Background:

This lesson introduces students to the general properties of solid material. They will increase their vocabulary and develop their skills as a scientist by sorting and categorizing different everyday objects that can be found in the classroom and home.

Anything that takes up space is called matter and materials are the matter that objects are made from. Examples of materials are metal, plastic, wood, glass, ceramics, and synthetic fibres. Each material can be used to make a range of different things; for example, wood can be used to make tables, chairs, spoons, pencils, etc. Different materials have different features, or properties. Material properties are described with adjectives, and can describe the strength, colour, smoothness, transparency, waterproofness, conductivity, etc. of a material. The different properties of a material make it suitable to make different objects. Objects have a specific purpose and will themselves have additional properties like shape. An object can be made from different materials used together; for example, a chair can be made from metal and plastic or wood.

Key Learning:

Different objects have many different properties and we can sort them in many different ways.

Resources:

- Selection of objects made from a variety of materials including wood, metal, plastic, natural fabric, synthetic fabric. Many of these objects can be found in the classroom; rulers, pens, paperclips, children's rain gear, soft items such as pillow, jumpers.

- **AMBER Resources:**
  - Powerpoint 'Properties of Materials' – use throughout the lesson
  - **Handouts:**
    1.1: Frayer Model template: Properties
    1.2: Frayer Model template: Object
    1.3: 2-way Carroll diagram
    1.4: 4-way Carroll diagram
  - **Video:** NanoWow: Exploring materials science from your home. https://youtu.be/cWk2zSKI09U (8.18 minutes)
  - **Title for 'Materials' Word Wall** – to be printed and put on wall

Key Vocabulary:

Material	Purpose	Properties
Flexible	Rigid	Object
Opaque	Transparent	Matter

Learning Objectives/Outcomes

Science:	Maths:	Literacy:
■ Describe and compare materials, noting differences in colour, shape and texture ■ Group materials according to their properties: colour, shape, flexibility, transparency, strength, shape, solubility, perishable vs. non-perishable	■ Sorting and classifying ■ Collect data from the environment and record in tabular form; represent data in appropriate format ■ Representing collections of objects using pictograms, block graphs, bar charts and bar-line graphs	■ Discuss the meaning of new tier 3 vocabulary (low frequency, subject specific words), using context, role-play, visuals and examples. Use this new vocabulary to talk about the properties of materials ■ Use comprehension strategies to engage with the text and to discuss what they have learned about the properties of material

Lesson Outline:

Introduction [20 minutes]

Whole class discussion and think-pair-share.

Students discuss different types of material and develop vocabulary to describe the properties of these materials. They explore the relationship between different materials, their properties, and different applications.

Using the powerpoint and/or objects for display, teacher shows the class different objects or material and has the students describe each.

- Follow the powerpoint slides to introduce children to key concepts for the lesson. A whole class discussion should be encouraged.
- Relate properties of material to application. Discuss the objects and their uses, *what type of material is being used? What property is important? What if we used another material?*
  - **Slide 2:** shows a variety of spoons and introduces student to the terms object, purpose, properties and materials.
  - **Slide 3:** Ask the students to discuss or think pair share, what type of spoon you would use under different circumstances and why.
  - **Slide 4:** Review with the students the vocabulary on this slide, then invite the students to identify which properties apply to the different materials the spoons are made from.
- Show other objects such as rain gear, pillow, etc. or watch the video: *NanoWow: Exploring materials science from your home*. https://youtu.be/cWk2zSKI09U (8.18)
  - » Ask students what is the purpose of the object? What type of material should it be made from? Ask them to imagine items being made from different material, e.g. *What would you think of a pillow being made of metal? would you want to sleep on it? Why or why not?*
  - » If watching the video, ask students what they understood from the video. Ask questions such as: what words did you hear in the video that were about properties? You could write these words down on the board.
- **Word building:** Build a word wall for Materials: handout 1.1 (slide 5)
  - Assign a property (e.g. transparent, opaque, rigid, flexible) to each team of students and have them fill out the Frayer Model template (handout 1.1). When complete, check for accuracy and have them explain the word to the class and put it up on the word wall. Alternatively, complete a grid for each word as a whole class collaborative activity.

Group Activity

Working like a scientist. Teams of 2–4.

Slide 6 and 7: review with the students how scientists work, observing, thinking, recording and asking questions

Activity 1: [10 minutes]

Slide 8 and 9: Each group of students should be given a box or bag containing objects that are found in their everyday lives. This should contain object made of the same materials (e.g. wood, plastic, metal, cloth) and also objects that are similar but are made of different material (e.g. plastic spoon, wooden spoon, metal spoon) or are different in some way (e.g. colour, shape, size) – alternatively – have the students look at what is at their desks to do this sorting exercise.

✓ In their groups, give them time to identify the objects and the materials they are made from. Give them a chance to explore and consider what they have in front of them. Depending on what the students are looking at, they will come up with different descriptive words. *Record the students observations and thinking on the Handout 1.2.*

Activity 2: [10 minutes]

Handout 1.3 » slide 10

Activity 2 and 3 involve students working in groups to sort and group objects into sets. Activity 2 asks students to group objects into two sets using one property of their choosing e.g a colour, a use of item, a type of material, a shape.

» They should **Record** this in the Handout 1.3 2-way Carroll diagram and write a sentence to explain why they chose this property (rationale) – for third class – teacher should model how to do this on the board. (slide 11)

» *We are grouping our object by _____or_____*

✓

Flexible	Rigid

- Have the students count the number of objects in each set.
  - Record this number on Handout 1.3.
  - Repeat this as many times as you like and as time permits.

Activity 3: [10 minutes]

Handout 1.4

Slide 12: Have them re-sort using two types of properties.

✓

	Smooth	Rough
Heavy		
Light		

Teacher then asks the students if they can re-sort their objects using different criteria. Can they find a property that makes the greatest number of groups, least number of groups, etc.

We are grouping our object by _____or_____ and _____or_____.

Whole class discussion (plenary) [10 minutes]

Slide 13: Discuss as a class what the students learned. *How were they working as scientists today? They Observed (what characteristics do these objects have?), asked questions (how can we categorize the objects?)*

✓ Review challenging vocabulary. Review challenging vocabulary e.g. *what do we mean by 'properties'? Can you give examples? Can you give me an example of something that is 'rigid'?*

Conduct simple revision quizzes at different points by covering all quadrants other than the word with post-its to test student recall and understanding.

Key point: different objects have many different properties and we can sort them in many different ways.

Integration

Maths:	Literacy:
Representations of data; communicating and expressing	Oral language (tier 3 vocabulary); describing the properties of objects using pictograms, block graphs, bar charts and bar-line graphs

Time Allocation: for a 60 minute class

Science:	Maths:	Literacy:
60 minutes	20 minutes	60 minutes

Modification

- This can be done as a whole class, using hula hoops on the floor to split the groups. Students can each be given an item and asked to describe it. Once the grouping criteria are decided, they can walk over and place their item in the proper category. This can be repeated with different criteria.
- Have students investigate (look, hold and feel) the basic categories: wood, metal, glass, etc. Then have them sort images of objects instead of actual objects.
- Discussion of properties can be done as a plenary, within smaller groups or as think-pair-share.
- Properties can be listed on the board and students can go up to the board and check (vote on) which properties each material has.
- Worksheet could be revised so students circle the correct properties for each material.

Extension Activities

- Have the students fill out Object templates at the beginning of the group activity.
- Have Students write a riddle about an object referring to its properties (this could be done in pairs) e.g. 'I am hard, sometimes flexible but I am always straight as an arrow. I am smooth and useful for maths. What am I?' (a ruler) (Literacy Strand: Writing. Element: Vocabulary/ Purpose, genre & voice).
- For Activity 1. Have the students decide what property they will use to sort their material (this can be done as a whole class or in their teams).
- Consider building out the lesson to address maths learning outcomes: Possibility of representing collections of objects using pictograms, block graphs, bar charts and bar-line graphs (3rd & 4th class curriculum). See *PDST Data Manual:* Pages 14–17, 37–41 for ideas.
- During activity 2: teacher can place the categories on the board and students can make a dot graph of the numbers of objects in each group, alternatively, students can make these graphs in their notebook.

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Teacher observation backed up by collecting sorting template as evidence of work: Frayer Model, Carroll diagram.
- Conduct simple revision quizzes at different points by covering all quadrants other than the word with post-its to test student recall and understanding.
- Traffic light self-assessment (end of lesson).

Lesson 01

Teaching Resources

Name: .....

What is its purpose?

Draw it!

Object

What is it made from?
(the materials?)

What are its properties?

Materials NOW 1.2: Frayer Model template – **Object**

Name: .....

What does this word mean?
Can you explain it?

Can you draw something that shows this property?

Property

What materials have this property?

What are some objects or materials that do not have this property?

Name: .....

We are grouping our objects by ..... or ..... and by ..... or .....

	Property	Property
Property		
Property		

Describe what you found.
We found that...

.....

.....

.....

.....

.....

.....

Name: .....

We are grouping our objects by ..... or .....

Property	Property

Describe what you found.
We found that...

.....

.....

.....

.....

.....

.....

LESSON

2-4

Material's Science

Lesson 2:
Making Oobleck

Materials NOW

Class Level:
3rd – 4th

Time:
60 Minutes

Strand:
Materials

Strand Unit:
Materials Changes

Safety: All material is safe and found in your kitchen. Good practice for doing investigations is to use safety glasses and a cover, similar to what children would use when painting, however, it is not necessary. Everything is water soluble and washes off.

Background:

This lesson has students change the properties of material by mixing them together. They observe the characteristics of cornstarch and water and then the solution of cornstarch in water.

A mixture of water and cornstarch to make a solution acts a little differently than what you would expect for a liquid. Water is a good example of a typical liquid, it flows in a constant manner; it doesn't get soupy or runny or stiffer when pressure is applied, therefore it follows Newton's law of viscosity. Cornstarch mixed with water at a ratio of 3:1 produces a good example of a non-Newtonian fluid. A non-Newtonian fluid is one in which the thickness and runniness (viscosity) of the fluid is not constant and can change under pressure. Cornstarch in solution, ketchup, and toothpaste are examples of this, they change their runniness with pressure.

This lesson challenges the students' idea of grouping material into liquid, solid, or gas and helps them develop their observation skills to see beyond what they expect to find. By having them observe something they weren't expecting, they are working as scientists, being open to new discoveries and changing their view of the world as they further explore it.

Key Learning:

The properties of material change, sometimes it is not so easy to put a material into one group.

Resources:

- Cornstarch, water, lollipop sticks, paper cups, ziploc bags (if keeping Oobleck for lesson 3 and lesson 8 on bioplastics, see resource roadmap)
- a Tablespoon or Graduated cylinder (need to measure 60ml and 30 ml)
- Dr. Suess book: Bartholomew and the Oobleck, https://youtu.be/eDef7vCgrk0

Optional resources for states of matter:

» Reviews states of matter. Nice cartoon. https://youtu.be/JQ4WduVp9k4 (3:12 minutes)

» Review states of matter and introduces oobleck as a non-Newtonian fluid

- **AMBER Resources:**
  » Powerpoint 'Making Oobleck' – use throughout the lesson – use throughout the lesson

  » **Handouts:**
  2.1: Student instruction sheet (1 per student)
  2.2: Student worksheet (1 per group)

Key Vocabulary:

Solubility	**Solvent**	**Liquid**
Solute	**Pressure**	**Solid**

Add 'solution', 'solute' and 'solvent' to the word wall using the **Vocabulary Frayer model template** from 'general resources'.

Learning Objectives/Outcomes

Science:	Maths:	Literacy:
■ Investigate how materials may be changed by mixing ■ Examine the physical changes that take place when physical force is applied	■ Use ratio to communicate a relationship between quantities ■ Measures: capacity ■ Representing collections of objects using pictograms, block graphs, bar charts and bar-line graphs	**Strand:** Oral language **Element:** Engagement, listening & attention ● Actively listen and extract meaning from the text Bartholomew and the Oobleck

Lesson Outline:

Introduction [5 minutes]

Whole class discussion

- Discuss and identify the phases of matter (gas, liquid, solid). This lesson can be a follow-up to previously taught lessons on phases of matter or, if that hasn't been covered yet in your class, briefly introduce it through the power point (slides 1–3) or use either video identified above.
- Discuss how to make solutions and go over the vocabulary. Again, if this has not been taught to students already, you can have an introductory lesson on this subject (you can mix powdered milk or hot chocolate as a good example of making a solution), the powerpoint has a slide with the terms (slide 3).

Group Activity [20 minutes]

Making Oobleck » Teams of 2

Remind students about the skills need to work like a scientist (slide 4 and 5). Give the students the water and cornstarch to make observations.

- Observe cornstarch and water (slide 6–8)
  - **Record** observations in the student worksheet (handout 2.1) ✓
- Read instruction sheet (handout 2.2)
  - Work through the instructions on making Oobleck on Handout 2.2 and PointPoint slides 9–11. This part of the lesson can be worked through as an independent reading exercise
- Mix cornstarch and water at a 3:1 ratio, use the lollipop stick to mix
  - » *Follow the questions on Slide 11 to support the students in making observations about oobleck.*

» **Record** observations on the student worksheet (slide 13, handout 2.1) ✓

Whole class discussion; plenary [30 minutes]

20 minutes for story » 10 minutes discussion

- Read Bartholomew and the Oobleck, Dr Suess; or use the read aloud youtube video at https://youtu.be/eDef7vCgrk0 (19 minutes) Ask students *'What properties did the cornstarch and water have that the Oobleck in the story had?' 'Can you say why we call the cornstarch and water mixture Oobleck?'* reading the story after the activity allows the students to make connections between the story and what they did. This provides them the opportunity to synthesize and apply new information to a different situation and helps them develop lateral thinking.
- **Slide 14** Discuss as a class what the students learned. How were they working like scientists today?

Key learning: the properties of material change, sometimes it is not so easy to put a material into one group.

Integration

Maths:	Literacy:
■ Children's attention is drawn to the measuring implements used and prompted to choose an appropriate measuring instrument for various amounts of ingredients. ■ The children could measure into a graduated cylinder, and record the addition each time, or they could measure what each container (spoon, scoop) holds and record the specifics when writing up. ■ Children are encouraged to write up their methods, and when doing so to use a variety of ways to refer to e.g. 0.5l as 500 ml, ½l	■ When reading the story, stop at points in the story and develop key questions and discuss understanding. Actively listen and extract meaning from the text Bartholomew and the Oobleck

Time Allocation: for a 60 minute class

Science:	Maths:	Literacy:
60 minutes	30 minutes	20 minutes

Modification

- Making Oobleck can be done as a demonstration. Place the Oobleck in a sealed bag and pass it around the class, having students hold it and move the liquid around in the bag and then squeeze it to feel the resistance. They won't be able to do the investigations this way, however.
- Read *Bartholomew and the Oobleck*, Dr Suess as part of the Introduction. This changes its function in the lesson and functions as a trigger or narrative to build the activity around. You can pull synthesis back in at the end of the lesson by following up with an extension activity (see below).
- Make a reading lesson from the student instruction sheet, reading the sheet as a class. This will support students who may be uncomfortable with reading.
- Differentiate measuring implements, e.g. Jugs with only ¼, ½ litre markings.
- Have all (or some of) the ingredients pre-measured so students need only make observations of separate ingredients, add together, and mix.
- Discussion of properties can be done as a whole class discussion or within smaller groups.
- Properties can be listed on the board and students can go up to the board and check (vote on) which properties each material has.
- Worksheet could be revised so student circle the correct properties for each material.

Extension Activities

- Student-directed investigations: Question raised from the story: *'Is there a scientific way Bartholomew could have solved the king's problem?'* Have the students hypothesize and design investigations to test.
- Research question: *Is there a ratio where the mixture does not act like Oobleck?*
  Answer: The ratio of 3:1 works to make the Oobleck, less water and it is difficult to get all the cornstarch wet (very resistant), more water than that and the cornstarch acts like a normal liquid.Students can then consider how they could apply their findings to the story.
- In both cases above, you could have students write out a story where the King or Bartholomew uses science to get rid of the Oobleck.
- Extend the lesson out into fractions and ratio in Maths. What ratios are involved in making hot chocolate, Oobleck, etc.

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Teacher observation
- Questioning
- Observation Worksheet
- Conferencing with the children who may be struggling, scaffolding the learning
- Traffic light self-assessment (end of lesson)

Instructions for making Oobleck For Teachers

Material Required:

- Cornstarch
- Water
- Lollipop sticks (one per group)
- Something to measure out material
  (tablespoon, medicine cup – must be able to hold water)
- Paper cup (one per group)
- Resealable plastic bag (for storing)

After making observations of cornstarch and water with your class follow these instructions to make oobleck.

Overview:

1. Add cornstarch to water at a ratio of 3:1
   (It doesn't matter how much as long as there is half as much water as cornstarch, 45 mls (three tablespoon) of cornstarch to 15 mls (one tablespoon) of water is enough.
2. Mix thoroughly
3. Observe solution
4. Record properties with your class and compare to original ingredients

Directions to make Oobleck:

1. Measure out 3 level (not heaped) Tablespoonsful of corn starch (45 ml):
   (a). There is merit in not insisting on highly accurate measuring, it is more child-centered and allows the focus to remain on working like a scientist – making and recording observations.
2. Using the same measure add one Tablespoon (15 ml) of water to the cornstarch in the paper cup.
3. Stir until all the corn starch is wet.
4. Observe the characteristics of this non-Newtonian fluid.
5. Store the Oobleck in an airtight container to use for the bioplastics lesson 3.

Notes:

- This is a pretty forgiving activity as long as you make sure there is more cornstarch than water (general ratio of 3:1).
- If students put too much water in, you have just made a simple solution and it will be runny. In this case, add more cornstarch to the mixture until you can feel the resistance with pressure.
- 3 Tbsp to 1 Tbsp works great but you can use larger volumes and this will give them more to work with. If you are moving on to bioplastics lesson (lesson 3) keep it to 45mls: 15mls as you will be adding quite a bit more water to your Oobleck to make the bioplastic.
- Any spills are easy to clean up, washes up easily. Once dry, the cornstarch is a powder again and can be dusted off surfaces.

Lesson 02

Teaching Resources

Name: .....

Making Your **Observations**

As you work through the activities, make observations about the properties of each material. Write **Yes** or **No** beside each property for each material in the table.

Properties	Water	Corn Starch	Bioplastic before heat	Bioplastic after heat	Bioplastic after drying
Transparent					
Smooth					
Runny					
Sticky					
Strong					
Hard					
Flexible					
Other Observations					

Prediction: I think that when we heat the mixture it will look .....

.....

Making **Bioplastic**

1. Take a paper cup

2. Write your group name on the side

3. add 15 ml (1 Tablespoon) of cornstarch to the cup

- **Make observations about the corn starch in your worksheet**
- **Make observations about the water in your worksheet**

4. Using the same spoon you used for the corn starch, add 60 mL (four Tablespoons) of water.

5. Stir well.

Now observe your solution and record in your worksheet

5. Add 5 ml (1 teaspoon) of vinegar

7. Stir

8. Add 5 ml (1 teaspoon) of glycerine

9. Stir

Now observe your solution and answer the following questions

- Record the properties of water, cornflour and 'bioplastic before heat' in your worksheet

- What do you think the mixture will look like after it is heated? What properties do you think it will have? Will it look the same?

- In your worksheet, write down your prediction.
  I think the mixture will be .....

  1. Give your cup to your teacher to be heated
  2. Your teacher will heat it and stir it once while in the microwave
  3. Once it is finished (about 1 minute), teacher will stir it and then pour it out onto some aluminium foil – DO NOT TOUCH, it is too hot!

- Without touching it, make some observations about how it looks – record these in your worksheet.

- Were your predictions correct? Did anything surprise you? Record this under your predictions.

Your teacher will tell you what you will do with it next.
The word PLASTIC means 'easy to shape'

- Is this mixture plastic? Why or why not?

Lesson 3:
Making Bioplastic

Materials NOW

Class Level:
3rd – 4th

Time:
40 Minutes
Note: the final product needs to dry for 2 or more days, allow 10 minutes for follow up any time after that

Strand:
Materials, Environmental Awareness and Care

Strand Unit:
Properties, Material Changes, Science and the Environment

Safety: The key concern is that the mixture can be **extremely HOT** when in the microwave and once it is out of the microwave. Students should **NOT TOUCH** it as it could cause **burns**. Once it has cooled but is still warm, it is safe for the students to handle or mould (see notes at end of teacher instructions). The material itself is safe and found in your kitchen. Good practise for doing investigations is to use safety glasses and a clothes cover, however, it is not necessary. Everything is water soluble and washes off. If the students are handling the cup during or after heating the material, they should wear oven mittens or garden gloves.

Background:

A materials scientist is a person who studies and analyses materials such as, metal, glass, rubber, ceramic, composites, and polymers (like plastic). The properties and structure of these materials are investigated to learn or gain new knowledge. Scientists then take what they learn and test ways to improve the materials, combine different materials to get new properties, or create brand new materials with certain properties and characteristics that could be used for different applications.

Materials scientists look for ways of improving materials to develop new technologies or improve on existing applications and technologies. To do that, they have to identify the properties of the material and look at both the chemistry and the environmental effects of each type of material.

The problems with petroleum-based plastics (see lessons 5–7) have led to the investigations of possible substitutes for various plastics. The development of bioplastics is one solution.

In this lesson students will make bioplastic. *Bio* means living things. *Plastic* means easy to shape.

This lesson can be approached from the materials or environmental awareness and care strand (see resource roadmap). This lesson provides students with an activity which underscores material change and creation of materials that are more environmentally friendly. It can be part of a wide range of investigations in SESE and can be part of or be a trigger for projects on material science research, environmentally friendly and sustainable products, and the circular economy.

Key Learning

Properties of material change when stirred and heated. Scientists can modify material to make materials with new properties, this can have applications to everyday life.

Resources:

- lollipop sticks, paper cups or mugs, aluminium foil or plates Cornstarch, water, vinegar, glycerine (this can be found in the bakery at Tesco, the sore throat section at Boots, and the skin care section at Holland and Barretts) – Olive oil is an alternative if glycerine is difficult to source)
- Measures for measuring tablespoon (15 ml) and teaspoon (5 ml)
- Microwave (or hob, pot and wooden spoon)
- **AMBER Resources:**
  - Power point 'Making Bioplastics'
  - **Handouts:**
    3.1: Student Instruction Sheet (1 per student/team)
    3.2: Student Worksheet (1 per student/team)

Key Vocabulary:

Solubility	**Solvent**	**Liquid**
Solute	**Prediction**	**Solid**

Add 'prediction' to the word wall using the **Vocabulary Frayer model template** from 'general resources'.

Learning Objectives/Outcomes

Science:

Materials

- Investigate how materials may be changed by mixing
- Describe and compare materials, noting the differences in colour, shape and texture

Science and the Environment

- Begin to explore and appreciate the application of science and technology in familiar contexts

Maths:

- Use ratio to communicate a relationship between quantities
- Measures: capacity

Literacy:

Strand: Reading

Element: Comprehension

- Use comprehension strategies to engage with the instructions in order to conduct the investigation.

Strand: Writing

Element: Purpose, genre & choice

- Write a summary of the investigation using appropriate chronological and scientific vocabulary.

Lesson Outline:

Have students change the properties of material by mixing and heating. Make an alternative to the plastic we are most familiar with.

Introduction [10 minutes]

- Review material covered before this lesson – this can be from the properties/Oobleck lesson stream or the environmental awareness/problems with plastics stream.
- Remind students about working scientifically (slide 2)
  - » In this lesson we introduce the concept of **predicting** to our scientific skills
- Identify and characterise the properties of plastics (Slide 3)
- Identify and discuss environmental issues associated with plastics and the characteristics of the material we need to replicate in more environmentally friendly ways. (Slides 4– 6)

Activity 1: Making Bioplastics [20 minutes]

Teams of 2–4

Have students now follow the instruction sheet (handout 3.1) to work independently (and/or use the power point – slides 11–16). Have students complete the student worksheet (handout 3.2) to record observations and write their predictions.

- Observe water and cornflour (the starting materials); identify the properties and record their observations.
- Mix cornstarch and water to a final ratio of 1:4 ratio (see notes below), use the lollipop stick to mix
- Add vinegar and glycerine according to the instructions, mix well
  - » **Record** observations
- Have the students predict what they think the mixture will look like after heated
  - » **Write** out the prediction

- Heat the mixture (see instructions below)
  - » **Observe** the changes and **record** the properties in the worksheet
  - » *Were their predictions correct? Did anything surprise them?*
- Have the students predict what they think the mixture will look like after is has been left to dry
  - » **Write** out the prediction
- Spread out in a thin layer on aluminium foil and allow the bioplastic to dry (1–2 days)
  - » **Observe** the changes as the material dries out and record the properties in the worksheet
  - » *Were their predictions correct? Did anything surprise them?*

When the investigation is completed, have the students write a summary of the investigation using appropriate chronological and scientific vocabulary in their copy books (slide 19).

» **Write** a summary of today's investigation – First we... then... after that... finally... we learned that... write your predictions and what you observed about your predictions.

Whole class discussion; plenary [10 minutes]

Slide 18

- What living thing did your bioplastic come from?
- Do you think it may be good to make bioplastics to replace current plastics?
- Discuss as a class what the students learned. *How were the students working like scientists today?*

Key point: Properties of material change when stirred and heated. Scientists can modify material to make materials with new properties, this can have applications to everyday life.

Integration

Maths:	Literacy:
Children's attention is drawn to the measuring implements used, and prompted to choose an appropriate measuring instrument for various amounts of ingredients	Use comprehension strategies to engage with the instructions in order to conduct the investigation.
The children could measure into a graduated cylinder, and record the addition each time, or they could measure what each container (spoon, scoop) holds and record the specifics when writing up.	Write a summary of the investigation using appropriate chronological and scientific vocabulary.
Children are encouraged to write up their methods, and when doing so to use a variety of ways to refer to e.g. 0.5l as 500 ml, ½l.	

Timer Allocation: for a 40 minute class

Science:	Maths:	Literacy:
40 minutes	15 minutes	15 minutes

Modification

- This can be done as a demonstration only, students can still predict and discuss but this would be done in a whole class discussion session, rather than teams.
- Teachers without direct access to a microwave could microwave the bioplastic in the staffroom while the students are on break, it is important however that the bioplastic is still warm if you want them to mould it. (see Teacher's instructions).
- Have all the ingredients pre-measured so students do not have to measure them out and need only add and mix.
- Discussion of properties can be done as a plenary or within smaller groups.
- Properties can be listed on the board and students can go up to the board and check (vote on) which properties each material has.
- Worksheet could be revised so students circle the correct properties for each material.

Extension Activities

- If students have done the Oobleck (lesson) already and they have Oobleck to work with, have them calculate how much water they need to add to change from a ¼ water and ¾ cornstarch (1:3 ratio) to a 4/5 water and 1/5 cornstarch (4:1 ratio). They would then have to calculate how much vinegar and glycerine they would have to add to keep the proportions correct (1 tablespoon: 1 teaspoon). Ans: you have 45 ml of cornstarch to start and 15 ml of water. To shift the ratio you would need 45ml X 4 to determine the total amount of water needed to make a 4:1 ratio = 180mL. There is already 15 mL of water in the solution therefore you need 180 – 15 = 165mL of water. Since the bioplastic recipe calls for a 15ml to 5 ml ratio between cornstrach and vinegar/glycerin (which is 1/3) and you have 45 ml of cornstrach then 1/3 X 45ml = 15mL, you would need 15 ml vinegar and 15 ml glycerine.
- There are a few things that can be done with the bioplastic product once made.
  - It can be spread out on a surface and left to dry (no one touches it).
  - Students could make moulds or use silicone moulds and pour the bioplastic into them to make shapes.
  - They could then test these shapes for strength and/or flexibility (see Lesson 8–10).
- Test for dissolvability/biodegradation – students can place cut and measured pieces of bioplastic into water, and salt and water. Use clear plastic cut into the same size as a control – compare and record observations over time. The plastic will stay the same, the bioplastic should turn white and then start to breakdown.
- Children could record their investigation in the form of a procedural writing activity or an investigation log.

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Teacher observation backed up by collecting sorting template as evidence of work: Frayer Model, Carroll diagram.
- Conduct simple revision quizzes at different points by covering all quadrants other than the word with post-its to test student recall and understanding.
- Traffic light self-assessment (end of lesson).

Instructions for making Bioplastic for Teachers

Ingredients:

- Corn starch
- Water
- Vinegar
- Glycerine (this can be found in the bakery section at Tesco, the sore throat section at Boots, and the skin care section at Holland and Barretts)

Equipment needed

- Heat resistant cup (paper/coffee cup, ceramic mug)
- Wooden stirrer – lollipop stick or wider
- Microwave oven (this can also be done in a pot on a hob – in this case you will constantly stir the mixture over low heat) In both cases the temperature needs to reach about 65°C – try to make sure it doesn't boil
- Measures (1 tablespoon and 1 teaspoon or something that will measure out millilitres)

How does this work?

Each of the ingredients in the recipe have a role in making bioplastic.

- **Starch:** the main material which will make the plastic, it is grainy and clumpy. Chemically, it is a long chain of glucose (sugar) molecules which stores energy. It is made by plants and we know it as complex carbohydrates found in pasta, cereals, potatoes. A great source of energy for people.
- **Vinegar:** a mild acid, adding it to the starch lowers the pH so the starch breaks down a little creating shorter chains of sugar.
- **Glycerine:** is a small molecule that gets between the starch molecules and stops them from sticking to each other allowing the starch chains to slide past each other – it is called a plasticizer because it is what allows the starch to become a plastic (easy to mould).
- **Water:** allows everything to mix together in solution, all the ingredients can interact. It is also a plasticizer.
- Heat and stirring (sheer) when a plasticizer is present allows the starch to melt and flow.

Directions to make bioplastic:

1. Take 15 ml (1 Tablespoon) cornstarch and place in the heat-resistant cup.
2. Add 60 ml (4 Tablespoons) water to the 15 ml of cornstarch (ratio 4:1).
3. Mix well.
4. Add 5 ml (1 teaspoon) of vinegar: this can vary and it doesn't matter too much if it is a lot or a little.
5. Mix well.
6. Add 5 ml (1 teaspoon) of glycerine: This also can vary – changing the amount of glycerine changes its flexibility – if there is not enough the plastic will be brittle, the more you put in, the more stretchy the final dried product will be. Five ml is a good amount and the product will be more resistant to tearing.
7. Mix well.
8. Remove the stir stick.
9. Place in microwave Medium High heat for 30 seconds.
10. Stir vigorously, the solution should be starting to turn from milky to translucent.
11. Repeat this 3 times (1 minute 30 Seconds in total)
12. Remove cup and stir vigorously – **CAUTION:** the mixture will be hot.
13. The material is translucent (appearance of vaseline)
14. Pour the bioplastic from the cup and spread out into sheets on aluminium foil to make thin sheets.
15. Let cool and dry for up to 3 days.

Notes:

- This lesson can be an extension of the **Lesson 2 – making Oobleck** you could modify the Oobleck to make the bioplastic but you would end up with a large volume (see extension). It is easier to make the bioplastic from scratch but connect this to lesson 2 and illustrate that you are changing the fractions of water and cornstarch to change the properties.
  - Extending the Oobleck lesson to make bioplastic allows students to change the properties from a Non-Newtonian fluid to a more familiar runny liquid. These observations are added to the student worksheet.
- There is merit in not insisting on highly accurate measuring, it is more child-centered and allows the focus to remain on working like a scientist – making and recording observations.
- The cooked bioplastic is too sticky to work with manually but you could pour/spread it into a silicone mould, like a biscuit mould. You could even have your students make moulds with clay, plasticine or aluminium foil and pour the plastic into that. Leave to dry (this could take 2–5 days).
- Depending on students the plastic can come out of the microwave looking anywhere from cake icing to Vaseline – ideally you want it to look more like Vaseline. **Do NOT** let the students **touch** it at this point, but they can continue to stir it. Depending on your class, teacher can do this step until the mixture has cooled. When it is warm to the touch even in the middle, the students can shape it or pour it onto sheets. Make sure it is stirred to allow the middle to cool.
- It must still be warm if you want your students to mould it into shape, once it cools it becomes difficult to mould.
- It will harden over time as the water evaporates and it can be tough, flexible, brittle, crumbly, opaque, or transparent.
- Drying time can take 2–5 days and thicker shapes will most likely crack while it dries.
- Any spills are easy to clean up, washes up easily. This will dissolve in water so can be easily cleaned.

Lesson 03

Teaching Resources

Name(s): .....

Record Your **Observations**

As you work through the activities, make observations about the properties of each material. Write **Yes** or **No** beside each property for each material in the table. What other things have you noticed that are not listed? Describe those in 'Other Observations'

Properties	Water	Corn Starch	Oobleck
Transparent			
Smooth			
Runny			
Sticky			
Strong			
Hard			
Flexible			
Other Observations			

When I stir the Oobleck.....

When I sink the stick into the Oobleck and try to pull it out quick, it feels like .....

Making **Oobleck**

1. Take a paper cup
2. Write your group name on the side
3. Add 3 Tablespoons (45 ml) of corn starch to the cup
4. Using the same spoon you used for the corn starch, add one Tablespoon (15 ml) of water.
5. Stir with the lollipop stick until all the corn starch is completely wet.

You have made Oobleck!

Now observe your solution and answer the following questions

1. What does this mixture look like?
2. Tilt the cup and let the mixture move around. What do you notice?
3. What do you notice about the mixture when you stir it? How does it feel?
4. Try to push the stir stick quickly into the Oobleck, what happens?
5. Let the stir stick sink into the mixture without forcing it, is the interaction different? How?
6. Now try to pull the stir stick out quickly. What do you notice?

Do you think oobleck is a liquid or solid??
Can it be both? Discuss with your group

7. When you are done, store or dispose of your Oobleck as your teacher directs.

Lesson 4:
Meet a Materials Scientist

Class Level:
3rd – 4th

Time:
40 Minutes

Strand:
Materials

Strand Unit:
Properties,
Material Changes

Safety: N/A

Background:

A materials scientist is a person who studies and analyses materials such as, metal, glass, rubber, ceramic, composites, and polymers (like plastic). The properties and structure of these materials are investigated to learn or gain new knowledge. Scientists then take what they learn and test ways to improve the materials, combine different materials to get new properties, or create brand new materials with certain properties and characteristics that could be used for different applications.

In order to be able to do this, a materials scientist needs to be able to design fair tests and conduct research.

In this lesson the students will meet a materials scientist, through this lesson and then through subsequent lessons (see resource road map) students will see how they can work like a materials scientist in the classroom.

Working scientifically will involve children in

- observing
- asking questions
- predicting
- hypothesising
- investigating and experimenting
- interpreting results
- recording and communicating results

Key Learning

Materials scientists use scientific methods to investigate the properties of materials, students can do this in their classroom too.

Resources:

- **AMBER Resources:**
  - Video/transcript What does a materials scientist do? (5 minutes)
  - Powerpoint 'Meet a Materials Scientist'
  - **Handouts:**
    4.1: Student Worksheet (1 per student)

Key Vocabulary:

Fair Test	Experimentation	Substitution

Add 'fair test' and 'substitution' to the word wall using the **Vocabulary Frayer model template**.

Learning Objectives/Outcomes

Science:

Materials
Materials and Change
Working scientifically
Science and the Environment

- Begin to explore and appreciate the application of science and technology in familiar contexts

Literacy:

Strand: Oral language/ writing

Element: Engagement, listening & attention/engagement

- Actively listen and extract meaning from the video by taking notes.

Strand: Oral language/reading

Element: Vocabulary

- Discuss the meaning of new tier 3 vocabulary (low frequency, subject specific words), using context, role-play, visuals and examples. Use this new vocabulary to talk about the properties of materials.

Lesson Outline:

Exploring the life of a materials scientist

Introduction: [10 minutes]

Whole class discussion

Tell students that today they will meet a material scientist and learn about working scientifically

What do they think a scientist does?
How do you know if a person is a scientist?
What do they think a material scientist does?

Lesson [20 minutes]

Students watch video and fill in worksheet » Handout 4.1
Slides 2-4

- Use the powerpoint to go over the steps of working scientifically.
- **Play the video**. What does a materials scientist do? This video interviews an AMBER scientist speaking about the importance of understanding properties of materials and running controlled investigations (fair tests). Materials scientists need to identify the properties of the material that are important for its use and when looking for a substitution, make sure the substitution has those same properties.
- Have the students answer the questions in their worksheet (handout 4.1). This will include prompts from the interview, What did the scientist Observe? What Questions did the scientist ask, what was their research question? How did they make their investigation a fair test?

Group Discussion [10 minutes]

Think-pair-share » Slides 5

- Have the students think about what questions they could ask this scientist?

» have them write down these questions in their copy book and share with the class.

Key learning: materials scientists use scientific methods to investigate the properties of materials, Students can do this in their classroom too.

Integration

Maths:	Literacy:
■ When discussing with the children what they would like to ask a scientist, supplement with "do you use mathematics in your job?" if none of the children suggest it.	■ Use comprehension strategies to engage with the text and to discuss what they have learned about being a plastics scientist.

Time Allocation: for a 40 minute class

Science:	Maths:	Literacy:
40 minutes	0 minutes	25 minutes

Modification

- Transcript of the interview could be printed out and student could work through this as a reading exercise.
- Students could work in teams to fill in the worksheet
- Worksheet could be adapted to match science terminology with phrases from the interview

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Teacher observation
- Question development
- Comprehension through worksheet responses

Extension

- Students could post questions they thought of onto the AMBER website and later discuss the answers they received.
- Students could use the computer to research scientists at AMBER or other types of scientists in different fields of science and explore what they do in relation to working scientifically.
  - Students could write a report or make a presentation on these scientists
  - Students could compare the scientists they researched. *What do they all have in common? How are they different?*

Lesson 04

Teaching Resources

Name: .....

Meeting a **Materials Scientist**

What is the name of the scientist?.....

What material do they study?.....

What did they Observe about the material? .....

What Questions did they ask? .....

What kind of experiment did they do?.....

How did they make their experiment a fair test?

What did they learn?.....

Are there any science words they used that you knew already?

How can you work like a scientist?.....

Asking Questions | Observe | Think/Predict | Test | Record

LESSON

5-7

Environmental Awareness

Lesson 5:
Get to know Plastics

Class Level:
3rd – 4th

Time:
50 Minutes

Strand:
Environmental Awareness and Care, Materials

Strand Unit:
Environmental Awareness, Science and Society, Caring for the Environment, Properties

Safety: Safety: All material should be safe and found in your classroom or at home.

Background:

This lesson focuses on plastics in general. It builds on student's knowledge of plastics; what is good and bad about plastic, how we use and dispose of it. The lesson introduces students to the idea of recycling numbers, which are used to identify different types of plastic.

Although all plastic is sourced from fossil fuels not all plastic is the same. In Ireland we put rigid plastic in the recycling bin and film plastic is thrown out as waste. This is not the case in all countries, for example, Northern Ireland collects film plastic for recycling. Ireland does no actual recycling of its own and instead sends off its plastics to be sorted and recycled in other countries. This has socio-political implications and environmental and geographical considerations. Different types of plastic (both rigid and film) have different recycling methods and need to be separated into their types before recycling can occur. Most plastic will have a recycling number (called a ***resin code***) stamped somewhere on it. This number tells you what type of material it is and how it can be recycled.

Key Learning

Plastic has both good and bad properties. Plastic can be sorted into different types based on the recycling number.

Resources:

- Students should be asked to bring in two items from home that they think are made of different types of plastic, this can be plastic you would throw out as waste or recycling or it can be any other plastic item – toy, etc.)
- Teacher should have a clear single-use water bottle and an opaque plastic drink bottle (milk, juice) for demonstration. If unavailable – use images on the ppt (slide 12)
- You will be making a chart on the board (this can be drawn on a white board or made more permanent on paper)
- Post-it notes for dot chart (see lesson outline)
- **Video:** how plastic is made. https://youtu.be/6PgjA3HISmw (5.16 minutes)
- **AMBER Resources:**
  - Powerpoint 'Get to know Plastics'
  - **Handouts:**
    5.1: Student note-taking table: Plastics – Good and Bad (1 for each student)

Key Vocabulary:

Recycle	Resources	Circular Economy
Properties	Disposal	Resin Code
Horizontal	Vertical	Axis

Learning Objectives/Outcomes

Science:

- Group materials according to their properties
- Become aware of the importance of the Earth's renewable and non-renewable resources
- Suggest and discuss possible actions for caring for the environment and consider the effects of these on people and the environment
- Realise that there is a personal and community responsibility for taking care of the environment

Maths:

- Sorting and classifying
  - Collect data from the environment and record in tabular form; represent data in appropriate format
- Representing collections of objects using pictograms, block graphs, bar charts and bar-line graphs

Literacy:

Strand: Oral language/writing

Element: Engagement, listening & attention/engagement

- Actively listen and extract meaning from the video by taking notes

Strand: Oral language/reading

Element: Vocabulary

- Discuss the meaning of new tier 3 vocabulary (low frequency, subject specific words), using context, role-play, visuals and examples. Use this new vocabulary to talk about the properties of materials

Lesson Outline:

Introduction: [20 minutes]

Whole class discussion

Start with a free-association whole class discussion on plastics. Ask the students, *What do you think of when you see the word Plastic?* (slide 2)

- Write the words and ideas down on the board. It is important not to edit or ask for clarification – your job during this is to simply record what the students say
- Use this list to have a conversation about plastic. Prompt the students with questions about their word association. Can they identify what is good and bad about plastics?
  - Plastic is made from a Petroleum waste product so it is cheap to make
  - Plastic is lighter than glass and ceramic so cheaper to ship, doesn't break so more durable, etc.
  - *Problems with plastic? What are they?* Ans: We have to get rid of it but it never goes away. Microplastics, gets into the food web
- (slide 3) Have the students discuss what they already know and let them add their thinking to their worksheet (handout 5.1) under the headings 'things I already know...'
- (slide 4) Show the video 'How plastic is made' https://youtu.be/6PgjA3HISmw – this is a good summary and shows briefly how plastic is made, some good things and bad things about plastics. (You can stop video after 4.35)
  - Model how to take notes in bullet-point form from the video for the 'good' side (pause the video at appropriate points). Then encourage the students to write their own bullet points for the 'bad' side while watching the video (slide 5)
  - Encourage them to share their findings with the class

Activity 1: Plastics inventory [10 minutes]

Group work » at their tables or in groups of 4

Students will conduct a plastic inventory by looking at the plastic associated with their lunch, and at their desk. Have the group count the number of items of plastic.

- How do we know it is plastic? What are the properties of plastic? See slide 6 for prompts on words used to describe some properties
- (slide 7) Have them raise their hands based on how much plastic they counted. How many tables counted 5 or less? 10 or less, 15 or less, more than 15? Hopefully they will be able to see how much plastic is around them.

Activity 2: Recycling numbers [15 minutes]

Students work together and help each other » Slide 8, 9

- Students should have brought at least two items of different plastic from home
- Now have the students look for the recycling number on each piece of plastic. Some may be difficult to see and in some cases there may not be a code – if a student had a piece of plastic with no code – this is an opportunity to discuss how that might be confusing at the sorting station or if people had to sort at home
- Have the students identify the recycling number on their plastics. Write the item type and recycling number on a post-it note for each item. (if you can have different coloured post-its (one for each number type that would be better but not necessary)
- Make a graph on the board, talk to the students about making a graph and what we need to put on it (labels, title, etc.) see slide 10
- Have each student go to the board and place a sticker for each item that was identified
- Have them stack them so they make a line (see slide 11)
  - Have the students make a graph in their copybook with the number of items in each category. Make sure they label axes and give the graph a title. Have them write a conclusion from the graph – something they have noticed (see slide 11)

Whole class discussion; plenary [5 minutes]

Consider the recycling numbers and how the properties may be different » Slide 12

- Show the students the two types of bottles on slide 12 (bring in examples for them to look at if possible); the single-use water bottle has a resin number of 1 and the opaque bottle has a resin number of 2
- Have them describe the differences

Next class they will look at this in more detail.
Recap how they were like scientists today (slide 13)

Key learning: Plastic has both good and bad properties. Plastic can be sorted into different types based on the recycling number.

Integration

Maths:	Literacy:
Representations of data; communicating and expressing	Oral language, writing with a purpose

Time Allocation: for a 40 minute class

Science:	Maths:	Literacy:
50 minutes	20 minutes	10 minutes

Modification

- Develop a word list and have students circle the words that describe plastics

Extension Activities

- The names of the plastics are intentionally left out and will be introduced in later lessons but could be introduced here.
- Have the students do a plastic survey at home. Over the weekend, have them record every type of plastic they interact with. Have them record the recycling code and item. They can bring this back to class to make charts and discuss the use of plastics in their household.
- Extend the conversation out into geography, economics, and society. Research different countries and compare their recycling programmes. Research the effects of shipping recycling to other countries.
- Have the students research and debate shipping plastics off to recycle or burn them here for energy. Which has a smaller environmental footprint?
- If there are a lot of plastic items in one category, ask the children, what can we do to fit everything on the graph? Supplement suggestions with “allow one post-it to represent two items” if it is not forthcoming from the class. In other words, they can change the scale of the axis so they can still accurately represent the numbers.

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Teacher observation
- Graph and note-taking chart

Lesson 05

Teaching Resources

Name: .....

What I **already know** is GOOD about plastic:	What I **already know** is BAD about plastic:
I learned from the video that plastic is good because...	I learned from the video that plastic is bad because...

Lesson 6:
Sorting Plastics

Class Level:
3rd – 4th

Time:
60 Minutes

Strand:
Environmental Awareness and care, Materials

Strand Unit:
Environmental Awareness, Science and Society, Caring for the Environment, Properties

Safety: All material is safe and found in your classroom or at home.

Background:

This lesson continues from lesson 5 'getting to know plastics' and will allow students to undertake investigations to determine different types of plastics based on the resin codes discussed in lesson 5. They will then consider some of the problems associated with these plastics.

Although all traditional plastic is sourced from fossil fuels it is not all the same. Ireland sorts its plastic and then sends it off to be recycled in other countries. For plastics to be recycled, they must be separated by type. The recycling number tells us the different types of plastics. However, visual sorting is not efficient enough to be practical on a large scale. One physical method of separating plastics is by a process called ***floatation.*** The plastics are shredded and placed into a liquid such as water. The plastics that are denser than water will sink, while those less dense than water will float. The floaters and sinkers are collected separately, and then the process is repeated with other liquids having different densities until the types of plastics have been sorted.

Key Learning

We can sort different types of plastics using the properties of floating and sinking. Floatation is a common way of sorting material.

Resources:

- Samples of each of the plastic types listed in the quick reference guide on page 6, cut into equal size strips.
- Isopropanol (rubbing alcohol) (NOTE; make sure it is 99% isopropanol – can be bought in pharmacy)
- Vegetable oil (corn oil is preferred)
- Glycerine (can be found in bakery section at Tesco or sore throat section in pharmacy)
- Water
- 4 cups or containers (one for each liquid) large enough to hold the plastic strips (preferably transparent so students can view the plastic from the side)
- Lollipop sticks (to push the plastic under the surface)
- **Video:** Plastics in Ireland https://youtu.be/E-pmxaiZ-NM (5.14 minutes)
- **Video:** Precious Plastic – learn about plastic https://youtu.be/fsqLJNyrVss (6.21 minutes)
- **AMBER Resources:**
  - Powerpoint 'Sorting Plastic'
  - Recycling Number chart (1 copy per table, or one displayed for the class)
  - **Handouts:**
    6.1: Worksheet_video: *Plastic in Ireland* (1 per student)
    6.2: Worksheet_video: *Precious Plastic* (1 per student)
    6.3: Student Worksheet_Investigation (1 for each team of 2 students)
    » **Homework 6.4:** Resin Code information Sheet (1 copy per student)

Key Vocabulary:

Density	**Resources**	**Suspend**
Bouyancy	**Floatation**	**Resin Code**

Add 'resin code', 'floatation' to the word wall using the **Vocabulary Frayer model template.**

Learning Objectives/Outcomes

Science:

- Group materials according to their properties
- Become aware of the importance of the Earth's renewable and non-renewable resources
- Suggest and discuss possible actions for caring for the environment and consider the effects of these on people and the environment
- Realise that there is a personal and community responsibility for taking care of the environment

Maths:

- Sorting and classifying
  - Collect data from the environment and record in tabular form; represent data in appropriate format
- Representing collections of objects using pictograms, block graphs, bar charts and bar-line graphs
- Scale (4th class)
- Calculate a fraction of a set using concrete materials

Literacy:

Strand: Oral language/writing

Element: Vocabulary

- Discuss the meaning of new tier 3 vocabulary (low frequency, subject specific words), using context, role-play, visuals, and examples. Use this new vocabulary to talk about the properties of materials

Strand: Oral language/writing

Element: Engagement, listening & attention/ engagement

- Actively listen and extract meaning from the videos by taking notes about the circular economy and the methods of determining plastic type

Strand: Oral language/writing

Element: Engagement, listening & attention/ engagement

- Predict the methods of determining plastic types, drawing on the experience of sorting plastics

Lesson Outline:

Introduction: [35 minutes]

Whole class discussion/ individual worksheets

Watch the video *Plastics in Ireland* (5.14 minutes) (slide 2)
You may need to pre-teach some vocabulary such as 'residents of Ireland', 'global cycle', 'circular products' (you could have students fill in Frayer Models for new words and add to the word wall)

- Using the student worksheet provided for the video (handout 6.1), pause the video at various times and model how to fill in the first two parts of the template (answer key provided), have the students try the rest on their own with guidance.

Whole class discussion

- Ask the students what they thought about this video? Did they learn anything new?
- How did they feel when they saw all that rubbish?

Tell the class that for plastics to be recycled properly they need to be sorted into their recycling numbers – but we throw everything out together. (slide 3)

How can we sort them?

- Have students suggest ways to sort them. Have them think of ways they might be able to sort plastic before watching the video.
- Have them record this in their worksheet for the next video (handout 6.2) (slide 4)

Now Watch the video: *Precious Plastic – learn about plastic* https://youtu.be/fsqLJNyrVss (this covers types of plastic and sorting with floatation) (6.21 minutes) (slide 4).

- Stop the video at points to allow the students to identify the methods used to sort plastic that are mentioned in the video and write this in their worksheet.

- Have students discuss what might be the best approach to use in the classroom, discuss limitations and safety and then direct them to consider floating and sinking. (slide 5)

Investigate an unknown plastic [20 minutes]

Teams of 2 » handout 6.3

each table or group: there should be 4 cups with the different liquids in them, along with lollipop sticks.

- Explain briefly how floatation works (slide 6)
- Print off the recycling number chart

Give each team of two students, 5 pieces of unknown* plastic (all the same size and shape).
(*see teacher instructions for set up).

- The teacher should make note of what plastic each group has to ensure they were successful in their identification (using different plastics that are different colours helps keep them sorted).
- Have the students put one piece of plastic at a time into each cup and observe if it floats or sinks. Once the plastic piece has settled, have the students circle the correct observation (yes or no) in their table to determine the type of plastic they have.
- Once they have completed all activities and filled in their worksheet, they can compare their results with the **recycling number chart** (slide 8) and determine what type of plastic they have.

Recap at the end (slide 9) Key learning: We can sort different types of plastics using the properties of floating and sinking. Floatation is a common way of sorting material.

Homework [5 minutes]

Individual

- The students should collect a Resin Code Information sheet and circle the type of plastic they had before taking this home. When they go home they should see how many pieces of this type of plastic they have in the house, they should record the object and its purpose.
- They can choose to make a table or draw a graph showing how much and how varied this type of plastic is in their home (they could make a Carroll diagram). Once they have done this have them write out a paragraph outlining what they know about this type of plastic and why and how it is being used at home.

Subject Integration

Maths:	Literacy:
Sorting, classifying, logical, sequential thinking	Communicating and expressing Oral language, engagement, listening

Time Allocation: for a 60 minute class

Science:	Maths:	Literacy:
60 minutes	10 minutes	20 minutes

Modification

- Provide a word bank for the video worksheets and have students match the words
- Conduct the unknown plastics as a demonstration

Extension Activities

- Instead of having them review the information sheet, have the students research one resin code plastic and find out the information for themselves. There are many good sources on the internet. https://www.chemicalsafetyfacts.org/types-plastic-food-packaging-safety-close-look/.
- Do an area clean up (preferably a beach, stream or park); count, identify and chart the different types of plastics found. You could use strainers and sift through soil to see if you can find any smaller pieces of plastics. You could sort these types of plastic and discuss why you may or may not see certain types washed up on shore.
- Students could make posters of the type of plastic they identified informing people of their use and using their data from their homes.
- Have the students put their plastics into salt water and see what they do, Have them research animals that feed at those levels (surface, bottom and within the water column) consider which animals would eat which type of plastic. See https://www.montereybayaquarium.org/for-educators/curriculum-and-resources/curriculum/plastic-in-the-water-column.

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Note-taking templates
- Teacher observation
- Successful identification of unknown plastic

Teacher Instructions: Investigating an unknown plastic

Before you begin

Prepare the following and put them in separate cups (either one set per table or if you have space you can set up stations) fill each cup halfway and label each container:

1. Rubbing alcohol: A solution of 3 parts rubbing alcohol to 2 parts water
2. Vegetable oil
3. Water
4. Glycerine (this can be purchased in the bakery section in Tesco)

Collect samples of each of the first six plastic types (use plastic that has a clearly labelled recycling number for your knowledge but make sure that number is not on a piece given to a student) cut them into strips and then cut each strip into 5 pieces (one for each treatment, plus bending).

1. Give each team 5 pieces of the SAME type of plastic
2. They should drop a plastic piece into each of the solutions. If it does not sink immediately, push it down below the surface with the lollipop stick – this breaks the surface tension.
3. Observe it until it stops moving.
4. Record on the data sheet whether it sinks or floats in that particular liquid.
5. Use the chart to determine the identity of the plastic samples.

If your student has PET or PVC they must do one more step as they can't tell them apart by sinking an floating.

8. Fold the sample in half – if it turns white at the fold it is PVC, if it doesn't it is PET.

All plastic strips can be disposed of in a recycling container and all solutions can be disposed down the sink.

Match the name of the material to the recycling code.

	Does plastic float?				
	Water	Alcohol & Water	Vegetable Oil	Glycerine	Colour of fold when bent
1 PET	No	No	No	No	No change
2 HDPE	Yes	No	No	Yes	-- --
3 PVC	No	No	No	No	White
4 LDPE	Yes	Yes	No	Yes	-- --
5 PP	Yes	Yes	Yes	Yes	-- --
6 PP	No	No	No	Yes	

Plastic Resin Identification Codes

Quick Reference Guide

1	2	3	4	5	6	7
PETE Polyethylene Terephthalate	**HDPE** High-Density Polyethylene	**V** Polyvinyl Chloride	**LDPE** Low-density Polyethylene	**PP** Polypropylene	**PS** Polystyrene	**OTHER**
Common Products • Water bottles • Soda bottles • Peanut butter jars	**Common Products** • Milk jugs • 5 gal buckets • Shampoo bottles • Laundry detergent containers	**Common Products** • Vinyl • Tubing/pipe • Siding • Auto product bottles	**Common Products** • Laundry baskets • Bread bags • Squeeze bottles • Plastic film	**Common Products** • Yoghurt containers • Amber-coloured pill bottles • Coffee cup lids • Straws • Kitty litter buckets	**Common Products** • Styrofoam cups • Solo cups • Egg cartons • To-go containers	**Common Products** • Toys • Sippy cups • CD/DVDs • Lenses
						

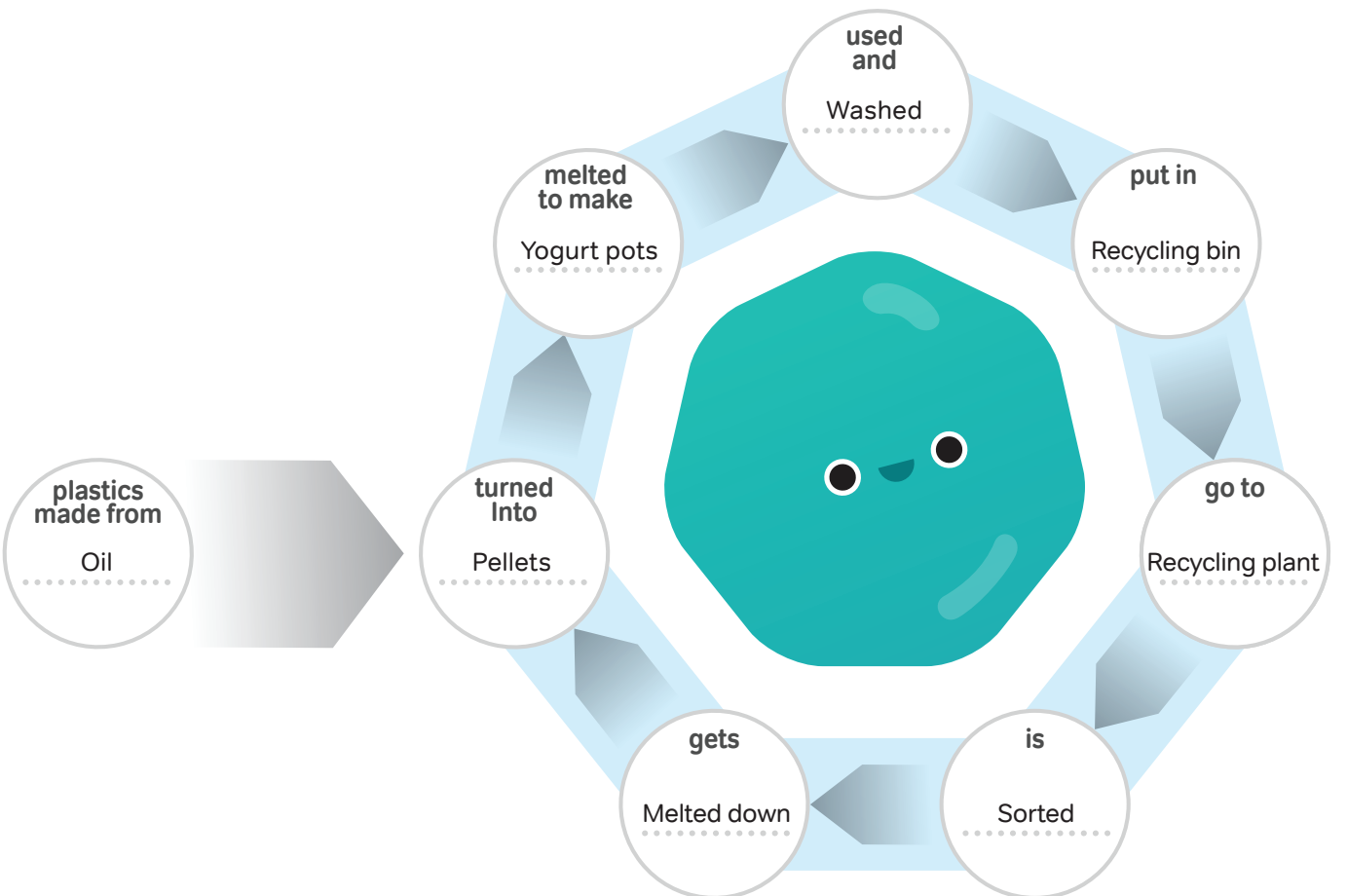
Other sources of information

https://www.preciousplasticdublin.org/collecting-hdpe-bottle-caps-recycling/

https://www.recycleandrecoverplastics.org/consumers/kids-recycling/

https://blog.nationalgeographic.org/2018/04/04/7-things-you-didnt-know-about-plastic-and-recycling/
look at some of the challenges of plastics and discuss government.

Answer Key



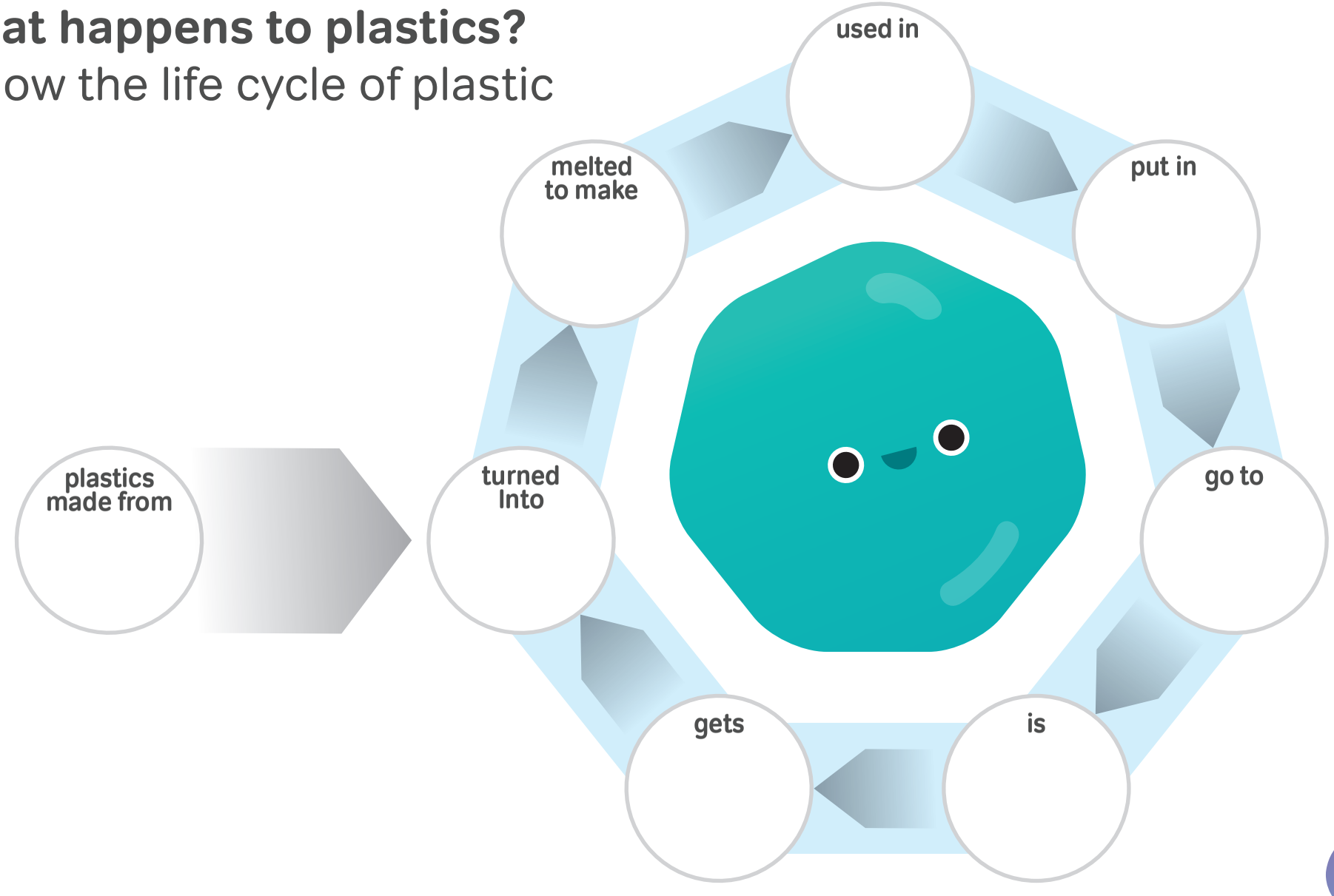
Lesson 06

Teaching Resources

Name: .....

What happens to plastics?

Follow the life cycle of plastic



Name: .....

Notes on Video:

Precious Plastics

Fill the first column in before watching the video.

I think I could tell plastic apart by.....	**Video:** Record the 6 methods used in the video, to determine type of plastic
	1.
	2.
	3.
	4.
	5.
	6.

Which method from the video would be the best for us to try? Why?

.....

.....

.....

.....

.....

.....

Name: .....

What **type of plastic** do I have?

- You should have five pieces of plastic – they are all the same type
- One at a time - place one piece of plastic in each condition
- Use a lollipop stick to make sure it is pushed below the surface to break the surface tension, watch it until it stops moving
- Observe your plastic and put a **circle** around the word that describes what you observe:

Did your plastic float? Circle Yes/No				**When I bend it, the fold...**
Water	**Alcohol and Water**	**Vegetable oil**	**Glycerine**	
Yes/No	**Yes/No**	**Yes/No**	**Yes/No**	
Other notes or observation I also noticed...	**Other notes or observation I also noticed...**	**Other notes or observation I also noticed...**	**Other notes or observation I also noticed...**	**Doesn't change colour**
				is white
				Other notes or observation I also noticed...

- Once this table is filled in – go to the chart and see what type of plastic you have.

My Plastic is ..... **with a recycling number of** .....

Homework

Resin code information sheet

1	2	3	4	5	6	7
PETE Polyethylene Terephthalate	**HDPE** High-Density Polyethylene	**V** Polyvinyl Chloride	**LDPE** Low-density Polyethylene	**PP** Polypropylene	**PS** Polystyrene	**OTHER**
Properties: Most common type – single use only **Common Items:** Water and soft drink bottles, some food packaging **Recyclable:** Yes, most common and easily recycled plastic. Should never be reused.	**Properties:** Hard, strong, resistant to wear **Common Items:** Milk containers, detergents, cleaning bottles, and hair care products, toys **Recyclable:** Yes, relatively simple to recycle can be reused too.	**Properties:** Soft, flexible, weather resistant **Common Items:** Plastic pipes and hoses, cooking oil bottles, blister packs, children's and pets' toys, plastic salad containers **Recyclable:** Generally, No. PVC contains toxins. Can be repurposed but not for food of children's use.	**Properties:** Soft, flexible **Common Items:** Cling film, squeezable bottles, bread bag and frozen food bags, thin grocery bags **Recyclable:** Depends on item and location, Ireland does not recycle this material or any soft, flexible plastic. Can be reused.	**Properties:** Tough, resistant to heat **Common Items:** Yogurt containers, drinking straws, bottles that contain liquids such as syrup and honey, medicine bottles, bag inside cereal box. **Recyclable:** Yes. Can be reused.	**Properties:** Lightweight, easily shaped, breaks down easily **Common Items:** Styrofoam – coffee cups, takeaway container, packing peanuts, CD cases, meat trays, plastic cutlery **Recyclable:** Generally, No. Toxic when heated, dangerous for the environment.	**Properties:** Varied, different, or mixed plastics, bioplastic **Common Items:** Sports Water bottles, baby bottles, electronics **Recyclable:** Generally, No. Check individual items.
						

Recycling number chart:

What **type of plastic** is it?

Does plastic float?					
	Water	Alcohol and Water	Vegetable oil	Glycerine	Colour of fold when bent
1 PET	No	No	No	No	No change
2 HDPE	Yes	No	No	Yes	
3 PVC	No	No	No	No	White
4 LDPE	Yes	Yes	No	Yes	
5 PP	Yes	Yes	Yes	Yes	
6 PS	No	No	No	Yes	

Materials NOW

Lesson 7:
Solutions to Plastic

Materials NOW

Class Level:
3rd – 4th

Time:
110 minutes (easily divided into 2 class times)

Strand:
Environmental Awareness and care, Materials

Strand Unit:
Environmental Awareness, Science and Society, Caring for the Environment, Properties

Safety: All material should be safe and found in your classroom or at home.

Background:

In this lesson students will discuss the possible solutions to problem plastic and look at how material scientists at AMBER are coming up with ways to solve these problems.

There is a big push to change the way we think about the items we produce; how we make them, how we use them and what we do with them when we're finished with them. The idea is to make it so that no item ends up in a landfill when it is no longer used. Instead of having a life cycle for a product (cradle to grave) there is no grave and rather the item is introduced back into the economy in one of several ways: it could be replaced, altered so it is more biodegradable and more effectively recycled. In this way precious natural resources are preserved, habitats are protected and pollution is reduced. This idea is called the ***circular economy*** and all of Europe has set a 2030 goal to reduce waste and develop this approach to economics and the environment.
https://unssc.org/circular-economy-and-2030-agenda/

Key Learning

The use and disposal of plastic has many factors that must be considered. There is no one simple solution but the conversation and research must continue.

Resources:

- **Video:** What really happens to plastic? https://youtu.be/_6xINyWPpB8 (4.01 minutes)
- **Video:** Without China, what's happening to the world's waste? https://youtu.be/Z0m7xhxu4dQ (3.00 minutes)
- **AMBER Resources:**
  - Powerpoint 'Solutions to plastics'
  - Videos/transcripts: AMBER scientist discussing solutions
  - **Handouts:**
    7.1: Worksheet: video – what really happens to plastic? (1 per student)
    7.2a & b: Worksheet: video/transcript - AMBER scientists (1 per student or pair)
    7.3: Instructions: 'You decide' (1 per team of 4)

Key Vocabulary:

Recycle	**Substitution**	**Circular Economy**
Microplastics	**Biodegradable**	**Bioplastic**

Add 'recycle' and 'single-use', biodegradable', and 'bioplastic' to the word wall using the **Vocabulary Frayer model template**.

Learning Objectives/Outcomes

Science:

- Become aware of the importance of the Earth's renewable and non-renewable resources.
- Suggest and discuss possible actions for caring for the environment and consider the effects of these on people and the environment.
- Realise that there is a personal and community responsibility for taking care of the environment.

Maths:

- Use a calculator to calculate a fraction of a quantity of money

Literacy:

Strand: Oral language/writing

Element: Engagement, listening & attention/engagement

- Actively listen and extract meaning from the videos by taking notes about the three plastic bottles, China's waste management and issues with recycling and AMBER scientists.

Strand: Oral language/reading

Element: Vocabulary

- Discuss the meaning of new tier 3 vocabulary (low frequency, subject specific words), using context, role-play, visuals and examples. Use this new vocabulary to talk about the properties of materials.e

Strand: Writing

Element: Purpose, genre & voice

- Create a poster to explain funding decisions, using information gleaned from this and previous lessons.

Lesson Outline:

Introduction: [10 minutes]

Video note-taking

In this lesson you discuss with your students some of the problems with plastic.

Video 1: Watch the video *'What really happens to plastic?'* https://youtu.be/_6xlNyWPpB8 (4.01 minutes)

- Have the students fill in the worksheet (handout 7.1) (slide 2)
- Stop the video and prompt the students as necessary

Activity 1: [15 minutes]
Walking debate
Slide 3

- Walking debate. Have the students stand in a line in the middle of the class, read out the series of statements on slide, if they agree they take a step back – if they are unsure, they stay in place. Ask students why they moved to where they did – discuss ideas. See 'Modifications' for alternative ways of running this activity.

- Statements for the walking debate. Read the following statements and have the students agree or disagree. (Slide 3)
  - » All single-use plastic bottles (resin code #1) can be recycled
  - » All single-use plastic bottles are recycled
  - » If I can't find a recycling bin, it is OK to throw out my bottle in the rubbish
  - » If I see a plastic bottle lying around outside, I will pick it up and throw it in the rubbish
  - » Shipping off our recycling is the best thing to do
  - » We should sort our plastics ourselves at home instead of putting them all together in the same bin
  - » The best solution to our waste problem is to recycle as much as you can
  - » We should never have invented plastic
  - » I can live without plastic
  - » All single-use plastic bottles (resin code #1) can be recycled
  - » All single-use plastic bottles are recycled
  - » If I can't find a recycling bin, it is OK to throw out my bottle in the rubbish
  - » If I see a plastic bottle lying around outside, I will pick it up and throw it in the rubbish
  - » Shipping off our recycling is the best thing to do
  - » We should sort our plastics ourselves at home instead of putting them all together in the same bin
  - » The best solution to our waste problem is to recycle as much as you can
  - » We should never have invented plastic
  - » I can live without plastic

- Discuss with the students the different points in the debate and ask for constructive differences. Highlight that this is what makes environmental problems challenging to solve – there are alot of different ideas, and information, so its sometimes hard to figure out the right thing to do.

Group Discussion: [10 minutes]
Is recycling the solution?
Whole class discussion

- Video 2: Watch the video 'Without China, what's happening to the world's waste?' https://youtu.be/Z0m7xhxu4dQ (3.00 minutes)
  - Stop the video at various places and prompt the students (slide 4)
    - » Why won't China take our waste anymore?
    - » Where does our waste go now?
    - » Why is waste disposal a problem?
    - » What do you think about children doing this work?
    - » What should Ireland do?
  - Allow for discussion and opinion

To close this part of the lesson, ask the children to put up their hands if they agree with the statement:

» the best solution to our waste is to recycle as much as we can

Activity 2: [15 minutes]
Think-pair-share
Pose these questions to your students » slide 5

- What do you think the major problems are with plastics? (there can be more than one)
- What can we do to solve these problems?
- Can you come up with specific ideas that could help?

✓ Have them write out their ideas and solutions in their copy book.

*** if you want to break this lesson up, this is a good place to stop. If you do stop: recall their ideas from the previous lesson and review their worksheets before continuing ***

Activity 3: [20 minutes]
Material Scientists try to solve these problems

Video note-taking and class discussion » handout 7.2 » slide 6

✓ Watch the videos of AMBER scientists and what they are doing to solve some of the problems with plastic.

Have the students fill in one worksheet for each scientist, noting the name of the scientist, what problem they are trying to solve, how they realized it was a problem, what they are trying to do to fix it.

Have the students look back at their possible solutions. Was there anything similar to the AMBER scientists work? Add 'biodegradable' and 'bioplastic' to the word wall.

Activity 4: [30 minutes]
You decide

Teams of 4 » handout 7.3 » slide 7, 8

In this activity your class is given a scenario: they have €100,000 to spend on solutions for plastic. Having heard from both AMBER researchers about possible solutions and learning and discussing a lot about plastic over these last few classes, the students are tasked with deciding how to spend the money. They must consider which research might have the best, most immediate or broadest impact for Ireland and they need to be able to say why they made their decisions (support their argument). Have the students use the information they have gathered so far over the past three lessons to make a decision about how the funding should be spent.

✓ They must design a poster defining plastics, explaining what's good and bad about plastic and what they think the main problems are. How did they divide the money and why.

Have them present their conclusions to you and the class – the 'government' representatives (granting body). The class can vote on everyone's proposal.

Group discussion (plenary) [10 minutes]

Revisit the walking debate to see if any students have changed their opinions. (slide 9)

Subject Integration

Geography	Maths	Literacy	SPHE
People and other lands – develop an awareness of the interdependence of these people and people in Ireland, Caring for the environment	Representations of data; communicating and expressing	Oral language, writing with a purpose	Making decisions, developing citizenship, relating to others, media education (extension activity)

Time Allocation: for a 110 minute class

Science:	Maths:	Literacy:
110 minutes	10 minutes	85 minutes

Modification

- If there is no room in the class, use the hallway or gym for the walking debate, at their desks, students could use stop light signs at their desk (red disagree, green agree, yellow uncertain), or stand and sit.

Extension Activities

- Plastic challenge. Have students attempt to live without single use plastics (or all plastic like in the video below) for a day, weekend, week (this includes candy and crisp wrappers), they should log their observations and feelings in a diary and report back to the class on their experience.
- Watch the video Living plastic free is harder than you think https://youtu.be/enaPjyMf2JY (5.44 minutes) (slide 10).
  - Have the students each write a short story about how they think life will be like when they are grown-ups. What will their relationship with plastic be like then?
  - Design posters of plastic free shopping, combining information they have learned from previous lessons.
- Have the students debate the issue of going plastics free using this free download https://www.twinkl.ie/resource/t2-s-1257-plastics-and-the-environment-the-great-debate-activity-pack
- Have students identify issues associated with plastics in the media and present their findings to the class, link with SPHE: Media education – explore and examine some issues that are frequently raised in the media, the way they are portrayed and the accuracy of these presentations.

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Templates and note-taking
- Poster presentation
- Walking debate revisited – any change of opinions

Lesson 07

Teaching Resources

Name: .....

3 Plastic Bottles

What happens to...?

Bottle 1	
Bottle 2	
Bottle 3	

Name: .....

Interview 1

Material scientists at AMBER are trying to solve these problems too

Who is the scientist? .....

What problem did the scientist identify?

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What did they think could solve the problem?

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How did they identify this problem?

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What science skills did they use? Did they use maths? Language skills?

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Name: .....

Interview 2

Material scientists at AMBER are trying to solve these problems too

Who is the scientist? .....

What problem did the scientist identify?

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What did they think could solve the problem?

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How did they identify this problem?

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What science skills did they use? Did they use maths? Language skills?

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Name: .....

Instructions for **'You Decide'**

You are in charge of €100,000 that you want to spend on solutions for plastic. You have to convince the government (your teacher and classmates) that the way you want to spend it is the best way.

You need to explain what's good and bad about plastic and what you think the main problems are. You have heard from both AMBER researchers about possible solutions and you have learned a lot about plastic over these last few classes.

You must decide how to spend the money. You can give all of the money to one researcher or the other, or give a fraction to each or some other idea that you like. You must consider which research might have the best, most immediate or broadest impact for Ireland and you need to be able to say why you have made your decision.

In your group, design a poster outlining your plan for the money.

Prepare a short presentation to explain the reason behind your decisions and to convince the government to agree to your choice for dividing up the money.

Here are some prompts to help you decide what to put into your poster.

Plastic is...

Some bad things about plastic

Some good things about plastic

What can we do about the bad things? Possible solutions

Can we live without plastic?

Can we reduced our use of plastic?

AMBER scientist 1 and their work

AMBER scientist 2 and their work

Why not?

How?

Solution 1

Solution 2

How we will divide the money?

Why have we made the decision we did?

LESSON 08

Skills

Lesson 8A:
Being a Materials Scientist –
(A) Understanding variables and planning a fair test

Materials NOW

Class Level:
3rd – 4th

Time:
55 minutes

Strand:
Materials

Strand Unit:
Properties, Material Changes, Design and Make

Safety: This is a learning and planning lesson.

Background:

Having made bioplastic in Lesson 3, students will continue to develop their scientific skills in Lesson 8: being a Materials Scientist, through a series of activities which will have students design and conduct a fair test: *Lesson 8A: Understanding variables in the making of bioplastic and planning a fair test.* Lesson 8B: conducting the test and recording the results. Lesson 8C: communicating the results and drawing a conclusion.

Lesson 8A: understanding and planning. Investigate what role each ingredient in the recipe does and then design a fair test to see how changing different ingredients (variables) of the recipe can change the final properties of the bioplastic. A **variable** is something that can be changed and measured, from the root *'to vary'*. This is opposite to a **constant.** In Lesson 3, corn starch, water, glycerine and vinegar were combined, heated and stirred to make the bioplastics.

- The **variables** in making bioplastic are: amount of corn starch, water, glycerine, vinegar, how hot, how much it was stirred (shearing force)* and length of time in the microwave (all of these can be changed and so they are variables).
- The **constants** in this procedure were: the cup, the stirrer, the measuring equipment. These could not change during the investigation – the cup is the cup.

*A shearing force is one which applies force from opposite directions – like a pair of scissors or tearing a paper: if you want to know more click on the link https://youtu.be/d1fjGy8tas0 and watch from 3.38–4.18 of this 5.10 video

Each of the ingredients in the recipe have a role in making bioplastic and will change the properties of the bioplastic if changed, and therefore can be considered variables.

- Starch: the main material which will make the plastic, it is grainy and clumpy. Chemically, it is a long chain of glucose (sugar) molecules which stores energy. It is made by plants and we know it as complex carbohydrates found in pasta, cereals, potatoes. A great source of energy for people.
- Vinegar: a mild acid, adding it to the starch lowers the pH so the starch breaks down a little and the chains are shorter.
- Glycerine: is a small molecule that gets between the starch molecules and stops them from sticking to each other (breaks the hydrogen bonds) allowing the starch chains to slide past each other – it is called a plasticizer because it is what allows the starch to become a plastic (easy to shape).
- Water: allows everything to mix together in solution, all the ingredients can interact. It is also a plasticizer.
- Heat and stirring (shearing force) when a plasticizer is present, allows the starch to melt and flow.

Key Vocabulary:

In this lesson students will design a fair test and try to change the property of the bioplastic; making it more stretchy and or stronger.

"Fair testing involves the identification of the conditions that make a difference in the outcome of an investigation. Children should identify

- the variable that they will change
- the variable that will be measured or judged
- the variables that will be controlled or held constant.

In carrying out fair tests, pupils should be encouraged to ask: *What is being tested? What will be changed? What will be kept the same? What will be measured or compared?"* Science Curriculum, 1999, page 20

Key Learning

The use and disposal of plastic has many factors that must be considered. There is no one simple solution but the conversation and research must continue.

Resources:

- **AMBER Resources:**
  - Powerpoint 'Investigating bioplastics'
  - **Handouts:**
    8.1: Student 'lab book'
    See teacher instructions below for instructions on assembly (1 per student – to be used throughout lesson 8)

Key Vocabulary:

Variable	**Fair Test**	**Plasticizer**
Constant	**Investigation**	**Control**
Molecule	**Shearing**	**Force**

Add 'variable' to the word wall using the **Vocabulary Frayer model template** from 'general resources'.

Learning Objectives/Outcomes

Science:

Materials

- Investigate how materials may be changed by mixing
- Describe and compare materials, noting the differences in colour, shape and texture

Working scientifically

- Investigating and experimenting
- Designing a fair test

Working scientifically

- Exploring materials, planning designs, and making models that will provide solutions to practical problems.

Maths:

- Estimate, compare, measure and record the capacity of a wide variety of objects using appropriate metric units (l, ml)
- solve and complete practical tasks and problems involving the addition, subtraction, multiplication and simple division of units of capacity (l, ml).

Literacy:

Strand: Reading

Element: Comprehension

Strand: Reading

Element: Purpose, genre & choice

Lesson Outline:

Have students design a fair test to make a bioplastic more flexible or stretchy.

Introduction: [5 minutes]

Whole class discussion » Slide 2, 3

Tell students that today they will be working like materials scientists

- Review the components of working scientifically using the power point (slide 2)
- Challenge them – can we change the properties of the bioplastic we made? (slide 3)

Activity 1: [5 minutes]
Making the lab book

Handout 8.1 – the lab book

- Have the students make their 'lab book' (handout 8.1) each student should make their own. (slide 4, see teacher's instructions below).

Activity 2: [15 minutes]
Understanding the role of each ingredient in the recipe

Slides 5 – 11

- Work through the power point explaining the role each part of the recipe has in making bioplastic.
- Have the students fill in the blanks and do the activities on page 1 of their lab book.

Activity 3: [10 minutes]
Identifying variables

Handout 8.2 » Slide 13

- Using the power point, discuss what is meant by a fair test. (slide 11)
- Explain the term 'variable' and add it to the word wall.
- Have the students identify all the variables involved in making bioplastic (variables are things that can be changed and if changed, might lead to a different outcome/may change properties of the material). Hint: they are the same ingredients in the recipe.
  - They should fill out the centre pages in their lab book which matches Slide 13 (Ans on slide 14)
- Ask the students. W*hat can we change the amount of? What other things can we change?*
  - Student should be able to recognize that we measured out amounts of starch, vinegar, glycerine and water so we could change those amounts
  - Students should recognize that we timed how long in the microwave and stirred at specific times. So we can change how long we heat and how much we stir the mixture.
- Have students fill out page 2 of the lab book

Note: Activity 4 and 5, below, involves having the students apply their knowledge and design their own experiment. This is an opportunity for them to test out ideas and see what happens – each group's design and plan may be different. This should be completely student designed, but of course can be scaffolded. They need to try it out and see what happens. If you want to give them guidance help them realize that more glycerine will make it more stretchy but if they think of something else let them try it. It is good practice for them to not know what the outcome is – and draw conclusions from their observations. Were their predictions correct? Don't be afraid to let them try – just as long as it's safe. Discovering through investigation, IS SCIENCE!

Activity 4: [5 minutes]
Designing a fair test (think-pair-share)

- Ask the student the following and have them think-pair-share. (slide 16)
  - *Knowing what you do about the role of each variable? How could we make the plastic more stretchy?*
    Ans: they should increase the amount of plasticizer, they could decide on increasing the amount of glycerine or water (easier to increase glycerine)
  - *Do you think a more flexible plastic will be stronger?*
  - *Starch is the base material'. What if we used a different Base material like potato starch instead of cornstarch? Do you think that will change anything?*
  - If you changed both the base material and another variable at the same time – is this a fair test?
    Ans: No, only one variable can be changed at a time – all the others must be kept the same.

Activity 5: [15 minutes]

Teams 4–5

They will be making two sets of plastic so it is a good idea to do this in groups of 4 so each team can make one bioplastic

- Challenge the students to see if they can make the bioplastic more stretchy.
- Have them brainstorm what they could do.
- They need to consider:
  - the variable that they will change
  - the variables that will be controlled or held constant (add the term 'constant' to the word wall).
  - How will they test to see stretchiness? Everything needs to be the same except the variable they changed.
- Check to make sure they have devised a fair test.
- Have them fill out page 3 and 4.
  - Have the students go through the check list for a fair test (page 4)
- They are ready for the next lesson. Go over how they were scientists today (slide 19)

Key point: It is necessary to plan for investigations to make sure we can answer our question. Designing a fair test means to change one variable but keep everything else the same.

They should plan ahead using the template in the lab book.

The properties we are testing for are ..... **The variable we will change is** ..... **We predict that changing this variable will make the plastic**	**This is how we are going to test our prediction:** We will have a control plastic and our test plastic. We will: ....
The materials we will need are:	**We will make sure this is a fair test by:** .... **A drawing of our experiment:**

Learning Objectives/Outcomes

Science:	SPHE:	Literacy:
■ The varying quantities of ingredients could be displayed very nicely in bar charts. It would be a clear and accurate representation of the components and show the variations clearly. It would also link nicely with the sorting activity from the earlier lessons. It would add a mathematics component to the communication element of the lessons and would emphasise the value of maths in clear communication of the details of a situation.	■ Could relate to food, nutrition, and health (discussions on starch and its role as an energy source), taking care of my body – food and nutrition.	■ Use the strategy of visualisation to create a sketch of key vocabulary terms/scientific concepts. ■ Respond to the prompts in the lab book to clarify scientific understanding

Time Allocation: for a 55 minute class

Science:	Maths:	Literacy:
55 minutes	25 minutes	20 minutes

Modification

- Have students work as a class to decide on the variables to change
- Variables (the steps to the recipe) can be listed on the board and students can go up to the board and check (vote on) which variables should be changed

Extension Activities

- For the design: students could change other variables and predict and then see the results.
  - Substitution for corn starch is potato starch (this can be purchased or even made in the classroom) or gelatine (animal-based substitute)
  - Olive oil could be used instead of glycerine (oleic acid acts as a plasticizer)
  - Heat with no stirring
  - Change temp – bring to a boil in each case have the students predict what property would change and how?

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Teacher observation
- Fair test check in lab-book
- Traffic light self-assessment (end of lesson)
- This is one of three parts, final assessment would be the completed lab book and presentation of findings (lesson 8C) Marking rubric provided.

Notes on designing a fair test:
Making bioplastic in sheets and letting them dry allows for the plastic to be cut into shapes. You could have them cut the two plastics into rectangles and then use a hole punch to make a hole – you could then tie a ribbon or hang a weight from the hole.

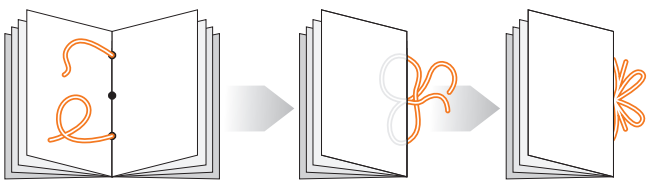
Remember for it to be a fair test, you need to change only ONE variable AND both the control and the test plastic needs to be treated exactly the same way.

Challenge them to think about both of these when designing their test. How can they make sure the plastic is treated the same? They can measure it before they cut it so both pieces are the same size. They can put the same stress on each (pulling it to see if it is stretchy is not enough) they need to do this in a repeatable way and be able to measure the results.

Teacher Instructions: Printing off the student lab book

- Print out the lab book first. It is designed to be printed double sided and put together as a booklet.
- Print it off on A4 paper and assemble. Use the page numbers to guide you. The title page and recipe (which is on the back of the title page are not numbered.
- Fold in half and punch three holes near the fold.
- Students can tie a ribbon through each hole to hold the pages together as illustrated below.

Simple Book Making Instructions
Stack up some pieces of paper and fold in the centre. Make three holes in the pages and pull cords through 2 of the holes. Both of the cords can be pushed through the centre hole as pictured above. Now that cord is pulled through the back of the book and tied in the back of the books seam. Taken from: https://www.artistshelpingchildren.org/bookmaking-crafts-make-books.html



1. Three holes in the pages and a cord pulled through two of them
2. Both cords are put through the centre hole
3. Bring the cords around the back

Answers to the Lab Book

PAGE 1

The Science Behind Bioplastics

Use the words to fill in the blanks.

Vinegar	**Long**	**pH**
Corn starch	**Plasticizer**	**Solution**

In this recipe, the base material is Corn Starch.
Starch is a long chain of glucose molecules.

The long chains can be made shorter by lowering the pH using the acid called Vinegar.
Adding glycerine makes the starch molecules slide over each other rather than stick together.
It is known as a Plasticizer.

Water can also act like a plasticizer and allows all the ingredients to become a Solution.

PAGE 2

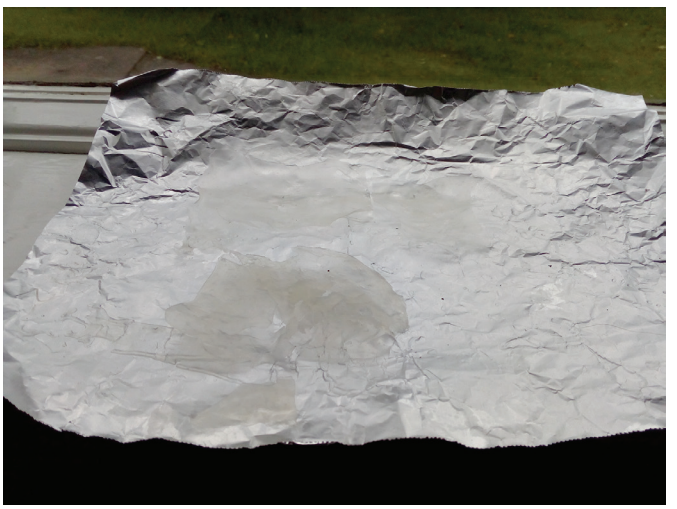
The Science Behind Bioplastics

We can change the amount of:

1. Starch
2. Vinegar
3. Gycerine
4. Water

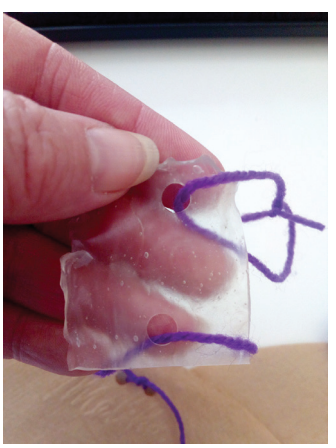
We can change how long we Heat it.
We can change how much we Stir it.

Example of a set-up to test for strength



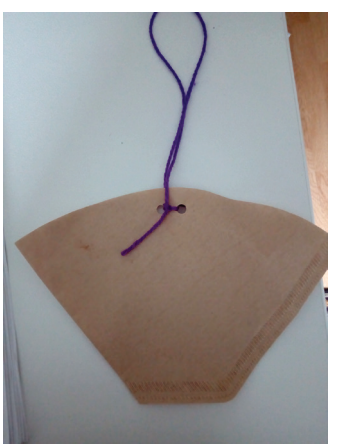
01.
Bioplastic; dried on aluminium foil

Test for Strength — an example



02.
Bioplastic cut to a specific, measured shape, and hole punched to loop the yarn through

Coffee filter used to hold weights, teid with yarn



03.
Coffee filter used to hold weights, teid with yarn

04.
Coffee filters tied to hanger by control plastic and text plastic

Make e sure the hanger is balanced, add weights to each until the bioplastics break. Measure how much weoight each could hold. You could use coins and then count them or weigh them. Chart the differences

Lesson 8:
Being a Materials Scientist
(B) Conducting the fair test

Materials NOW

Class Level:
3rd – 4th

Time:
50 minutes (divided into two class periods)
Note: the final product needs to dry for 2–5 days, allow 25 minutes for the completion of their tests.

Strand:
Environmental Awareness and care, Materials

Strand Unit:
Environmental Awareness, Science and Society, Caring for the Environment, Properties

Safety: The key concern is that the mixture can be **extremely HOT** when in the microwave and once it is out of the microwave. Students should **NOT TOUCH** it as it could cause **burns**. Once it has cooled but is still warm, it is safe for the students to handle or mould (see notes at end of teacher instructions in lesson 3). The material itself is safe and found in your kitchen. Good practise for doing investigations is to use safety glasses and a clothes cover, however, it is not necessary. Everything is water soluble and washes off. If the students are handling the cup during or after heating the material, they should wear oven mittens or garden gloves.

Background:

Students will continue their investigation through a series of lessons: Lesson 8A: Understanding variables in the making of bioplastic and planning a fair test. *Lesson 8B: conducting the test and recording the results.* Lesson 8C: communicating the results and drawing a conclusion.

Lesson 8B: Conducting their study.
In lesson 8A students designed a fair test and tried to change the property of flexibility in the bioplastic. In this lesson they will conduct their study.

"Fair testing involves the identification of the conditions that make a difference in the outcome of an investigation. Children should identify

- the variable that they will change
- the variable that will be measured or judged
- the variables that will be controlled or held constant. In carrying out fair tests, pupils should be encouraged to ask: *What is being tested? What will be changed? What will be kept the same? What will be measured or compared?*" Science Curriculum, 1999, page 20

See lesson 3 – making bioplastics for teacher's instructions and tips. Students should have done lesson 3 before this series.

Key Learning

It is necessary to plan for investigations to make sure we can answer our question. Planning ahead makes testing easier. Investigations need to be planned out and conducted safely and purposefully.

Resources:

- Lollipop sticks, paper cups, plates
- Hole punch, rulers, ribbon, other items students may need from their design.
- Base material: Corn starch, water, vinegar, glycerine (this can be found in the bakery at Tesco, the sore throat section at Boots, and the skin care section at Holland and Barretts) – Olive oil is an alternative if glycerine is difficult to source.
- Microwave
- **AMBER Resources:**
  - Power point 'Conducting a fair test' (You can use this as a guide or just let the children get on with their investigations.
  - **Handouts:**
    8.1: Student 'lab book' (made in Lesson 8A)

Key Vocabulary:

Variable	Fair Test	Investigation

Learning Objectives/Outcomes

Science:

Materials

- Investigate how materials may be changed by mixing.
- Describe and compare materials, noting the differences in colour, shape, and texture.

Working scientifically

- Investigating and experimenting
- Designing a fair test

Design and Make

- Exploring materials, planning designs, and making models that will provide solutions to practical problems.

Maths:

- Estimate, compare, measure, and record the capacity of a wide variety of objects using appropriate metric units (l, ml)
- Solve and complete practical tasks and problems involving the addition, subtraction, multiplication and simple division of units of capacity (l, ml).

Literacy:

Strand: Reading

Element: Purpose, genre & choice

Lesson Outline:

Have students change the properties of material by mixing and heating.
Make an alternative to the plastic we are most familiar with.

Introduction: [5 minutes]

Use the PowerPoint to remind students what a fair test is. Recap their work from lesson 8A and make sure they are comfortable with what they need to do.

Remember: Students have applied their knowledge and designed their own investigation. This is an opportunity for them to test out ideas and see what happens – each group's design and plan may be different. This should be completely student designed, but of course can be scaffolded. They need to try it out and see what happens. It is good practice for them to not know what the outcome is and draw conclusions from their observations. Were their predictions correct? Don't be afraid to let them try – just as long as it's safe. Discovering through investigation, IS SCIENCE!

Conducting their fair test [20 minutes]

- Have the students do their investigations (wear garden gloves if necessary, reinforce planning, safety and proper lab behaviour)
- Make observations about what they did. Record any measurements made (Page 9)
- They need to put their bioplastic to one side to dry
- Once dried – carry out their planned tests for stretchiness and strength which they have designed and described in the lab book [25 minutes]
- Have them draw a self portrait of being a materials scientist (space available on page 10)

Integration

Maths:	Literacy:
■ The varying quantities of ingredients could be displayed very nicely in bar charts. It would be a clear and accurate representation of the components and show the variations clearly. It would also link nicely with the sorting activity from lesson 6. It would add a mathematics component to the communication element of the lessons and would emphasise the value of maths in clear communication of the details of a situation.	■ Respond to the prompts in the lab book to clarify scientific understanding

Timer Allocation: for a 50 minute class

Science:	Maths:	Literacy:
50 minutes	20 minutes	15 minutes

Modification

- Variables (the steps to the recipe) can be listed on the board and students can go up to the board and check (vote on) which variables should be changed
- Have all the material they need, premeasured and ready for them to collect
- Do this as a demonstration done by the teacher. Have the students predict how the material would be different knowing what they do about each element.

Extension Activities

- Students could change other variables and see the results..
  - Substitute cornstarch with potato starch (this can be purchased or even made in the classroom) or gelatine (animal-based)
  - Olive oil could be used instead of glycerine
  - Place the solution in a Ziploc bag and microwave with no stirring
  - Heating on a hob (medium heat) with constant stirring could replace microwaving

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Teacher observation, carrying out investigation
- Questioning about content of the lab book

Lesson 8:
Being a Materials Scientist
(C) Sharing Findings

Materials NOW

Class Level:
3rd – 4th

Time:
50 minutes

Strand:
Materials

Strand Unit:
Properties, Material Changes

Background:

Having investigated properties of bioplastics by testing their prediction, students now **communicate the results of their investigations, drawing conclusions and making a presentation to the class.**

Sharing findings is an important part of being a scientist. This includes putting data into graphs and pictures and being able to present results and conclusions.

Resources:

- Art supplies
- A4 or A3 paper to make a poster page (or go bigger if you like) (1 sheet per team of 4).
- **AMBER Resources:**
  - Power point 'Communicating your findings'
  - **Handouts:**
    8.1: Student 'lab book'
    (made in Lesson 8A, completed in Lesson 8A and 8B)
    8.2: Worksheet 'Designing your Poster' (1 per team)

Key Learning

Scientists make predictions about their investigations and let the data tell the story. There is no right or wrong, as long as the test is fair, the results speak for themselves.

Key Vocabulary:

Science Communication	Fair Test	Investigation

Learning Objectives/Outcomes

Science:

Materials
- Investigate how materials may be changed by mixing.
- Describe and compare materials, noting the differences in colour, shape, and texture.

Working scientifically
- Investigating and experimenting
- Designing a fair test

Maths:

- Measuring and interpreting data
- Collect, organise and represent data using pictograms, block graphs and bar charts

Literacy:

Strand: Reading

Element: Purpose, genre & choice

Lesson Outline:

Students take the results of their investigations and explain it to the class

Introduction: [5 minutes]

Using the PowerPoint, discuss the importance of science communication

Designing and Planning [10 minutes]

- Using the student worksheet (handout 8.2), have the students plan and design how they want to make their poster
- Use the power point to show the information they need to have on it.
- Have them write out the list of material they will need to make their poster

Notes: Ideally, the teacher would model how to make this poster. Use a template as a scaffold for those who might need it. Consider encouraging children to use sophisticated vocabulary in the poster, e.g. omitted, stirred vigorously, our consensus was etc.

Making their Poster [15 minutes]

- Give the students time to make their Posters

Group Presentations [20 minutes]

Teams take turns presenting and explaining their work. As they are getting ready, model how to use chronological words such as – **at first, then...**etc

- Teacher asks prompt questions to the class to facilitate discussion.

Why did different teams get different results?
What can we learn about science from this?

Key Point: Scientists make predictions about their investigations and let the data tell the story. There is no right or wrong, as long as the test is fair, the results speak for themselves.

Subject Integration

Maths:	Literacy:
The varying quantities of ingredients could be displayed very nicely in bar charts. It would be a clear and accurate representation of the components and show the variations clearly. It would also link nicely with the sorting activity from the earlier lessons. It would add a mathematics component to the communication element of the lessons and would emphasise the value of maths in clear communication of the details of a situation	Respond to the prompts in the lab book to clarify scientific understanding Create a poster that demonstrates an understanding of how to effectively conduct a fair test using plastic in science

Timer Allocation: for a 50 minute class

Science:	Maths:	Literacy:
50 minutes	25 minutes	20 minutes

Modification

- Use a template as a scaffold for those who might need more guidance.

Extension Activities

- Present their findings to another class
- Learn more about bioplastics and how they might help with the plastics problem (tie-in to Environmental awareness lessons)

Assessment

NOTE: ✓ identifies artefacts for possible assessment

- Teacher observation
- Questioning and discussion
- Poster design and content
- Presentation

Lesson 08

Teaching Resources

Name(s): .....

.....

.....

Being a Materials Scientist **planning your poster** (1)

Write these questions in your copy book and answer the questions using you lab book:

- What did you want to know?
- What was your test variable?
  – what variable did you change and how?
- What did we think would happen (prediction)?
- What material did we need?
- What investigation did we design to test our prediction
- What were our results? What happened?
- Was our prediction right?
- What did you learn?

Sketch out your Poster in your copybook or on the back of this page.

Make sure you have the following on your poster page.

1. Title, Names or group members
2. Question – what do you want to know?
3. What was your test variable – what variable did we change and how?
4. What variables did we keep the same?
5. Predication – what do we think will happen?
6. Research design – How are we testing this prediction?
   – what is the procedure?
7. Results – What happened?
8. Conclusions – What did we learn?
7. When you are done, store or dispose of your Oobleck as your teacher directs.

You can use drawings or photos in your poster
– design it the way you want (following teacher's rules)

Once you have designed it, make a list of the material you will need to make your Poster: Write this in your copy book.

Name(s): .....

.....

.....

Being a Materials Scientist **planning your poster** (2)

Here are some examples but it doesn't have to look like this – just make sure all the information is there.

Title, Names or Group Members

- What do you want to know?
- What was your test variable
- What variable did we change and how?
- What do we think will happen?
- What material did we need?

PROBLEM

Questions

Variable

HYPOTHESIS

Prediction

MATERIALS

Specific list

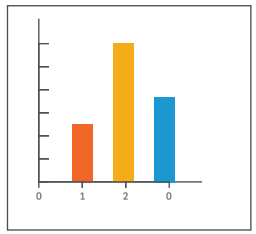
CREATIVE TITLE

RESULTS

Title of Chart

				Arrange

Title of Graph



Picture with caption

Picture with caption

PROCEDURE

Step by step

1. ---------
2. ---------
3. ---------
4. ---------
5. ---------

CONCLUSION

Answer
Were you right
Possible errors in application

Research Design

- How are we testing the prediction?

What did we learn

Results
What did you learn from your work? Explain your data.

Conclusions
Was your prediction right or wrong Can you make a new one?

Recommendations
From what you learned, would you try anything new?

Results

- What Happened?
- Make a table with all you variables and how much you used
- Show control and test

Something like this

Variable	Control	Test
Variable	Amount	Amount
Constarch	15 ml	15 ml

Further support

The AMBER 3rd and 4th class Materials Science series offers teachers an opportunity to explore science in a hands-on, inquiry-based way. AMBER wants to support and encourage teachers to allow student-led investigations and integrate crucial subjects necessary for the development of scientific skills in students.

We encourage you to:
→ **Try our lessons**
→ **Sign up for our CPD**
→ **Join our community of practice.**

If you have any comments about our programmes or require any assistance, please contact us. We are here to help you incorporate the world of materials science into your lesson planning.

Acknowledgments

This programme was developed by Dr. Penny Humby along with a team of teachers and educators. The main activities were tested with multiple classes to ensure the programme meets the learning and teaching standards for 3rd and 4th class in Ireland.

The team:

Dr. Penny Humby, AMBER Education Officer and Science Education, Trinity College Dublin

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Ms. Martina Mulhall, recently retired deputy Principal and Science Coordinator at Timahoe NS Co Laois.

Ms. Catherine Whelan, deputy principal at Mount Sion Primary School in Waterford.

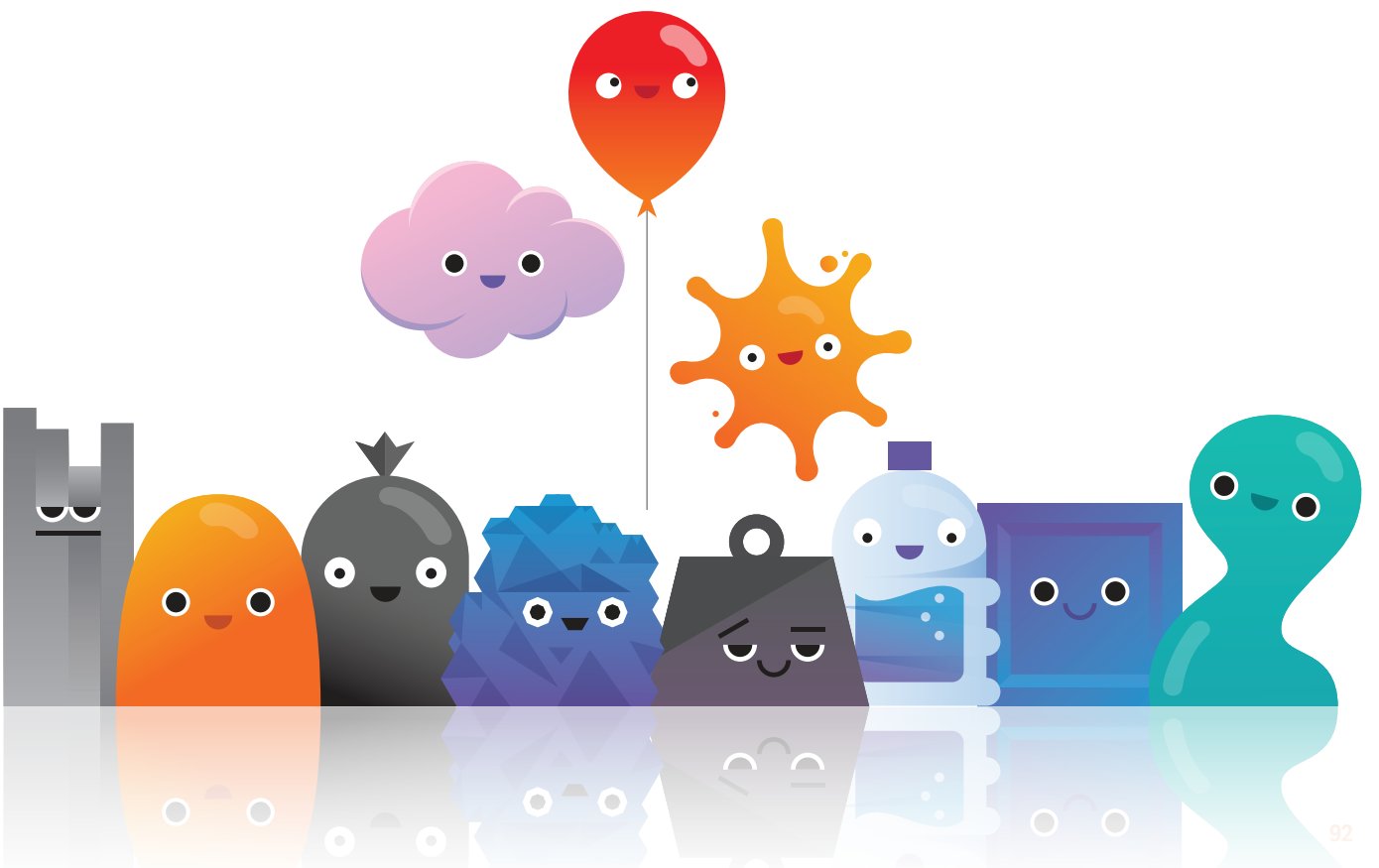
Ms. Laura Maher, primary school principal teacher and past STEM coordinator at Scoil Choilm CNS. Scoil Choilm CNS in Dublin 15.

Dr. Sandra Austin, SESE Education, Marino Institute of Education

Dr. Aisling Twohill, Maths Education, Dublin City University

Dr. Tara Concannon-Gibney, Literacy Education, Dublin City University

Dr. Rachel Kavanagh, Communications Manager, AMBER



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