STEAM KITCHEN

Integrating HOME ECONOMICS and STEAM

A Guide to Interdisciplinary Learning for Sustainability

The outcome of the Erasmus+ KA201 project STEAMKitchen

Tallinn 2025

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STEAMKitchen

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EXECUTIVE
Summary

The STEAMKitchen project offers an exciting new approach to education by creatively integrating Home Economics and STEAM (Science, Technology, Engineering, Arts, and Mathematics). Imagine lessons where science meets cooking, technology blends with nutrition, and chemical reactions enhance everyday meals.

This interdisciplinary approach provides teachers with practical tools and examples to engage students in exploring sustainable living, creative problem-solving, and the science behind their food. STEAMKitchen fosters a deep understanding of sustainable practices and enhances students' educational experience by emphasising practical life skills within a scientific and technological framework.

Objectives

- Foster student engagement in Home Economics and STEAM subjects.
- Enhance students' quality of education by integrating content from both Home Economics and STEAM.
- Create engaging learning activities and teaching materials.
- Provide a platform for teachers to develop and share ideas.
- Encourage informed and sustainable choices.

STEAMKitchen achieves these objectives by developing learning activities that present challenges, provide guidance, and demonstrate practical applications of scientific and technological concepts in everyday life.

These learning activities encourage critical thinking, problem-solving skills, and sustainability awareness, preparing students for real-world challenges and potentially sparking interest in further STEAM education. STEAMKitchen can also serve as a professional development tool for teachers, helping them improve their competencies in both Home Economics and STEAM education.

STEAMKitchen also addresses the gender disparities in the Home Economics and STEAM fields by promoting inclusivity and empowering all students to explore and excel in these subjects. By equipping students with essential life skills and knowledge while promoting gender equity and sustainable practices, this project contributes to a highly effective and future-ready education system.

INTRODUCTION

Integrating Home Economics with STEAM (Science, Technology, Engineering, Arts, Mathematics) education underscores the relevance of practical life skills in a scientific and technological context. Home Economics traditionally focuses on essential daily life skills, such as cooking, budgeting, and home management. Combined with STEAM, these skills expand to incorporate scientific principles, technological tools, engineering processes, artistic creativity, and mathematical concepts (Figure 1, next page). This interdisciplinary connection enhances students' learning outcomes and prepares them to address real-world challenges holistically.

Educators and students can discover innovative solutions to everyday problems by exploring the integration of Home Economics and STEAM and achieve a deeper understanding of how the resulting knowledge can be applied in practical, sustainable, and aesthetically pleasing ways. This fusion also encourages a more inclusive and engaging learning environment, one where the boundaries of traditional learning are redefined, thus promoting a diverse and inclusive curriculum.

STEAMKitchen aims to support decision-makers and educators in implementing STEAM into learning practices by focusing on sustainability issues related to everyday activities. This guideline helps to understand and inspire the creation of learning activities by fusing concepts from both fields, providing teachers with the means for integrated learning experiences.

STEAMKitchen can turn any learning environment, including a home economics classroom into a makerspace for STEAM activities by addressing three pillars:

1 Integrated face-to-face and digital activities
Combining traditional and modern learning methods.

2 Green approaches
Promoting environmentally conscious practices.

3 Sustainable resource management
Encouraging the responsible use of resources.

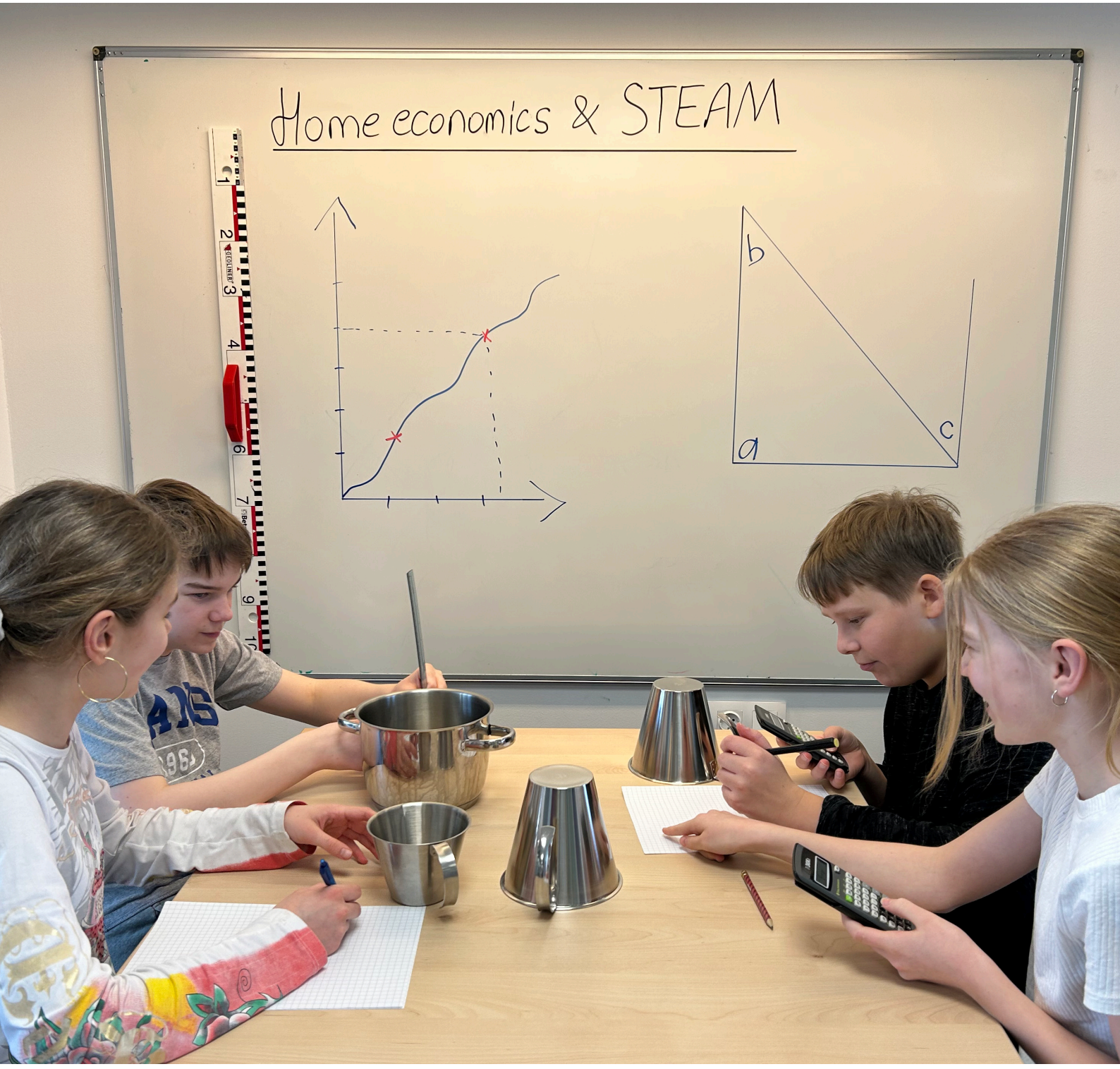


FIGURE 1 **COMBINING HOME ECONOMICS AND STEAM IN CLASSROOMS**

We believe that **integrated knowledge** is essential for dealing with complex sustainability-related problems and that such knowledge is achievable by combining different school subject areas.

AIMS

The STEAMKitchen project aims to transform teacher education by supporting educators in integrating STEAM with Home Economics with a focus on sustainability. This approach enables content-based learning and the application of knowledge to everyday activities. The project fosters a modern learning environment by offering inspiration and guidance on integrating various subjects, including digital skills, into daily teaching. It provides learning opportunities for both pre- and in-service teachers through a handbook and an e-course. The handbook, available in five languages, provides learning activities, while the English e-course teaches implementation methods, inspiring interdisciplinary teaching that benefits students across multiple subjects. The learning activities aim to make STEAM content more accessible to all students by showcasing its relevance in everyday life. These resources ensure the project's long-term sustainability and impact.

The STEAMKitchen aims to familiarise learners with Home Economics, promote self-sufficiency, and encourage learners from all genders to share household responsibilities equally. The approach also highlights the value of integrating STEAM with Home Economics and offers practical guidance on how to do so. Moreover, the focus on sustainable development encourages new understandings of how various school subjects can contribute to citizen awareness.

PARTICIPATING COUNTRIES:
Austria, Estonia, Finland, and Norway.

METHOD:
Creating interdisciplinary learning activities that combine Home Economics and STEAM (Science, Technology, Engineering, Arts, and Mathematics) subjects.

GOALS:

- **Support** the collaboration between Home Economics and STEAM teachers and connect the learning activities to student's everyday lives.
- **Empower** students to make sustainable decisions.
- **Increase** all students' interest in Home Economics and in STEAM subjects.

RESOURCES:
A handbook with learning activities is available in English, Estonian, Finnish, German, and Norwegian.

STEAMKitchen – **transforming** teacher education & offering **inspiration** and **guidance** across multiple subjects and skills

TOWARDS
sustainability

1 Integrated activities, green apporaches & sustainable resource management

The STEAMKitchen transforms learning spaces, such as home economics classrooms, into food-oriented makerspaces that emphasise sustainable thinking and practices. It focuses on integrated activities, green approaches, and sustainable resource management, and offers educators resources and guidelines to inspire and implement enriched learning activities, thus equipping them with the skills necessary to address complex sustainability challenges and promote sustainable lifestyles (see the "Sun, Water, and Wind" activity; Figure 4, page 28).

2 Interpersonal and cultural awareness through transdisciplinary learning

Students need knowledge and skills to make informed and sustainable choices, understand product safety, and be knowledgeable about science, technology, and sustainability. Interpersonal and cultural awareness are also crucial for solving real-world challenges and promoting sustainable living. These Key Competencies for Lifelong Learning, as defined by the European Commission (2018), should be developed through transdisciplinary learning that fosters the four C's: communication, collaboration, critical thinking, and creativity (Kivunja, 2015).

3 Teachers in vital role as guides and empowerers

Integrating sustainability into these competencies equips students to tackle complex societal and environmental challenges and to make responsible choices for a sustainable future which can be challenging for both students and teachers. Teachers play a vital role in guiding students through discussions and reflections on values such as sustainability, responsibility, and ethical consumption. By creating an open classroom environment, teachers can empower students to navigate ethical dilemmas and form their own values while considering broader social and environmental impacts, thereby helping students become conscious and responsible citizens.

HOME ECONOMICS EDUCATION
in Participating Countries

Though often associated with cooking and cleaning, Home Economics encompasses a broader range of topics that **equip individuals with valuable skills to handle complex situations** in both personal and professional life.

According to the European Commission (2018), active and creative participation in society demands specific Key Competencies for Lifelong Learning, including technological and social skills that support innovation. These competencies are now reflected in many curricula and include problem-solving, critical thinking, collaboration, computational thinking, self-regulation, and creativity (European Commission, 2018). Creativity, alongside critical thinking, communication, and collaboration is also part of the four C's of the 21st century and has been identified as a crucial skill to develop (Taar & Palojoki, 2022, Trilling & Fadel, 2012).

All the participating countries have included Home Economics in their education systems, each with unique emphases. They have incorporated sustainability and health education, ensuring that their students develop practical skills and competencies.

The curricula in the participating countries differ depending on their focus on the different topics related to their national educational goals (often reflected in the subject's name). Table 1 provides an overview of Home Economics education in the participating countries, including the number of lessons and the grade levels at which the subject is taught.

COUNTRY	SUBJECT NAME	NUMBER OF LESSONS	AGE	GRADES	ELECTIVE
Austria	Nutrition and Household *(Ernährung und Haushalt)*	38 x 50 min	12	6	Yes
Estonia	Home Economics *(Kodundus)*	up to 80 x 45 min	10 to 16	4–9	No
Finland	Home Economics *(Kotitalous)*	114 x 45 min	13 to 14	7	Yes
Norway	Food and Health *(Mat og helse)*	197 x 60 min	6 to 16	1–10	No
					MANDATORY

TABLE 1
OVERVIEW OF HOME ECONOMICS EDUCATION IN THE PARTICIPATING COUNTRIES

COUNTRY

Austria

To become a Home Economics teacher in Austria, a master's degree is necessary. Home Economics is primarily taught in lower secondary to students aged between 10 and 14. In vocational schools, depending on the school, it may also be taught at the upper secondary level. Most schools are either academic secondary schools (AHS), where the subject is an elective, or new secondary schools (NMS), where the subject of *Nutrition and Household*, with at least one lesson (50 minutes) per week, is mandatory; thus, leading from no lessons to 38 lessons for most students. In other kinds of schools with a more vocational focus, such as polytechnic schools (PTS), that prepare students more strictly for professional life, the subject can take different names, such as *Nutrition, Kitchen Management, Service* and might cover over 300 lessons. In vocational middle and higher schools (BMHS) or secondary schools for economic professions (HLW), Home Economics is either included in general education or as a subject covering at least 38 lessons, depending on the school's focus. The curricula for all subjects and the focus of each school are available in German and other languages used in Austria (Bundesministerium für Bildung, Wissenschaft und Forschung, 2024).

The focus

The multidisciplinary subject *Nutrition and Household* focuses on the key cultural competencies for everyday life, helping students achieve **a self-determined and responsible understanding of nutrition, health, and consumer education.**

It promotes self-awareness, responsibility, and reflective thinking about knowledge, values, and actions in the context of health and sustainability, contributing to students' active participation in society and the economy. In nutrition, health, and social well-being, the subject can help students gain skills for managing their daily eating habits, with a focus on health and sustainability, including understanding food production. Moreover, in life management, economics, and production, students can develop skills for organising their everyday life, engaging in responsible consumption and production, performing sustainable economic practices, and fostering social and cooperative relationships.

COUNTRY

Estonia

In Estonian schools, Home Economics is taught by a Handicraft and Home Economics teacher who has completed a master's degree at a university and has a teaching profession qualification. It is taught at the basic education level as a compulsory subject and belongs to the subject field *Technology* with Crafts, Handicrafts, and Technology Education (Vabariigi Valitsus, 2023). At the first level of basic school (grades 1 to 3, ages 7 to 10), Crafts is taught by the class teachers, with some topics related to Home Economics. The teaching of the main subject takes place in grades 4 to 9 (ages 11 to 16) by the subject teacher according to the curriculum.

The distribution of lessons in different grades among the subject field *Technology* is outlined in the school curriculum. Most often, there is one weekly lesson (45 minutes) in grades 4 and 9 and two weekly lessons in grades 5 to 8. The organisation of studies should ensure that students acquire the necessary knowledge, skills, and competencies in all three subjects, as they share expected learning outcomes at the end of each school level. The subjects in the *Technology* field are typically taught in study groups, which means that students can attend classes in several subjects during a year, and one exchange period can last from 8 to 15 weeks (depending on the number of changes).

The focus

By focusing on knowledge, skills, and attitudes, Home Economics emphasises **an individual's overall well-being and ability to navigate daily life.**

Through collaboration and critical thinking, students explore their potential across various domains and understand sustainability in their living environment as well as their role in fostering it. The recommended study content in Home Economics is divided into three topics: food education, consumer education, and behavioural culture. The second school level (grades 4 to 6) focuses on learning the subject concepts and mastering the essential work techniques and technologies necessary for addressing practical challenges. The third school level (grades 7 to 9) focuses on enhancing their subject knowledge and refining their practical skills through problem-solving. Moreover, the students develop their ability to analyse their behaviour and understand the consequences of their decisions.

COUNTRY

Finland

In Finland, Home Economics is taught by subject teachers with five years of university studies and a master's degree. It is taught at the basic education level as a mandatory subject, with a total of 114 study hours. Typically, it is taught in the 7th grade (students aged 13) for 3 x 45 minutes lessons, though the education providers can decide on the division of mandatory study hours, lesson duration, and elective subjects in the local curricula. Home Economics is a popular elective subject in the 8th and 9th grades (Table 1), and it is also possible to take elective lessons in the lower grades if it is stated in local curricula. The national core curriculum for basic education is designed for nationwide application (Finnish National Core Curriculum for Basic Education, 2014). In this subject-bound curriculum, each subject's tasks, objectives, and content areas are specified. In addition, the curriculum identifies transversal competencies and emphasises that learning is shaped by social interactions and constructed through shared experiences.

The focus

Home Economics education aims to develop students' knowledge, skills, attitudes, and ability **to manage a sustainable everyday life** that promotes their physical and mental well-being.

It nurtures students' development into conscientious consumers and engaged and active family and community members. The subject aims to teach

(1) practical skills,

(2) collaboration and interaction skills, and

(3) knowledge and information management skills.

The content areas connected with these goals are food knowledge and food culture, housing and living together, and consumer and financial skills at home (private economy). In Home Economics lessons, the tasks typically combine theory and practice and emphasise students' ability to work collaboratively in the classroom.

COUNTRY

Norway

In Norway, no formal qualifications are required to teach Food and Health in grades 1 to 7. While having at least 30 ECTS credits to teach the subject in grades 8 to 10 is recommended, this is not a mandatory requirement. A minority of teachers teaching the subject have academic qualifications in Food and Health, constituting a group that would particularly benefit from a handbook with teaching material tips. At the elementary level, 75% of teachers delivering food and health education lack the necessary credit points. Middle and secondary school numbers are 46% and 47%, respectively (Arnesen et al., 2023).

Food and health lessons are taught at the basic education level and are compulsory for all students. The subject is usually taught in the 4th (students aged 9), 6th, and 9th grades, with a total of 114 hours in grades 1 to 7 and 83 hours in grades 8 to 10. In 4th grade, students typically have one lesson hour per week, but most schools combine all these lessons into a monthly practical session lasting 3 to 4 hours. In 6th and 9th grades, 2 to 3 hours of lessons per week throughout the school year (38 weeks) are commonly scheduled.

The focus

The core curriculum for basic education is designed for nationwide application. Students have competence aims and assessments after years 4, 7, and 10; they are expected **to develop life skills by learning to plan healthy meals, cook, and enjoy meals with others.**

The core elements of the subject are a healthy diet, sustainable food habits and consumption, and an understanding of food and meals as an expression of identity and culture (Ministry of Education and Research, 2019). The curriculum focuses on two interdisciplinary topics: sustainability and healthy life skills, and the STEAMKitchen offers new opportunities for interdisciplinary collaboration.

SIMILARITIES BETWEEN
the Participating Countries

Austria, Estonia, Finland, and Norway include Home Economics in their education systems, each with unique emphases. Norway's *"Mat og helse"* begins in basic school, focusing on nutrition and food preparation. Finland's *"Kotitalous"* and Estonia's *"Kodundus"* prioritise practical skills and sustainability, with Finland emphasising the skills needed for leading an independent life. In Austria, Home Economics is taught at various school levels, with the curriculum integrating modern technology and focusing on skills such as digital nutrition counselling and sustainable household management.

All the countries integrate sustainability and health education in their curricula, ensuring that students develop practical skills alongside theoretical knowledge. The skills in this context refer to cooking and budgeting, including broader attributes, such as critical thinking and problem-solving, which are critical for applying one's learning effectively in various situations. Home Economics supports students' growth into responsible consumers, and active family, home, and community members.

In all participating countries, Home Economics education aims to give a comprehensive understanding of sustainability challenges through a holistic approach, integrating practical skills with critical thinking.

In all the countries, Home Economics education emphasises the development of competencies, aiming for a comprehensive understanding that integrates practical skills with critical thinking on sustainability in everyday life. Even when Home Economics is taught separately, it demands fostering interdisciplinary learning and teacher collaboration. The overarching goal of the subject is to address sustainability challenges through a holistic approach.

The common goal is to address **sustainability challenges** and develop practical skills

FROM STEM TO **STEAM**
Advantages and Benefits

Integrating art and design thinking into STEM education **promotes creativity, communication, cooperation, and critical thinking.**
(Wittayakhom & Piriyasurawong, 2020)

For example, incorporating ethnomathematics – combining subject knowledge and cultural considerations – familiarises students with diverse ways of thinking and helps them develop knowledge in different sociocultural contexts (Rosa & Orey, 2021). This interdisciplinary approach, incorporating arts into STEM to create STEAM, fosters a more holistic understanding (Liao, 2016).

While STEM provides solutions through critical thinking and technological knowledge, STEAM incorporates cultural and artistic approaches, enhancing creativity and emotional engagement. STEAM encourages creative expression and a deeper understanding of diverse perspectives using arts-based methods such as visual storytelling and design thinking that consider local historical and cultural contexts. STEAM addresses this through its novel approaches that emphasise the interactions between learners, teachers, and tasks, resulting in unique and creative outcomes.

DISCIPLINARY | **MULTI**DISCIPLINARY | **INTER**DISCIPLINARY | **TRANS**DISCIPLINARY

FIGURE 2
DIFFERENCES BETWEEN APPROACHES

While STEM education is multidisciplinary or transdisciplinary, focusing on individual subjects and traditional problem-solving methods, **STEAM incorporates the Arts to promote inter- and transdisciplinary learning, generating broader, more creative, and personalised problem-solving approaches** (Figure 2). In STEAM, the Arts act as a unifying force, bridging and connecting different subjects.

- **STEAM goes beyond knowledge acquisition**, focusing on helping students apply their skills to real-world challenges through projects, such as designing sustainable housing or exploring biodiversity (see the "Cooking Salmon with Heat and Acid" activity; Figure 6, page 30).
- **STEAM encourages holistic education.** By blending arts with STEM, STEAM fosters creativity, problem-solving, and critical thinking, thus promoting learning through experimentation, inquiry, and concrete activities and engaging students with real-world challenges from multiple perspectives.
- **STEAM enhances critical and creative thinking**, which are essential for solving complex problems. The inclusion of arts allows students to explore and express their ideas innovatively, thus fostering a more comprehensive understanding of the subjects involved. It also helps students attain essential 21st-century skills, such as collaboration, communication, critical thinking, creativity, and digital literacy, thereby effectively preparing them for future careers.
- **STEAM incorporates ethical and cultural dimensions** to offer an enriched learning experience. By exposing students to traditional ecological knowledge, for example, STEAM helps them deepen their critical thinking and cultural awareness.
- **STEAM creates an engaging and inclusive learning environment** by addressing various learning styles and encouraging students to participate actively in their education. It fosters resilience and helps bridge the gender gap in STEM fields.
- **STEAM learning happens everywhere**, from classrooms to museums. Schools often integrate STEAM into their curricula through interdisciplinary projects, but it can also extend to after-school programmes, online platforms, and collaborative spaces where students can engage in real-world problem-solving.
- **STEAM emphasises active learning**, with students taking on roles such as investigators and designers, while teachers act as facilitators. This dynamic shifts the focus to collaborative learning, where both students and educators grow through mutual discovery.
- **STEAM involves integrated technologies** and inter- or transdisciplinary approaches, enabling students to develop creative solutions and take ownership of their learning process.
- **STEAM views failures as integral and as learning opportunities**, encouraging students to experiment, prototype, and iterate and learn from their mistakes.

By blending arts with STEM, STEAM encourages **holistic education** and enhances **creative thinking**

The scenarios in our project have the following attributes:

1 **Multiple Aspects of Arts**

Incorporating design, culture, history, and local customs, such as using local ingredients and presenting projects in the context of local culture.

2 **Complexity**

Encouraging multidisciplinary approaches and challenging students to develop inter- or transdisciplinary solutions.

3 **Reflection**

Promoting communication and collaboration through group work and enabling students to reflect on and understand complex topics with empathy for different perspectives.

4 **Tangible Results**

Allowing personal expression and ownership through non-deterministic, visible, or tangible results that can be shared and reflected upon, thereby fostering creativity and critical thinking.

As STEAM education evolves, **strengthening inclusivity** remains a critical goal

Historically, STEM fields have witnessed gender imbalances, with one gender pursuing careers in science and technology more than the other. By integrating arts and emphasising collaborative, project-based learning, STEAM attracts all genders. For instance, encouraging children who favour arts to participate in engineering projects while highlighting the artistic and creative aspects of STEAM activities ensures a broader appeal. Similarly, introducing students to the aesthetic and practical aspects of home and design promotes a more equitable learning environment. These approaches promote gender balance and prepare every student to thrive in diverse and interdisciplinary scenarios.

STEAM
in Austria

Cross-curricular themes spanning multiple subjects encourage students to learn **beyond subject-specific boundaries.**

In Austria, STEM subjects are a focus in teacher education, hoping to attract children to technology, natural sciences, or mathematics from an early age. Special efforts are being made to attract more women to STEM fields, and the government has created a strategy for research, technology, and innovation that focuses on STEM knowledge, talents, and skills. However, STEAM is yet to have a similar focus as STEM in the Austrian educational system. Pre-service teachers cannot major in STEAM but can attend courses that focus on STEAM subjects. Additionally, to promote transdisciplinarity, secondary teachers must major in two subjects. Pre-service teachers majoring in Home Economics and Mathematics exist but are rare.

Overarching topics, previously called educational principles, include teaching students to think interconnectedly. The Austrian Ministry of Education created these principles to nurture STEAM education. Cross-curricular themes spanning multiple subjects encourage students to learn beyond subject-specific boundaries. Competencies in socially relevant areas can be developed effectively through interdisciplinary approaches, especially in STEAM.

Thanks to the governmental special programme, some schools and kindergartens started focusing on STEM subjects and having a double weekly lesson as part of the timetable and curriculum. Some schools also have a STEAM curriculum from Grade 5, extending to school leavers and offering various labs in upper secondary school classes, and even a STEAM-focused final exam. These actions are part of a longer project which is still in the experimental phase. However, at most schools, motivated teacher groups organise STEAM projects, collaborating with school interns, local companies, or other schools.

Following the government's initiative to bring STEAM subjects closer to students, numerous research groups are pursuing STEAM projects. The Johannes Kepler University (JKU) plays a leading role, partnering with Ars Electronica JKU in the "STEAM Lab", where schools can participate in STEAM workshops. However, despite active pedagogical research, more attention is needed in teacher training and school practice to fully integrate STEAM into the curriculum. Moreover, since many in-service teachers did not experience transdisciplinarity during their education, additional materials and courses are essential for them to learn about STEAM.

STEAM
in Estonia

Integrated learning across various subjects through common themes, projects, and cross-disciplinary approaches.

In Estonia, STEAM education is often referred to as MATIK, which is considered to be more like STEM, and the Arts (i.e. "K" in the Estonian acronym), although present, are often overlooked. It focuses on integrating subjects instead of teaching them as standalone courses. The Estonian National Curriculum for Basic Schools promotes integrated learning across various subjects through common themes, projects, and cross-disciplinary approaches. This approach encourages teachers' collaboration and offers students a holistic educational experience.

The Ministry of Education's Educational Development Plan 2021–2035 emphasises the development of general competencies, including mathematical, scientific, and technological literacy. Students are expected to use mathematical language and methods in various contexts, understand scientific models, make evidence-based decisions, and recognise the influence of science and technology in our society. The plan also promotes the purposeful use of new technologies to support learning objectives.

Teacher training universities in Estonia, such as Tallinn University, have adopted approaches based on the STEAM framework to ensure integrative science teaching and learning. Tallinn University established EDUSPACE, a dedicated facility for STEAM learning that hosts courses and in-service training and conducts research on STEAM pedagogies. EDUSPACE also provides schools with materials and tools for integrative lessons, including robotics and coding. Collaborations with Estonian EdTech start-ups have resulted in new products and tools for STEAM education, enhancing its implementation in schools. Several EdTech start-ups aim to improve teachers' digital skills through innovative training and collaboration, thereby benefiting teachers in Estonia as well as the rest of the world.

The Centre for Innovation in Education at Tallinn University advances innovative educational approaches by focusing on curriculum innovation, open learning environments, and interactive teaching methods. Estonia also encourages students to participate in extracurricular competitions and events, such as the Rakett69 TV program, and join organizations such as the AHHAA Science Centre and HK Unicorn Squad that offer opportunities to showcase their STEAM skills and participate in various learning experiences.

STEAM
in Finland

Emphasis on **multi- and interdisciplinary approaches** to learning and problem-solving skills with focus on critical thinking, creativity and communication.

Finland is renowned for its strong education system and master-level teacher education for all teachers, from kindergarten to upper secondary education. It nurtures a solid commitment to the research-based development of teacher education and classroom pedagogies. The Finnish National Core Curriculum strongly emphasises multi- and interdisciplinary approaches to learning and problem-solving skills, which are fundamental to STEM and STEAM education. Moreover, it focuses on fostering critical thinking, creativity, collaboration, and communication skills – all essential for success in STEAM fields. Rather than being taught as separate subjects, STEAM concepts are integrated across various subjects, encouraging students to establish connections between different disciplines. The autonomous teachers and teacher teams at the school or the municipality and city level set the learning opportunities and goals. An example of a city-level process is the STEAM in Oulu working model (https://www.steaminoulu.fi/in-english/).

At the school level, teachers have the autonomy to design learning experiences that incorporate STEAM principles in their teaching practices. Project-based learning and inquiry-based approaches are commonly used to engage students in practical activities that integrate STEAM concepts. Schools are encouraged to collaborate with local industries and community organisations to offer real-world contexts for learning and expose students to STEM- and STEAM-related careers.

Finland has various national initiatives to promote STEAM learning among its students and upgrade its teachers' skills. Government-sponsored initiatives provide funding and resources to support schools that implement innovative STEAM programmes and projects. For example, the LUMA Network of Finnish universities offers STEM and STEAM facilities at several universities and technical universities, providing students with opportunities to experience university research and product development through laboratory work and workshops. The national initiatives also offer teacher training courses and programmes. Finland also participates in international collaborations and initiatives to advance STEAM education globally, contributing its expertise while learning from other countries' best practices.

STEAM
in Norway

Significant shift in educational policy towards adopting more **practical and problem-based approaches.**

The current educational landscape in Norway reveals a growing alignment with STEAM principles, although the Norwegian national curricula do not explicitly emphasise the STEAM framework. There is a significant shift in educational policy towards adopting more practical and problem-based approaches, particularly in STEAM subjects, which have been traditionally taught in a theory-driven manner. This shift supports the integration of STEAM methodologies into education.

Regarding teacher training, the national guidelines and frameworks provide some support for equipping pre-service teachers with STEAM-oriented mindsets, although they currently lean more towards STEM-focused education. Fortunately, the upcoming revisions to these guidelines are expected to incorporate STEAM-related elements, such as contextualising science within societal issues, applying transdisciplinary thinking, and promoting inquiry-based educational strategies.

The practical implementation of these STEAM principles can be seen in teaching natural science disciplines, which are offered as a unified subject from grades 1 to 11. This structure presents ample opportunities for interdisciplinary approaches, as the curriculum encourages the contextualisation of scientific concepts using real-world problems.

The recent curriculum reforms have also introduced overarching themes such as sustainable development, democracy and citizenship, and health and life skills. Each subject interprets these themes to varying extents, fostering integration between sciences and subjects such as Home Economics and the Arts.

Norway's educational system strongly focuses on cultivating critical thinking, problem-solving, and analytical reasoning skills within STEAM subjects, and this aligns well with its broader holistic and interdisciplinary education goals. The emphasis on collaboration and integration across disciplines makes STEAM education suitable for the Norwegian context.

CONNECTIONS BETWEEN
Home Economics and STEAM

At school, we can arrange learning activities where the art of cooking is combined with an understanding of complex scientific principles. At home, these principles become meaningful: various everyday household tasks can be connected to the school-learned principles of biology, chemistry, mathematics, or physics. This is the potential of integrating Home Economics with STEAM education. By merging these disciplines, we can create interdisciplinary experiences that connect deeply with students' lives, both in and out of classrooms. We aim to achieve a future where students are equipped with the knowledge and skills to tackle real-world challenges and thus make their education relevant.

Integrating Home Economics with STEAM education creates interdisciplinary learning experiences that are connected to students' everyday life tasks and that incorporate creativity, scientific knowledge from biology, chemistry, and physics, technological advancements, cultural awareness, mathematical precision, and sustainability.

The examples in Figure 3 (next page) demonstrate how the fundamental principles of STEAM subjects such as chemistry and physics are essential to many everyday tasks (e.g. problem-solving in the kitchen), thus reinforcing the interdisciplinary nature of Home Economics.

STEAM education can offer many advantages, such as connecting to students' lives outside schools and fostering their communication, creativity, collaboration, and critical thinking skills (Trilling & Fadel, 2012). Kit Ng et al. (2022) have written about pedagogical settings in which teachers use technologies in project- and problem-based learning, maker- and design-based learning, and collaborative learning. These projects can be extended to solving complex challenges that students bring to classrooms, thus extending towards more transdisciplinarity (Meletiou-Mavrotheris et al., 2022). We thus aim to combine STEAM approaches with Home Economics in activities teachers can use in their lessons to use concepts from STEAM subjects as well as Home Economics.

We aim to achieve a future where students are **equipped with the knowledge and skills to tackle real-world challenges** and thus make their education relevant.

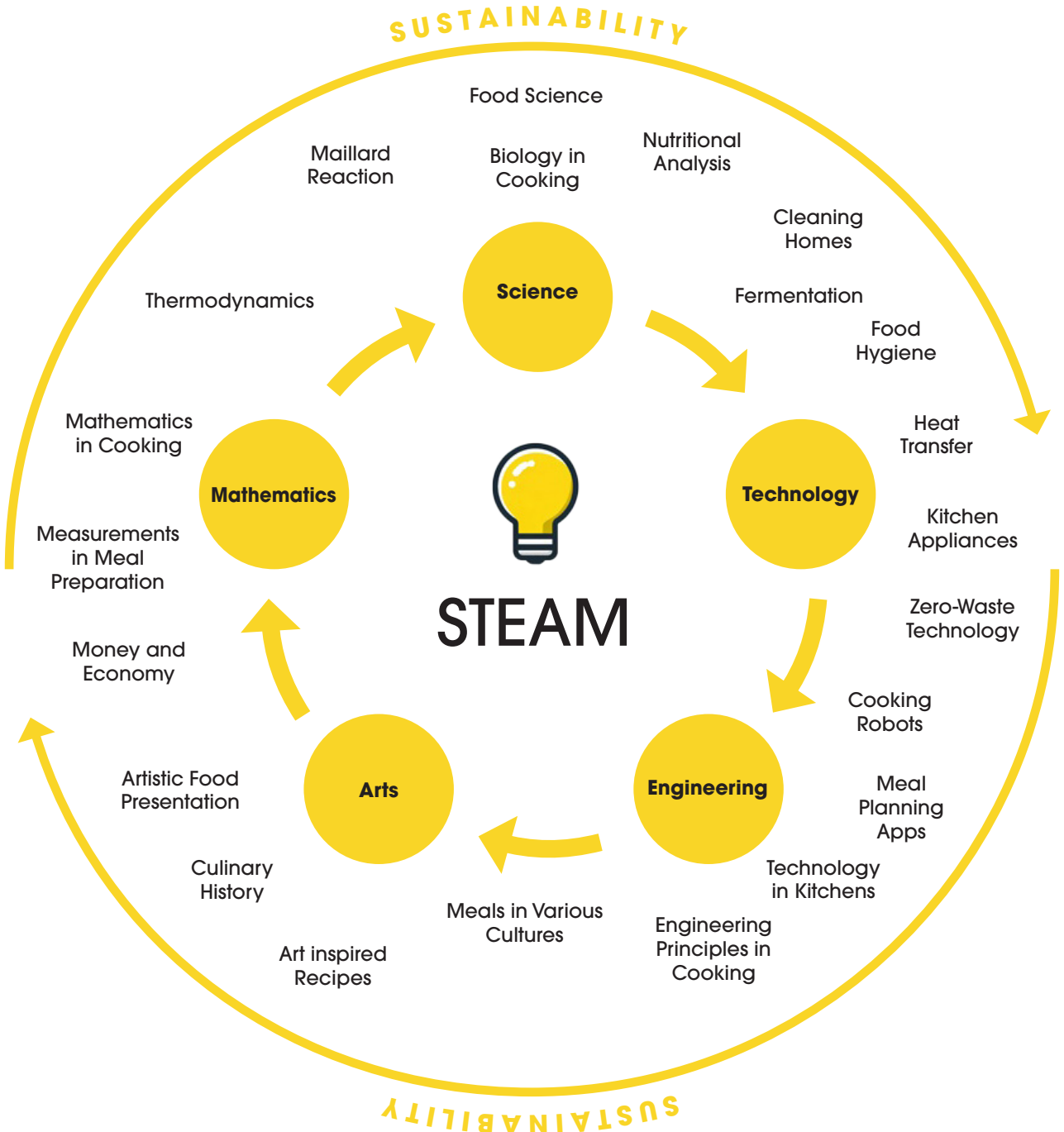


FIGURE 3

SUSTAINABILITY THEMES AND STEAM PRINCIPLES IN HOME ECONOMICS

STEAM Principles in HOME ECONOMICS

By integrating Home Economics with STEAM, students can gain a comprehensive understanding of, for example, cooking and food preparation, including the role of creativity, scientific principles, technological advancements, cultural awareness, and mathematical precision. Figure 3, previous page

By exploring the **science behind cooking and baking** through experiments (see the "Gluten Formation and its Role in Dough" activity; Figure 5, page 29), students can enhance their understanding of the processes involved. One area of focus is the chemical reactions during cooking. Students can conduct experiments to observe phenomena such as caramelisation, fermentation, and the Maillard reaction. For example, they could compare the textures and flavours of various types of bread made using different leavening agents.

Nutritional analysis involves examining the nutritional content of various foods and recipes to better understand their ingredients. This helps students make informed decisions about their diet and health. They can calculate each dish's calories and macro- and micronutrients using software or apps. Such a detailed analysis provides insights into the nutritional value of the foods they consume. Students can **modify traditional recipes** to make them healthier by reducing sugar, fat, and sodium while maintaining the flavour and texture. This promotes healthier eating habits and encourages the awareness of seasonal and regional ingredients for improved sustainability.

The kitchen thus becomes a chemistry and biology lab, where cooking involves captivating chemical reactions. Understanding the **chemistry behind cooking** enhances a student's culinary skills and deepens their appreciation of food science. Exploring such reactions allows students to experiment with ingredients and techniques, leading to a more comprehensive understanding of food science and its applications in **cleaning, preserving, and creating homemade products**.

Physics in the kitchen offers a new perspective on how we cook and maintain our homes. From understanding the mechanics of slicing and chopping to observing the thermodynamics of cooking, physics offers insights into the processes that make our everyday tasks more efficient and effective. For example, studying heat transfer can explain why certain cooking methods, such as frying or baking, yield different results. Pressure, temperature, and wave physics principles can be explored through pressure cookers and microwave ovens. Integrating physics into Home Economics can thus help students understand the forces and energy at play in the kitchen.

Technology significantly improves cooking and kitchen management. Using advanced tools and devices, students can gain precision and efficiency in their culinary activities. **Smart appliances**, such as sous-vide machines, smart ovens, and induction cooktops, enable precise cooking and improve dish quality and consistency. **Cooking apps** and software aid in recipe management, nutritional analysis, and meal planning, and digital cooking tools, such as thermometers and scales, further streamline cooking, ensuring accuracy and efficiency.

Applying engineering principles and design concepts allows students to create functional and innovative kitchen environments. By considering ergonomics and efficiency, they can design optimal kitchen layouts that maximise workflow. Investigating the **engineering behind kitchen tools** and appliances, such as pressure cookers, can help students appreciate technological advancements and improved cooking outcomes.

Artistic food presentation explores the creative, aesthetic, and gustatory aspects of cooking. Students can apply design principles to create visually appealing dishes, learn plating techniques, and delve into **culinary history and culture**. Through cultural cooking classes, students can prepare traditional dishes, learn about their significance, and research the history of ingredients.

Integrating mathematics into cooking and meal planning enhances students' understanding of its practical applications. By incorporating concepts such as ratios, proportions, and budgeting, students can develop valuable skills. For example, adapting recipes for different group sizes can help them understand mathematical concepts in a real-world context. By **calculating the cost** per serving of different recipes, students can learn about financial planning and make informed decisions about cooking and meal preparation.

Any learning environment, such as a kitchen, becomes a well-equipped **makerspace** where practical skills and scientific knowledge converge. Maintaining a home requires an **understanding chemistry, physics, and technology** for tasks such as cleaning, household repair, ventilation, and efficient energy use, thus highlighting the interdisciplinary nature of Home Economics.

What is a makerspace?

Any space can be a makerspace: **a classroom, a kitchen, or even the woods**

The key ingredients are the participants (a group of students, pre-service teachers, or teacher trainers) working on a shared project, the task itself, and the necessary equipment. A classroom becomes a makerspace when students are designing invitation cards for a style party, a chemistry lab while dyeing cloth, and a forest when exploring how bees produce honey. Equipment in a makerspace can include anything from cleaning materials and cooking utensils to paper, pencils, and even chemicals for analysing ingredients. Any equipment can be considered appropriate in STEAMKitchen depending on the safety regulations of the respective places and the activities teachers choose to conduct. A makerspace might utilise complex technology such as 3D printers for food or simple tools such as cookie cutters and pencils. It is crucial to consider hygiene and safety guidelines, which should be established and monitored by the activity leader.

In makerspaces, we **create, analyse, observe, and experiment**

While labs and makerspaces have differences, they overlap in terms of **creativity, experimentation, and tool use**. A kitchen, depending on the activity, can be both. It can function as a lab when exploring the chemical reactions of cooking or experimenting with different techniques (see the "pH of Detergents with Red Cabbage pH Indicator" activity; Figure 8, page 31). A trip to the woods turns the woods into a makerspace when students create objects using natural materials and gain knowledge about the process and environment. Makerspaces prioritise creativity and learning through doing. We thus consider each place where objects or experiences can be created a makerspace. While labs usually focus on more analytical approaches following special methods to verify certain ideas, every surrounding, depending on the needs of the teacher and students, can serve as both a makerspace or a lab in STEAMkitchen.

STEAM KITCHEN

Integrating HOME ECONOMICS and STEAM

Task Idea Examples

The following examples demonstrate how integrating Home Economics with STEAM education and vice versa can create engaging, interdisciplinary learning experiences. The complete experiment manuscripts are available in the STEAMKitchen handbook.

While some activities show how Home Economics concepts can enrich STEAM, some others show how STEAM subjects can enrich Home Economics. The detailed learning activity descriptions are published as a handbook, which discusses the age group of the students, activity length, learning goals, and other necessary information. Additionally, clear and comprehensive guidance, along with supporting visual materials, will provide teachers with valuable insights and flexibility in adapting the activities to their specific teaching contexts.

STEAM and Home Economics

Generating activity ideas that integrate STEAM and Home Economics requires brainstorming between teachers from both disciplines to identify relevant questions and ensure curriculum alignment. Adapting learning plans and finding suitable time slots can be challenging, so timely communication and collaboration between teachers is crucial.

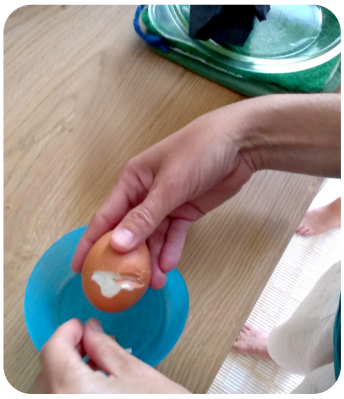
Task Idea Example
Sun, Water, and Wind

This activity integrates science, technology, and Home Economics by **connecting the concepts of renewable energy**, such as solar power and climate change, **with cooking** and the use of solar technology.

The participating students wrap an egg in black paper, cover it with two glass bowls, and place it in the sun. After two and a half hours, the egg is hard-boiled, demonstrating the power of solar energy. This is followed by discussions on constructing a sun-powered oven, and students bake windmill-shaped biscuits to connect their culinary activities to wind energy, further linking science to food preparation (Figure 4).

FIGURE 4

COOKING WITH SOLAR ENERGY



Task Idea Example

Gluten Formation and its Role in Dough

This activity helps students understand **gluten formation** from different types of flour and its role in baking.

It integrates biology and chemistry with Home Economics by investigating the protein structures in flour and their impact on the baking process. Students experiment with various types of flour, including barley, rye, and wheat, to make dough balls. Then they wash out the starch, leaving behind the gluten mass, which they bake in the oven (Figure 5). This helps students visually compare which flour types form the strongest gluten network. Based on their findings, they choose the most suitable flour for making strudel, illustrating the practical importance of gluten for baking.

FIGURE 5

DOUGH, GLUTEN, AND STRUDEL MAKING

Task Idea Example

Cooking Salmon with Heat or Acid

This activity, initially conducted in Norway, explores the **effects of heat and acid on the denaturation of proteins** in fish, integrating biology and chemistry with Home Economics through cooking.

The activity aims to investigate how proteins change during cooking and how different methods, such as boiling or using an acidic juice, affect the salmon's texture, taste, and appearance. Students boil a piece of salmon and marinate another in lemon or lime juice for 30-60 minutes. They observe that, while both methods cause changes on the fish surface, the acid-treated salmon retains a raw core and exhibits a firm texture, whereas the boiled salmon becomes soft and flaky. This activity thus helps students understand how heat and acid have different effects on the protein denaturation process and offers insights into the science behind standard cooking methods (Figures 6 and 7).

FIGURE 6

PREPARATION OF SALMON WITH HEAT

PREPARATION OF SALMON WITH ACID

FIGURE 7

Task Idea Example

pH of Detergents with Red Cabbage pH Indicator

This activity, which integrates chemistry with Home Economics, introduces the **concept of pH** to students.

It involves the use of a homemade red cabbage indicator to test the pH levels of different cleaning agents. The activity aims to investigate the pH of common household cleaners and to understand their properties in relation to surface cleaning and their environmental impact. Students prepare a pH indicator solution by soaking red cabbage in warm water. Then they test substances with known pH values, such as lemon juice, water, baking soda, and laundry detergent, to establish a pH scale, using which they test three mystery cleaning agents: an acidic toilet cleaner, a neutral dish soap, and an alkaline dishwasher detergent (Figure 8). After determining the pH of each product, the students match the cleaning agent to its correct packaging and reflect on the environmental friendliness and appropriate usage of these products.

FIGURE 8

CALIBRATING THE RED CABBAGE PH SCALE AND THE THREE MYSTERY CLEANING AGENTS

WHAT
Learning Activities Can Offer

STEAMKitchen makerspaces are **dynamic environments** where Home Economics meets innovation through STEAM principles.

These inclusive spaces invite students to engage in practical, collaborative, and creative learning regardless of their background or skill level. Makerspaces foster learning experiences that enhance the understanding and application of sustainability in everyday life. For successful interdisciplinary activities in makerspaces, consider the following aspects:

Interdisciplinarity To foster creativity, activities should integrate elements from multiple subjects, including Home Economics and at least one STEAM subject. Cultural norms should be considered and made explicit to promote diverse perspectives.

Sustainability Activities should utilise local resources, including ingredients, infrastructure, and knowledge. Reusing materials and knowledge is encouraged, and waste should be minimised by using seasonal and regional products.

Economy Regional and cultural contexts influence access to and affordability of resources. Activities should reflect these considerations.

Connections to Curricula Activities should be connected to both Home Economics and STEAM curricula. The key skills are identified to help teachers align activities with their curricula.

Timely aspects Time estimations for the activities are provided along with suggestions for optimal timing and duration.

Safety and Regulations While many regulations are based on European Union policies, their local implementations may differ. Safety guidelines are provided, and teachers are responsible for ensuring students' safety during activities.

Skills and Age Groups Information about the supported skills and suggested age groups is included to help teachers integrate activities into their lessons.

Processes and Roles Learning activities are clearly explained to support effective implementation and encourage collaboration while exploring new concepts and solving tasks.

IMPLICATIONS
and Recommendations

The STEAMKitchen bridges Home Economics with STEAM subjects, emphasising **sustainable living and practical skills**. It supports teachers by providing activities and resources that **merge theory and practice** and incorporating sustainability and gender equality to ensure comprehensive and future-oriented education.

Recommendations:

For Policymakers

Strengthen the integration of Home Economics and STEAM in school curricula by supporting policies that promote interdisciplinary learning, sustainability, and gender equality. Enhance the collaboration between teachers and schools. Develop guidelines that balance theoretical and practical content. Provide financial support for schools to acquire modern technologies and equipment for STEAM-based activities. Encourage collaboration between educational institutions and industries.

For Teacher Educators

Focus on training future educators in interdisciplinary methods that connect Home Economics and STEAM and emphasise both theory and practice. Encourage pre-service teachers to design innovative classroom projects that integrate both areas. Provide students a diverse range of teaching materials, handbooks, and digital tools, including examples of activities that promote sustainable thinking.

For Teachers

Incorporate learning activities that merge Home Economics and STEAM, independently or in collaboration with colleagues. These can include kitchen experiments, technology use, or creative projects focused on sustainable practices. Create interactive learning environments, such as "Makerspaces" in kitchens, where students learn through collaboration and experimentation. Embed topics such as sustainable food systems and responsible consumption into lessons to develop students' awareness of eco-friendly behaviour.

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Notes