STEAM KITCHEN

Integrating HOME ECONOMICS and STEAM

A Handbook of Learning Activities for Sustainability

The outcome of the Erasmus+ KA220 project STEAMKitchen

Tallinn 2025

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PART 1

INTRODUCTION


PRIMIGI
Experience Italian style Passion Technology Experience Italian

1

Welcome to the STEAMKitchen Handbook

This is the *STEAMKitchen Handbook*, a collection of 20 interdisciplinary learning activities that integrate Home Economics and STEAM (Science, Technology, Engineering, Arts and Mathematics) education. These activities are designed to support you in delivering engaging lessons that integrate practical skills, scientific thinking and creative exploration. Each activity addresses sustainability challenges in daily life.

The activities combine Home Economics with the STEAM perspective, offering interdisciplinary entry points for various topics, such as pH and acidity. Do not worry; you do not need to be an expert in STEAM and Home Economics. You just need eagerness and a willingness to experiment with an interdisciplinary mindset.

You can use this handbook in your teaching as a catalyst for your professional growth and interdisciplinary practices. Co-planning and/or co-teaching lessons can inspire professional dialogue between subject teachers and provide new insights, enriching both student learning and professional development.

This handbook is the outcome of the *STEAMKitchen project*—a collaborative initiative involving teacher educators and teachers of Home Economics and STEAM subjects from Estonia, Finland, Austria and Norway. It offers practical exercise ideas that complement the previously published STEAMKitchen Guidelines and enrich their context. It is published in the English, Norwegian, Finnish, German and Estonian languages *(https://www.tlu.ee/en/steam)*. Thank you for your interest in this handbook and for your dedication as an educator. May the ideas in this material support and inspire you on your professional journey.

Figure 1 (page 6). Creating a solar oven, see Activity 8.


Alphamännchen auf Crashkurs

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Home Economics and STEAM

Home Economics is an interdisciplinary school subject that equips students with the knowledge and skills they need to manage their everyday lives sustainably and responsibly. It covers food preparation, nutrition, financial literacy, cleaning and consumer education. Through practical and collaborative learning, students enhance their well-being, relationships and readiness to engage with society.

At its core, Home Economics promotes sustainable living—both locally and globally. It fosters critical thinking and reflection on how everyday choices intersect with broader ecological, economic, social and cultural systems. By bridging theory and practice, it supports learners in taking responsibility for themselves, others and the environment.

STEAM is an educational approach that integrates Science, Technology, Engineering, Arts and Mathematics. It encourages students to work across these disciplines to solve real-world problems, fostering critical thinking, innovation and teamwork—key skills for the 21st century. STEAM approach originates from STEM (Science, Technology, Engineering and Mathematics). The inclusion of the Arts into this approach introduces creativity, imagination and design thinking, making STEAM more engaging and inclusive.

STEAM learning is typically collaborative, exploratory and process-oriented. Students plan, build and test ideas while connecting abstract concepts to concrete experiences. This pedagogical approach deepens students' understanding and prepares them to apply interdisciplinary knowledge to sustainability challenges, such as climate change, ethical technology use and responsible innovation.

Figures 2 (page 8) and 3 (this page). Integrating Home Economics and STEAM in creating art with natural dyes in Activity 10.

3

Benefits of Integrating Home Economics and STEAM

Integrating Home Economics and STEAM enables the creation of learning experiences that prepare students to become active, critical and responsible agents of a sustainable future.

Building sustainability competencies lies at the core of both Home Economics and STEAM education. These competencies help students understand the complex interconnections between everyday life, science, technology, society and the environment. Interdisciplinary approaches offer powerful ways to support this development, motivating students to explore how sustainability challenges cut across multiple domains of knowledge.

Bringing together the methods and concepts of Home Economics and STEAM instills learning with new depth and relevance. It reveals how scientific thinking, creative problem-solving and practical life skills intersect in real-world situations. The integrated activities in this handbook support the development of key competencies across these dimensions:

- **Sustainability:** The activities promote sustainability through the environmental, economic, social and cultural lenses. By linking technical knowledge with ethical and societal reflection, the activities broaden students' understanding of sustainable living by interlinking knowledge in the environmental, economic, social and cultural domains.

- **Inclusion:** The activities are designed to embrace diverse skills and perspectives. This approach motivates students with varied strengths to participate and encourages them to take on new roles as designers and investigators. Teachers act as facilitators of collaboration and an equitable classroom culture.

- **Real-world connections:** Working with real and complex problems invites students to engage critically with global and local issues and increases their potential to use their learned knowledge and skills in their daily lives. It fosters creativity and innovation while encouraging reflection on values, diversity and social responsibility, with the teacher guiding this process through active scaffolding.

- **Student motivation:** Connecting learning to students' everyday lives sparks their curiosity and increases their engagement and ownership. As they approach content from multiple disciplinary perspectives, they find learning more meaningful.

4

Combining Learning Activities

Each activity can be used on its own or in combination with others. Three different strategies for combining them into meaningful wholes are given in the next sections.

4.1 Content-Based Combinations

The learning activities cover a range of phenomena relevant to various school subjects. You can use these phenomena as starting points in building meaningful interdisciplinary connections, or you may begin with selected subjects and explore which phenomena naturally align with their content. This strategy is also useful for initiating a discussion on possible collaboration with your colleague.

The first example, **Learning Activity 9** (Figure 4), explores various scientific and cultural aspects related to salt. The second example, **Learning Activity 1** (Figure 5), focuses on the phenomenon of colours and natural dyes, connecting chemistry, art and sustainability. You can construct similar mind maps for all of the activities.

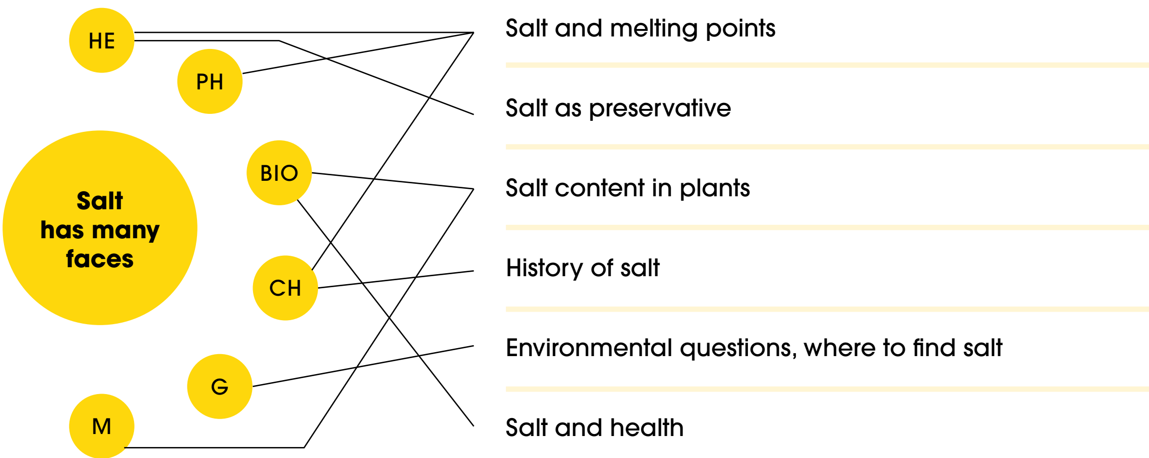

Figure 4. Mind map illustrating interdisciplinary approaches to the topic of salt in Activity 9 from subject- and content-based perspectives.

HE = home economics | PH = physics | BIO = biology | CH = chemistry | G = geography | M = mathematics

This task promotes sustainability by using soaking water for dyeing fabrics. Students explore nutrition, sustainable food practices and natural dyes while learning about the chemical and biological processes involved. This task fosters creativity, problem-solving skills and interdisciplinary learning by blending science, sustainability, creativity and practical skills.

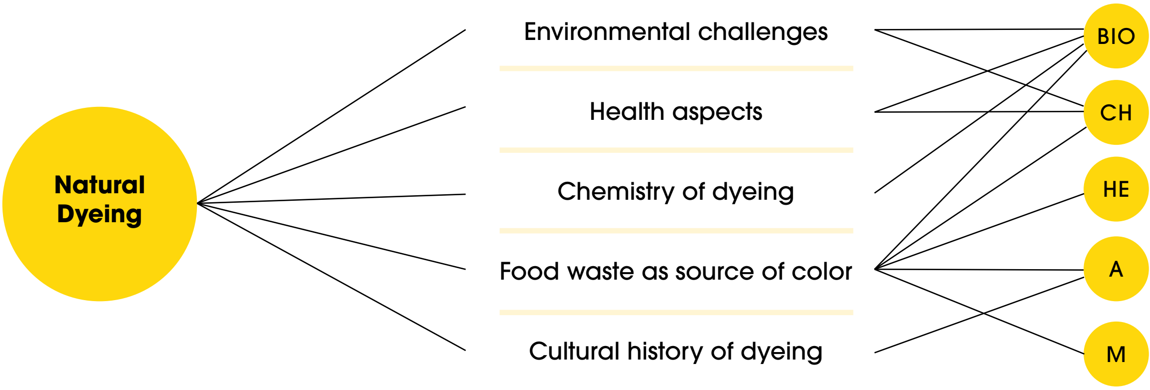

Figure 5. Mind map illustrating interdisciplinary approaches to the topic of natural dyeing in Activity 1 from subject- and content-based perspectives.

BIO = biology | CH = chemistry | HE = home economics | M = mathematics | A = arts

4.2 Sustainability-Led Combinations

Sustainability is one of the guiding principles behind all the learning activities in this handbook. We have aimed to address all four dimensions of sustainability: environmental, economic, social and cultural. You can combine the activities to delve deeper into a particular aspect or select those that enable you to cover multiple dimensions at once. Note that many activities already address more than one dimension of sustainability.

ENVIRONMENTAL SUSTAINABILITY
This domain refers to the responsible management and conservation of natural resources to ensure that ecosystems can maintain their health and productivity over time, reducing negative impacts on the environment while supporting biodiversity.

ECONOMIC SUSTAINABILITY
This domain pertains to practices that support long-term economic growth without negatively impacting the social, environmental and cultural aspects of the community, ensuring efficient and responsible use of resources.

SOCIAL SUSTAINABILITY
This domain involves fostering a healthy, equitable and supportive community in which people's needs are met, social well-being is promoted and social injustice is reduced.

CULTURAL SUSTAINABILITY
This domain involves preserving cultural heritage, traditions and diversity while promoting cultural exchanges and understanding, ensuring the continuity of cultural identities and practices across generations.

ACTIVITIES AND SUSTAINABILITY

The learning activities in this handbook address one or several dimensions of sustainability. It is possible to examine a particular dimension of sustainability from different perspectives by selecting several related activities or to approach sustainability more comprehensively by choosing tasks across multiple dimensions.

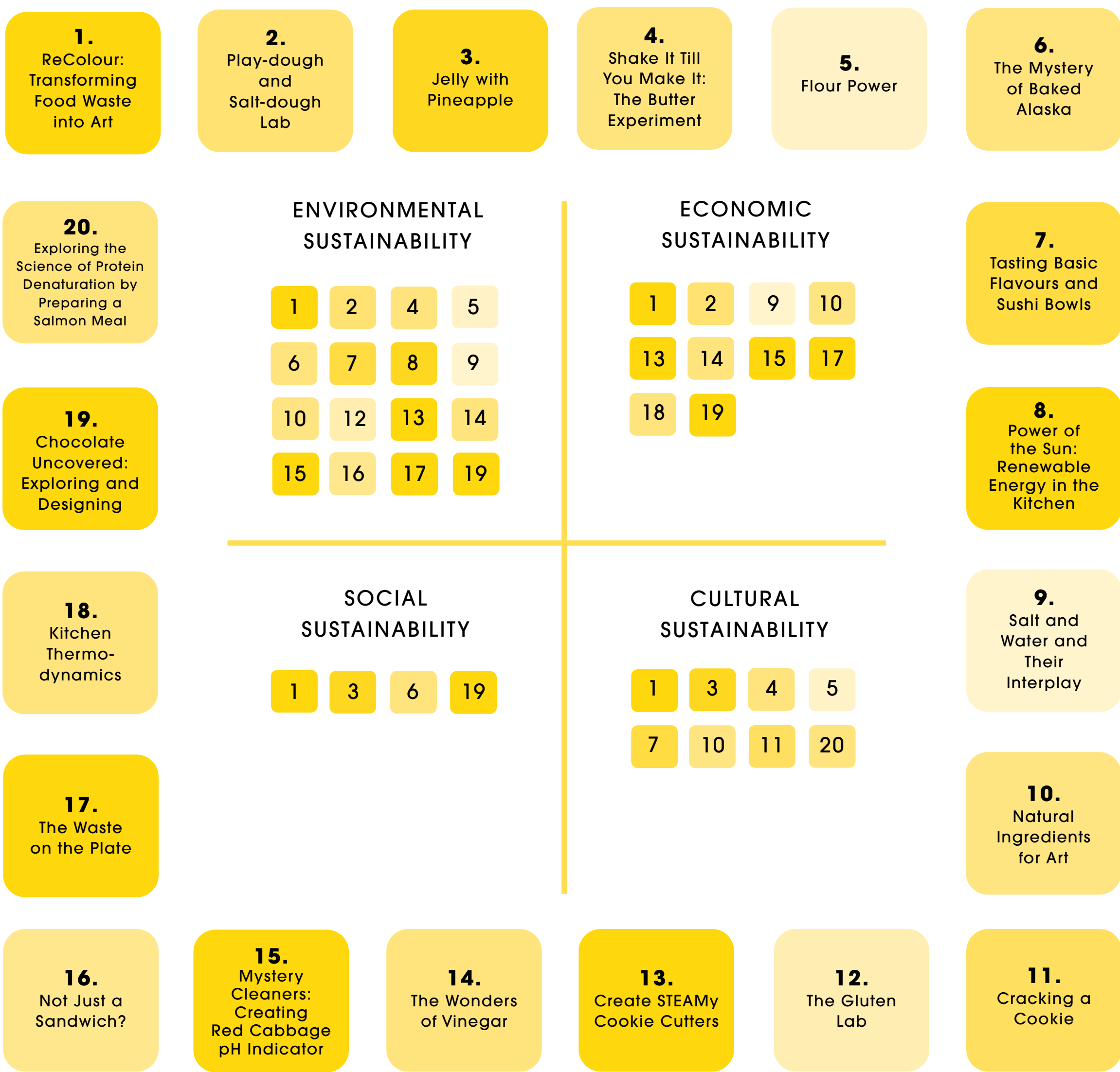

Figure 6. Learning activities and their links to different sustainability dimensions.

4.3 Thematic Combinations

The learning activities in this handbook are divided into the five themes enumerated. Some of these themes are more content-driven (Themes 1, 2 and 3), while others emphasise the learning method (Themes 4 and 5). By combining different learning activities within these themes, you can create various types of learning projects. Please note that the following themes are merely examples; many other options exist for combinations, depending on, for example, the national curriculum.

1. SCIENTIFIC EXPLORATION OF FOOD AND COOKING

Connect Home Economics with natural science by transforming the kitchen into a laboratory. Everyday cooking becomes a gateway to scientific concepts, helping students understand molecular and chemical changes in food preparation.

- Protein denaturation in salmon (Activity 20).
- Emulsification and phase separation in butter making (Activity 4).
- Enzyme activity with fresh pineapple and gelatin (Activity 3).
- Salt´s effect on boiling and freezing points (Activity 9).

Figure 7. Cream whipped into butter to explore the emulsification and phase separation in butter making in Activity 4.

2. CULTURAL ROOTS AND IDENTITY IN FOOD PRACTICES

Encourage students to reflect on their cultural roots through food-related activities such as cooking and crafting, offering them opportunities to explore their personal identity and tradition.

- Sushi bowls help students understand flavours and Japanese food culture (Activity 7).
- Cookie traditions connect food with cultural identity and history (Activity 11).
- Chocolate and cocoa production combine local food culture with global food systems, trade and ethics (Activity 19).

3. DESIGN, AESTHETICS AND CREATIVE EXPRESSION

Support students in developing their visual skills, and explore how food and science can be creative and expressive media by including artistic and aesthetic dimensions into food preparation and material handling.

- Visual presentation of sushi bowls, 3D modelling and butter packaging design integrates artistic principles with culinary activities (Activities 4, 7, 13).
- Salt-dough and play-dough modelling combine chemistry and design (Activity 2).
- Red cabbage pH indicator visuals and natural dyeing techniques combine chemistry and art (Activity 15).

Figure 8. Salt-dough and play-dough activity combines chemistry and design in Activity 2.

4. ANALYTICAL WAYS OF WORKING: MEASUREMENTS AND ANALYSIS

Create a stage for students to actively engage in data collection, experimentation and quantitative reasoning, showcasing scientific and analytical approaches embedded in practical contexts.

- Measuring waste, packaging and creating graphs (Activity 17).
- Churning time vs. temperature in butter making (Activity 4).
- Scaling recipes and effects of the leavening agent in baking (Activity 11).
- Thermodynamic mapping in the kitchen using heat sensors (Activity 18).

Figure 9. Thermodynamics are discussed based on measurements of temperatures in the kitchen in Activity 18.

5. PROBLEM-SOLVING AND INQUIRY-BASED EXPERIMENTATION

Cultivate students' critical thinking, interdisciplinary connections and sense of agency by adopting an inquiry-based approach where they hypothesise, experiment and reflect.

- Vinegar in textile care, cooking and cleaning to explore acidity and sustainability (Activity 14).
- The 'gluten lab' for testing different flours and dough elasticity (Activity 12).
- Creating mystery cleaner pH scales using red cabbage as a natural indicator (Activity 15).
- Trial and error in jelly making to understand enzyme action (Activity 3).

Figure 10. Gluten lab (Activity 12) invites inquiry-based experimentation with using different flours in bread baking.

5

Creating Home Economics and STEAM Collaboration

5.1 Start Small, Scale Up

Integrating Home Economics and STEAM does not require a complete overhaul of your teaching practice. We recommend beginning with manageable steps and expanding gradually. Collaboration enables educators to identify meaningful questions, align curriculum goals and ensure that all perspectives are respected. While revising lesson plans and coordinating co-teaching sessions may require effort, mutual planning and communication are keys to success.

To support the collaboration process, we suggest the following step-by-step approach:

- **Find a colleague** interested in interdisciplinary collaboration. Begin your collaboration by discussing what 'interdisciplinarity' means to both of you, what motivates you to work together and what subject-specific norms might influence your students' learning experiences. You can use *Section 3 Benefits of Integrating Home Economics and STEAM* to reflect on your shared goals.

- **Choose one activity** from the handbook. Read it together and discuss how it connects to both of your subject areas. Clarify the learning goals—not only for your students but also for your professional growth as teachers. Discuss assessment strategies in advance—often, it is more effective to assess the process rather than just the final outcome.

- **Adapt the activity** to fit your students' age group and learning context. Use resources you already have. Note, for example, the availability of local ingredients. If needed, start with only part of the activity and expand it during coming lessons.

- **Plan the practicalities** and share responsibilities. Decide who will teach what, when, where and how. Even if co-teaching is not feasible, colleagues can support specific aspects—such as clarifying terminology. Identify relevant safety regulations and anticipate what safety instructions or materials might be needed.

Try out the activity in the classroom. After the lesson, reflect on the outcome. Remember that the first time is rarely perfect—give yourself space to learn and grow. Ask your students for feedback, too; their perspectives can help refine the activity.

Finally, share your experiences with colleagues. Both successful practices and lessons learned from challenges are valuable to document and share. Exchange of ideas in your communities strengthens collaboration and helps build a supportive professional environment.

5.2 Makerspace as a Learning Environment

Learning by doing lies at the heart of integrating Home Economics and STEAM. This involves creating *makerspaces*, where students not only create and analyse objects but also observe, reflect on and explore ideas. The emphasis is on process, experimentation and creativity rather than formal research, making this setting ideal for practical, inquiry-based learning. Makerspaces also encourage students to engage in collaborative, interdisciplinary learning.

Any learning space can be transformed into a makerspace, depending on the students' needs and the teacher's facilitation. Even a mobile, temporary space can be a makerspace. A trip to the forest becomes a makerspace experience when students construct objects from natural materials and deepen their understanding of local resources and environments. A Home Economics classroom or a laboratory is an example of a makerspace, as many learning activities there involve experimentation, such as testing cooking methods, exploring food preservation techniques or observing chemical reactions.

The tools and equipment used in a makerspace vary—from high-tech tools such as 3D printers to simple everyday items such as pots, pans, paper and pencils. Students should have access to different kinds of tools that support diverse ways of working. Regardless of the setting, safety and hygiene regulations must always be followed, and the school's regulations for different learning spaces must be noted. The teacher must ensure that clear rules are in place and that students work in a safe and supportive environment.

Figures 11 (page 19) and 12 (page 20). Any learning space can be transformed into a makerspace.


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PART 2

LEARNING ACTIVITIES

On the next page you can see an overview of the learning activities with their corresponding age groups, school subjects and sustainability dimensions.

All learning activities presented in this handbook follow a consistent structure to facilitate their implementation. They are designed to be adaptable, interdisciplinary and centred on active, student-led learning. For assessing the learning, we encourage you to focus the learning process and student reflection rather than solely on the final outcome.

School subjects as in the overview table

A&C .... Arts and Crafts
A .... Arts
BIO .... Biology
CH .... Chemistry
G .... Geography
H .... History
HE .... Home Economics
HLTH ED ... Health Education
ICT .... Informatics
M .... Mathematics
PH .... Physics
SCI .... Science
SOC ST .... Social Studies

Sustainability dimensions as in the overview table

ENV .... Environmental Sustainability
ECON .... Economical Sustainability
SOC .... Social Sustainability
CULT .... Cultural Sustainability

ACTIVITY	AGE GROUP	School subjects													Sustainability dimensions				PAGE
		A&C	A	BIO	CH	G	H	HE	HLTH ED	ICT	M	PH	SCI	SOC ST	ENV	ECON	SOC	CULT	
1. ReColour: Transforming Food Waste into Art	All	●		●	●			●							●	●	●	●	26
2. Play-dough and Salt-dough Lab	6–9		●		●			●			●				●	●			30
3. Jelly with Pineapple	6–16			●				●			●						●	●	34
4. Shake It Till You Make It: The Butter Experiment	9–16		●					●			●		●	●	●			●	38
5. Flour Power	10–12		●		●		●	●			●				●			●	42
6. The Mystery of Baked Alaska	10–14		●		●	●	●	●				●			●		●		46
7. Tasting Basic Flavours and Sushi Bowls	10–15		●	●	●	●		●			●				●			●	50
8. Power of the Sun: Renewable Energy in the Kitchen	10–18					●		●			●	●			●				52
9. Salt and Water and Their Interplay	10–18		●	●	●	●	●	●			●				●	●			58
10. Natural Ingredients for Art	10–18		●	●	●		●	●			●				●	●		●	62
11. Cracking a Cookie	12–15				●			●			●							●	66
12. The Gluten Lab	12–15		●	●	●	●		●							●				70
13. Create STEAMy Cookie Cutters	12–18		●		●			●		●	●	●			●	●			74
14. The Wonders of Vinegar	13–15			●	●			●							●	●			78
15. Mystery Cleaners: Creating Red Cabbage pH Indicator	13–15		●		●			●							●	●			84
16. Not Just a Sandwich?	13–15			●				●	●	●					●				88
17. The Waste on the Plate	13–15		●		●			●			●				●	●			92
18. Kitchen Thermodynamics	14–16			●				●	●		●	●				●			96
19. Chocolate Uncovered: Exploring and Designing	14–16		●	●	●			●							●	●	●		100
20. Exploring the Science of Protein Denaturation by Preparing a Salmon Meal	14–16			●	●	●	●	●										●	104

Here you can find an example of the structure of a learning activity which helps you to read and interpret the learning activities in this handbook.

School subjects
Each activity links Home Economics and STEAM. The strongest connections are marked here.

Key concepts
Here, 3-5 key concepts are listed. These can serve as keywords in your search for activities.

Example of an activity

Here the key elements of each activity are described.

KEY TAKEAWAY
This section highlights the core message or intended learning outcome of the activity for the teacher.

Before you start, please consider the following

STUDENT LEVEL
The recommended student group can be adjusted according to the teacher's and students' needs.

PREREQUISITES
Description of the general prior skills and knowledge required.

TIME NEEDED
One lesson is expected to last 45–60 minutes, but the length can be adjusted as needed.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS
Note that the teacher needs to be aware of the safety requirements related to the learning space (e.g., the presence of fire extinguishers and first aid items), learning activity (e.g., food safety regulations, risk of burn injuries when cooking and electrical safety) and ways of working (e.g., respect for others' work, no pushing and no rushing).

PREPARATIONS
Tasks that the teacher must complete in advance to carry out the activity with the students.

Aim

This section outlines the learning objectives and links them to the content of the activity. After reading this section, you should have a clear understanding of the purpose of the activity and how it will unfold in practice.

Teacher's activity

This section provides instructions for the teacher's preparation before the activity. This applies only to activities for which special preparations are required.

Student's activity

Here, you'll find the instructions for implementing the activity. These instructions are mainly intended for students. The focus is on active learning, where students combine theory and practice, experiment and evaluate, and reflect on their process.

In this section, in addition to 'lesson', the terms 'workshop' and 'experiment' are used, depending on the nature of the activity. Experiments involve exploratory, investigational or analytical work, while workshops refer to group-based and more reflective activities.

Adaptations

Additional ideas for extending or modifying the activities are provided here. These can also be combined with other activities for longer projects (see Section 4.2). Some activities may require additional information which is available on this project's homepage (*https://www.tlu.ee/en/steam*).

Links to other tasks are also listed here, along with brief explanations of the intended nature of the connections.

School subjects

home economics,
art and crafts,
science

Key concepts

fabric dying,
food waste repurposing,
art

1

ReColour: Transforming Food Waste Into Art

This learning activity promotes sustainability by using soaking water from food waste to dye fabrics. Students explore nutrition, sustainable food practices, and natural dyes while learning about the chemical and biological processes involved in dyeing. These enhance 21st-century skills by fostering creativity, information literacy, and scientific enquiry abilities.

KEY TAKEAWAY

Everyday materials have hidden potential. Food byproducts, which are often discarded, can be repurposed, thereby reducing waste and promoting an eco-friendly mindset.

STUDENT LEVEL

Basic – suitable for all ages.

PREREQUISITES

No prior knowledge needed.

TIME NEEDED

4–5 lessons – two for home economics, two for arts and crafts (can be adjusted as needed), and one science lesson to explain the principles behind dyeing.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Home economics classroom or any classroom with a sink available.

PREPARATIONS

Soaking beans for making the dying mixture:

1) Place approximately half a kilo of black beans into a pot and pour 2 litres of clean water over the beans.
2) Let the beans soak overnight in a cool place to allow the pigment to dye the water.

After about 12–24 hours, you will have a pot filled with a purplish black water. The beans are ready to be used for cooking in home economics, and the soaking water can be used for dyeing.

ACKNOWLEDGEMENTS

Burland, Madeleine Gray, *'Chemistry in Art: The Science of Dye'* (2020). Honors Projects. 493. *https://scholarworks.bgsu.edu/honorsprojects/493*

Aim

The task ties together science (chemistry and biology), arts, and crafts (creativity and design), and home economics (sustainability and resourcefulness). Students will connect these areas and gain a holistic understanding of how these different disciplines intersect in real-life applications. Moreover, students will explore the fundamentals of dyeing while observing sustainability in action. They will learn to create natural dyes from food waste and how to make the process both nontoxic and biodegradable.

During this learning activity, the students will: 1) experiment with plant-based dyes (bean soaking mixture), explore colour intensity, and develop fabric dyeing techniques (Arts & Crafts); 2) understand beans´ function as a protein source, the importance of soaking beans, and their role in sustainable cooking (e.g. tacos or chili con carne) (home economics); and 3) investigate the chemical processes involved in soaking and boiling beans, nutrient changes, and the effect of natural pigments on different materials (science).

Teacher's activity

This learning activity has three sessions (sessions A, B, and C). These sessions can be completed in any order.

In session A, students actively participate in the dyeing process, making decisions about and experimenting with different fabrics, colours, and mordants while designing patterns with different techniques.

In session B, the teacher selects a recipe that allows the use of pre-soaked beans as teaching materials/raw materials (e.g. tacos or chilli con carne).

In session C, students learn about the science, since dyeing fabrics with bean water demonstrates concepts such as chemistry and biology in action. This session should be completed as either the first or last lesson.

- **Chemical properties:** The pigments in bean water (e.g. anthocyanins in black beans) bind to fabric fibres due to chemical interactions. Mordants, such as alum or vinegar, can alter pH levels and impact pigment adherence and colour outcomes.
- **Biological compounds:** The dyeing process highlights how natural compounds from plants (such as tannins or anthocyanins) can produce colours. This is connected to studies of plant biology and their secondary metabolites.

- **Environmental science:** Reusing bean water illustrates sustainable practices, aligning with circular economy principles by reducing waste and encouraging resource conservation.

Questioning and Exploration: The activity encourages curiosity. Students ask questions such as: 'How does the pH affect the colour of the fabric? ', 'What factors change the intensity of the colour? ' or 'Can different types of beans produce different colours? '

Scientific Investigation: Students observe and reflect on the process, form hypotheses, and analyse results, which all promote critical thinking and scientific reasoning.

Reflection: After the activity, students reflect on why each process worked or didn't work, and why. This reinforces learning by connecting theory to practice.

Students' activity

SESSION A – DYEING

1. Preparing the dying mixture

- Remove the beans from the water. The soaking water is now ready to use for dyeing.
- The beans can be stored in the fridge if prepared during Session B – Home Economics within the same week. The beans can also be stored in the freezer for later use.

2. Colouring process

- **Step 1 – Dyeing:** Add the fabric to the dye (maximum 100 g of fabric per 2 litres of dye) and leave it as long as possible, for at least 10–20 minutes. The dye works almost right away, but the longer the fabric remains in the dye, the stronger the colour becomes.
- **Step 2 – Washing:** Remove the fabric from the soaking water and wash it by hand in soapy water to remove any excess pigment. Leave to dry.

Natural dye works best with plant or animal fibres, such as cotton, linen, wool, or silk.

Natural dyes are less colourfast than synthetic dyes. Adding vinegar to the final rinse can help you bind the dye to the fabric fibres, making the colour last longer. Wash the dyed fabrics gently in cold water with mild detergent to preserve the colour. If you decide not to use anything to fix the colour, the fabric stays the same without the dye washing out much. However, make sure to wash the dyed clothes separately from other clothes, just in case.

SESSION B - HOME ECONOMICS

Use pre-soaked beans to cook a meal (e.g. tacos or chilli con carne).

SESSION C - SCIENCE BEHIND PIGMENTS

Reflect together on the following questions:

- How does pH affect the colour of the fabric?
- What factors change the intensity of the colour?
- Can different types of beans produce various colours?
- Can you use other raw materials (e.g. plants, waste or food products) as a source of colour?

Adaptations

Students can experiment with different raw materials and fabric types to see how variations affect outcomes, fostering problem-solving skills and creativity. Different raw materials can be experimented with to produce various colours. For example, black beans often produce blue hues, whereas other beans might yield warmer tones. Other materials result in different colours: avocado pits (pink), blueberries (purple), pomegranate seeds (yellow), onion peel (yellow), and coffee (brown). The process can also be used to dye yarn that can later be used for knitting.

Try adding a teaspoon of vinegar or baking soda to the dyeing mixture and observe the chemical reaction/change in colour.

Try folding, twisting, or tying the fabric before dyeing to create patterns (tie-dye effect).

This activity could be combined with the following:
Activity 10: Natural Ingredients for Art – students can learn more about how to extract colour from plants and how they are used in art and food.

School subjects

home economics,
chemistry,
arts,
mathematics

Key concepts

chemical reaction,
colour theory and design principles in art,
environmental impact of material,
biodegradable materials

2 Play-Dough and Salt Dough Lab

This activity concentrates on creating colourful, fun, and sustainable play dough and salt dough while learning the chemistry of materials, their interactions, and experimenting with colours and textures. Students will use natural, biodegradable, or food-grade ingredients to explore eco-friendly alternatives to store-bought play dough that minimise environmental impact and promote responsible material choices and waste reduction.

KEY TAKEAWAY

Ingredients interact in ways that create unique textures. Everyday chemical reactions can be observed and understood, and sustainable materials can be explored, fostering creativity through hands-on experimentation.

STUDENT LEVEL

Primary (6–9-year-olds).

PREREQUISITES

A basic understanding of safe lab practices (e.g. avoiding ingestion), an awareness of primary and secondary colours, and a familiarity with basic measurements (e.g. teaspoons, cups, and grams).

TIME NEEDED

2 lessons (designing and refining creations) and a multi-lesson project (creating themed art pieces).

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Classroom, kitchen, or laboratory; running water and an oven for baking the salt dough.

PREPARATIONS

Measurement tools and secure materials for making dough.

Aim

This activity aims to integrate art and science concepts by allowing students to create functional or decorative objects while experimenting with proportions and material interactions to analyse texture formation. It encourages critical thinking about the environmental impact of synthetic versus homemade materials and fosters discussions around sustainability. By using natural, biodegradable, or food-safe ingredients, students will also develop an awareness of material reuse and eco-friendly alternatives to store-bought dough in artistic and scientific applications.

Teacher's activity

Students will explore different recipes for salt dough and play dough, comparing their ingredients and properties and observing chemical reactions in everyday materials.

1) Prepare materials for the activity.

2) Discuss gluten and explain the chemistry behind it.

EXAMPLE RECIPES

Salt dough recipe

5 dl flour
2,5 dl salt
2,5 dl water

- Mix and knead the ingredients to form the dough
- Roll out and cut the dough into shapes.
- Bake the dough at 100°C for 1 hour. Turn the shapes over and bake them for another hour.
- Turn the oven off and leave the salt dough shapes inside to finish baking with the residual heat.
- Decorate the shapes using natural colouring once they cool.

Play dough recipe

5 dl flour
2,5 dl hot water (more if needed)
2,5 dl salt
1 tablespoon oil
1 tablespoon baking powder
Food colouring or natural dyes (e.g. beetroot or turmeric)

- Mix and knead the ingredients to form the base material.

Students' activity

1) Decide whether to create salt dough or play dough and select a recipe.
2) Familiarise yourself with basic measurement units (teaspoons, cups, grams) and use the appropriate measuring tools.
3) Discuss measurement and proportions while considering the desired amount of dough.
4) Prepare the dough. Knead it properly to create gluten.
5) Observe the dough's elasticity, texture, and durability.
6) Create artistic or functional objects (e.g. decorations, jewellery, or key chains)
7) Discuss how different materials and methods impact environmental sustainability (e.g. store-bought play dough ingredients) and how the self-made play dough is eco-friendlier and more sustainable than store-bought play dough

Adaptations

Students can enhance their creativity by using natural pigments for colouring, which adds an eco-friendly and artistic element to the activity.

Students can also develop themed projects, such as holiday decorations, animal figures, and different celebrations throughout the year (e.g. Easter, Christmas, and birthdays) to make their work more engaging and purposeful.

Experimenting with natural and eco-friendly materials provides students with an opportunity to explore sustainable options and to make conscientious decisions when buying decorations or play dough.

This activity could be combined with the following:
Activity 10: Natural Ingredients of Plants for Art can be integrated to encourage students to explore natural dyes, sustainable materials, plant-based pigments, and eco-friendly art practices.

Figures 13 and 14. Creating objects with salt and playdough.

School subjects

home economics,
biology,
mathematics

Key concepts

proteins,
enzymes,
degeneration of proteins/enzymes,
food preservation

3 Jelly with Pineapple

In this activity, students will learn about enzymes in fruit (bromelain in pineapple) and how some proteins can break down other proteins, as bromelain does with gelatine. They will also learn how heat treatment in canning kills enzymes and how canning preserves food. In addition, they will learn to modify ingredient proportions in recipes and make their own jelly recipes.

KEY TAKEAWAY

All living organisms contain proteins, some of which are enzymes. Heating above a certain temperature will denature and destroy proteins, causing enzymes to stop functioning. Canning is used to preserve food.

STUDENT LEVEL

Primary to lower secondary (6–16-year-olds).

PREREQUISITES

Basic skills in food hygiene and food preparation.

TIME NEEDED

1 lesson for making jelly (plus time for the jelly to set) and 1–2 lessons to discuss/elaborate results, depending on the level of discussion (fewer lessons for younger age groups).

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Home economics classroom or space with cooking facilities.

PREPARATIONS

1) Acquire various ingredients for jelly with fresh or canned pineapples.
2) Reflect on student competence and consider whether they should make their own recipes or if recipes should be made for them.
3) Lastly, find kitchen equipment if using a regular classroom.

Aim

This activity aims to inform students that enzymes are present in all living organisms. Moreover, the activity aims to teach students that enzymes are proteins that make things happen, that heat treatment can destroy enzymes, and that canning is a way of preserving food by killing all microorganisms and enzymes present in the food via heat treatment. Lower-level students can learn basic home economics and math by measuring, heating, and mixing following detailed instructions. Higher-level students can make the recipe themselves by figuring out the portion size and how much gelatine to use for the volume of liquid they have – this involves more advanced math.

Students' activity

1) Make the recipe by reading the instructions on the package of gelatin. Agree on portion size and adjust according to how many students will eat the jelly.
2) Heat the liquid (chosen juice/ squash) and mix with gelatine.
3) Let the liquid cool down a bit before adding pineapple.
4) Add fresh pineapple to one batch and canned pineapple to another, then leave the jelly to set.
5) When it becomes clear that the jelly with fresh pineapple does not set, start discussing why while eating the other jelly.

Suggestions for discussion questions:

- Why is there a difference between fresh and canned pineapples?
- What has been done to the canned pineapple?
- What are proteins and enzymes?
- What is gelatine?
- Why we can food? For how long has canning been done?
- Is it possible to can food in other ways (i.e. other than using metal cans)?

Adaptations

If students use a very hot liquid, the jelly might set even when fresh pineapples are used. This is because heat can destroy bromelain. If this happens to one group, use this opportunity to discuss how their procedures differed from the others and explain what happened.

Jelly with fresh pineapple can be made as just one portion (e.g. one portion per group of students or one for the class). Seeing as the jelly will not set, it is not necessary to make more than one portion, as any leftover fresh pineapple can be eaten. Alternatively, the still liquid jelly can be heated, and more gelatine can be added to make the jelly set. Why it sets after being heated can be discussed.

Fresh strawberries, grapes, bananas, or other fresh fruits not containing bromelain can be used to vary the taste of the jelly. This demonstrates that not all fruits contain enzymes that break down proteins.

Alternatively, one or more groups can make their jelly with fresh pineapple and agar-agar instead of gelatine. The students will then find that jelly with fresh pineapples sets. The difference between gelatine and agar-agar can also be discussed, and using agar-agar in jelly making ensures that everyone can enjoy the jelly together.

Students can further explore bromelain and its various uses. Bromelain is sold as a dietary supplement, among other things. Students can obtain information on bromelain online and discuss whether the identified health benefits seem believable (21st-century skills). Canning as a conservation method can be explored from a sustainability viewpoint.

How heat treatment destroys enzymes can be related to why very high fevers are dangerous.

This activity could be combined with the following:
Activity 6: The Mystery of Baked Alaska to explore proteins from different perspectives.
Activity 9: Salt and Water and Their Interplay to identify the use of salt as a preservative.

Figure 15. Experimenting with fresh and canned pineapple and kiwi jellies.

School subjects

home economics,
mathematics,
science,
arts,
social studies

Key concepts

taste,
sensory aspects,
food culture,
calculation,
fat

4 Shake It till You Make It: The Butter Experiment

This learning activity enhances students' 21st-century skills through collaboration and helps them discover the magic of making butter by separating fat grains from heavy cream or sour cream. In the old times, butter made on farms was an important commodity providing income to farmers, and it also helped preserve milk. Students get to experiment with flavours, observe changes during churning, and enjoy the delicious results of their efforts.

KEY TAKEAWAY

Know how to correct mistakes. If one whips cream too long, it becomes butter; instead of throwing it away, the product can be salted a bit and then eaten as butter.

STUDENT LEVEL

Primary to lower secondary (9–16-year-olds).

PREREQUISITES

Basic skills in food hygiene and food preparation.

TIME NEEDED

1 lesson, or 2 lessons to include sensory evaluation.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Home economics classroom or space with cooking facilities.

PREPARATIONS

Use heavy cream or sour cream with a high fat content to make it easier to separate the fat. Using products at room temperature will also speed up the process.

Aim

This activity aims to provide students with practical experience in making butter as they learn about the processes involved (churning and the separation of fat and buttermilk) in the activity. Through active participation, the students will develop practical skills, explore different flavours, and gain a deeper understanding of how cream/sour cream transforms into butter.

Students' activity

1. MAKING BUTTER

1) Pour the cream or sour cream into a kitchen mixer with a whisk. Cover the top to minimise splashing. Your butter is done when the fat separates from the liquid (buttermilk) and forms a solid lump.
2) Remove the butter from the bowl. Remember to keep the buttermilk, which is a type of low-fat milk and can be used in most types of cooking, such as bread baking or waffles. Buttermilk from sour cream can also replace skimmed cultured milk. It can also be frozen and used later. Wash the butter in a new bowl with cold water (the presence of buttermilk will reduce the butter's shelf life). Change the water several times until it is completely clear.
3) Add salt and mix well.

2. TASTE – FLAVOUR YOUR BUTTER

Create your own flavoured butter! Add spices, garlic, herbs, or salt to make the butter taste just the way you like it. Try a few different combinations and give your creations fun names!

3. MATH TASKS

Calculate how much butter you'll get from different amounts of cream or sour cream and calculate the ingredient ratios

Percentage check: Weigh the cream before and after churning. How much liquid (buttermilk) was removed? Calculate the percentage of fat you managed to separate and identify whether this depends on the temperature.

Learn what happens during the churning process – why the fat separates and what's going on at the molecular level (hint: emulsification – during the process, the fluid's viscosity, or resistance to flow, increases).

Measure and compare: Use a timer to see how long it takes to churn your butter. Try changing the temperature or amount, and then compare your results: Experiment with chilled, room-temperature, and slightly warmed cream (must be below 30°C, which is the temperature at which butter starts to melt). Which one churns faster? Why? (What happens to the viscosity with the temperature? At low temperatures, butter is very hard; at room temperature, it is workable. Lastly, when butter is hot, it acts almost like a fluid.

Power of movement: Think about how your mixing turns liquid into solid. What role do force, friction, and motion play in making butter?

Adaptations

Add cream to an empty container with a lid and let the students shake the container one after another until butter is produced. If the container is transparent, the students will be able to observe the entire step-by-step process. The students could design their own butter packaging in arts and crafts class. They can create labels, packaging, or even butter moulds. Drawing, collages, or digital tools (such as 3D printers) can be used to make the packaging creative and eye catching.

This activity could be combined with the following:
Activity 9: Salt and Water and their interplay to learn more about the importance of salt as a flavour enhancer and preservative.
Activity 13: Create STEAMy Cookie Cutters to design and print a butter mould.

Figure 16. Washing the butter in cold water.

School subjects

home economics,
chemistry,
arts,
mathematics,
history

Key concepts

chemical reactions,
bread-making techniques,
ingredient substitutions,
historical and cultural perspectives on bread,
nutrition and health impacts

5 Flour Power

This activity examines the historical and cultural significance of bread-making, its nutritional value, and sustainable ingredients used in making bread. Through this activity, students explore how ingredient selection influences health, food security, and environmental sustainability.

KEY TAKEAWAY

Through simple ingredients and baking techniques, flour can be transformed into bread that is tasty, nutritional, and sustainable.

STUDENT LEVEL

Primary (10–12-year-olds).

PREREQUISITES

Basic kitchen safety knowledge, understanding of measurement tools and their usage (teaspoons, cups, grams), and familiarity with dietary concepts such as allergies or intolerances.

TIME NEEDED

2 x 2 lessons (mixing, rising, and baking) and a multi-lesson project (creating variations and exploring nutritional impacts).

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Kitchen or classroom with oven access and tables for group work, kneading, and shaping.

PREPARATIONS

Look for different bread recipes and consider different kinds of flour – some with baking powder and others with yeast. Secure the availability of ingredients for different recipes, prepare measuring tools, and ensure that baking equipment is available.

Aim

Students will explore bread's cultural and historical evolution while developing basic baking skills and learning about ingredient substitutions for dietary needs. They will also analyse how different ingredients affect bread texture and have possible impacts on health.

Teacher's activity

Begin by introducing the topic and engaging students in a discussion about the history of bread-making and the various types of bread they are familiar with. Explain how different ingredients impact bread texture and nutritional value and demonstrate mixing and kneading techniques. Then, assign roles within each group for students to mix ingredients, knead the dough while observing changes in texture, and allow it to rise. Once ready, students shape the dough into loaves, rolls, or creative forms and then bake them. Finally, discuss the sensory outcomes (sight, smell, taste, and texture) of the process and reflect on how different ingredients influence flavour, texture, and sustainability.

Figures 17 and 18. Experimenting with different flour.

Students' activity

1) Select different recipes to compare their effects on texture, kneading techniques, and baking times during the process.
2) Allow the dough to rise (if needed); then, observe any changes.
3) Shape and bake the bread pieces.
4) Discuss the sustainability of baking your own bread, its nutritional value, ingredient alternatives, and the health benefits of avoiding preservatives.
5) While tasting different types of bread together, discuss each type's aesthetics (texture and taste) and reflect on the experience of making the bread.

Adaptations

Use alternative flours (e.g. almond or rice flour) to create gluten-free bread. Explore the nutritional value (e.g. fibre content) of different flour combinations.

Incorporate local grains or spices to investigate cultural connections and bread-making traditions.

Examine cultural differences in bread types, such as shape, size, and how it is typically consumed (e.g. side dish or sandwiches).

This activity could be combined with the following:
Activity 4: Shake It Till You Make It: The Butter Experiment – Combine into a larger event that brings together different classes within the school or integrates multiple lessons for the same class, allowing students to taste a variety of breads and flavoured butters together.
Activity 9: Salt and Water and Their Interplay – (1) Salt is a taste intensifier. In Italy, there is a type of bread without salt – is it tasty? (2) Does salt impact dough? Does dough without salt rise equally well as dough with salt?

School subjects

home economics,
chemistry,
physics,
arts,
geography,
history

Key concepts

protein chains,
chemical and physical changes in food preparation

6 The Mystery of Baked Alaska

In this learning activity, students learn how protein chains in egg whites change their shape when whipped or heated. They learn how whipped egg whites (meringue) act as thermal insulators in the dessert Baked Alaska (ice cream covered with meringue). Students understand the oven's working principle and learn how to use laboratory equipment (microscope). The activity fosters students' critical thinking and source criticism skills while raising their climate awareness.

KEY TAKEAWAY

Food preparation is always connected to chemistry and physics. By understanding how proteins behave and how heat moves, we unlock not only better baking but also deeper insight into climate and culture. Explore and taste!

STUDENT LEVEL

Primary to lower secondary (10–14-year-olds)

PREREQUISITES

Basic skills in cooking and baking, experience in using an oven, knowledge of geography/ history, climate awareness.

TIME NEEDED

2–3 lessons, depending on the level of discussion.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Home economics classroom or space with cooking facilities, a microscope.

ACKNOWLEDGEMENTS

Images by Kadri Märtson

PREPARATIONS

1) Take the eggs out of the fridge a few hours before using them, as they will foam better at room temperature. Think about how these egg yolks can still be used after the lesson to avoid food waste.
2) Prepare the Baked Alaska recipe.
3) Prepare the worksheet for students. These allow students to make notes, draw protein structures and produce a cross-section of the dessert.
4) Be ready to explain conduction, convection, protein denaturation, and coagulation. Have the correct shapes of protein chains illustrated.
5) Think about how student groups will present their results; for example, the worksheet could be scanned for presentation and projected to a large screen. The content could also be adapted as an electronic poster.

Aim

This activity aims to explore the role of eggs in cooking and the science of egg proteins by experimenting with egg whites. Experiments allow students to engage in discovery and analysis, which promotes their understanding of several scientific aspects (e.g. egg protein changes and heat isolation), critical thinking (e.g. source criticism in finding information about Alaska and glaciers), problem-solving skills (compiling the desserts and acting fast to prevent the ice cream from melting), aesthetic thinking (e.g. presenting and visualising their findings about history and geography).

Students' activity

LESSON 1: THE SCIENCE OF EGG WHITES

1) Work in groups (3-4 students) and experiment with one egg white. Mix a small amount of egg white (in different whipping stages – slightly mixed with a fork; whipped for 20 seconds, and whipped for 40 seconds) in ½ dl of water and prepare the sample for chain observation under the microscope. Ask the teacher for guidance.
2) Draw the protein structures on the worksheet.
3) Use the rest of the whipped egg white to make meringue. Continue making baked Alaska according to the recipe. Instead of making one big dessert, it can also be made in small, oven-safe cups or ramekins – one for each student. Be sure that students are ready to eat the cake as soon as it comes out of the oven.

LESSON 2: THERMAL INSULATION AND THE GLOBAL CONTEXT

1) Draw a cross-section of the dessert on the worksheet (presenting all layers). Discuss among the group how it was possible that the ice cream inside the dessert did not melt in the oven. What role did egg white play in the dessert? What acts as a thermal insulator in this dessert? Explain the concept of heat transfer in the oven that manifested in this dessert.
2) Search for information about Alaska and icebergs/glaciers. Write interesting facts on the worksheet (one historical, two geographical, and three climate-related facts).
3) Share your results with the other groups.

Adaptations

Ask students to study the history of the baked Alaska recipe and the various names for this dessert. Use egg yolks for lemon curd to avoid leftovers or let students research recipes that use egg yolks and vote on one to make for the next class.

This activity could be combined with the following:

Activity 20: Exploring the Science of Protein Denaturation by Preparing a Salmon Meal to allow students to learn more about the protein chains in fish.

Activity 12: The Gluten Lab to better discuss protein chains in grains.

Figures 19 and 20. Insulating ice cream with meringue.

School subjects

home economics,
biology,
mathematics,
chemistry,
arts,
geography

Key concepts

taste,
sensory aspects,
symmetry,
food culture

7 Tasting Basic Flavours and Sushi Bowls

This learning activity promotes cultural sustainability by focusing on Japanese food culture and making sushi bowls. Students learn about basic flavours and improve their sensory skills. The activity fosters students' creativity, problem-solving, and aesthetic skills.

KEY TAKEAWAY

Food is not only fuel but also a source of aesthetic and cultural heritage. Be creative and remember the aesthetics. Learn to taste and learn new tastes.

STUDENT LEVEL

Primary to lower secondary (10-15-year-olds).

PREREQUISITES

Basic skills in food hygiene and food preparation.

TIME NEEDED

2–3 lessons, depending on the level of discussion.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Home economics classroom or space with cooking facilities.

PREPARATIONS

Acquire various ingredients for the sushi combinations but allow students to modify the recipe themselves.

Aim

This activity aims to identify and verbalise the basic tastes found in the ingredients used in sushi bowls by exploring various taste combinations. Combining the teaching of basic flavours through the making of sushi bowls can constitute a diverse learning experience that promotes students' creative and aesthetic thinking (how to create visually appealing sushi bowl my, for example, paying attention to colours, shapes, and presentation), problem-solving ability (differentiating various flavours and creating flavour combinations), understanding of scientific (e.g. biology of sensory experience) and mathematical concepts (e.g. symmetry), and deepening cultural understanding (e.g. how to use chopsticks).

ACKNOWLEDGEMENTS

We are thankful to Pauliina Mäkitalo, Saimi Hynönen, and Nina Vinni for creating the original idea for this learning activity.

Teacher's activity

1) While the rice is soaking, introduce the students to Japanese food culture and cultural heritage as well as the role sushi plays in Japanese culture.
2) While the rice is boiling, discuss a) the idea of sensory experiences and flavour; b) how this idea represented in various sushi bowl recipes; and c) the critical points in the recipes, such as cutting the shapes and combining colours and flavours.
3) At the end of the lesson, discuss a) whether the tastes were difficult to identify and verbalise, b) the role of sensory aspects of food, and c) which elements contribute to the creation of an appealing dish that represents Japanese food culture, food heritage, and cultural sustainability.

Students' activity

1) Prepare a sushi bowl in stages: First, soak the rice; then, boil the rice according to instructions.
2) Create a plan for sushi bowl preparation. Plan a sushi bowl for yourself or for sharing in the group or with your pair. Each ingredient in the bowl should present some basic flavour (e.g. salted salmon as salty, broccoli as bitter, mango as sweet, lemon-marinated carrot as sour, and soy sauce as umami.
3) Prepare the sushi bowls. Remember to focus on the visualisation and symmetry of the bowls, which are central aspects of Japanese food culture.
4) While eating together, discuss how the basic flavours and their combinations are represented and experienced, and which flavours pair well with each other.

Adaptations

The learning activity can be connected to the SAPERE method for having more emphasis on sensory aspects. Take pictures of the sushi bowls and edit them to make them look even more appealing. Cooperate with the art teacher on this activity. Compare and discuss why some pictures look more attractive than others.

This activity could be combined with the following:
Activity 11: Cracking a Cookie to connect the lesson to cultural sustainability.
Activity 20: Exploring the Science of Protein Denaturation by Preparing a Salmon Meal to identify the taste and sensory aspects of salmon meal preparation.

School subjects

home economics,
physics,
geography,
mathematics

Key concepts

renewable energy,
solar cooking,
reflection and absorption,
heat transfer

8 Power of the Sun: Renewable Energy in the Kitchen

This learning activity fosters students' creativity, problem-solving, and aesthetic skills. It also raises their awareness of renewable energy and its potential for household use. Students will gain hands-on experience in solar cooker construction and cooking experimentation. Through this task, students learn about solar energy and its practical applications. They also explore related topics in physics, geography, and mathematics.

KEY TAKEAWAY

Renewable energy is an option that is available even for single households. Solar panels are not the only form of renewable energy. Some meals need less time and a lower temperature to cook than others.

STUDENT LEVEL

Lower secondary (10–14-year-olds) and upper secondary (15–18-year-olds).

PREREQUISITES

Basic skills in crafting, data collection and presentation, and knowledge of angles and reflections.

TIME NEEDED

2–3 double lessons, but extendable as desired.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Classroom, a crafting room, and a sunny spot at school or at home.

PREPARATIONS

Depending on the selected difficulty level, prepare the necessary crafting utensils and materials as well as the instructions for students.

Aim

Students learn about renewable energy (physics) and discuss how renewable energy, especially solar energy, can be used at home (home economics). They discuss its usability (geography), related social questions (geography) and relevant questions concerning angles, the number of sunny hours, and diagrams (geography, mathematics). The students learn about reflection and absorption (physics) and collect and present data (mathematics) while experimenting with different colours and mirrors (physics).

Students create a solar cooker (A, B, or C), cook an egg or another simple meal (home economics), and discuss how cooking temperatures differ depending on the ingredients (home economics) and angles (mathematics) used. Data about the solar cooker experiment is collected, presented, and analysed (mathematics). Depending on the solar oven, students learn about volume and surface area (mathematics), quadratic functions, parabolas, and paraboloids and their focus (mathematics).

A: solar oven using glass bowls or jars
B: solar oven using a shoe box
C: solar cooker using a paraboloid

Students' activity

PHYSICS

Workshop 1: Renewable energy and photovoltaics
(one double lesson)

1) Determine how much energy your family uses annually.
2) Discover how much energy a well-placed solar panel can produce.
3) Find out how a solar panel works.
4) Identify other renewable energy resources suitable for household use.
5) Present your findings.

Use the following keywords in a web search:
'renewable energy' and *'environment for kids'*.

Workshop 2: Absorption and reflection depending on the colour – Experiment with different colours and mirrors
(one double lesson)

1) Find out about the differences between reflection and absorption.
2) Design an experiment to test how colour impacts absorption to find out which colours absorb more heat or reflect it. Collect data and think of a suitable way to present it.
3) Present your findings.

Enter the following keywords in a web search:
'sciencing' and *'what colours absorb more heat?'*.

Mirrors
(two double lessons)

1) Find out the different reflecting properties of convex, concave, and plane mirrors. Where are these mirrors used?
2) Collect, summarise, and present your findings.

Enter the following keywords in a web search:
'Understanding concave and convex mirrors: A simple guide'.

HOME ECONOMICS

Workshop 3A (easy): Creating a solar oven using two glass bowls
(20 minutes to prepare and 2 hours to wait)

- Wrap an egg in black paper. Then, place the egg under two glass bowls (a smaller one and a bigger one). Alternatively, you can use two jars, one placed inside the other.
- You may also watch the video and follow the instructions (search for terms such as *'Solar Cooker + Boiling Eggs with Solar Energy + YouTube'*. You may also search for *'Forsche mit uns! Solarkocher - Eier kochen mit Sonnenenergie + YouTube'* if you speak German): *https://www.youtube.com/watch?v=vwplHuB6NV0*. Study the instructions; then, prepare your solar oven and the egg you want to boil.

1) Estimate how long it will take to prepare a hard-boiled egg. Put your oven in a sunny place. Check on your egg after an hour, and then every 30 minutes.
2) Look for recipes using hard-boiled eggs.

Workshop 3B (middle): Creating the solar oven using a box
(one double lesson and three lessons)

Study the following instructions for preparing your solar oven:

To build a solar oven, you will need two cardboard boxes (sizes S and L), old newspapers, black paper, duct tape, electrical tape, two pieces of glazing film, aluminium foil, push-pins, all-purpose adhesive, scissors/cutter, a pencil, and a ruler.

1) On the lid of the box, cut a U-shaped flap. Cut along three sides and leave the fourth side as a hinge. Cover the inside of the flap and the inside of the box completely with aluminium foil. The shiny side must face outward, as this side will reflect the sun's rays.
2) Cover the opening in the lid with plastic wrap to create an airtight window. This allows sunlight to enter the oven while trapping the heat inside. If you're using two boxes, fill the space between them with a crumpled newspaper to better retain heat. For pizza boxes, you can simply place rolls of newspapers on the bottom and sides of each box.
3) Glue black paper to the bottom of the oven. Black absorbs solar energy best and converts it into heat. Place the oven in the sun and adjust the flap to direct the sun's rays directly onto the makeshift window. You can now place a small container of food or water on the black paper inside and let it cook or heat up.

Choose something to cook (e.g. egg, fish, or sausage) or melt (e.g. chocolate, butter, or cheese) and place it into the oven. Melting is, of course, quicker than cooking. Place the oven in a sunny place. Check on your meal and determine how long cooking or melting takes, what you can cook this way, and whether there are differences in food quality (taste, structure, or colour) between food cooked in a solar oven and food prepared using traditional cooking methods.

Use the following keywords in a web search:
'simple solar oven from a cardboard box'.

Workshop 3C (challenging): Creating a solar cooker using a paraboloid (whole-class project)
(one double lesson and three lessons)

1) Read about different models of solar cookers. Search for solar cookers, devices, and direct sunlight. Choose a model to build.
2) Study the instructions contained here: *https://bit.ly/42L0XCt*
3) Make a work plan, construct the solar cooker, and follow the safety rules.
4) Install the solar cooker and prepare a light meal (e.g. sausages or noodles). Follow the safety rules. The surface reflects light; thus, eye protection is vital. You can also burn yourself while cooking.

Alternatively, you can make a solar hotdog cooker using a reflective parabola.

Experimenting with solar cooker – different cooking times and what happens while cooking, roasting, etc.
(three lessons)

After creating your solar oven, you can use it to:

- Experiment with different dishes.
- Identify what can be cooked in a solar cooker.
- Test cooking times – do solar ovens take more or less time to cook than traditional cooking methods?
- Determine whether food quality is the same.

You may find further information about solar cookers by entering the following keywords in a web search: *'The science of cooking: How heat transforms ingredients'.*

GEOGRAPHY

Workshop 4: Number of sunny hours
(one double lesson)

Study how the number of sunny hours changes depending on geographic location

- Study the world map. Find the sunniest part of the Earth.
- Find out where solar cookers are used and why they are used.
- Discuss social and geographical questions related to the use of solar cookers.

Find additional information by entering the following keywords in a web search: *'sustainable solar oven for rural communities'.*

You may also watch the following video (search for *'Restaurant using solar powered ovens + YouTube'*): *https://www.youtube.com/watch?v=YaG6VwQcr5M*

MATHEMATICS

Workshop 5: Parabola and paraboloid
(one double lesson)

Find out what parabolas and paraboloids are.

- Where are these used?
- What is a parabola's and a paraboloid's focus?
- What are the properties of parabola's and paraboloid's focus?

Additional information can be found by entering the following keywords in a web search: *'maths', 'fun', 'parabola'* and *'paraboloid'.*

Figures 21 and 22. Making the solar cooker and testing it in action.

Adaptations

Clothes that absorb heat can be designed, making them more suitable for winter. Other clothes can be designed to reflect heat, making these clothes better suited for use during the summer.

This activity could be combined with the following:

Activity 6: The Mystery of Baked Alaska – heat absorption and isolation are related topics and could be discussed simultaneously.

Activity 19: Chocolate Uncovered: Exploring and Designing – a solar oven is perfect for melting chocolate, which requires lower temperatures than cooking.

Activity 18: Kitchen Thermodynamics – various materials, just like colours, absorb and transfer heat differently.

School subjects

home economics,
chemistry,
biology, geography
arts,
history,
mathematics

Key concepts

boiling and freezing point,
environment and salt,
preservative

9 Salt and Water and Their Interplay

This learning activity fosters problem-solving and experimentation skills. It sheds light on the diverse roles of salt, starting with its influence on boiling and freezing points, its use as a preservative, and its application as a means of exchange in ancient times. The activities also raise students' awareness of the environmental aspects of salt harvesting.

KEY TAKEAWAY

All living creatures need just the right amount of salt.

STUDENT LEVEL

Lower secondary (10–14-year-olds) and upper secondary (15–18-year-olds).

PREREQUISITES

Basic skills in data collection and presentation.

TIME NEEDED

2–3 double lessons; extendable as desired.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Classroom, a lab, or a kitchen to experiment with boiling and freezing.

PREPARATIONS

Depending on the selected activity, ingredients to prepare a dish and appliances for freezing and boiling water.

Aim

Students learn about salt, how it is created (chemistry), where it can be found, and how it is harvested (geography). The students learn about the value of salt during human history (history), its effect on freezing and boiling points (physics), and its influence on plants, animals, and the human body (biology). They learn about salt's role as a flavour improver and preservative (home economics), how sculptures can be made out of salt, and why salt is added to paintings (arts). They study salt's crystal structure and determine salt content when mixing various solutions (mathematics).

Students' activity

CHEMISTRY

Workshop 1: Salt as a crystal

(one double lesson)

1) Find out how salt crystals are built.
2) Select a method (drawing, computer modelling, crafting) and make a model of the salt crystal.
3) Find instructions on how to make your own salt crystals; then, create one.

Further information can be found by entering the following keywords in a web search: *'salt association + how to grow a salt crystal'.*

PHYSICS

Workshop 2: Saltwater and boiling/freezing

(one double lesson)

Study boiling, freezing, and the different forms of the same material.

1) Identify how salt affects the boiling and freezing points of water.
2) Conduct experiments to measure how the amount of salt added to a mixture affects boiling and freezing points.
3) Find out why people float in salty water.
4) Present your data and findings.

You may find further hints by entering the following keywords in a web search: *'why adding salt to the water increases the boiling point'* and *'melting snow and ice with salt'.*

HOME ECONOMICS

Workshop 3: Salt and tasting

(one double lesson)

1) Prepare a dish (e.g. porridge or a risotto), but do not use any salt in cooking.
2) Study how a lack of salt use in cooking influences the taste of the dish.
3) Taste the dish again and again after adding some salt. What other flavours can you taste?

Additional information about how salt affects taste can be found by entering the following keywords in a web search:
'The science of salt + How salt affects the taste'.

Workshop 4: Salt as a preservative

(one lesson + waiting for results)

Study how salt is used as a preservative.

1) Determine what can be preserved by adding salt (e.g. meat, vegetables, or fruits).
2) Find out how and why salt functions as a preservative.
3) Place a rose or another flower into a bowl full of salt; then, study how the flower changes. Cover the flower to quicken the effect.

Additional information can be found by entering the following keywords in a web search:
alternative living + ACS + salting food.

BIOLOGY

Workshop 5: Salt affects all living creatures

(1 lesson)

Study how salt affects the life of humans, animals, and plants.

1) Identify how salt affects the human body.
2) Determine how salt affects plants. Is there salt in all plants?
3) Find out how salt affects animals. Do all animals need to consume salt? Which animals need less salt than others?

Additional information can be found by entering the following keywords in a web search:

The human body: *Weird science, salt is essential.*

Plants: *Impact of salts on plants.*

Animals: *Salt library, why do animals need salt?*

GEOGRAPHY

Workshop 6: Salt harvesting

(one double lesson)

Where can you find and harvest salt?

1) Find out where salt can be found and how it is harvested.
2) Determine how salt harvesting impacts local industries and the environment.
3) Collect data and present your findings.
4) If possible, visit a salt mine or refinery.

HISTORY

Workshop 7: Salt as currency
(one lesson)

Study the history of trade.
1) Find out what people used to pay for goods (e.g. salt, spices, or gold).
2) Find out when and where the first coins and banknotes appeared.
Additional information can be found by entering the following keywords in a web search: *'salt works + the history of salt'.*

MATHEMATICS

Workshop 8: Study the mathematics behind salt
(one double lesson)

1) Find out how much salt can be found in human beings as well as in certain plants and animals.
2) Determine how much salt we need to eat in a day. Illustrate your findings.
3) Introduce salt to different solutions and determine their salt content.

ARTS

Workshop 9: Salt in paintings
(one double lesson):

Experiment with adding salt to watercolours.
Additional information can be found by entering the following keywords in a web search: *salt painting or experiment with salt in watercolour painting.*

Adaptations

Study the different types of salt and their colours.

This activity could be combined with the following:
Activity 5: Flour Power to assess salt's impact on taste and raising.
Activity 19: Chocolate Uncovered: Exploring and Designing – deforestation to grow chocolate and the environmental aspects of salt harvesting.
Activity 12: The Gluten Lab – gluten allergies and salt's impact on blood pressure can be discussed with a broader reference to the saying: 'you are what you eat'.

School subjects

home economics,
biology,
chemistry,
mathematics,
history,
arts

Key concepts

natural dyes,
edible flowers,
sustainable materials,
plant-based pigments,
eco-friendly art

10 Natural Ingredients of Plants for Art

This activity encourages students to explore the chemical components found in plants, especially secondary plant metabolites such as pigments and pectins. These substances often give plants their colour, structure, or taste, and they can be used in sustainable ways for art, food, and science projects. Students reflect on how these compounds are used traditionally in various cultures and understand their potential uses in eco-friendly practices.

KEY TAKEAWAY

Natural ingredients can produce powerful and beautiful results. By using flowers and plants for art, food, and remedies, we learn to appreciate their versatility. We also reflect on sustainable, cultural, and environmental practices and learn to distinguish edible plants and flowers from non-edible ones.

STUDENT LEVEL

Primary to upper secondary (10–18-year-olds).

PREREQUISITES

Basic knowledge of plant biology and safe lab practices.

TIME NEEDED

2–3 lessons (presented as, for example, a workshop or a project day)

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Classroom, kitchen, or lab with sources of water and heat, self-collected plants, and painting materials

PREPARATIONS

1) Pre-soak or dry plants for easier pigment extraction.
2) Check the edibility and safety of used flowers/plants.
3) Set up stations with instructions (e.g. for dyeing, tea-making, or painting).

Aim

The activity encourages students to learn about natural resources and their practical applications in art, food and health. By conducting hands-on work with natural pigments, edible flowers, and herbal ingredients, students learn about the connections between plant biology, chemistry, cultural traditions and sustainability. They reflect on the environmental impact of synthetic materials and the benefits and challenges of using natural alternatives.

Teacher's activity

Students discover connections between biology, culture/traditions and sustainability through natural pigments, edible flowers, and herbal ingredients. They reflect on the environmental impacts of synthetic materials and the benefits and challenges of using natural alternatives to these synthetic materials.

Introduction

- Explain the goal to extract colour from natural ingredients for art or food. In addition, explain the connections between colour extraction and everyday materials, such as flowers, vegetables, and food scraps. Use leftover paprika powder or collect flower petals and pour hot water over them to provide students with an example.
- Explain what secondary plant metabolites are, where they can be found, and how they are connected to colour. Discuss the significance of colours in nature and culture.
- Where can we find local plants that can be used for dyeing?

Assist students during the process and provide materials.

Optional: Allow students to bring materials from their homes or collect materials during the lesson.

Lead a discussion of results in the plenum.

Students' activity

Introduction and research

Investigate how plants are used in art, food, or cultural practices (e.g. on the internet) and determine how to extract pigments from plants or scraps.

Collect or select materials

Choose plants, flowers, leaves or food scraps suitable for colouring. For example, lupine can be used as a dye and for eating (be careful – some types of lupine need processing first before they can be eaten).

Extract pigments/create colours

- Use simple tools like a mortar and pestle, water, or heat to extract colours.
- Observe: What kind of colours can be extracted? How vibrant are these colours?

Use the colours

Paint on paper, dye fabric, and create decorations.

Documenting process (photos, labels, and results)

Share outcomes with peers (e.g. create a flower recipe book, an art exhibition, or a pigment collection).

Reflection

- What are the cultural, historical or aesthetic reasons behind colour use in food or clothing, and how does this affect perceptions of beauty or deliciousness?
- What makes a colour edible or non-edible? Can colour be natural and not edible?
- How was dyeing done throughout history, how are industrial dyes and pigments produced today, and what are the environmental consequences (e.g. water pollution or energy consumption) of dye consumption??
- How do plant compounds influence colour, taste, and texture, and how do they behave under different conditions (e.g. heat, pH, or oxidation)?
- What are secondary plant metabolites, and where can they be encountered (e.g. pectin in jam, anthocyanins in coloured vegetables, or essential oils in scented products)?


Figures 23 and 24. Making and testing the natural dyes.

Adaptations

Use local plants and food scraps to make the activity regionally adaptable.

Introduce a cultural perspective of using colours (e.g. explore batik, herbal medicine, or traditional dyes) and compare colour creation throughout human history: Which colours were used in medieval times, and why were some so expensive? How can we recreate them?

Turn the activity into a culinary challenge: Use colourful foods (e.g., spinach, beetroot, turmeric, or red cabbage) to cook rainbow pasta and colour eggs or pastries naturally.

Medicinal use of plants may be mentioned as part of cultural history.

This activity could be combined with the following:
Activity 2: Play-Dough and Salt Dough Lab – exploring natural materials through touch and form; connecting chemistry, creativity, and sustainable thinking in tangible ways.
Activity 15: Mystery Cleaners: Creating a Red Cabbage pH Indicator – investigating natural pigments and their chemical behaviour; fostering curiosity through visual transformation and linking household science with eco-awareness.
Activity 19: Chocolate Uncovered: Exploring and Designing – using a beloved material to blend scientific understanding with aesthetic exploration; encouraging students to rethink food as both medium and message.

School subjects

home economics,
chemistry,
mathematics

Key concepts

traditional cookies,
chemistry of leavening agents,
accurate measurements

11 Cracking a Cookie

This activity promotes cultural sustainability by focusing on a typical cookie produced in one's regional or family food culture. The experiments deepen the understanding of the mechanisms of different chemical leavening agents and their functional mechanisms while baking cookies. Students learn scientific accuracy and experimental methods through this activity.

KEY TAKEAWAY

Careful measurements are needed for success in baking. Understanding the chemical reactions involved in baking helps determine whether a recipe is functional or not.

STUDENT LEVEL

Lower secondary (12–15-year-olds).

PREREQUISITES

Basic skills in hygienic and work safety in the kitchen.

TIME NEEDED

Experiment 1 – one lesson;
Experiment 2 – two lessons.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Home economics classroom or a space with cooking facilities.

PREPARATIONS

1) Acquire ingredients to prepare the cookies and leavening agents: baking soda, baking powder, and enough cups and spoons for measuring.
2) Choose the cookie recipe(s) or assign this task to your students. The recipe should be representative of local food culture or various food cultures from students' homes.

Experiments 1 and 2 can be conducted either separately or together during the same lesson.

ACKNOWLEDGEMENTS

We are thankful to Satu Eiranto, Hilma Peltonen, and Venla Ruohonen for creating the original idea for this learning activity.

Aim

In this activity, baking traditional cookies that are typically produced in family, local, or regional cultures is given a new perspective by analysing the reactions of leavening agents in the recipe. First, students familiarise themselves with the scientific method by observing and reporting the chemical reactions in four basic experiments in which baking soda and baking powder are exposed to different temperatures and pH levels. Based on the cookie recipe chosen, the students make hypotheses concerning why and how the leavening agent reacts in the recipe. These hypotheses are tested by baking the cookies. Be responsible about food waste—limit the number of inedible cookies produced during experimentation.

Students' activity

Experiment 1:
Experimenting with leavening agents in different liquids and conditions

1) In small groups, conduct four experiments to examine the reactions of baking soda and baking powder to different liquids (water/vinegar) and temperatures (hot/cold).
2) Take out six identical transparent drinking glasses or measuring beakers, baking soda, baking powder, and a measuring set.
    a) Pour 1 tablespoon of baking soda into three glasses and 1 tablespoon of baking powder into the other three glasses. Label these containers with tape.
    b) Pour ½ dl of cold water into the first glass with baking powder. Observe the changes in the glass and record your observations.
    c) Pour ½ dl of hot water into the second glass with baking powder. Observe the changes in the glass and record your observations.
    d) Pour ½ dl of vinegar into the third glass with baking powder. Observe the changes in the glass and record your observations.
    e) Repeat the same procedure: Add liquids B, C and D into the last three glasses containing baking soda.
3) Make sensory observations (i.e. sight, smell, and sound) regarding the reactions and describe them on a digital platform (e.g. Padlet) that allows the observations to be reviewed with the whole class.
4) Discuss the similarities and differences between the observations and the need to use accurate wording with the entire class: Are the observations similar or different? Why? How were the observations phrased? Were the observations easy to understand?

5) With your study group, choose two cookie recipes. Make sure that one recipe has baking powder and the other baking soda. Scale the recipe down as much as possible while keeping it functional.
6) Discuss why and how the chosen cookie recipe is prevalent to the food culture you've chosen (either local or international). Also note the cookies' nutritional information.

Experiment 2:
Cookie baking with variations in leavening agent

1) Alter the leavening agent in the cookie recipe chosen for the lesson:
    a) Make one batch of dough with too much leavening agent (use double or triple amount in the recipe).
    b) Make the second batch of dough with no leavening agent at all.
    c) The third batch of dough should have the wrong leavening agent (e.g. baking soda without any acidic substance).
    d) Lastly, the fourth batch of dough should serve as the control and use the basic recipe.
2) With your pair or in a small group, hypothesise what will happen to the cookies (e.g. how their size and consistency will vary). Reference the observations made in the previous lesson.
3) Bake the cookies by following the recipe.
4) When the cookies are ready, note your sensory observations (i.e. sight, smell, and taste) of these cookies together with the whole group. Assess whether your hypothesis holds and describe the differences in taste and appearance of the cookies using phrasing that is as understandable and accurate as possible.
5) Discuss the importance of following the recipe and making accurate measurements, especially when using teaspoons and smaller measurements.

If Experiment 2 is done without having previously conducted Experiment 1, discuss the cultural aspects of the food, such as why and how the chosen cookie recipe is prevalent in the family, region, or international food culture.

Adaptations

Having four small groups covering four different food cultures varies the discussion of the food cultures through the recipes used.

To strengthen the idea of cultural sustainability and to enrich the learning experience by connecting chemistry with personal and collective histories, students could be guided to reflect more deeply on the origins, transformations, and symbolic meanings of their chosen cookie recipes. For example, have the students discuss the following questions: How did this recipe come about in their family or region? Has it changed over the generations? Is the recipe linked to particular events, rituals, or identities?

This activity could be combined with the following:
Activity 16: Not Just a Sandwich? to discuss the nutritional value of snacks.
Activity 13: Create STEAMy Cookie Cutters to approximate the optimal use for and cutting of the cookies.

Figure 25. Using different cookie recipies for presenting cultural variations.

School subjects

home economics,
biology,
chemistry,
geography,
history,
arts

Key concepts

grain cultivation,
gluten formation,
dough elasticity,
traditional breads

12 The Gluten Lab

Through this activity, students explore gluten formation in various flours. They discover the conditions necessary for gluten formation through scientific and critical thinking and leverage this knowledge to make dough. The activity is complemented by a study on the cultivation and use of grains in Europe and the related sustainability challenges.

KEY TAKEAWAY

European breads traditionally rely on wheat; however, using grains such as rye, barley, spelt, and buckwheat in the bread-making process supports biodiversity, sustainability, and cultural variety. If gluten in the dough is not essential to your recipe, consider using alternatives.

STUDENT LEVEL

Lower secondary (12–15-year-olds).

PREREQUISITES

Experience in using the oven.

TIME NEEDED

2 x 2 lessons.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Home economics classroom or a space with cooking facilities.

PREPARATIONS

Lesson 1

1) Acquire ingredients for experimenting and prepare a worksheet that enables students to take notes and support their analysis.
2) Familiarise yourself with the gluten formation process in the dough and the potential of gluten formation in various grains (i.e. learn which type of dough needs gluten structures which do not). Do not forget to explain coeliac disease in a sensitive way.

Lesson 2

1) Prepare recipes and ensure the availability of ingredients. Choose a simple pasta recipe (e.g. carbonara) that also leaves time for discussion.
2) Provide students with a map of Europe, either printed or digital, that they can complement with their findings. Be ready to guide students to topical web pages to find relevant information.
3) Lastly, lead the discussion towards sustainability content.

Aim

This learning activity links scientific experimentation with cultural and environmental contexts by examining how wheat cultivation and gluten function in the context of food preparation.

The experimentation task engages students and promotes their understanding of the scientific aspects (e.g. chemistry in gluten formation; geographical and biological differences in wheat cultivation) and mathematical content (e.g. understanding statistical results). It supports aesthetic thinking (e.g. in the presentation of their results on a map) and deepening cultural understanding (e.g. of breads in various cultures).

Students' activity

Experiment 1:
How is gluten formed in dough?

In groups of four, experiment with four different types of flour (e.g. plain wheat flour, pasta flour, barley flour, rye flour, and rice flour).

1) Take 3 dl of flour and add 1 dl of water. Knead the dough ball for at least 3-5 minutes.
2) Wash the dough ball under cold running water over a sieve until no more white liquid (starch) is released from the dough ball.
3) In your group, examine the remaining pieces of dough and compare the content/non-content of gluten. Draw conclusions about which type of flour formed more gluten.
4) Use a straw and try to blow air into the piece of dough. What happens when you do this?
5) Bake the pieces of dough in the oven at 200 degrees for about 15 minutes. Examine the results and draw conclusions.
6) Discuss what conditions were necessary for gluten formation (i.e. what did you do with the flour before washing?). What is gluten, and what is its role in the dough (proteins forming elasticity in dough)?

Experiment 2:
Applying gluten knowledge in pasta making

1) Work in groups of four and follow the recipe to make your pasta dough. Pay attention to the technique you use for making the dough.

2) While the dough is resting, study grain cultivation in Europe (What are the main grains cultivated? What kind of breads are common in various countries?). Study the statistics. Practice your critical thinking skills by summarising your findings. Map your results.
3) Make the pasta dish. Think about the validity of the results of previous lessons' gluten tests (What are the necessary conditions for gluten formation? What role does gluten play in pasta dough formation?)
4) Discuss the results on a map based on sustainability (e.g. maps that discuss monocultures, water consumption, or pesticides).

Adaptations

To emphasise gluten disorder, celiac disease could be studied and discussed.

To reduce waste, ask the student pairs to select one type of flour for experimenting, not all four types of flour.

The same experiment could be used to make seitan instead of or in addition to baking bread in the oven.

The second lesson could also enable students to experiment with various doughs. What happens if you do not knead pasta dough? What happens if you knead cookie dough?

This activity could be combined with the following:
Activity 20: Exploring the Science of Protein Denaturation by Preparing a Salmon Meal to learn more about the protein chains in fish.
Activity 6: The Mystery of Baked Alaska to learn more about the protein chains in eggs.
Activity 5: Flour Power to build on connections in dough making.

Figure 26. Washing the dough ball.

School subjects

home economics,
mathematics,
chemistry,
physics,
arts,
informatics

Key concepts

geometry,
tessellation,
(food) waste,
3D modelling

13 Create STEAMy Cookie Cutters

This learning activity connects geometry, sustainability, and food preparation through the playful task of designing and using cookie cutters. Students learn about the concepts of tessellation, perimeter, and area while reflecting on food waste and responsible material use. The activity fosters creativity and problem-solving by integrating 3D design, cultural reflection, and hands-on baking.

KEY TAKEAWAY

Mathematics and sustainability are present in everyday tasks. Reducing waste requires planning and design thinking. Tools like 3D printing can support sustainable solutions – but only if used thoughtfully.

STUDENT LEVEL

Lower secondary (12–18-year-olds)

PREREQUISITES

Basic baking skills, basic knowledge of geometry, prior experience or introduction to 3D modelling platforms such as CookieCAD.

TIME NEEDED

2 x 2 double lessons – one lesson for designing/creating the cutters, a break for printing the cutters, and another double lesson to finish if necessary and to bake/decorate cookies.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Home economics classroom or space with cooking facilities and a classroom or informatics room, scissors, paper, crayons or pens, computers, 3D printers, and baking materials.

PREPARATIONS

1) Introduce tessellation, solids, 3D printing, food waste, and wicked problems.
2) Prepare access to 3D printers and modelling software (optional).
3) Provide a local and traditional cookie recipe, dough ingredients, paper, graph paper, pencils, baking trays, etc.

Aim

Exploring geometric concepts such as area, perimeter, and tessellation by designing and using custom cookie cutters (use, for example, PLA and a clean printer for food safety; conduct a web search for 'The Essential Guide to Food Safe 3D Printing'). Students learn to optimise a shape to reduce material use. They also reflect on sustainability in everyday contexts through optimising paper, dough, and printing material/time. Students connect mathematical thinking with resource use and waste, as well as sustainable and material use, while enhancing their practical and creative skills through hands-on activities and critical discussion.

Teacher's activity

Students will create cookie cutters and minimise dough waste, printing time, and printing material.

- **Part 1: Design and modelling.** Introduce the task of creating cookie cutters that minimise dough waste.
- **Part 2: Baking and Testing.** Discuss how leftovers can be minimised by shape choice and placement.
- **Part 3: Reflection in a plenum.** Facilitate a reflection session and introduce students to the term 'wicked problem'.

Students' activity

Part 1: Design and modelling

1) Brainstorm shapes: Which shapes tessellate? Which shapes minimise dough waste? Look at floors, floor patterns, or images from MC Escher.
2) Sketch 2–3 designs on graph paper and calculate their areas and perimeters.
3) Compare designs: Which designs are visually appealing, tessellate, and result in small amounts of leftover dough/paper?
4) Either upload designs to CookieCAD, generate STLs, print custom cutters, or
5) Use/compare existing cutters brought from home or cut shapes from paper.

Part 2: Baking and testing

1) Prepare the workspace and dough.
2) Use the designed cutters to cut out cookies as efficiently as possible.

3) Challenge: Don't reroll dough scraps; instead, find creative uses for leftovers.
4) Bake and cool the cookies.
5) Decorate the cookies (optional but highly recommended for personalisation/taste and aesthetics).

Part 3: Reflection in a plenum

- Maths: Which shapes worked best and minimised leftovers and created the most visually appealing results (i.e. shapes from cut-outs from paper, stamps, and already available cookie cutters)? How much dough was used for each shape?
- Home economics: How did the cookies taste? What kind of texture did they have? What differences did you notice in the cutting precision of the cookie-cutters? Reflect on teamwork. How high did the cookie-cutter have to be? How many cookies could we get out of the dough?
- Sustainability/complexity of food/material waste:
  - What makes 3D printing sustainable or unsustainable?
  - Which issues are solved by clever forms of manufacturing?
  - How do we treat imperfect results in food and beyond?
  - What's a 'wicked problem'? How are they connected to food waste?
  - How can small choices in everyday life can have big effects?

Adaptations

Use knives or pre-existing cookie cutters instead of 3D-printed cutters.

Transfer the concept to fabric design: Use cutter shapes for batik stamping.

Extend the experiment to the field of art by exploring colour placement and visual symmetry.

This activity could be combined with the following:

Activity 17: The Waste on the Plate to delve deeper into waste and reusing, enabling a reflection on things we consider to be ugly and a waste.
Activity 11: Cracking a Cookie to connect the comforting and warm emotions of cookies with local ingredients, deepening the students' understanding of the link between food and culture.

Figure 27. Making cookie cutters with 3D printer.

School subjects

home economics,
chemistry,
biology

Key concepts

acid, pH,
dissolution,
laundry,
cleaning,
cooking

14 The Wonders of Vinegar

In this activity, students explore how an ordinary household substance – distilled vinegar – can be used in various domestic contexts, such as cooking, cleaning, and laundry. Students investigate the principles underlying vinegar's effectiveness and learn about acids and acidity.

KEY TAKEAWAY
Understanding the functionality of a substance is key to using it intentionally and effectively.

STUDENT LEVEL
Lower secondary (13–15-year-olds).

PREREQUISITES
A basic understanding of pH as a scientific concept (see, for example, the learning activity 15 'Mystery Cleaners: Creating a Red Cabbage pH Indicator'); basic skills in cleaning, laundry work, and food preparation.

TIME NEEDED
2–3 lessons.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS
Home economics classroom or a space with cooking facilities.

PREPARATIONS
1) Gather the required ingredients, especially for poaching eggs.
2) Additionally, soak an egg in vinegar 1–2 days before the activity.

ACKNOWLEDGEMENTS
We are thankful to Eveliina Keinänen, Jessika Kulonen, and Helena Mäntylä for creating the original idea for this learning activity.

Aim

This activity aims to examine the use of distilled vinegar in various household activities to foster students' understanding of the fundamental principles of how acids function as well as of the differences between weak and strong acids. The activity includes three workshops in which students work in small groups to investigate the role distilled vinegar plays in various contexts: cooking (i.e. poaching an egg, where the acidity of vinegar affects protein coagulation), laundry care (using vinegar as a fabric softener), and surface cleaning (where vinegar's acidity helps remove limescale). The activity ultimately aims to identify the scientific principles behind practical applications and to enable students to critically evaluate these applications.

Teacher's activity

At the beginning of the lesson, present students with two learning questions for them to answer after completing the workshops:

1) What functions does distilled vinegar have as an acid?
2) Why is understanding a substance's functionality more valuable than merely following pre-existing instructions that apply these functionalities?

The learning activity consists of three workshops, each of which focuses on a different household application of vinegar. Each workshop lasts approximately 20 minutes. Students work in small groups that progress through the workshops in the same sequence, from one to three. Ensure sufficient time at the end for a reflective discussion.

Students' activity

Workshop 1: Vinegar in laundry

First, explore the kind of substance distilled vinegar (i.e. plain, unflavoured table vinegar without added spices) is. Then, explain why it can be used as an alternative to commercial fabric softeners in laundry care. Seek information regarding distilled vinegar and answer the following questions:

1) What kind of substance is distilled vinegar?
    a) Compare distilled vinegar with flavoured vinegars (e.g. red wine vinegar) in terms of its use as a food product.

b) Compare distilled vinegar as a chemical compound with other acids naturally abundant in fruits and berries as well as with commonly industrially produced strong acids, such as phosphoric acid and hydrochloric acid.

2) How does vinegar function as a fabric softener, and what should be considered when using distilled vinegar in this way?
(For example: Its acidity neutralises static electricity generated during washing, it helps rinse chemical residues from fabrics and limescale from the washing machine, and it neutralises odours; consider dosage and suitable fabric types.)

3) Compare homemade or commercial vinegar-based fabric softeners with artificial fabric softeners. Argue which option to choose, as well as when and why each option should be chosen. *(Consider factors such as eco-labels on packaging, the use of colourants, fragrances, and preservatives.)*

Workshop 2: Vinegar and eggshell experiment

1) Investigate what has happened to the egg the teacher placed in vinegar 1–2 days prior to the activity and explain why these changes have occurred. Discuss whether the same effect would occur with other acidic solutions, such as lemon juice or cola.
(Vinegar's acidity dissolved the calcium carbonate layer of the eggshell; the underlying protein membrane remains intact, so the egg retains its shape. Other acidity solutions hold the same function.)

2) Consider practical applications of this phenomenon and reflect on what needs to be considered, or what consequences might follow, in the following situations:
   - Adding vinegar to the water when dyeing eggs.
   (Chemistry, art: Acetic acid in vinegar reacts with the calcium carbonate of the shell, removing a very thin layer and allowing the dye to adhere more effectively.)
   - Using acidic cleaning agents to remove limescale.
   (Chemistry/HE: Removing hard limescale requires time, as does dissolving the eggshell; increasing exposure time improves results. After cleaning, the surface may need to be rinsed or neutralized to prevent ongoing reactions, such as in tile joints.)
   - Drinking acidic soft drinks every school break.
   (Health education and oral health: Acidic soft drinks containing strong acids can erode tooth enamel.)
   - Ocean acidification: Why it occurs, who is affected, and why they are affected.
   (Biology and geography: Ocean acidification results from increased atmospheric carbon dioxide, acid rain, and runoff. As the sea becomes more acidic, organisms

with calcium carbonate shells or skeletons, such as corals, molluscs, and some algae, do not harden properly and may suffer. This impacts food webs, leading to a loss of fish that rely on these species for food or shelter, which in turn results in reduced fish stocks, potentially contributing to climate-induced migration.)

Additional question:

Why is it unlikely for the use of acidic softeners to contribute to ocean acidification in areas with wastewater treatment?

Figure 28. Experimenting with egg and vinegar.

Workshop 3: Vinegar in cooking

Explore how the acid in vinegar affects proteins in poached eggs.

(Acidity causes the egg's proteins to coagulate, helping the poached egg maintain its round shape.)

1) First, determine what a poached egg is and the role of vinegar in its preparation (i.e. where and why vinegar is used to poach eggs).
2) Then, prepare a poached egg following the teacher's instructions and enjoy it with toast.

Reflective discussion

After completing the three workshops, work with your group to answer the initial learning questions. Discuss your answers collectively with the class.

Figure 29. Experimenting with vinegar in cooking.

Adaptations

Consider extending the experiment by soaking a milk tooth or a chicken bone in vinegar or a soft drink to observe how acids affect calcium-rich materials like enamel or bone (Cola will also stain the tooth´s surface).

Explore how flavoured vinegars are made and create your own flavoured vinegar.

Learn how to make fragranced fabric softeners and experiment with making them for use in home economics lessons or as gifts.

This activity could be combined with the following:
Activity 15: Mystery Cleaners: Creating a Red Cabbage pH Indicator to deepen students' understanding of the role of pH in substances and cleaning.
Activity 20: Exploring the Science of Protein Denaturation by Preparing a Salmon Meal to explore the role of pH in protein coagulation when preparing salmon.

School subjects

home economics,
chemistry,
arts

Key concepts

pH,
cleaning,
safety,
everyday tasks

15 Mystery Cleaners: Creating Red Cabbage pH Indicator

The activity focuses on ecological sustainability and safety in cleaning. Students are guided to learn about pH theoretically and practically by creating a pH scale with familiar everyday materials and using a self-made pH indicator to determine the pH of three mystery cleaners. This helps to relate the concept of pH to household cleaners and everyday cleaning practices. The activity improves problem-solving skills, analytical and critical thinking, and collaboration.

KEY TAKEAWAY

The pH level of everyday cleaners affects their use in terms of 1) the kind of dirt the cleaner can be used for. Furthermore (2), both high- and low-pH cleaners pose risks to safety and impact the environment; thus, they should be used only occasionally.

STUDENT LEVEL

Lower secondary (13–15-year-olds).

PREREQUISITES

Basic knowledge of the safe use of chemicals.

TIME NEEDED

2 lessons.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Classroom, kitchen, or laboratory with running water and a place to wash dishes; pH testing paper (for example, from the pharmacy); equipment to prepare the red cabbage solution (a knife, a cutting board, a sieve, and a bowl).

PREPARATIONS

Secure materials for testing pH and creating a red cabbage pH indicator scale; select three mystery cleaners/liquids (preferably acidic, neutral, and alkaline cleaners).

Aim

In this activity, students work collaboratively to define pH in small groups. They test the pH of familiar everyday materials and create a pH scale by using these materials. The students analyse and categorise the cleaners placed on the scale, concentrating on their hazard labels and applications. Critical thinking is needed to create guidelines for safe everyday cleaning at home from the user's and the environment's point of view. Students develop their problem-solving skills by making a pH-colour scale with red cabbage and determining the pH level of three mystery cleaners and the applications they are used in.

Students' activity

1) Discuss your prior knowledge of pH in small groups. Use books and digital learning tools to write a definition of pH.
2) Test the pH of familiar household materials, such as milk, lemon, vinegar, water, eggs, soft drinks, fruits, vegetables, and various cleaners using pH paper. Place the materials on a line and note their pH levels from 0 to 14. All groups create a shared scale.
3) Study the cleaners placed on both ends (low and high pH values) and the middle (pH value of 6–8) of the scale. Categorise the cleaners in each group by answering the following questions:
   - What type(s) of dirt can be cleaned by the cleaners in this group?
   - What kinds of hazard labels do these cleaners have? What do the labels indicate about their safety relative to the user or the environment?
4) Write short and easy guidelines for choosing environmentally and user-friendly cleaners for everyday cleaning based on your observations and internet searches.

Create a pH indicator with red cabbage.

1) Finely chop a wedge of red cabbage. Soak the wedge in 5 dl of hot water for 15–30 minutes. Drain off the cabbage, which can then be used for cooking. The remaining liquid constitutes the basic solution.
2) Pour a small amount of the basic solution into four small decanter glasses or clear glasses (approximately 25–50 ml per glass). Add the following ingredients in different decanters: 1 teaspoon of lemon juice (acidic), 1 teaspoon of bicarbonate soda (mild alkaline), and 1 teaspoon of laundry detergent powder or liquid (alkaline). One glass is left as is without adding anything (close to neutral).
3) Align the decanters from low to high based on their pH levels.

4) Create a visual pH scale by painting the colours on white paper or taking a picture of your scale. Describe the colours in words.

Use the pH indicator scale to determine the pH levels of three mystery cleaners/liquids and where these cleaners should be used.

1) Pour a little of the basic solution into three decanters. Then, add 1 teaspoon or tablespoon of each mystery liquid into the different decanters. Infer the pH level of each mystery cleaner.
2) Discuss where these cleaners could be used and why these cleaners should be used in these locations (acid to clean limescale, neutral to everyday use, and alkaline to clean grease or remove stains). Which of these cleaners is the most user-friendly? Why is this the case?

At the end of the task, answer the following questions:

- What does a cleaner's pH level affect? (What kind of dirt does the cleaner clean? What kinds of hazards does the use of this cleaner pose?)
- What happens if you try to clean grease with a low-pH cleaner or remove limescale with a high-pH cleaner? (The cleaner does not work.)
- Cleaners are typically not used straight from the bottle. What happens to the pH when the cleaner is diluted, and why are cleaners sometimes used undiluted?

Figures 30 and 31. Creating a pH scale with red cabbage.

Adaptations

Blueberries also act as a natural pH indicator. You can use them to make the pH indicator.

Discuss pH in digestion: testing the pH of spit, discussing the role of acidity in the stomach, etc.

Make homemade soap in chemistry class and test its pH level.

Mystery testing non-cleaner products (`cleaning hacks') such acidic soft drinks, lemon, vinegar, ketchup, or usually neutral or weakly alkaline toothpaste, which can be used to scrub and clean metals. Discuss why they might work for cleaning and why they might not be recommended over traditional cleaning products.

Determine what other materials besides chemical cleaners are used for cleaning and why they work (e.g. sand in Africa and soap nut/washing nuts for laundry).

Launch a campaign centred around buying detergents in refill shops.

This activity could be combined with the following:
Activity 14: The Wonders of Vinegar to deepen students' understanding of the role of acid (distilled vinegar) in various household activities.
Activity 10: Natural Ingredients of Plants for Art – red cabbage can also be used to dye fabrics.

School subjects

home economics,
biology,
health education,
informatics

Key concepts

sustainable food choices
(economy, ecology, social, cultural);
healthy food choices

16 Not Just a Sandwich?

This learning activity combines critical thinking and argumentation skills with sustainable and healthy food choices involved in sandwich preparation. By planning and preparing a sandwich and collaboratively justifying the decisions made in this process, students enhance their understanding of the sustainability dimensions of daily life choices.

KEY TAKEAWAY

Sustainable and healthy living is made up of small but meaningful choices. No single decision defines the whole, yet understanding the factors behind these choices is important.

STUDENT LEVEL

Lower secondary (13–15-year-olds).

PREREQUISITES

Basic skills in food preparation; basic knowledge of sustainability dimensions (ecological, economic, social, and cultural) and nutritional concepts (e.g. on the food pyramid and nutrients).

TIME NEEDED

2 lessons separated into different days or weeks.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Lesson 1 – a classroom with laptops;
Lesson 2 – a home economics classroom or a space with cooking facilities.

PREPARATIONS

Lesson 1

Prepare the following if necessary depending on the level of each student group

- A list of webpages to help students search for information on healthy and sustainable food choices.
- Reflective questions to support pupils' information search and joint discussions.

Lesson 2

Acquire ingredients and food supplies for use in sandwich preparation.

ACKNOWLEDGEMENTS

We are thankful to Emma Kontkanen, Varpu Sirén, and Salla Toivonen for providing the ideas for this learning activity.

Aim

This learning activity aims to enhance the students' understanding of sustainable and healthy food choices in planning and preparing a sandwich. Students collaboratively explore these food choices from different viewpoints by searching for information and explaining the reasoning behind their choices. Joint discussions and reflections enhance their logical reasoning, critical thinking, and argumentation skills, widening their perspectives on the sustainability dimensions of daily life choices.

Teacher's activity

At the beginning of the lesson, divide students into small workgroups (3-4 students) and give them their learning questions: How to create a sandwich that supports sustainable and healthy food choices? Why do everyday decisions matter?

Students' activity

Lesson 1:

1) First, plan how to construct a sustainable and healthy sandwich. Start by searching for information on sustainability on the internet (use the web pages provided by a teacher if necessary).
2) Discuss your findings with a group and state arguments related to the health and sustainably aspects of your choices. Consider both sustainability dimensions (ecological, economic, social, and cultural) and health information (e.g. the use of a food pyramid); then, validate your arguments while considering all the components of a sandwich (bread, spread, vegetables, and source of protein).
3) Compile this information into a memo or table.

Lesson 2:

1) Prepare the sandwiches in a group based on your choice.
2) Present your sandwich to others. Explain and justify your chosen ingredients in and how they support sustainable and healthy snacking.
3) Reflect and discuss the choices and process together with the whole group and the teacher.
4) At the end of the lesson, eat the sandwiches together.

Adaptations

If the students do not have prior knowledge of sustainability, one additional lesson should be dedicated to exploring sustainability aspects before planning begins. Similarly, nutritional information should be discussed in consideration of the students' age and prior knowledge (e.g. what does healthy food or healthy food choices mean for the students? What should be taken into account to ensure that food has nutritional benefits).

Depending on the age of the students, advance from what and how questions to why questions.

Students can enhance their computational skills, creativity, and visuality by creating a poster of a sustainable sandwich with pictures of the sandwich and reasoning behind their choices.

Students can take a photo of the current content of their fridge at home and plan a sandwich or snack based on the available food – this serves as a pre- or post-learning task. Moreover, this task connects sustainability more directly to students' daily lives.

Students can make a podcast as a group to promote sustainable and healthy self-made sandwiches.

Organise a debate in the classroom. Students can argue for their choices and widen their knowledge and perspectives during joint discussion.

This activity could be combined with the following:
Activity 5: Flour Power to explore how various flours affect the nutritional value of the bread used.
Activity 17: The Waste on the Plate to discuss how meal leftovers could be used as filling for the sandwiches.

The following table can be used to record information and the reasoning behind each decision.

Table 1: Sandwich preparation spreadsheet

	Bread	Spread	Vegetables	Protein source	Conclusion
Healthy +					
Healthy -					
Ecological sustainability (e.g. food chains or carbon footprint) +/-					
Economic sustainability (e.g. fair trade) +/-					
Social sustainability (e.g. food ethics or fairness for people and animals) +/-					
Cultural sustainability (e.g. cultural taste) +/-					

School subjects

home economics,
mathematics,
arts,
chemistry

Key concepts

waste,
various materials/packages,
visualising waste on the plate

17 The Waste on the Plate

This learning activity encourages students to think critically about how waste is generated during food preparation. Students systematise their knowledge of waste management through their conclusions and the presentation of results. The activity promotes a discussion on the wicked problems related to waste management and leads students as consumers to make more sustainable choices. Ultimately, the activity fosters students' critical thinking, creativity, and aesthetic skills.

KEY TAKEAWAY

The amount of waste generated daily is a significant global problem. Everyone can reduce the amount of waste they generate through their choices (e.g. choosing reusable materials). However, it's important to remember that packaging food is sometimes essential.

STUDENT LEVEL

Lower secondary (13–15-year-olds).

PREREQUISITES

Basic cooking skills.

TIME NEEDED

2 x 2 lessons.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Experiment 1 – a home economics classroom or a space with cooking facilities;
Experiment 2 – a classroom appropriate for presentations.

PREPARATIONS

Experiment 1

Choose a menu based on the packages of the ingredients such that students will produce different kinds of waste (plastic, metal, cardboard, glass, and bio waste). Example menu items include Biff à la Lindström, carrot-pineapple salad, boiled potatoes, milk, or kefir.

Experiment 2

Find a topical video and statistical materials about waste generation of waste management.

Think about group division

Students can be divided into the same groups as in the food preparation lesson or based on waste groups (i.e. waste materials such as plastic, metal, paper, or cardboard).

Aim

This activity aims to systematise the knowledge of waste management and lead students as consumers to make more sustainable choices in their everyday lives. Demonstrating waste generation through practical food preparation and package examination enables the integration of hands-on action and analytical thinking. It promotes students' mathematical ability (i.e. the ability to measure waste, study statistical results, and make comparisons), critical thinking (changes in consumer choices), scientific thinking (developing a methodology for measuring; systemizing the materials), and creative and aesthetic thinking (visualising waste generation as a meal; presenting results visually).

Students' activity

Experiment 1:
Cooking a meal to visualise the amount of waste generated per meal

1) Prepare one meal in groups of three or four by following a recipe. Collect all possible waste that is left from making this dish. If needed, wash the food packages.
2) Sort waste based on materials and document the results. Weigh all the waste and make notes based on the waste materials.
3) In addition to serving the food, organise the waste on the table. Serve it creatively (e.g. on the plate as a meal) and take pictures.
4) Store the waste for using it in the next lesson (biowaste will not be stored).

Experiment 2:
Examining packages and their materials

1) Watch a relevant video about waste generation or waste management to familiarise yourself with topical illustrative materials and statistics.
2) Develop a methodology within the group for determining the amount of waste generated in the lesson (e.g. in grams or pieces).
3) Study the materials and labels on the packages left from the previous lesson.
4) Evaluate which of these packages are reusable or recyclable. Calculate the percentage of recyclable versus non-recyclable waste (packages) using the amounts scaled in the previous lesson.
5) Analyse which of the materials can be avoided by making different choices at the store. If needed, visit an online shop to examine their selection of packaged food items. Calculate the effect of making different choices (make graphical illustrations).

6) Design (on paper) a scale for a home economics classroom that enables all bio waste to be weighed.
7) Visually present your results using available digital tools together with pictures, allowing you to discuss sustainability within the context of meal preparation and food packaging.
8) Participate in the discussion of waste management (e.g. discuss waste as a source for business, food safety, waste imports/exports, using mono-/polymaterials).

Figure 32. Observing the amount of waste in cooking .

Adaptations

Students can think about how to follow and support waste reduction at their homes – this can serve as a post-task activity. Electronic posters could be designed as collaborative tasks that include more than one group – this can make the results even more illustrative. The lesson could be continued by experimenting with materials (e.g. package composition) or by making alternative materials. In addition, a field trip to a waste-sorting centre could be conducted to allow students to learn more about regional waste processing methods and technology.

It is possible to compare the waste from purchased lunches versus homemade lunches in countries with students who bring packed lunches to school.

Instead of giving students recipes, let them select between two or three meal options with differing packaging types. This could spark conversations about packaging choices from the start of the activity.

This activity could be combined with the following:
Activity 16: Not Just a Sandwich? – combining these tasks enables a consideration of sustainability from various dimensions (ecological, economic, social, and cultural), both from the food's as well as from the package's point of view.

School subjects

home economics,
physics,
mathematics,
biology,
health education

Key concepts

heat,
temperature mapping,
heat transfer,
kitchen safety,
energy efficiency

18 Kitchen Thermodynamics

This learning activity explores thermodynamics by engaging students in measuring and mapping temperatures in the kitchen. Through explorations and guided discussions, students connect scientific principles of heat transfer with real-world cooking and safety practices. The activity encourages applying science practices and thinking to everyday environments, thereby deepening the practical understanding of thermodynamics.

KEY TAKEAWAY

Understanding kitchen thermodynamics is crucial not only for safe and effective cooking but also for promoting energy efficiency and sustainable practices.

STUDENT LEVEL

Lower secondary (14-16-year-olds).

PREREQUISITES

A basic understanding of kitchen appliances, measurement techniques, and safety protocols.

TIME NEEDED

1–3 lessons (adjustable based on the depth of the discussion).

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Home economics classroom or a space with cooking facilities, laboratory, or a home kitchen; kitchen thermometers; infrared devices (if possible); notebooks/tablets; whiteboard/active board; and safety equipment.

PREPARATIONS

1) Ensure that all thermometers (infrared and conventional), heat cameras (if available), and kitchen appliances are functional.
2) Verify that safety equipment (e.g. fire extinguishers and first aid kits) is in proper working order.
3) Organise the learning space by designating specific kitchen areas for data collection.
4) Prepare data recording tools (whether printed worksheets or digital spreadsheets) and set up a temperature mapping board or digital tool (e.g. Thinglink for photo tagging).
5) Review safety protocols and measurement procedures with students.

Aim

This learning activity aims to enable students to investigate and understand heat and temperature in the kitchen setting. By measuring different temperatures and sources of heat and cold and exploring heat transfer principles, students learn how these factors influence cooking processes, food safety (such as by inactivating unwanted microbes), and energy consumption. Ultimately, the activity encourages students to apply scientific reasoning to everyday cooking and to adopt habits that promote sustainability, such as conserving energy.

Students' activity

Exploration and measurement

Before you begin exploring, think about where you expect the hottest and coldest spots in the kitchen to be.

1) Use thermometers (infrared and conventional) to measure the temperatures of appliances (e.g. the stove, oven, or refrigerator) and substances (e.g. boiling water or hot oil) in the assigned kitchen areas.
2) Record data on the provided worksheets or digital spreadsheets.

Figures 33 and 34. Measuring tempreratures in kitchen.

Data mapping

Create a temperature map of the kitchen using either a digital photo tagging tool (e.g. Thinglink) or a physical board in which each measurement point is annotated.

Group discussion

1) Analyse your results by discussing observed temperature gradients, identifying heat sources, and understanding heat transfer methods.
2) Consider why different appliances and spaces (e.g. a cooking zone versus a refrigerated area) exhibit varied temperature ranges, and discuss how these differences impact food safety and energy efficiency.

Safety and sustainability focus

1) Discuss the risks associated with high temperatures (e.g. burns from hot oil) and review kitchen safety protocols.
2) Extend the conversation to energy use by comparing the costs of heating and cooling kitchen appliances.
3) Visually present your results using available digital tools together with pictures, allowing you to discuss sustainability within the context of meal preparation and food packaging.
4) Participate in the discussion of waste management (e.g. discuss waste as a source for business, food safety, waste imports/exports, using mono-/polymaterials).

Adaptations

This activity can be used for different age groups, by modifying the content according to the student's level.

Have advanced students conduct thermographic analysis using infrared cameras and complex data collection, data logging, and data analysis.

Modify measurement activities or discussion points for students with special needs, emphasising safety and accessible engagement.

Integrate interdisciplinary links by discussing how different cultures manage cooking heat and energy usage, reinforcing scientific, economic, and cultural sustainability aspects. Reflect on questions such as:

- How do different cooking traditions adapt to available energy sources or local climates?
- What are the thermodynamic implications of traditional versus modern cooking methods (e.g. tandoor, clay oven, or solar cooker)?

This activity could be combined with the following:
Activity 8: Power of the Sun: Renewable Energy in the Kitchen to continue the discussion on heat transfer and sustainable energy sources.

School subjects

home economics,
geography,
biology,
chemistry,
arts

Key concepts

properties of chocolate,
origin of chocolate,
chocolate production,
food labelling,
3D shapes

19 Chocolate Uncovered: Exploring and Designing

In this learning activity, students explore chocolate by examining its ingredients, origin, and nutritional content, paying special attention to fats and their functions. Students learn about food labels and the use of the double-boiler method, understanding which foods require this cooking methods and why. Students design and create three-dimensional shapes from melted chocolate, analysing the feasibility of their ideas and planning how to turn liquid chocolate into solid forms.

KEY TAKEAWAY

Chocolate is an interesting product that requires knowledge and special care when used in cooking. When consuming chocolate, keep in mind that it is a luxury product with sustainability and ethical aspects.

STUDENT LEVEL

Lower secondary (14–16-year-olds).

PREREQUISITES

Basic concepts of nutrition, food production, and transportation; basics of food preparation and safety.

TIME NEEDED

1–2 lessons, depending on the content and instructions of the topics to be studied.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS

Regular classroom, and a home economics classroom, or space with cooking facilities. Practical tasks require thermometers and a good source for a proper double boiler for melting chocolate or other setups.

Aim

This activity aims to explore chocolate's use as both a global product and a material for creative work by examining its origins and sustainability impacts, understanding its physical and chemical behaviour, and applying this knowledge through practical (i.e. the principles of melting chocolate) and aesthetic activities, such as designing and evaluating three-dimensional chocolate models.

PREPARATIONS

Think about how students can explore the following themes:

History and culture: the origins of chocolate and its cultural significance.

Chocolate production journey: from cacao farming to the final product, including harvesting, fermentation, and early processing stages.

The chocolate processing and tempering: the structure and behaviour of chocolate during factory processing, focusing on tempering and the differences between chocolate types.

Sustainability issues: fair trade, deforestation, and ethical cacao farming.

Options on how to find information

a) offer a selection of links to information (country-based materials on these themes),

b) direct students to find information online, and

c) find suitable video materials. Decide on a format for teams to present their work in (e.g., presentation, infographic, or video).

Decide how much chocolate each group can use during the task. The 3D chocolate models could be designed around a single theme, such as geometric shapes, architecture, or nature. Consider when and where these chocolate creations could be used (e.g. for cake decorating or food art projects).

Teacher's activity

Students work in small teams to explore one of four aspects related to handling chocolate. Each team will select a topic, gather information from the provided materials and/or reliable online sources, and prepare a short presentation for the class. The activity's goal is to deepen students' understanding and allow them to share their findings with their peers. The teacher provides the presentation criteria and guide the presentation setup (e.g. the presentation format, tools, and environment).

- Students should be shown different double-boiler setups for practical tasks. This allows them to discuss which method is best suited for to the situation.
- During practical tasks, keep an eye on sustainability principles (e.g. no waste, using the decorations) and security (double-boiler method).

Students' activity

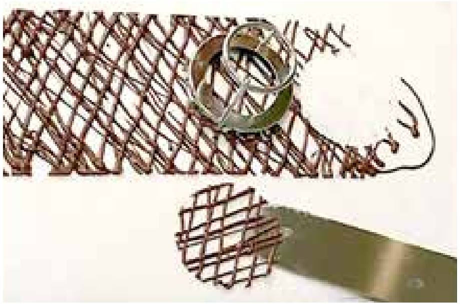
Choose a topic from the following list, gather information from the provided materials and/or reliable online sources, and prepare a short presentation for the class. The themes are as follows:

- **History and culture** – the origins of chocolate and its cultural significance.
- **Chocolate production journey** – from cacao farming to the final product, including harvesting, fermentation, and early processing stages.

- **The chocolate processing and tempering** – the structure and behaviour of chocolate during factory processing, focusing on tempering and the differences between chocolate types.
- **Sustainability issues** – fair trade, deforestation, and ethical cacao farming.
- **Health and science** – benefits and challenges of consuming chocolate.

Practical task:
Choose a chocolate melting method and a method of making 3D shapes out of melted chocolate.

Reflect on your learnings by answering the following questions:
- What did you learn about chocolate that surprised you?
- How can we enjoy chocolate responsibly? Factor in the environmental, economic, and ethical costs of chocolate.
- Which designs stood out to you, and why?
- How could you improve your designs in the future?



Figures 35, 36 and 37. Creating shapes with melted chocolate.

Adaptations

Taste Test: Organise a blind test with small pieces of dark, milk, and white chocolate – discuss the textures, taste, and ethical/environmental impacts of each type of chocolate.

Comparative test: Conduct a small test to observe how dark, milk, and white chocolate behave when melted. Discuss differences in melting points, texture, and behaviour.

This activity could be combined with the following:
Activity 18: Kitchen Thermodynamics to understand the necessary heat transfer in the kitchen context, given that chocolate requires temperature-sensitive work.

School subjects

home economics,
biology,
chemistry

Key concepts

protein denaturation,
heat,
acid,
cooking methods,
food science

20 Exploring the Science of Protein Denaturation by Preparing a Salmon Meal

This learning activity promotes scientific understanding and culinary skills by focusing on the denaturation of proteins in salmon. Through this activity, students learn about the effects of heat and acid on fish, thereby improving their observation and analytical skills. The activity can introduce sustainability concepts to students by discussing issues such as the impact of farmed versus wild-caught salmon. This enhances students' 21st-century skills by developing their creativity, problem-solving, and scientific-enquiry abilities.

KEY TAKEAWAY
Different cooking methods can significantly change the texture and taste of food, even when using the same ingredients.

STUDENT LEVEL
Lower secondary (14–16-year-olds).

PREREQUISITES
A basic understanding of kitchen safety and hygiene.

TIME NEEDED
Two lessons.

THE LEARNING SPACE AND EQUIPMENT REQUIREMENTS
Home economics classroom or a classroom with running water.

PREPARATIONS

1) Reserve the ingredients and tools needed:
   - salmon pieces (enough for each of the students to taste salmon prepared with both methods),
   - lemon/lime juice,
   - small bowls,
   - and small pots for each group.
2) Prepare two pieces of salmon for each group: one for boiling and one for acid treatment.
3) While setting up, introduce the concept of protein denaturation and its relevance in cooking.

ACKNOWLEDGEMENTS
Image by Kaja Aasvold Minothi

Aim

This activity aims to investigate how proteins in salmon change during different cooking processes by exploring the effects of heat and acid. Teaching protein denaturation through salmon cooking creates a diverse learning experience that promotes students' scientific thinking (their ability to understand chemical reactions), science enquiry skills (their ability to observe and analyse changes), and culinary skills (their ability to prepare and taste fish using different methods).

Students' activity

1) Slice the first salmon piece in thin pieces and marinate them in lemon or lime juice for about 20–30 minutes
2) Heat the water and steep the other piece of salmon in a small pot.
3) Throughout the process, observe and write down how the salmon's appearance, texture, and smell change.
4) After cooking and marinating the salmon, compare the two pieces of salmon and note differences in texture, colour, and overall appearance.
5) Taste both samples and discuss the differences in flavour and mouthfeel.
6) While eating the salmon, discuss how heat and acid have different effects on the salmon protein's denaturation process.

Feel free to include the fish as an ingredient in a composed dish or meal (e.g. a poke bowl).

At the end of the lesson, discuss:

- What differences did you notice between salmon cooked with heat and salmon marinated in acid?
- What caused these differences, and what scientific processes were involved?
- How can you use this knowledge when preparing other foods or trying new cooking methods?

More open-ended questions should also be discussed:

- How might these cooking methods affect the nutritional value of salmon?
- Can you think of traditional dishes from different cultures that use heat or acid to cook fish?
- How might they be similar to or different from what we did today?
- How do you think professional chefs use scientific knowledge in their cooking?
- How would you use what you've learned about heat and acid cooking methods to design a new salmon dish?

Adaptations

This activity can be used for different age groups, by modifying the content according to the student's level.

Students could explore protein denaturation using different protein-rich foods, such as egg, chicken, or various types of fish. This would allow them to observe how heat and acid affect the texture and appearance of diverse ingredients. Additionally, the activity could be adapted to investigate the impact of different acidic marinades, including vinegars, citrus juices, and even yoghurt. Students can also be encouraged to try other cooking methods, such as frying, baking in the oven, or sous-vide (a cooking technique in which the food is vacuum-sealed in plastic and heat-treated in the packaging) at different temperatures.

Introducing meats to the activity could open up discussions on why we, for example, do not eat cold-marinated chicken, but similarly prepared fish is fine.

Comparing how salmon or other proteins respond to these various acid sources would deepen the understanding of the chemical processes involved in denaturation. These adaptations provide opportunities for students to more broadly and creatively apply their newfound knowledge to everyday culinary settings.

This activity could be combined with the following:
Activity 7: Tasting Basic Flavours and Sushi Bowls to explore the taste and sensory aspects of food.
Activity 15: Mystery Cleaners: Creating a Red Cabbage pH Indicator to deepen students' understanding of the role of pH in substances and cleaning.
Activity 14: The Wonders of Vinegar to explore different aspects of pH.

Figure 38. Investigating how proteins in salmon change during different cooking processes.

Notes