Exploring Innovation through Tinkering: A Joint Workshop between CERN Science Gateway and IdeaSquare

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Abstract

This report describes an outreach project undertaken as part of the 2025 CERN Summer Student Programme, supervised by Dr. Anastasia Tezari and Dr. Adelina Lintuluoto. The project involved the design and implementation of a hands-on tinkering workshop targeted at everyday visitors with little to no prior scientific background, developed through collaboration between Science Gateway and IdeaSquare. The workshop, titled *Tinker Lab* (*Brico Lab* in French), was offered in both English and French over a three-week period from 5 to 19 of August 2025, comprising 20 workshop sessions and totalling 322 participants. Focused on the theme of thermal insulation, the workshop emphasized hands-on tinkering and innovation activities. Each session included a guided facility tour to complement the interactive learning experience.

1 Introduction

Science Gateway, CERN's outreach and education centre inaugurated in 2023, has welcomed over 500,000 visitors, offering a wide range of educational activities designed for diverse age groups and audiences. As its public engagement program continues to evolve, there is scope to further diversify the workshop catalogue, in particular tinkering-oriented experiences that allow visitors to engage with science through creative problem-solving. IdeaSquare, CERN's dedicated innovation and prototyping space, is uniquely suited for this type of workshop experience. Its maker-friendly facilities and focus on bridging fundamental research with practical applications provide an ideal environment for learning through making and experimentation.

I was selected as a CERN summer student to develop and run a new workshop concept as part of the collaboration between Science Gateway and IdeaSquare, creating a distinctly innovation-focused experience for CERN's public engagement portfolio. As an additional benefit, this initiative helped accommodate Science Gateway's growing visitor numbers by providing a complementary venue.

2 Workshop Objective

The objective of the tinkering workshop was to design a meaningful and engaging hands-on experience for CERN visitors, aligned with the missions of Science Gateway and IdeaSquare. To achieve this, the intended learning gains of the participants were first defined, and several possible workshop concepts were then explored before selecting the final approach.

2.1 Goals

Through the workshop, participants shall:

- Engage in open-ended tinkering and prototyping using accessible materials.
- Develop problem-solving, out of the box and critical thinking skills by experimenting and iterating.

- Discover links between science and society, reflecting on how playful experimentation can inspire impactful solutions.
- Understand and appreciate the value of creativity.
- Engage in an inclusive, collaborative community, where learning comes through doing and sharing.
- Experience CERN's culture of exploration and innovation.

2.2 Theoretical Basis & Potential Concepts

Drawing from *inquiry-based learning* principles, which emphasize learner-centred exploration and active problem-solving, the workshop design incorporated hands-on activities aligned with IdeaSquare's innovation philosophy. The approach to *experiential learning* [1] (as presented in Figure 1) based on learning by doing, provided the foundation for developing activities that would engage visitors in an authentic scientific inquiry. Different concepts were considered during the design phase.

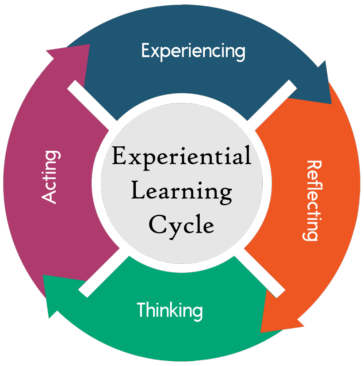


Figure 1: Experiential learning cycle [2].

2.2.1 Concept of Failure

One idea was to build the workshop around the notion of failure as a positive outcome. Participants would attempt a challenge designed to be difficult or fail on the first try. This would highlight that failure is not an endpoint but an opportunity to learn and improve, echoing the way scientific discovery often advances. While conceptually strong, practical implementation of the idea raised challenges: creating meaningful failure within a limited time proved difficult.

2.2.2 Frugal Innovation

So came the idea of *frugal innovation*, where participants work under strict material and design constraints [3]. Using only low-cost and limited resources, they would be challenged to come up with inventive solutions to open-ended problems. This approach was found to be particularly suitable, as it naturally fosters creativity, embraces constraints as part of the process, and could be implemented in a straightforward and engaging way.

2.2.3 Scientific Method

The principles of the scientific method provide a natural framework for implementing frugal innovation. Ideally, participants would formulate ideas, test them, observe outcomes and refine their solutions iteratively. Within this workshop, the scientific method offers more than a framework for tinkering: it models how participants can transform curiosity and trial-and-error into deeper understanding and more refined innovations.

2.3 Feasibility

After evaluating the different potential approaches, it became clear that frugal innovation offered the best balance between engagement, creativity and practical feasibility.

The feasibility of this approach was further supported by the context provided by IdeaSquare. As CERN's innovation space, IdeaSquare emphasizes collaborative experimentation, rapid prototyping and creative exploration within real-world constraints. By designing the workshop around frugal innovation, the activity naturally aligned with IdeaSquare's ethos: participants could engage in hands-on creation and out-of-box thinking, while limited resources kept the overall workload manageable.

3 Implementation

3.1 Chosen Theme

Thermal insulation was chosen as the central theme of the workshop as it is a popular and familiar topic, offers a strong connection to CERN's research and technological applications, and could be effectively supported with the resources already available. The goal was to allow participants to explore this concept through hands-on tinkering, using only the materials provided.

3.2 Materials

Initially, a variety of materials including paper, cardboard, aluminium foil and bubble wrap were considered. However, to simplify preparation and maintain a clear focus on creativity and frugality, the materials accessible to workshop participants were ultimately restricted to scrap paper, which was later recyled. This limitation encouraged participant designs to differ by structure, layering and folding techniques, rather than material complexity, making the challenge inherently more creative.

Two additional components were essential for the workshop's scientific approach: infrared (IR) cameras and reusable cold packs. IR cameras detect thermal radiation and visualize temperature differences through color-coded images, making thermal insulation performance immediately visible to participants.

Cold packs naturally warm up over time through heat transfer from the surrounding environment, making them ideal for demonstrating how effective insulation can slow this warming process. This setup allowed participants to test their paper-based insulation designs and receive visual feedback through the IR camera display. The cold packs were rolled-up to resemble the *dipole* magnets at CERN (Figure 2).

Figure 2: An example of a rolled-up cold pack, shown with a CERN dipole magnet in the background.

3.3 Proof of Concept

Before implementing the workshop, preliminary testing was conducted to validate the design choices and ensure the effectiveness of using paper as the sole material for achieving observable temperature differences.

To explore whether different construction approaches would yield measurable differences various designs (including single layers, multiple layers, folded structures and air-gap configurations) were tested with a hand as the heat source. One example is shown in Figure 3, where a photograph of the setup is presented alongside the thermal reading from an IR camera. These tests successfully demonstrated that the approach is effective.

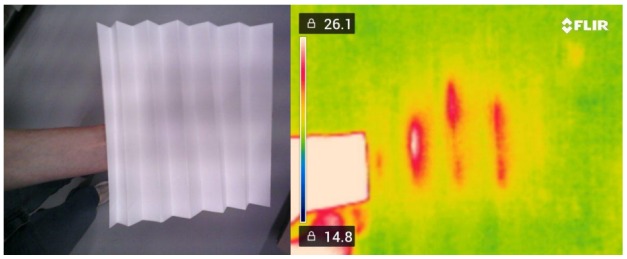


Figure 3: An example of a paper design, with its corresponding thermal reading from an IR camera.

3.4 Control Subject

To make the workshop resemble a scientific study, a *control subject* was incorporated: a dipole with no insulation. This allowed for direct comparison of thermal performance, demonstrating the effectiveness of different paper-based insulation approaches against the baseline and reinforcing the scientific method through controlled experimentation.

3.5 Outline of the Workshop

A complete workshop outline, including the timing of each activity, is presented in Table 1.

Time (min)	Activity	Equipment
10.00	Introduction	
10.00	Experimenting	5 sheets of paper and IR camera
05.00	Presentation	
10.00	Designing	5 sheets of paper, IR camera, tape and scissors
10.00	Guided tour	
05.00	Discussion	

Table 1: Full outline of the workshop.

Introduction The workshop begins with brief introductions of the presenters, who outline their backgrounds and roles. A safety briefing ensures that all participants are aware of the guidelines for handling the equipment and materials. This is followed by a short overview of the workshop's objectives and key concepts, including the principles of thermal insulation.

Experimenting Participants are then invited to experiment with simple materials in order to explore basic thermal properties. Using only sheets of paper, the IR camera and their own body heat, they can immediately observe how heat transfer and insulation behave in practice. By manipulating the paper into different configurations they discover how structure can influence performance. This preliminary activity serves as a warm-up, enabling participants to familiarize themselves with their resources, while also encouraging curiosity and playful exploration before tackling the main design challenge.

Presentation A short presentation introduces the concept of frugal innovation, placing the workshop in a broader context.

Designing Next, the rolled-up cold packs are distributed, with one assigned per table to encourage teamwork. Participants are challenged to design their own thermal insulation structures using paper, tape, scissors and the IR camera. They are encouraged to test, compare, and refine their prototypes while collaborating with their table group.

Guided Tour To complement the design activity, participants are introduced to the IdeaSquare space and its mission through a short presentation. They then embark on a guided tour of the facility, where they learn about ongoing projects and witness how interdisciplinary teams tackle innovation challenges in real time. This tour not only reduces idle waiting during thermal effect testing but also connects the practical experiments they are engaged in with the larger setting and purpose of the workshop.

Discussion The workshop concludes with a group discussion where participants share their observations and reflect on the design process. Before closing, facilitators highlight the link between the workshop, CERN's broader mission, and the potential of simple yet effective innovation practices. Additional time is reserved for questions.

4 Execution

To facilitate participation, information about the workshop (including a brief description and registration details) was made available through the Science Gateway website. Figure 4 presents a screenshot of the webpage where participants could access this information and complete their subscription. This ensured that all interested visitors had clear and direct access to the necessary details prior to the activity.

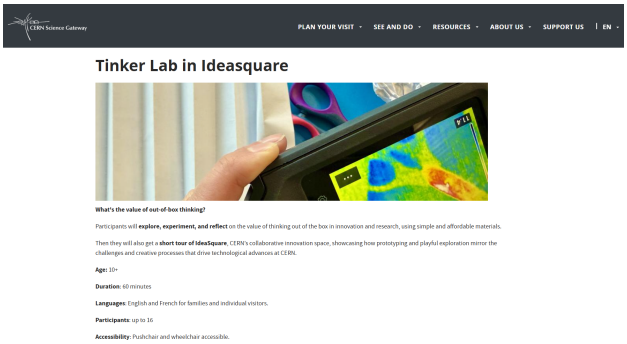


Figure 4: Screenshot of the Science Gateway webpage with workshop description and registration details (visit.cern/tinker-lab).

Given the available space (seen in Figure 5), approximately 16 participants could be accommodated, organised into four groups, each at a separate table. This setup ensures that every group has a sufficient working area for experimenting with materials. The four-table arrangement also encourages collaboration within each group.

Figure 5: IdeaSquare space and table layout, with the famous red double-decker bus in the background.

Figure 6: Introducing thermal insulation to the participants.

To accommodate CERN's multilingual visitor base, each workshop session was delivered with bilingual support. A second presenter was always present, enabling simultaneous delivery in both English and French (Figure 6). This approach ensured that all participants could fully engage with the content regardless of their preferred language.

Many teams came up with different design ideas to achieve the same goal. Figure 7 presents some of the designs. Participants were encouraged to observe the designs of other teams, both to gain insight into different approaches and to better understand the prototyping process, while also emphasizing that there is no single solution or approach to the problem.

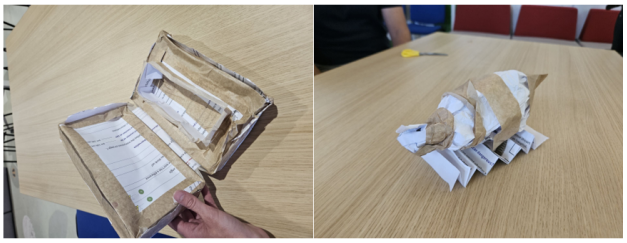


Figure 7: Participant design examples.

All the results before and after the guided tour were recorded on the whiteboard and the difference between initial and final temperature measurement was calculated. A consistent outcome was found during all the workshops. Whatever the design approaches, the participants design was always better than leaving the control dipole without any isolation. An example is shown in Figure 8, where participants wrote down their initial and final measurements.

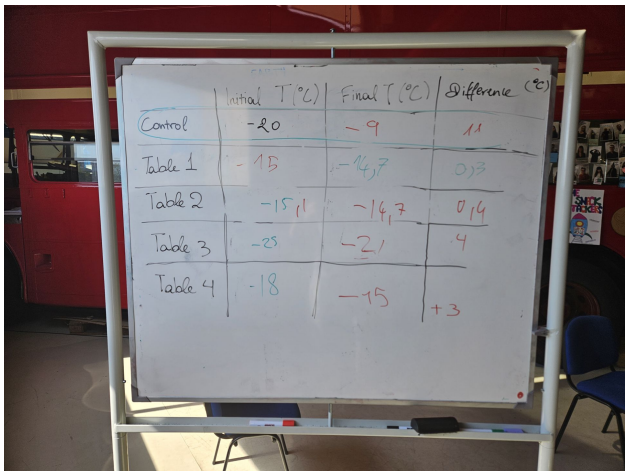


Figure 8: Temperature measurements written by the participants.

5 Feedback

Over a period of three weeks, 20 workshops were delivered to the public, averaging 2 to 3 sessions per day, totalling 322 participants. The audience response was overwhelmingly positive. To better quantify this feedback and identify opportunities for improvement, a short voluntary survey was introduced at the end of the workshop, accessible via a QR code displayed on the final slide.

Figure 9: The final slide with survey QR code.

The survey consisted of four questions: the three first were rated on a 11-point Likert scale ranging from *Not at all* to *Extremely*, while the final optional question invited written feedback on potential improvements.

5.1 Survey Results

In total, 31 participants responded to the survey, and the results are presented in Figures 10 – 13.

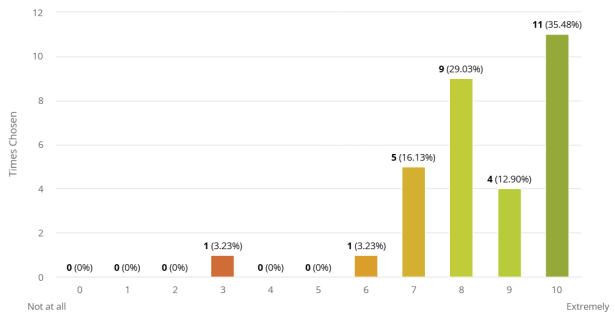


Figure 10: Did the workshop make you feel creative?

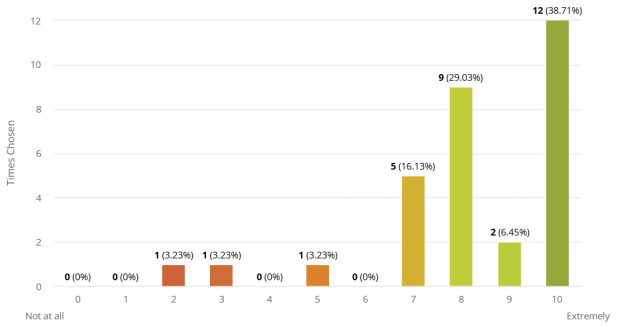


Figure 11: Did the tour of the space add value to the workshop?

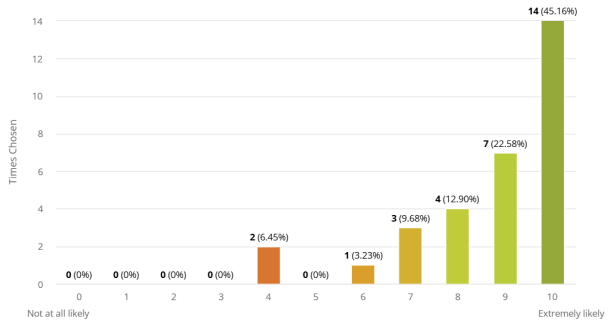
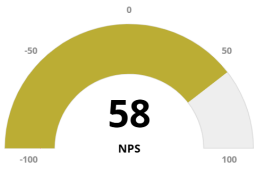


Figure 12: How likely is it that you would recommend the workshop to a friend or colleague?

The Net Promoter Score (NPS) is a customer loyalty metric that uses a single question to gauge how likely customers are to recommend a company, product or service. The score was derived from responses to the third question. Respondents are categorized into three groups: *Promoters* (9-10), *Passives* (7-8) and *Detractors* (0-6). The score is rated on a scale from -100 to 100, were a score above 50 is generally considered excellent. As shown in Figure 12, the NPS score of this workshop is 58.



Detractors (0-6)	Passives (7-8)	Promoters (9-10)	Net Promoter Score
3 (9.68%)	7 (22.58%)	21 (67.74%)	58

Figure 13: Net Promoter Score distribution

5.2 Participant Suggestions

Many participants highlighted that the workshop was engaging, creative and enjoyable. They appreciated the interactive nature of the activities, the atmosphere created by the facilitators, and the simplicity of using everyday materials in meaningful ways. For example one participant noted:

"A very interesting workshop; we didn't notice the time passing. The speakers were very friendly."

Constructive feedback focused on practical aspects that could further enhance the experience. Suggestions included more detailed explanations during the tour, and the addition of hints or example designs at the end of the activity. Some participants also wished for a longer tour of the space or more varied experiments. Indicatively, a participant remarked:

"We would like to get clues at the end to improve our result."

6 Discussion

The TinkerLab workshop successfully demonstrated that meaningful scientific engagement can be achieved through simple materials and frugal innovation principles. Over three weeks, 20 workshop sessions engaged 322 participants with consistently positive feedback, including a strong NPS score of +58. The paper-only thermal insulation challenge effectively validated inquiry-based learning through hands-on experimentation. All participant designs outperformed the uninsulated control, reinforcing scientific concepts while fostering creative problem-solving. The guided facility tours complemented the hands-on activity and added significant value to the overall experience.

The workshop format proves scalable and adaptable, with potential to diversify CERN's public work-

shop catalogue through innovative, tinkering-oriented experiences. This approach validates using accessible materials and constraint-based challenges to engage diverse audiences in authentic scientific inquiry, offering an effective model for future educational programs.

Acknowledgments

Throughout the workshop series, I was supported by Dr. Anastasia Tezari, Dr. Adelina Lintuluoto, Helen Ellerkamp, Hugo Corcelle and Karla Pena Rodriguez, who provided essential translation and facilitation assistance. I was also supported by Dina Zimmermann, Mirabelle Breidvik, Giulia Gaddi, Ole Werner and Catarina Batista, who provided valuable insights regarding the space as well as the guided facility tour.

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