Anette Bentz, Claudia Wiepcke

FOSTERING PROBLEM-SOLVING SKILLS THROUGH SUSTAINABLE ENTREPRENEURSHIP AND COMPUTATIONAL THINKING: THE DEMAND OF THE TIME AND A NEW CHALLENGE FOR TEACHERS

1 Introduction

The intersection of entrepreneurship, sustainability, and digital technologies has become key in driving innovation and addressing global challenges in our rapidly evolving world [Younah Kang, 2020; Matthew Lynch, 2021; Adam & Alhassan, 2021; Robertsone & Lapiņa, 2023]. This un- derscores the need for digital sustainable practices in the business sector, where companies play a critical role in shaping the future of our planet [UNEP, 2024]. In the field of education, the combination of sustainable thinking and action with entrepreneurial thinking and action can be an important contribution to the solution of social and economic challenges (Strachan, 2018; Frentz et al., 2022). In this context, entrepreneurship is understood as the application of entrepreneurial thinking and action as a bundle of principles, decision-making logic, and techniques that anyone can acquire to a certain extent [Sarasvathy & Venkatamaran, 2011]. Moreover, entrepreneurship is seen as the creation of value, whether by founding an innovative organization [Gartner, 1989] or within an existing organization (Shane & Venkataraman, 2000). Similarly, the use of technology and digital media is considered a key competence that should be mastered by all people, as the transformation of society through digitalization is manifesting itself in all areas of life (Vuorikari et al., 2022). Therefore, sustainable and entrepreneurial education is seen as a motivational bridge to get young people excited about technology [Kourilsky & Walstad, 2002]. Accordingly, it is beneficial to initiate educational activities that address social and environmental problems using innovative, digital and economic problem-solving processes and focus on developing learners' skills [Mittelstädt et al.,

2023]. For example, school projects such as hackathons allow pupils to gain practical experience and develop a deeper understanding of business relationships [Sarasvathy & Venkatamaran, 2011]. Hackathons have become increasingly popular in K-12 education as they provide a unique opportunity to give pupils hands-on experience in technology, critical thinking, and collaboration [Lazarou et al., 2024]. The three areas - sustainability, entrepreneurship, and digital technologies – have in common that they promote problem-solving skills [Wing, 2006; Younah Kang, 2020; Matthew Lynch, 2021]. Hence, to improve the learning process and further strengthen problem-solving skills, predefined problem-solving methodologies like *design thinking* or *computational thinking* can be supportive. For example, design researcher Cross (1982) already criticized the fact that the school system lacks a design culture. In his view, design thinking encompasses a learning approach that was neglected in general education, to the significant detriment of both students, whose potential was not fully developed, and society, which missed out on the future problem-solving skills of citizens. Nowadays, design thinking is identified as a new paradigm to tackle problems in various fields such as IT, business, education, and medicine [Dorst, 2011]. In schools, design thinking is usually introduced by integrating it into other subjects, such as sci- ence, technology, or other STEM subjects [Rusmann & Ejsing-Duun, 2022; Zhang et al., 2020; Zhou et al., 2022]. Design thinking develops learners' problem-solving skills through creative practice [Johansson-Sköldberg et al., 2013; Razzouk & Shute, 2012]. Hence, design thinking is intended to help students develop practical and cognitive skills as well as specialized knowledge. Furthermore, design thinking is applied to prepare students for their future lives and careers by fostering competencies such as creativity, collaboration, communication, and critical thinking, the key competencies of the 21st century [Razzouk & Shute, 2012]. Moreover, *Computational Think- ing* is a term, that has been coined by Wing (2006) and describes the idea of transferring thought processes and skills, which are required to effectively address problem-solving using computers. Therefore computational thinking has been particularly shaped in the field of (computer science)

education. Computational thinking has been extensively studied and linked to the development of problem-solving skills [Wing, 2006; Gomes & Mendes, 2007; Moreno-León et al., 2020; Standl, 2017]. Moreover, the integration of Computational Thinking as a problem-solving process Standl (2017) empowers learners to solve complex challenges [Younah Kang, 2020]. By breaking down problems into smaller parts, removing unnecessary components, and developing systematic algorithmic reusable solutions, this methodical approach to programming is aimed at reducing complexity in problem-solving processes. Studies show that entrepreneurial thinking [Bijedic, 2012; Ebbers, 2008; Hack et al., 2008], computational thinking [Eickelmann et al., 2019; Fehrmann & Zeinz, 2023; Münzing, 2022] and design thinking [Johansson-Sköldberg et al., 2013; Razzouk & Shute, 2012] can promote problem-solving skills in students. The problem-solving approaches are complementary to each other in significant aspects. While design thinking emphasizes creative idea generation in a business context and focuses on inventive thinking with a radical customer or benefit orientation [Lockwood, 2010], computational thinking brings structure and analysis to problem-solving [Wing, 2006]. The integration of both approaches not only strengthens pupils' problem-solving skills but also enhances their critical thinking, creativity, and collaboration [Tan et al., 2023].

2 Invervention

To effectively prepare pupils for a rapidly changing world with multifarious challenges, we present a learning approach that seamlessly merges the topics of sustainability, entrepreneurship, and infor- matics. At the heart of the unit is the use of problem-solving methods to develop general problem- solving skills. An initial overview of the workshop structure is provided in Figure 1. As depicted there, pupils are given a sustainability problem and are introduced to the hackathon process. After- ward, pupils are guided to apply design thinking and computational thinking mindsets, facilitated by a *Problem-Solving Canvas* (PSC) outlined in the Appendix and elaborated upon as follows.

The result is a digital, entrepreneurial concept presented to a panel of judges.

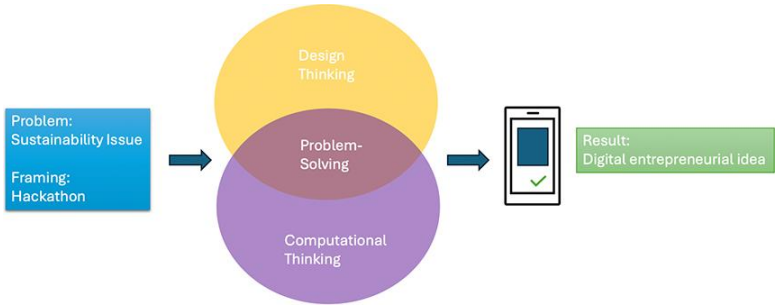


Figure 1. Overview of the Intervention

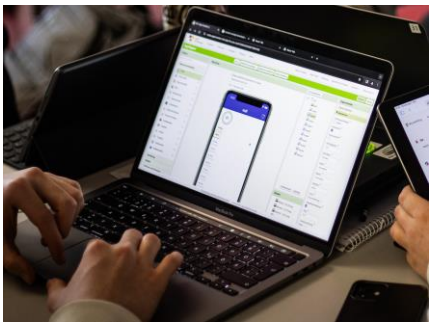


Figure 2. Drawing and Programming a Prototype

In detail, the project targets middle school pupils (grades 7-10) and is conducted within the classroom setting, the pupils work in groups of 4. Prior to the event, pupils receive an introduction to the project and the MIT App Inventor programming environment, along with a presentation of the project leaders and the hackathon schedule. On the day of the hackathon, pupils are introduced to the problem statement and handed the Problem Solving Canvas. Following this, they undergo a guided design thinking process to identify the user group and develop a solution for the problem. Using stencils as depicted in Figure 2, pupils create a prototype for their idea. Once the proto- type accurately reflects all relevant processes, it is programmed using the MIT App Inventor, a user-friendly platform tailored for K-12 pupils, enabling the creation of smartphone apps through block programming, compare Figure 2. To support pupils in their learning process and visualize the thinking processes for educators, we utilize the Problem-

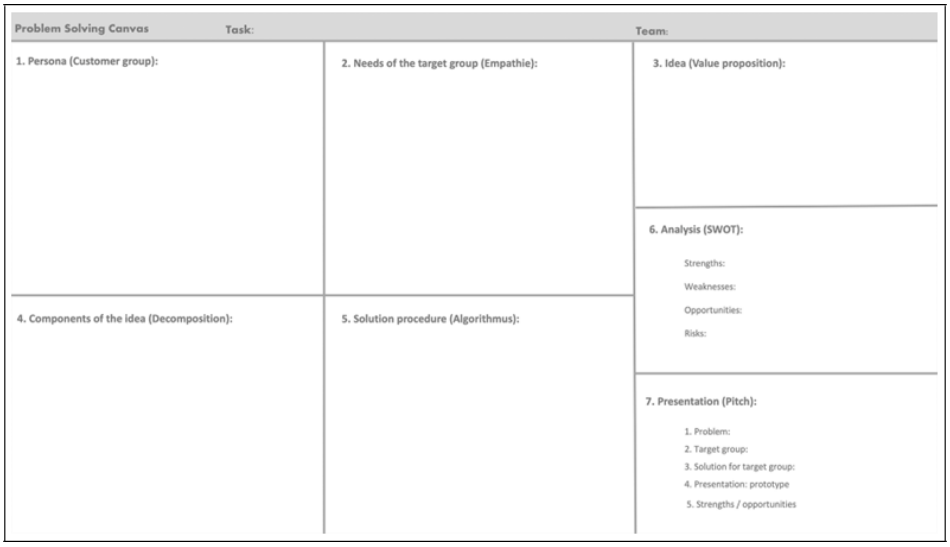
Solving Canvas, available in the At- tachment. The structural idea originates from the Business Model Canvas (BMC), which serves as a visual tool to help businesses define their business model clearly and structure. However, in its original form, it may appear complex for K-12 pupils and does not align with the requirements of developing problem-solving skills through hackathons. Therefore, the fields have been adapted: Fields 1 and 2 focus on the target group, and Field 3 on the value proposition, inspired by the original BMC. Moreover, fields 4 and 5 target the computational thinking area by structuring the problem, and fields 6 and 7 aim to analyze and present the solution.

3 Discussion

The future-oriented education of pupils in K12 education requires innovative approaches, espe- cially interdisciplinary and project-based lessons that pupils find valuable and take them beyond simply learning for school. Initial research suggests that pupils are highly motivated to conduct hackathons, especially in the context of entrepreneurial ideas combined with sustainability topics, leading to strong engagement [Lazarou et al., 2024]. Preliminary results of our workshops confirm these findings: The pupils were eager to present their results, even in challenging learning situa- tions and after long hours of work. Moreover, the pupils had no problems getting to grips with the problem and developed exciting business ideas in the process. It was found that the use of sten- cils appealed more to pupils with less programming knowledge than to those with existing skills. These pupils spent more time drawing and creating more complex analog prototypes. In contrast, pupils with advanced programming skills wanted to start programming faster and spend less time drawing. Preliminary results also show that the use of the PSC supports pupils in their process and is also a valuable addition for teachers as the pupils had no problems understanding and completing the canvas independently. Therefore, the PRC facilitates the teaching process by significantly clarifying the current state of students' ideas, thus making it easier to track and provide effective support during group work. It is important to note that the PSC is not in competition with the

BMC. The PSC aims to adopt the valuable visualization technology of the BMC and possibly use these advantages in other applications. In addition, the PSC can serve as a stepping stone to work- ing with the BMC. If the pupils have already had a positive experience with the structure of the canvas, the transition to the more complex BMC might be easier for them. Additionally, both the Stencils and the MIT App Inventor are well suited for implementation in K-12 education. How- ever, it should be noted, that prior preparation in the form of tutorials for the MIT App Inventor is recommended. Working with computers and smartphones and transferring self-programmed apps proved to be extremely motivating and posed no problems for the pupils. Particularly noteworthy are the creative ideas for sustainable everyday life that pupils developed, which provide a valuable basis for further teaching content. Overall, the combination of entrepreneurship, sustainability, and informatics using hackathons and the PSC indicates that this is a future-oriented and motivating method of lesson design.

A Problem Solving Canvas



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***Бентц Аннете, Випке Клаудиа*. Розвиток навичок вирішення проблем через стійке підприємництво та компютерне мислення: вимога часу і новий виклик для вчителів.**

Підготовка учнів до стрімко мінливого світу з численними викликами вимагає нових методів, розроблених у відповідь сучасним викликам. У цьому контексті перетин підприємництва, сталого розвитку та цифрових технологій виявився важливим фактором для інновацій та вирішення глобальних проблем. Саме тому, щоб надати учням можливість

знаходити рішення у дедалі складнішому світі, ми зосереджуємося на зміцненні як загальних навичок вирішення проблем, так і предметних знань. Щодо навичок вирішення проблем, то для їхнього успішного розвитку застосовується комбінація дизайномислення, підприємницького мислення та комп'ютерного мислення, які добре описані у відповідних дослідженнях. Для подальшого вдосконалення цих підходів і візуалізації процесу мислення ми розробили та пропонуємо педагогам для використання візуальну схему для вирішення проблем, яка наслідує схему для опису бізнес-моделі (Business model canvas) та натхненна нею. Щодо предметних знань, проєкт, описаний в даній роботі, зосереджується на інтеграції сталого розвитку, підприємництва та інформатики, які описуються як ключові ресурси в літературі. Методологічні хакатони на основі проєктів були обрані авторами дослідження як один з найефективніших сучасних методів навчання, оскільки, як свідчать дослідження, навчання на основі проєктів – це більш стійке та захоплююче навчання, що привертає та тримає увагу учнів. Хакатони ставлять перед учасниками задачу критично аналізувати питання сталого розвитку та розробляти цифрове підприємницьке рішення, використовуючи дизайн (design thinking), підприємницьке та комп'ютерне мислення. Хакатон завершується сеансом виступів, де учні представляють свій підхід та розроблений ними додаток для смартфона перед експертним журі.

Ключові слова: дизайн мислення, комп’ютерне мислення, вирішення проблем, хакатони, стійкість, підприємництво.

***Anette Bentz, Claudia Wiepcke*. Fostering problem-solving skills through sustainable entrepreneurship and computational thinking: the demand of the time and a new challenge for teachers.**

Preparing today’s pupils for a rapidly changing world with multiple challenges requires thoughtful methods. In this context, the intersection of entrepreneurship, sustainability, and digital technologies has emerged as a critical factor for innovation and addressing global challenges. Thus, to empower pupils to identify solutions in an increasingly complex world, we concentrate on strengthening both cross-cutting problem-solving skills and subject-specific knowledge. Considering the problem-solving skills, a combination of design thinking, entrepreneurial thinking, and computational thinking is applied, which are both well documented in related research. In order to further enhance those approaches and visualize the thought processes, we use a problem-solving canvas that we defined and that was inspired by the busi- ness model canvas. Considering subject-specific knowledge, the project focuses on integrating sustainability, entrepreneurship, and informatics, which are described as key resources in the literature. Methodological, project-based hackathons are chosen,

as project-based learning is described to correlate positively with more sustainable and engaging learning. In summary, hackathons challenge pupils to critically analyze sustainability issues and develop a digital, entrepreneurial solution through the use of design, entrepreneurial, and computational thinking. The hackathon concludes with a pitch session where pupils present their approach and smartphone app to a jury.

Key words: design thinking, computational thinking, problem solving, hackathons,