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Fighting Food Waste—Good Old Boys or Young Minds Solutions? Insights from the Young Foodwaste Fighters Club

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Abstract: Food waste is a major problem, and it is estimated that 1/3 of all food is wasted. The climate crisis has fuelled an interest in looking for solutions as well as increased interest from youth to take action. School plays an important role here. The research goal was to explore that role in developing young people's engagement with food system change. The challenge of food waste was used as a case to create new solutions, while at the same time to create learning. The YouFoo Club program was used for the study and included 4 schools. It built on Project Based Learning, the Knowledge Triangle, and the concepts of 21st century skills; took advantage of scientific and digital principles; ran for 8 weeks; and concluded on International Food Waste Day. A sample of schools was recruited, the process was structured as a case competition, and the end goal was to present the solutions at the final event. The research shows that it is possible to bring youth into solution making, that the process contributed to learning, and that it fitted well with principles of Education for Sustainable Development. The following were found to be drivers: understanding evidence and knowledge, insight into digital technologies, the possibility of being able to work with mentors and role models, the possibility of participating in external projects, the setting of clear performance-oriented end goals, and the understanding of the importance of developing science communication skills.

Keywords: food waste; food systems literacy (FSL); young minds solutions; school; mentoring; STEM teaching; project-based learning; Whole School Food Approach (WSFA)

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1. Introduction

Food waste and losses have been globally recognized as one of the most serious threats to the resilience of the food system. Food waste is becoming a global issue, and it has been estimated that one-third of all the food produced worldwide for human consumption is wasted every year along the food supply chain, while a large number of people still do not have enough food for an active and healthy life [1]. This corresponds to a loss of over USD 1 trillion according to the World Bank. Food waste is a huge societal problem globally, significantly challenging the current climate action goals [2,3]. According to Scherhaufer et al. [4], an estimated 88 $\times$ 10^6 tons of food is wasted in countries across the European Union each year. This has significant impacts on important environmental indicators such as Global Warming Potential (GWP), Acidification Potential (AP), and Eutrophication Potential (EP). According to Scherhaufer et al. [4], the annual food waste in Europe corresponds to 1.7 $\times$ 10^6 tons of SO_2 emissions and 186 $\times$ 10^6 tons of CO_2 emissions. According to Beretta et al. [5], it may be estimated that one-quarter of the climate impact of food consumption is caused by food waste.

Public awareness of food waste and support for food waste mitigation measures have been increasing [6], not only by consumers but also among actors in the different sectors of the food system. Food waste mitigation has been studied in various sectors, including food service and hospitality [7–9], as well as in retail [10–14]. In particular, the fruit and vegetable value chain has been studied. Food waste in domestic settings is also a growing research field [15–17]. Altogether, studies have pointed to the fact that values, attitudes,

personal beliefs, and habits play a major role in food waste mitigation and can serve as hindrances to food waste reduction behavior. As a result, population strategies are of great importance. In particular, intervention at an early age and in school settings might provide a key way to invest in the long-term mitigation of food waste. As, in many countries, pupils experience food service at their daily lunches, the school food service is relevant to look at in relation to the teaching of food waste reduction. For instance, [18] have studied food waste at a school and found that up to half of the food was wasted.

As young people are those who will be most seriously affected by adverse climate impact in the future, it comes as no surprise that young people are increasingly engaging in the climate debate and showing interest in contributing to the development of solutions [19–26].

The voices of young people have been permeating the public climate debate for quite some time, seemingly having contributed to making significant changes in how societies think about the grand challenges of our time, as well as how strategies and actions can be initiated [24,25]. Traditionally, societies have relied on the idea that with age and experience comes knowledge, insight, and power. However, the emerging field of youth research has pointed to the fact that this generational balance seems to be shifting in the favor of youth. In particular, the climate crisis has shown that young people not only can come up with new ideas but also want to have a say in the decisions that will influence their future [23,24]. Young people in higher education already contribute ideas and evidence in case competitions, enter internships with companies, and conduct graduate and doctoral research. However, so far, the role of primary education in innovation has not been studied or reported to a large extent. Obviously, primary school plays an important role, as this is where youth spend a great part of their daily lives; as such, the idea that school deserves to be an important part of the local ecosystem regarding both food and knowledge has spread [27–30]. Recent insights from youth and climate research have contributed to an improved understanding and, in particular, determining the role that schools can play in developing the engagement of young people in food system change. The climate crisis has, at the same time, introduced a need for solutions, and this new solution-oriented approach has spread to the educational system. However, few studies have focused on the roles that youth can play in creating solutions that can help to transform the food system and, in particular, the role that school can play in this learning and transformation process.

Against this backdrop, and with food waste as the object, the purpose of the Young Foodwaste Fighters Club study—in short, the YouFoo Club study—was to explore the reach of using the learning space that exists in school and around youth to create new ideas toward solutions for food waste mitigation. An important part of the research was to explore to what degree such new solutions could contribute to a new type of food system literacy training, as well as to study the importance of such solutions in the overall discussion regarding food system change.

2. Conceptual Foundation

The work is inspired by two main pillars of social phenomena: the increasing engagement of youth in climate action and the increased interest schools have been taking in climate education.

Although the adult generation has pointed out that there is a widespread lack of democratic and political involvement [31] among young people, it is clear that, in recent years, we have seen a dramatic change in the engagement of young people in climate change issues [24,30,32,33]. As food accounts for about one-third of man-made climate impact [34] it can be speculated that there is also increased youth engagement in changing the food system to a more climate-friendly one. Research has shown that involving young people in design processes as co-creators offers various advantages [35,36] and, in the case of food, work has been carried out to develop design and science learning at school as leverage for creating a new type of food literacy that is more focused on systems thinking [26,37]. According to Jerneck [38], in terms of youth participation, a new engagement seems to

have developed in the wake of the financial crisis that began in 2008, which has led to an increased interest in future scenarios of social development and job opportunities [38]. The youth climate movement "Fridays for Futures," which emerged as young people became increasingly worried about issues such as climate change [20,39], is one example of such youth engagement [25,40], which indicates a lack of governmental and institutional commitment to transformative change [41]. The emergence of the new Generation Climate has followed in the wake of the Greta Thunberg movement—a generation that seems to be much more oriented toward finding solutions. As the relationship between food and climate is obvious, some programs have been trying to explore this connection in more detail. According to studies conducted by EIT Food [42] and Food Tank [43], important components of young people's expectations in the domain of future food systems can be summarized as follows: to be part of the solution; to have better labeling on products; to have better advice on the link between diet and mental health, clearer overall health, and nutrition advice; and information increased access to safe and nutritious food, improved food system resilience, and a healthier and sustainable production and consumption regime. Studies have shown that young consumers tend to practice a more sustainable lifestyle when it comes to food consumption. For instance, data from COOP and the Danish Vegetarian Association have demonstrated that the proportion of consumers that are partially or fully vegetarian is higher in the young consumer segment [44].

Integrating Climate Education and Education for Sustainable Development (ESD) at school is not a novel concept. Ever since the UN framework for ESD began to spread in the educational system, schools have increasingly begun adapting to the climate agenda. School climate education, the SDGs, and sustainable development have long been at the center of a debate regarding the role that schools should play when it comes to the "grand challenges" of not only society but also mankind. As argued by Klafki, the environmental challenge is a prime example of an overarching, epoch-making key issue that the school must be engaged in; in his work on the "Schlüsselprobleme" of mankind, Klafki [45] has argued that not only does the school have a moral responsibility to educate young people about environmental issues, but that these issues also provide good learning if topics are familiar to students and selected from areas that students can relate to. It also means that topics should be both time-typical and universal, and that they do not necessarily have a given answer in advance. Klafki talks about these as epoch-making key problems and includes environmental issues and modern communications technology as examples [45]. In parallel with the increased youth engagement in climate mitigation strategies, schools have increased their engagement in what has been coined as Education for Sustainable Development [46]. In essence, ESD transcends the one-directional delivery of knowledge and is not restricted to only the formal education environment but can be applied to all kinds of learning settings, be it informal or non-formal educational settings such as business organizations, media, community organizations, and civil society associations [47]. Increasingly, schools are now naming the SDGs as an overall transversal principle that should permeate the entire curriculum. Keeping in mind that almost half of the SDGs are related to food in some form, this opens interesting avenues for integrating food into this kind of teaching.

3. Methods

We developed our research case around the idea of the Young Foodwaste Fighters Club (YouFoo Club), as an experimental framework through which we could study how young minds operate at school. The research was developed from previous experiences in the Young Minds Food Lab and culminated at International Food Waste Day on 29 September, 2020. The day was initiated by the FAO and, in Denmark, is celebrated by the Ministry of Food, Agriculture, and Fisheries as an event. One of these was a young people and school event, where pupils from schools presented their solutions to a delegation of the food minister and other high-level politicians, as well as journalists. The overall principle of

the YouFoo Club builds on some of the insights that have been created in the development of the Young Minds Foodlab (YouMiLa.dk) and the SESAM programs [23,26,29,37,48].

For the program, a sample of schools was recruited over the spring and summer of 2020, using the concept of project-based learning as the main principle. We structured it as a case competition, where the end goal was to be able to step forward and present their solutions at the final public event in a one-hour time slot to a selected audience. All schools worked with the project for an average of four sessions from mid-August to late September, each being 2–3 h (including breaks).

For the program, we developed close co-operation between the PI, a group of senior mentors, and undergraduate students from the Global Nutrition & Health (GNH) program. These are referred as program junior mentors. The program was built on the conceptual idea of Open School. After refining the plan and recruiting schools for the event, the project supervisor and junior mentors went to visit the schools in person. A central element in the concept was to develop the ideas together as a dialogue and in a co-creational manner. We developed as a starting point an approach in which we formed a list of basic ideas that could be discussed with teachers.

We used, for four schools as listed in Table 1 and initiated the process with an ideation phase. The junior mentors from the University College, worked over 8 weeks refining and going through feedback cycles with the teachers and pupils at the schools. During the ideation and development process, the interns collected data through informal interviews [49] with the teachers involved. All interview parts of the meetings were recorded. The questions for the interviews were focused on the following topics: their impression and attitude toward working with external mentors, their ideas and views on working in a student-driven mode aiming to create "real solutions," their views on the "practice first, theory next" approach, and their views on working with food as part of SDG and ESD education. The purpose of the challenge-based approach with a final event was to set a project-oriented goal and facilitate a process that could be studied with the participating teachers as the main informants.

Table 1. Participating schools. The table shows an overview of the four schools that participated in the YouFoo programme as well as their characteristics and the context in which the programme was fitted into.

School Name	Project Context	In- or After-School
Kokkedal	Math and science teachers. Open activity for 8th graders, 5th and 3rd graders, and 2nd graders—science club.	An after-school club activity
Lindevang	The school has food literacy as one of its priorities and runs a school educational garden. It specializes in programming, microbit teaching, and coding. It hosts the Coding Pirates after-school club on its premises.	An after-school club activity
Nærheden	The Foodlab is a fully equipped semi-industrial kitchen and is part of the newly built Læringshuset ("the Learning House"). The school is built entirely for project-based learning (PBL).	In-school activity
Dansborg	"La Villa" is an old school janitor building adjacent to the school. It has been turned into "Studio 17," and functions as a science club, both in school and after school hours.	In-school activity

The approach focused on the development of specific learning workstations designed for science, included a digital component, and was linked to food waste mitigation. A lead teacher at each school was appointed with the responsibility of running the project at their school in cooperation with and guided by the project coordinator (i.e., the PI), the mentors, and the junior mentors. We used a multiple case study research structure with four different schools. All schools had been selected from a larger pool of schools, and all had some kind of tradition and experience in working with food system issues.

4. Inclusion and Enrollment of Schools

The formal inclusion criteria for the schools were that they would be interested in developing lesson plans around a learning station, that they should have a responsible teacher willing to organize the project environment, that they should be backed up by the headmaster, that they should be willing to participate in the challenge, and, if selected, they would be willing to go and present their findings at the International Food Waste day event on the 29th of September under the heading "Young Minds Techno Solutions to Food Waste Mitigation". For the preparation phase, which lasted 8 weeks over spring 2020, one junior mentor was assigned to each school. Our junior mentors were all students in the Nutrition & Health BSc program at Copenhagen University College. The junior mentors participated as part of the external assignment and had two months for preparation. Each student carried out an initial meeting to present and align their expectations with the school in the presence of the lead researcher (i.e., the senior mentor). The sample of schools used in the study is shown in Table 1.

We used the following principles as inclusion criteria in the sample of YouFoo schools: they should have an openness and curiousness toward using the Whole School Approach, including that of using mentors and a Science2School approach; they should be willing to explore the richness of project-based learning; and they should have a strategy for developing science education as well as experience in teaching principles such as microbits, micro-sensors, micro-computers, and coding, either as a stand-alone initiative or as part of the formal curriculum related to the new subject—Computational Thinking—which in Denmark has been newly introduced as Technology Understanding.

The *Whole School Approach* [50,51] —in short WSA—was originally created as a conceptual framework for schools working with health promotion. However, it has recently experienced a revival and has been further developed as a framework that schools can use to work with Education for Sustainable Development. In the case of food issues and food systems literacy training, the WSA has also been applied [52]. WSA—sometimes referred to as an Open School approach—promotes an open and outreaching way of working across the school and beyond the school boundaries with local actors in matters where strategic goals are to be met. It also means that what goes on in the classroom needs to be consistent with school policies—the school ethos. Additionally, it means that the school should see itself as part of the local community and its social and economic ecosystem.

Development of the *STEM agenda* is an important focal area of Danish schools, comprising an attempt to prepare students for a more science- and knowledge-intensive future. Most schools in Denmark have, over the past decade, made significant efforts to upgrade their STEM teaching and introduced creative learning environments that support the use of construction, engineering, and building approaches by installing Fab Labs and Makerspaces. The idea is based on the development of new didactic approaches to teaching and the development of transversal skills, such as digitalization, critical thinking, collaboration, design-thinking, and projectification—an approach that is already significantly established in the field of innovation and design [53].

Project-based learning (PBL) is a relatively new didactical principle that has been introduced in schools as an alternative to traditional subject-oriented teaching. The idea is to create a project-based environment that resembles the projects that take place in real-life companies, with more disciplinary teams working together outside of traditional subjects. It is guided by insights from project management and planning, in the sense that it is time-bound, goal-oriented, trans-disciplinary, unique, and difficult. Project-based learning is sometimes interchangeable with the concept of problem-based learning. Both principles underline the practice-first theory-last approach—the idea that, in order to understand a topic, things need to be built and theory needs to be applied along the way.

The *Mentorship Approach* has been used for many years by schools in order to introduce the principle of Vicarious Learning: a modeling principle through which pupils can mirror themselves and in which the Science2School transfer of knowledge can be introduced. We used the form inspired by the Knowledge Triangle, introduced originally by the OECD

as a way to formalize more structured cooperation between schools, universities, and the market. As such, we created a group of interested senior mentors that could assist schools in solving the various technical challenges and, at the same time, could function as facilitators for the type of Vicarious Learning that we wanted to promote.

5. Study Design

A case study approach was chosen to explore the case of the YouFoo program due to its ability to capture an in-depth understanding of emerging phenomena related to social practices [54]. The case study designs allowed the researchers to develop and present a rich understanding of the context and mechanisms involved in the learning and solution creation among young people and to get an impression of answers to the 'how' and 'why' questions. As a result, the qualitative approach of the case study does not claim to be able to put exact numbers on how frequent a phenomenon is but, instead, claims to be able to explain the nature of the phenomenon. In this case, the phenomenon studied was the uptake of food waste literacy by young people through the YouFoo learning activities at school.

6. Ideation of Solutions

We used the idea of ideation as the concept for staging a process through which pupils could develop ideas as part of the project-based learning process from conception to mock-up under the guidance of the teacher and the junior mentor. All ideas were supposed to be aimed at fighting food waste in either a domestic, retail, or food service setting. A set of inclusion criteria for ideas was developed in order to guide development, which is provided in Table 2.

Table 2. Inclusion criteria for ideas. The list was used to guide the schools, teachers, and pupils to develop food waste solution ideas.

The idea should be within food waste mitigation in domestic, food service, or retail settings.
The idea should be developed in groups of 2–3 students that should develop the idea, build it, and act as "explainers".
The groups should be supervised by a teacher and should have access to technical assistance from the junior, external, and/or senior mentor.
A scientific element or principle should be included—the "explaining".
If possible, include one or more digital elements (e.g., sensor data displayed on a large screen).
All stations should be organized in the form of a table with electrical outlets provided.
Some kind of "eyecatcher" (mock-up, model, roll-up, big screen, or other) should be included.

In addition, a template was developed to assist the junior mentors, the teachers, and the pupils in their work. In Table 3, an example of a filled-out template is provided.

Table 3. Example lesson plan. Each school was asked to fill out, in cooperation with the junior mentor, the following template describing their food waste mitigation idea.

Title	Introduction to Food Waste and its importance. Fermentation in the context of food preservation
Equipment	Standard laptop + a projector for the slides and/or a standard school black or white board
Areas of learning	Environmental Science Biology Chemistry Food Science Home Economics
Method	Facilitation of active learning and students engagement in developing solutions Q&A at the end of the lesson, involvement of students; Project Based Learning

Table 3. *Cont.*

Teaching/learning goals	• Exercise the ability to present essential information and summarize large amounts of text; • Feel out the classroom and adjust according to the interest levels of students; • Understand the problem of food waste and its ecological footprint; • Gain a basic understanding of the process of fermentation, its application, and importance. • Gain an understanding of applications of how digital sensor technology can be used to follow the fermentation
General outline	Introduction to Young Food Waste Fighters Club Present main topics and define main terminology—food waste, greenhouse gas emissions, ecological/carbon footprint, lactic acid fermentation, bacterial colonies, shelf life, food preservation, sustainability, etc. Conduct a presentation with many visual elements—pictures, graphs, tables, etc. Review statistics and isolate the most contrasting numbers to create a greater emphasis on the problem Present the types of fermentation and explain lactic acid fermentation as the one closely linked to the project at hand Shelf life and the role of fermentation in food preservation Role of fermented food in health and food preservation (natural disasters and pandemics) Videos are welcome as a more comprehensive way of showing the information Q&A time

At the end of the eight-week YouFoo process, all ideas were collected and lined up in order for the project team to be able to select the best ones. The shortlist of ideas is shown in Table 4. This list was then used to select four that were to be presented at the final event. The selection criteria were based on the following: 1. potential of being able to reduce food waste; 2. a strong digital component; 3. an underlying scientific principle that could be explained; and 4. the novelty of the idea.

Table 4. Shortlist of ideas and concepts. The table shows a list of the ten ideas that were generated in the first round of the ideation process.

#	Concept/Idea
1	A canteen food waste audit, which aims to measure quantitative data as it relates to food waste, identify "hot" waste items, and uses qualitative interviews to explore why food is being wasted and information about motivations;
2	A community pantry focuses on the waste stream that originates at home. The idea of the pantry is to engage parents and children in discussions about food waste outside of school by asking them to search at home and contribute items that would otherwise go to waste to a shared pantry at the school. This idea works hand in hand with a food-sharing app, so students involved in this project will work with the app to also upload the food to the app for others in the community;
3	Identification of "hot" food waste items—preferably from the school's canteen audit—and turn them into something else using the idea of Waste2Value. Using these items, they are asked to create a campaign for food waste that can later be used to educate other students;
4	Using the Plant Jammer app to plan for recipe-building ugly fruits or vegetables and for foraged plant food;
5	The smart batch code embedded barcode built into a household fridge;
6	The smart batch code embedded barcode developed into an app for domestic use;
7	Collecting food waste data with a smart scale in the school canteen;
8	Fermentation in the form of kimchi: the students work with the fermentation of plant foods to give them a longer lifespan and reduce waste;
9	The Smart Nose: a light "family" version of a device developed by AmiNIC unit that functions as an artificial nose, which can reveal signs of food starting the degradation process at an early stage;
10	The UFO concept: the Unidentified Fridge Objects (UFO) is an attempt to fit a chilling cabinet or fridge with micro-sensors that are able to measure temperatures in different locations in the fridge and to develop an algorithm that is able to optimize the placement of different types of food in order to maximize their shelf life.

7. Data Collection and Facilitation

A Participatory Action Research approach was used as a collaborative strategy of cyclical curriculum innovation and research. The project was aimed at fostering the communication and evaluation abilities of students, as essential components to prepare young people for active climate participation in society [46]. The approach to program development and data collection was based on an action research approach, with emphasis on the insights from Participatory Action Research, but which has been adapted to scientific education by Eilks and Ralle [55] and Eilks, Markic, and Witteck [56]

8. Results

In the following section, our findings are presented based on an analysis of the collected data. Data were categorized under a set of thematic headings that emerged from the data and can be seen as features that can be used in the development of future learning approaches at schools related to food waste mitigation.

9. Mentoring and Outreach Open Up the School

The idea to create, construct, build, and engineer new solutions is obviously dependent on close cooperation with external partners; namely, close cooperation with the local community, university partners, and private enterprises has been repeatedly highlighted as an important theme. It is something that could add to the local food economy, not only in financial terms but also in the social dimension. As one headmaster phrased it:

"*Mentoring should not only be about commercial and science careers. I think also "social" entrepreneurship needs mentoring*".

This adds an important dimension to the work with food solutions, as it calls for a reach out to the local community, "livelihood" thinking, and a consideration of career vocation. It underlines the importance of not only working with commercial solutions but also thinking about social innovation types of solutions. The teachers were positive about finding new inspiration and seemed to like that their pupils could interact directly with both the junior and senior mentors. All teachers unanimously reported that the pupils were thrilled about the role modeling aspect; namely, the vicarious learning aspect that this added. Science and community involvement, as well as project organizing, were seen as important values. As one teacher said:

"*Working project based suits us well and aligns well with our didactical strategies*".

The YouFoo junior mentors followed a project mode of working with children and informed the process by presenting them with different ideas in project groups. It goes without saying that schools need mentors in order to be able to work in the YouFoo mode:

"*School is not a university we need to find the right balance between you and us*".

The concept of the Knowledge Triangle, along with the Open School approach, allowed us to foster Science2School cooperation that was found to be very useful by teachers.

10. Reaching Out to Communities

The idea of reaching out to local communities and taking a Whole School Approach seemed to be a theme across the participating schools. More teachers highlighted the fact that this style of teaching and learning, using the everyday example of food waste as the case, was a good example of the interaction between families and households. The involvement of local retailers was also considered useful. As expressed by one of the participating teachers:

"*To involve families and local community is an extra dimension*".

The Science2School cooperation seemed to fit well with the expectations of the schools:

"*Out of school collaboration is simply interesting to us*".

11. Makerspaces as a Tool for Solutions

Introducing construction, engineering, and building as a learning activity in the school setting obviously requires some infrastructure. The solution-oriented approach has spread in the school community, and many places, makerspaces, and Fab Labs have been introduced as a way to provide the tools and equipment that can be used to create mock-ups and prototypes. This development has been going on for years, and some teachers were quite critical of this development. They at least advocated for the idea that this infrastructure should be applied much more in daily teaching than what seems to be the case right now:

"*Makerspaces has become a buzzword, but it is as simple as installing a lasercutter and a 3D printer. Important thing is what you build around it*".

The development toward having makerspaces is a trend that has permeated the school sector and is very much related to the idea of experiential learning and STEM teaching. The ideas seem to involve leaving the blackboard teaching mode behind and moving toward something new. In this change process, the practice-first, theory-last approach comes in very handy, as mentioned by the teachers. However, along the same line, teachers also had concerns regarding the wider implications of the trend when it comes to the neighboring schools in the community and pointed to the distance between local schools as a problem. Another concern was also that overdoing the experience aspect might have drawbacks. As one teacher expressed it:

"*Some times an intracommunal makerspace becomes a bit like a Tivoli tour*".

12. Projects Can Promote a Solution-Oriented Mode

Working in a solution-oriented mode goes well in hand with the project-based approach to learning. This, however, introduces a need for schools to leave the traditional subject-oriented approach behind and focus on project outcomes in order to be able to leave the "One subject—One theme" mode, in favor of a project-oriented mode that aims to stretch across more of the school subjects. The project-based learning mode, as found in the interviews, was a challenge and a novel concept for many teachers.

"*One challenge I see is ownership—who owns the station. To have more teachers feel responsible is not straightforward to me*".

The same challenge seems to apply to the sharing of the mock-ups and installations that became the output of the projects. Summarizing the views linking subjects transversally across the school was seen as inspiring but challenging. For instance, teachers raised the following questions: who should feel responsible for the project, and who should act as the project manager in the day-to-day operations? The simple question of what should happen with the installation after the projects also became an issue, having worked toward an end goal that is presentation-oriented:

"*Teachers often feel that it need to be "someones" that one will then need to take the overall responsibility*".

On the other hand, despite these challenges, there seemed to be very little doubt in the minds of the teachers that constructing, building, and presenting installations was well-received among the pupils.

13. Construct First, then Theory

Having to work toward an end goal that is learning- and presentation-oriented introduces the need for discussing the order of theory versus practice. Obviously, as the YouFoo approach is construction, engineering, and building-based, it is very well suited to the project-based approach in the sense that learning becomes initiated by problems and goals rather than by theory. That is not to say that theory is not important, but theory comes in as an explainer secondarily in the process. As one of the participants expressed it:

"*The idea is to challenge students with real life problems and to start with the problem and use some form of theory to solve it*".

One important feature of the explanation and presentation part of the solution approach is the importance of being able to present something spectacular, as well as that the solution will eventually be presented to an audience. One teacher phrased it in the following manner:

"*I think an important feature of the building & construction approach is that it has the potential to become something spectacular—something grandiose*".

As such, we observed some clear signs that the special kind of didactic innovation can be seen to be useful both in a solution-oriented context and in a learning context. The inductive practice-first, theory-last approach was found to work very well in the project-based learning mode we applied:

"*Since we are a PBL school then we try to apply a kind of practice first theory next*".

"*One way to balance is to ask their solutions and then challenge them afterwards. That's respect for the PBL model*".

14. Food Waste as a Learning Case for Sustainability Teaching

The idea of using food as an example of a challenge related to education about sustainable development and sustainable development goals was well-received by teachers. Many of the teachers were already working intensively with the SDGs and were aware of the fact that almost half of the goals were related to food and that, as such, they could provide good cases and examples to be used in learning. In some cases, the work was coordinated with the teaching in home economics, whereas, in other cases, the work was spread across more subjects involving more teachers in order to create a project environment for the development of food waste solutions.

"*Over the past years we a kind of an urban foodie fascination emerge—that you start living your life through food*".

It was mentioned several times that food waste was seen as a kind of "down to earth" topic that most students could relate to in their daily lives with their families. As one participant phrased it:

"*Projects needs to be of practical significance and sourced from the daily lives of young people*".

In addition, most teachers found that being specifically referred to in the SDG 12.3 added to the relevance. Furthermore, the ease of being able to develop a "science case" around it was highlighted. In Denmark, food waste has become a mainstream issue, which most families are forced to relate to. One teacher stated:

"*Kids are already familiar with the food waste agenda from home*".

The close relationship between food and climate issues cannot be over-emphasized. We found, in several instances, that as climate and SDG teaching are very prominent in most schools, it is important to make a direct link between food and the SDGs. As mentioned above, having food waste singled out as an SDG was seen as very important:

"*The 17 SDGs needs to be an integral art of the Science teaching we are doing at school*".

15. World-Class Innovation, or just Good Enough for Learning?

The new solution-orientedness and ambition for constructing, engineering, and building creative ideas obviously introduce a question regarding how good the solutions should be. Should they be turn-key solutions, as such, or should they be considered learning opportunities, or considered both? It goes without saying that not all solutions developed in the school would be world-class or cutting-edge; one teacher stated:

> "*I am a bit critical to the idea that everything should be innovation. Something brand new. It can be too much of a "grandiosity thinking". Not every child could do something world class. How about just "as good as it gets?*"

This can be seen as a clear sign of the fact that the primary goal in the eyes of the teachers is to create learning, where the orientation toward solutions introduces an important component and creates an attractive learning environment.

16. Young People, Participation, and Self-Determination

An important part of the YouFoo approach was to develop learning activities around opportunities in relation to green food system transformation and oriented toward tangible solutions. This creates a special kind of learning space for the pupils in which the focus is on a well-defined end goal that includes an explanation and a tangible output—the solution. In practice, it operated as an informal project environment co-created by pupils, the junior mentors, and, in some cases, ad hoc technical/scientific mentors with the teacher as the supervisor. This learning environment was seen as an important part of the solution-oriented nature of the project. One teacher stated:

> "*My experience is that if we can have pupils take ownership both in constructing and in explaining and communication then we have as strong case*".

Teachers were obviously very interested in how the impacts of the YouFoo approach could be assessed in a fair manner. As pupils are different and as there is little methodological consensus on how to measure learning impacts, this issue was given quite some attention during the sessions. One teacher suggested that:

> "*Let's involve the pupils in a discussion on how to measure outcomes*".

This approach resembled the idea seen in collective impact, where end-users are involved in deciding outcome measures.

17. Talent and Diversity

Diversity among students is an important aspect to relate to. As pupils are different, so are their learning styles. As one teacher phrased it:

> "*It's important that the topics and the particular project direction we choose allow for pupils differences*".

> "*Breaking up in groups where we assign a "talent" to lead the group could be a way*".

Working in the project mode made it visible that the students were very different in the ways that they learn and develop new skills. One teacher raised the question of whether all pupils should be treated equally, or whether they should be treated according to their learning style and personal background. In this aspect, one teacher stated:

> "*Working with these topics to me makes it imperative to discuss talent*".

Keeping the project-based orientation in mind, it is interesting to consider diversity in a project group at school as an asset rather than a limitation. In other words, the different students in a project group fill out different roles that are complementary to each other. For instance, as a teacher mentioned:

> "*Our students are quite different some are willing to lead some are more shy. And some just love to perform*".

Most of the teachers found it inspiring and useful to work in a project-based manner and, in particular, they found it useful to work with set goals and a final deadline involving a presentation to an audience. In other words, both the process and outcome were perceived to be important; as one teacher expressed:

> "*To present the outcomes is good but the process leading to that is what interests me*".

18. Digital, Data-Driven, and Design Approaches

Both schools and teachers appreciated the digital approach that was part of the work, such as the use of smart bar codes for food waste mitigation or sensors for the measurement of temperatures in the mock-up fridge. Most of the school had been involved in teaching using micro-sensors, micro-computers, or coding and programming. Some of them had been doing this in the context of stand-alone projects, while others had been doing this as part of the teaching in the computational thinking/technological understanding context.

"*Why don't we build the sensors ourselves with ultrabit*".

Some of the schools were used to working in the project-based mode, while others had to adapt to this kind of didactic style. However, the teachers were mainly positive about the practice-based approach utilizing building, construction, and engineering concepts. In particular, the design thinking approach to building was seen as a positive asset. Two of the participating teachers phrased it as follows:

"*We like to have more teachers involved across the subjects*".

"*You know to be able to work cross disciplinary*".

"*We already work PBL oriented so something that can be organized as a project could be really nice*".

19. STEM or STEAM?

The solution- and goal-oriented work obviously introduced a need for linkages to the other construction and engineering competencies of the school. One teacher put it in the following way:

"*Design and handicraft are creative processes. So is cooking. I see some direct links*".

Some teachers raised the question of which subject to include in the work in developing prototypes and warned against seeing the focus on solutions as only a matter of the integration of STEM subjects. Design and art subjects were brought into the discussion by one teacher, who stated:

"*Steam instead of STEM. Being able to explain and to construct is an art and so is food preparation. Design is a creative art like process*".

As can be seen in the quote, the presentation part of the solution should not be underestimated. In other words, having a solution without being able to explain it is only half the job done: it can be seen as an indication of the fact that communication is an art in itself.

20. Discussion

Bringing youth into the process of solution making acts as an important driver for their own academic achievement and learning, thus providing huge potential for students. This can provide an important contribution to the development of Education for Sustainable Development within the domain of food systems literacy. We found that the following potentials were viewed as important drivers for the expansion of our approach: understanding evidence and knowledge, insight into digital technologies, the possibility of being able to work with mentors and role models from out of school, the option of working out of class and in projects, the setting of a clear performance-oriented end goal, and the possibility of young people to develop performance and science communication skills. We also learned that, for such a kind of learning to work, schools and teachers must be skilful in project organization and be committed to working under the ideas of Open School and the Whole School Approach.

The results demonstrated that new attention is being given to young people's solutions. We found that there was a new type of openness with respect to listening to the opinions, ideas, and solutions of young people in a broad sense and, in particular, when it is related to climate mitigation. Furthermore, an increased interest in using the school as an environment

for creating those solutions can be observed, for instance, in a STEM or science teaching context. The results suggest an outline for the mobilization and engagement of young people when it comes to food system issues. Although we see that climate is the overall driving factor that is creating this engagement, increased attention to food issues can be observed at school.

The results also showed that working in construction, engineering, and building modes fit well into the interests that schools have in the context of the new type of STEM teaching, along with the use of makerspaces and Fab Labs. This seems to bring with it a more practice-oriented learning style, where theory and science come in along the way. This does not, to any extent, mean that theory becomes less important, only that it should come in with an in-built delay. This manner of inductive teaching was found to resonate well with the ideas and strategies that schools seem to have in the upgrading of STEM teaching.

In terms of food literacy—a special kind of learning that can lead to a better understanding of food—it can be concluded that the YouFoo project made an important contribution to next-generation food literacy training. In this way, food literacy can be promoted at school, while taking both individual and planetary health into consideration. It can be argued that a new generation of food literacy training at school needs to adopt a systems-based thinking approach. We found that the project-based and open/outreach-based approaches helped in creating a sense of understanding facilitating whole-systems thinking. When using the Whole School Approach, it became clear the pupils increased their awareness of the many different stakeholders that are involved in food systems and the associated value chain. This type of new-generation food literacy can be referred to as Food Systems Literacy, as it goes beyond the traditional understanding of food literacy and follows a systemic approach. Students learned that food waste in the school context involves stakeholders such as headteachers, school administrators, parents, and students, as well as researchers and external mentors. In our case, it also became clear to students that the media and policy levels can be very important parts of innovation and solutions.

Interestingly enough, we found that our young minds approach to working with technology and science-assisted food waste innovation in a school context created an informal sandbox atmosphere, facilitating a new type of "free-style" learning and a change in approach that set few boundaries for what could be done. In brief, we found that many professionals engaged in food innovation experience a lot of inertia and resistance when working with innovation in companies, in particular when the solutions can be categorized as "wicked problems". In these cases, the solutions are often complicated, systemic, and require many stakeholders to agree that these problems stretch over disciplinary borders and include many different stakeholders. We have observed the "no-boundary" way of thinking in our work, regarding the smart bar code food waste technology that was part of our program. In particular, for the smart barcode, we experienced that there is much inertia, resistance, and mistrust toward new technologies in professional settings, whereas, in our sandbox-type of school innovation lab, these phenomena seem to have no effect or do not exist.

In particular, with the final YouFoo event in mind, we learned that there is not much interest in listening to young people from the public and policy sides. We learned that, for such a kind of solution-oriented young minds approach to work, it is important to work outside the home economics class. We were successful in expanding the work beyond the home economics classroom, involving subjects such as math, physics, and biology in the solutions. An important insight is that teachers found it beneficial to work in a project-based manner, in which the traditional style of thinking about traditional subjects was left in favor of a more cross-curricular approach. Obviously, it is important to use such a kind of young minds approach to solutions in a balanced way; in other words, it is necessary to create an approach where the young people's solutions do not end up as only images on Facebook or a web-page. As such, there is a need for incorporating food systems innovation learning and linking it much better to common practice at schools, namely, sustainability education and SDG teaching.

However, we also learned that schools are busy places and that they need to keep an eye on all provisions in their national curricula. We took this into account by carefully studying these provisions before approaching the schools. In particular, it became apparent that the schools were dependent on a long-term time frame for planning. This needs to be taken into account when researchers wish to carry out fieldwork with schools. We also learned that adding a mentoring and match-making approach is very attractive for schools. Having an enterprise attached to each of the workstations gives pupils an opportunity to talk to business people and learn how they can use science and digital insights in their enterprises. It also gives pupils an opportunity to consider their own future careers. In this respect, the idea of the knowledge triangle serves as a good model for understanding how to work with the topic and how to organize university/school cooperation.

Importantly, we find that exploiting the close connection that exists between climate issues and food and agricultural issues can pave the way for food systems literacy training at school. As has been argued by Corner et al. [33], there is a need to involve young people when it comes to engaging other youth more effectively in the climate change issue [33]. They argued that young people seem to respond positively to messages that frame climate change as a contemporary concern requiring an immediate response and are receptive to the idea of protecting the 'things they love' from climate change. They further argued that scientific jargon such as 'managing climate risks' and concepts such as the '2 degrees limit' can be unfamiliar and disengaging for young people, and focusing on the social dimension, such as that which can be obtained through project-based learning, offers various advantages.

The idea that young people's solutions and innovations can actively contribute to sustainable development has been increasingly studied. Trajber et al. [24] and Galler et al. [53] have argued that young people's everyday experiences in relation to the social and environmental threats presented by climate change are largely overlooked, despite their being the generation that can be expected to be most affected by climate change. However, as pointed out by the EIT Food [42], it should be kept in mind that, despite the clear indications of the active attitude of the youth, it will be nearly 15 years before Generation Climate, along with the Millennials, form the majority of the voting age population. As such, it can be assumed that influencing policy making for food systems transformation with a young mind's voice through democratic processes is a long-term process. As such, it is obvious that there is a role for creating attention to the food systems change issue in schools, which can be expected to foster School2Family learning and raise awareness in general. The fact that many students do not find science classes interesting or motivating is a challenge for future technology- and knowledge-intensive societies.

The YouFoo approach, along with other educational approaches to increase food waste literacy among young people, can make an important contribution to changing norms, attitudes, and behavior in society in general. Specifically, preparing young people for food waste mitigation thinking can have positive implications both for families, retail, food services, and food manufacturing. For families, it can help to strengthen household food waste reduction efforts while, for the food sector in general, it will lead to a new-generation workforce that can understand food waste reduction and circular food economies in a bright new way, thus adding positive effects to corporate food waste reduction efforts.

The issue of engaging young people in food systems transformation has also been brought up by other researchers, who argue that the food–agricultural system needs maintenance and critical re-thinking. According to the work of Muiderman [28], several themes seemed to stand out when examining youth engagement in these issues. Leavy and Smith [57] and Udoroja [22] have argued that there needs to be more outreach from the agri–food industry through a connected inter-professional collaborative approach and that young people often have prejudices toward the sector associated with food and agriculture due to the hard physical work and low wages. Here, the Open School and Whole School Approaches can be seen as means to create links between schools, young people, and the local food economy. As argued by Leavy and Smith [57] and Udoroja [22], there is a lack

of knowledge, information, and education and, in a longer time frame, a lack of access to green jobs and markets, as well as the ability to engage and to be listened to in policy dialogue; these are all hindrances that urgently need to be remedied.

Such a scenario was presented in the Food Wave 2022 report, in which they outlined a wide range of youth-led companies, organizations, and initiatives across 18 European cities, which are all making a change in the food and climate fields [58].

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Institutional Review Board Statement: Ethical review and approval were waived for the study due to the following. The author used a personal professional network maintained as part of the authors research to ask participants about participation in the study. Since this is kept and maintained on LinkedIn there is no need for any particular GDPR approval since accepting invitations on LinkedIn automatically means that the person give permission to be contacted for professional purposes. As regards to the ethics there is neither a need for approval since in all cases these were adults (no minors were participating). Informants participation has been on two levels. One is participation in the development of the ideas and the other has been acting as informants. All participants gave acceptance to participate based on information in a handout.

Informed Consent Statement: The approach used is similar to an informed consent for the following reason. In all cases where interviews were initiated by them confirming the reading of the handout. They confirmed that they have been informed about the purpose of the study and they give at the same time the permission to record the interview and use it as part of the research process.

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