

338 FuturePitch@Smartfeld: Prototyping Tomorrow with Entrepreneurship and New Technologies

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Abstract

In 2015, 17 Sustainable Development Goals (SDGs) were defined as an urgent call for global action. "Creating tomorrow" sustainably requires innovative use of new technologies and interdisciplinary collaboration. FuturePitch combines STEM education with sustainable development, aiming to provide self-efficacy experiences in technology, entrepreneurship, and SDG challenges. Students engage in hands-on activities, creating and refining prototypes. This workshop fosters critical thinking, teamwork, and communication, inspiring students to contribute to sustainable development through innovation.

Introduction

The United Nations defined 17 Sustainable Development Goals (SDGs) in 2015 as an urgent call for action by all countries in a global and collaborative partnership (United Nations 2015). The SDGs aim to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030.

Sustainable Society and the Aspects of Innovation, Entrepreneurship and New Technologies

"Creating tomorrow" with such a sustainable world in mind means that society is fundamentally dependent on continuous innovation, which in turn thrives on a steady influx of new ideas. In order to tackle the complex and multifaceted challenges posed by a sustainable development (Akkari und Maleq 2020), societies thus must foster (learning) environments where creativity and innovative thinking are encouraged and supported.

But creativity and innovation alone are still not enough. Even the best ideas need advocates who can effectively communicate and sell them

to the broader public. This requires individuals with the skills to discuss, pitch and promote innovative ideas.

Additionally, it requires teams with a collaborative skills set in order to realize these ideas by transforming them into tangible products and solutions. Because only the combination of persuasive communication and practical implementation ensures that innovative ideas gain the traction and support necessary for widespread adoption and implementation.

Finally, the use of new technologies can act as a powerful additional catalyst in achieving the SDGs (Mondejar *et al.* 2021). Creative use of advanced technologies such as artificial intelligence (AI), big data analytics, and the Internet of Things (IoT) enable more efficient and effective solutions to complex global challenges. For instance, AI-powered precision agriculture technologies can optimize resource use and increase crop yields, directly contributing to SDG 2: Zero Hunger. Similarly, IoT-orchestrated renewable energy technologies such as solar and wind power together with smart storage solutions can play a crucial role in achieving SDG 7: Affordable and Clean Energy. Likewise, digital platforms and communication tools can enhance education or healthcare delivery, supporting SDG 4: Quality Education and SDG 3: Good Health and Well-being. By leveraging the potential of these cutting-edge technologies, society could accelerate progress toward the SDGs, ensuring that sustainable solutions are scalable, inclusive, and impactful.

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Fostering innovative thinking, entrepreneurship and experiencing positive self-efficacy in the combined fields of new technologies, STEM-education (science, technology, engineering and math) and SDGs were the main ideas behind the development of the FuturePitch-Workshop at Smartfeld (www.smartfeld.ch).

Workshop Overview

Goals and Objectives

The primary goal of FuturePitch is to enhance learners' self-efficacy in applying new technologies and entrepreneurial skills to address SDG-related challenges. Key objectives include (1) encouraging students to apply their personal imagination and problem-solving skills in impactful ways (2) developing competencies in new technologies, problem-solving, and entrepreneurship through hands-on activities and (3) fostering an understanding of entrepreneurship, scalable solutions and their benefits in addressing global challenges.

Structure and Implementation

The workshop has been designed as a co-creative partnership project between the school and the extracurricular educational lab Smartfeld. It consists of four to six preplanned lessons conducted at school and two half days spent at Smartfeld. The structure intentionally ensures that the SDG awareness-raising and the creative phase occur within the school environment in order to prevent an over-favorable perception of Smartfeld as the "cool & innovative place" and the school just as the "normal place." In this setup, schools serve as the incubators for idea generation and as a "take-off base" of an exceptional learning experience, while Smartfeld provides the resources and expertise to further develop, refine and technologize these ideas. This approach reinforces the role of teachers, positioning them as key facilitators in the creative process and ensuring that the school remains a central and engaging part of the learning journey.

School Phase 1:

SDG – Sensibilization and Ideation

In Phase 1 of the workshop, students are sensitized to the Sustainable Development Goals and then regroup into interest-based teams aligned with

specific SDGs. To do so, they are presented with various challenges, framed as short stories about potential inventions that could help achieve the SDGs. These challenges not only encourage students to think creatively and collaboratively about innovative solutions but also help them understand that global issues can also be addressed locally. This phase raises awareness about the global and local importance of the SDGs and inspires students to actively engage in developing impactful ideas that can make a difference in their own communities.

To enhance the ideation process, students are engaged in typical creativity exercises common in the design-thinking toolbox (Lewrick *et al.* 2020), e.g. "30 Circles" or "Create as many ways as possible for a duck to cross a street without walking". These exercises aim to convey that the core message or idea is what truly matters, rather than the aesthetic quality or realistic aspects of a first solution. By emphasizing the importance of innovative thinking over perfection, these activities encourage students to freely explore a wide range of ideas and develop their creative problem-solving skills.

School Phase 2:

Prototyping and Plussup-method

Now, the ideas are brought together into an analog prototype, such as a model made from cardboard and glue (figure 1). This process helps to manifest the idea, making it tangible and open to further development. To enhance this development, we use the "plussing" method, popularized by Pixar, which is a collaborative brainstorming technique designed to enhance and build upon initial ideas in a constructive manner rather than just pointing out what's wrong. Instead of saying "no" or "but," students say "yes, and..." to add their own thoughts to someone else's idea with the mindset of letting the other person's idea shine. We observed that this approach tremendously helps to induce a positive and creative atmosphere with a feeling that everyone's ideas can grow and get better. By working together and plussing to each other's suggestions, students very often realize that they can make their projects together far more exciting and effective as the original idea.

The plussing-additions are collected and, if agreed upon, incorporated into the cardboard prototype, enriching the initial concept. Additionally, students complete in this phase a paper-sheet project organizer to document their output and to prepare for a smooth and efficient transfer of their project to the Smartfeld Lab.

The project organizer sheet lists the team members, the SDGs the project addresses, the purpose and function of the analog prototype, the challenges faced, the approach taken, and the solutions developed. To facilitate understanding for themselves and for the Smartfeld-team of how the prototype should work students also create an instruction manual. Since the prototype is analogue, the project organizer concludes with a section for technical questions addressed at the Smartfeld-team, e.g. which technical tasks the analogue prototype should be able to perform at the pitch event.

But only on the surface this last section seemed to be addressed to the Smartfeld-Team. It's real purpose is to relieve the teacher of any technical responsibility or questioning so that they are not put off by the apparent technical complexity of technologizing an analogue prototype – these questions thus remain the responsibility of the Smartfeld team to solve.

An example for a typical challenge that was developed together with teachers and pupils is the development of a more sustainable and more user-orientated drinks vending machine (see figure 3). SDG-related ideas include saving on plastic bottles by preparing drinks from local fruit syrup, which is diluted with still or sparkling water according to taste and poured into users' cups or bottles. As different juices can be dispensed, the machine allows individual flavours to be mixed. To make it attractive to users, it recognizes the user, knows their individual preferences and can support the user's health by, for example, reducing the sugar content over time, reducing the amount of caffeine in the drinks (as many students currently prefer caffeinated drinks but want to reduce their daily caffeine intake) or, for example, adding certain vitamins that the user prefers or needs in their drinks.

The realization of the analogue prototype is typically a large cardboard-box with a slot where you can place your mug or bottle, and the project-

organizer-sheet includes questions like: Really? How can a cardboard-box ID you? How do we program this? And – How can we show at a pitch that this sustainable drinks vending machine knows when the bottle is full?

This might demonstrate why we allow to keep the technical solutions out of the ideation phase and, if preferred, out of the responsibility of the teacher – even the experts at Smartfeld are often challenged by some if not most of these questions on how to use new technologies to promote the SDGs.

Other challenges include a waste bin, shown in figure 1, that helps users dispose of their waste correctly and promotes the recycling process, a user-friendly and energy-efficient smart home, a movement game for school breaks that helps to relax and promotes concentration or a “plant taster” – an agricultural robot who can recognize plants and their needs and then supply them individually with water and fertilizer, thus strongly saving resources.

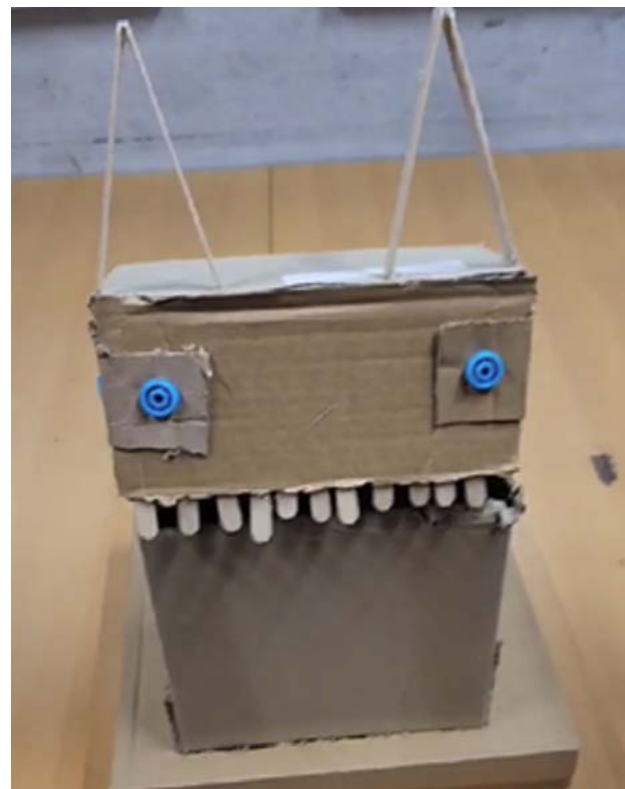


Figure 1: Example of a cardboard prototype of a "Recyclomat", a waste-bin which shall help users to collect and recycle waste. It senses that users are close-by (e.g. ultrasonic sensor), attracts them to use the waste-bin (e.g. by attractive light signal or sound) and sorts the waste (e.g. by color sensor and moving internal wiper). Waste bins energy supply shall be by solar cells.

Smartfeld Phase 1: Technologization

In the first phase at Smartfeld, students bring their analog prototypes along with their ideas to further develop them. Here, they are tasked with adding sensors, actuators, and the micro:bit platform to enable their prototypes to perform their intended tasks conceptually. For example, in the case of a drinks vending machine prototype, the students would demonstrate that it can identify a mug and pour an individualized drink into it. This part of the workshop is the most complicated, as many students are not familiar with using sensors and actuators or programming them. To alleviate fear or the feeling of "I cannot do this," we introduced the Smartfeld bit:boards (figure 2). The Bit-boards demonstrate over 28 different circuits with which students can directly interact. They can explore how the same sensor or actuator can be used for different tasks, such as using an ultrasonic sensor to measure distances or to sense when a mug is full, and on how to use colored LEDs e.g. to simulate hot or cold water flowing from one tank into another. By experimenting with the bit:boards, students gain numerous ideas on how to conceptualize and enhance their prototypes, making the task of integration of technology much more accessible and engaging.

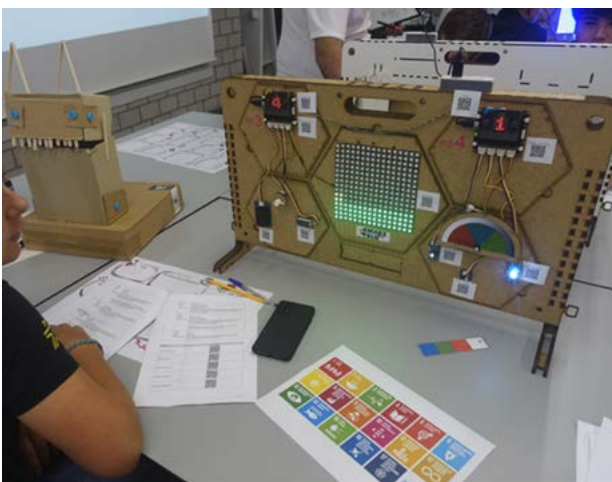


Figure 2: A Smartfeld bit:board which enables students to interact instantly with sensors and actuators and explore potential integration into their prototype. QR-codes on bit:board link to an online-wiki with information and code-examples for sensors and actuators to use and adapt.

All circuits of the bit:Board are documented in a Wiki, where examples of the block-based software code in Microsoft MakeCode are stored, along with explanations of how the sensors or actuators actually work and can be programmed. This resource allows students to quickstart with a working example they have just experienced and that they can then modify and adapt to the specific task they want to incorporate into their prototype. This approach is crucial for the workflow at Smartfeld, as it enables the teams to work independently and in parallel from each other and efficiently reduces the need for technical support for common programming task. Thus, the Smartfeld-experts can refocus on answering to more complex questions of the students.

More importantly, students learn that many of their apparently very specific tasks can be solved by adapting existing and documented code solutions, rather than having to design it from scratch - very similar to today's approach to programming.

By providing this wiki with accessible, pre-written code-examples and clear instructions, students experience a workflow where they can focus on customizing their projects and applying their newfound knowledge effectively – and see how their analogue prototype becomes more and more interactive and engaging.

At the same time, this phase allows us to address various challenges posed by modern technology, for example: What advantages, but perhaps also disadvantages, can there be if the drinks machine knows you personally - is it perhaps enough for it to recognize the cup instead - and what difference does this make from a data protection perspective?

In this phase, the project increasingly follows the typical basic concepts of design thinking, especially experimental iteration, and as the prototype becomes more and more tangible, new ideas develop that can be tested and implemented directly, which in turn often lead to further new ideas.

Smartfeld Phase 2: Refinement, Pitch and Discussion

The second phase culminates in the pitch of the prototype, which serves as a significant motivation

for the teams. This impending pitch drives them to integrate the most suitable and feasible ideas into their prototypes within the remaining available time. To ensure that innovative ideas which may exceed the current programming skills of the students or are technically constrained are not left out, students are encouraged to include a future outlook in their pitch. They might say, "Additionally, our machine will soon be able to do this ... and thus address that SDG...." Since the success of their pitch hinges on the overall persuasiveness of the project, students tend to select solutions that appear achievable rather than presenting mere fantasies. This approach ensures a balance between creativity and feasibility, highlighting practical and convincing solutions.



Figure 3: The sustainable drink vending machine is an example of a technologized prototype presented during the pitch in Smartfeld Phase 2. This machine can detect individual cups using color codes on the bottom of the cups and a color sensor. Upon identification, it automatically loads individualized drink preferences, which users can adjust, such as sugar content. The mixing and pouring process is visualized with colored LED stripes. Additionally, the machine tracks metrics such as sugar or caffeine intake and provides support to the user based on their consumption patterns.

After the pitch, a short retrospective session begins, during which the different projects, the solutions their prototypes offer, their potential impacts concerning the SDGs, and the teams' experiences during the workshop are discussed. Given that the whole second phase at Smartfeld is particularly energetic and demanding for the students, teachers are also encouraged to discuss the outcomes of the workshop in more detail during regular school lessons. Since all resources are open source, the prototypes can be brought back to school for further refinement or more detailed discussion, thus enhancing the conversation about the use of new technologies for a sustainable future.

Outcomes and Discussion

Feedback from students and teachers shows that FuturePitch has the potential to efficiently foster skills related to the SDGs and STEM. Participants report increased self-efficacy after moving from theoretical discussions to concrete problem-solving activities. The workshop not only promotes critical thinking, teamwork and effective communication, but also instils a strong problem-solving mindset, which is essential for future challenges.

The FuturePitch workshop has yielded several key findings that underscore the effectiveness of its approach. Firstly, the importance of making tangible objects cannot be overstated; hands-on creation helps students to better understand and engage with the concepts they are learning.

Analogue prototyping, in particular, creates significant value to the ideation process by allowing students to visualize and iterate on their ideas in a physical form. This approach also underscores the product-oriented nature of the workshop, which focuses students' motivation on creating viable, but innovative solutions. Additionally, the pitch component of the workshop promotes along with entrepreneurship a sense of ownership over the projects, as students must articulate and defend their ideas to their peers and mentors. Finally, the "work in progress" approach inherent in the pitch and prototype format encourages continuous improvement and iterative development, fostering a mindset of ongoing learning and adaptation.

On the other hand, the prototype status of the solutions presented avoids the claim that viable solutions for a sustainable future can be created within just a few days. The workshop does not claim to find real solutions. Instead, it emphasises from the outset that the aim is to develop the necessary skills to understand and tackle the SDGs.

However, the key element for the 'creative flow' observed during the workshop seems to be the development of the Smartfeld bit:board, i.e. a tool that (1) significantly lowers the access barriers for the creative use of modern technologies and (2) enables individual experimentation. As the bit:board is always close to the students during the technologization- phase, 'just-in-time' learning is supported, i.e. the pupils can deal step by step with precisely the technical or programming problem that interests them most at the time - allowing for a personal "flow"-experience in the combined field of SDGs and new technologies.

These elements combined create a robust educational experience that effectively integrates innovation, self-learning, entrepreneurship, and sustainability. By bridging the gap between theoretical learning and practical application, FuturePitch enables young learners to see the potential impact of their creativity and problem-solving skills on global challenges.

Conclusion

The FuturePitch workshop exemplifies how entrepreneurship, technology, and sustainability can be blended into an engaging and cohesive learning experience that prepares young individuals to be proactive contributors to a sustainable future. The workshop not only addresses the urgent need for innovative solutions to SDG challenges and the potential of the use of new technologies

to address these - but also empowers the next generation of inventors with confidence and skills to make a difference.

Smartfeld at a Glance

In St.Gallen, the higher educational institutions have created a common lab to fuse technology and creativity for STEAM-Education: Smartfeld (www.smartfeld.ch). Smartfeld currently reaches out to 4000 pupils per year. Backed by foundations, it started in 2022 to develop, implement and run its new open source workshop "FuturePitch: Prototyping tomorrow" by combining the creative potential of its partners and active teachers in a co-creative approach based on the OECD Learning compass 2030 (OECD 2019). In short, it tackles SDGs, future skills and physical computing in co-creation with active teachers and influenced by entrepreneurial start-up spirit. Smartfeld's feedback loops represent a shortcut between teacher education and the students' educational system, thus "lessons learned", as well as established good practices, can rapidly be distributed and discussed between relevant stakeholders, as well as disseminated, e.g., via teacher training events, conferences and research-based formats.

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