ICSE International Centre for STEM Education Science Factory

D3.2

HOW TO ENCOURAGE MENTORING ACROSS THE PARTNERSHIP

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

Information about the report
D3.2 / WP 3
Publication date: 30/11/2025
Report/WP title: How to encourage mentoring across the partnership

Project Information
Agreement no. 101093387
Project title: ICSE Science Factory
Project acronym: ICSEfactory
Start date of project: 01/01/2023
Duration: 38 months
Program: Horizon 2020-CSA

Contact Information
Coordinating Institution: University of Education Freiburg, International Centre for STEM Education (ICSE)
Coordinator: Prof. Dr. Katja Maaß
Project Manager: Elena Schäfer
Authors: Matija Bašić, Matea Dvoršćak
Lead partner for this report/WP: Faculty of Science / WP3
Website: https://icse.eu/international-projects/icse-factory/

This report is based on the work within the project ICSE Science Factory (ICSEfactory). Coordination: Prof. Dr. Katja Maaß, International Centre for STEM Education (ICSE) at the University of Education, Freiburg. Partners: ICSE at University of Education Freiburg, Albert-Ludwigs-Universität Freiburg, Schülerforschungszentrum Südwürttemberg, Germany, Instituto de Educação da Universidade de Lisboa, Instituto Superior de Engenharia de Lisboa, Camara Municipal de Lisboa, Portugal, Faculty of Science University of Zagreb, Sveuciliste u Zagrebu Fakultet Elektrotehnike I Racunarstva, Hrvatsko Matematicko Drustvo – Croatian Mathematical Society, Croatia, Hacettepe University, Once Ogretemen Vakfi – Teachers First Foundation, Turkey, Edex – Educational Excellence Corporation Limited – University of Nicosia, Paidagogiko Institouto Kyprou – Cyprus Pedagogical Institut, Cyprus.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Agency. Neither the European Union nor the granting authority can be held responsible for them.

Table of Contents

EXECUTIVE SUMMARY 4

1. OBJECTIVES AND METHODOLOGY 5

Objectives for Mentoring within the ICSE Science Factory 5

Timeline for Establishing Mentoring Relationship with Local Partners 6

2. Fostering Collaboration and Growth: Mentoring Stories from the ICSE Science Factory 9

Mentoring Through Co-Creation: Building Open Schooling Projects Together 9

Mentoring Through Collaboration: Connecting Schools with Experts, Institutions, and Communities 11

Mentoring in Practice: Open Schooling Through Molecular Cuisine in Nursing Homes 12

Mentoring as a Two-Way Process: Expanding Networks and Building Collaboration 13

Conceptual Framework for Mentoring in Cross-Sector Partnerships 15

3. Guidelines for Encouraging Mentoring Across the Partnership 17

General Guidelines for Establishing Mentoring Relationship with Local Partners 17

Guidelines for Mentoring Schools 17

Guidelines for Enterprises 18

Guidelines for Mentoring Community Members 19

Guidelines Across Different Groups of Partnership 20

Suggestions for Continuous Monitoring of the Mentoring Process 21

4. Reflections and the way forward 22

Appendices 25

Funded by the European Union

EXECUTIVE SUMMARY

The ICSE Science Factory is a project that supports the EU's efforts to address the shortage of scientists and scientifically informed citizens. Our goal is to build partnerships that enhance science education for all and promote science careers as a vital part of societal development.

To achieve this broader aim, several sub-goals have been defined. We strive to provide science-related activities for all citizens, increase the interest of young people, especially girls and women, in science, and establish strong networks among different sectors of society, including professionals and members of the local community. By pursuing these objectives, we aim to help mitigate the shortage of scientists across Europe who are equipped to engage in scientific discourse and trust the role of science in solving contemporary societal challenges, an essential component for maintaining a safe and healthy society.

One of the core goals of the ICSE Science Factory project is to create cross-sectoral partnerships within local communities, bringing together students, teachers, scientists, researchers, STEM professionals from enterprises, and others. To build functional and sustainable partnerships, all project partners have committed to fostering mentoring relationships across the various groups within these local networks.

This document, based on partners' experiences and best practices shared throughout the ICSE Science Factory project, provides a conceptual framework on how to establish effective mentoring relationships with and among local partners. Framework base on the examples of successful practice emphasizes reciprocity, co-creation, responsiveness and sustainability. The document also includes suggestions for ongoing monitoring of the mentoring process. Additionally, it highlights key challenges that may arise and offers practical solutions to support strong, long-term collaborations.

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

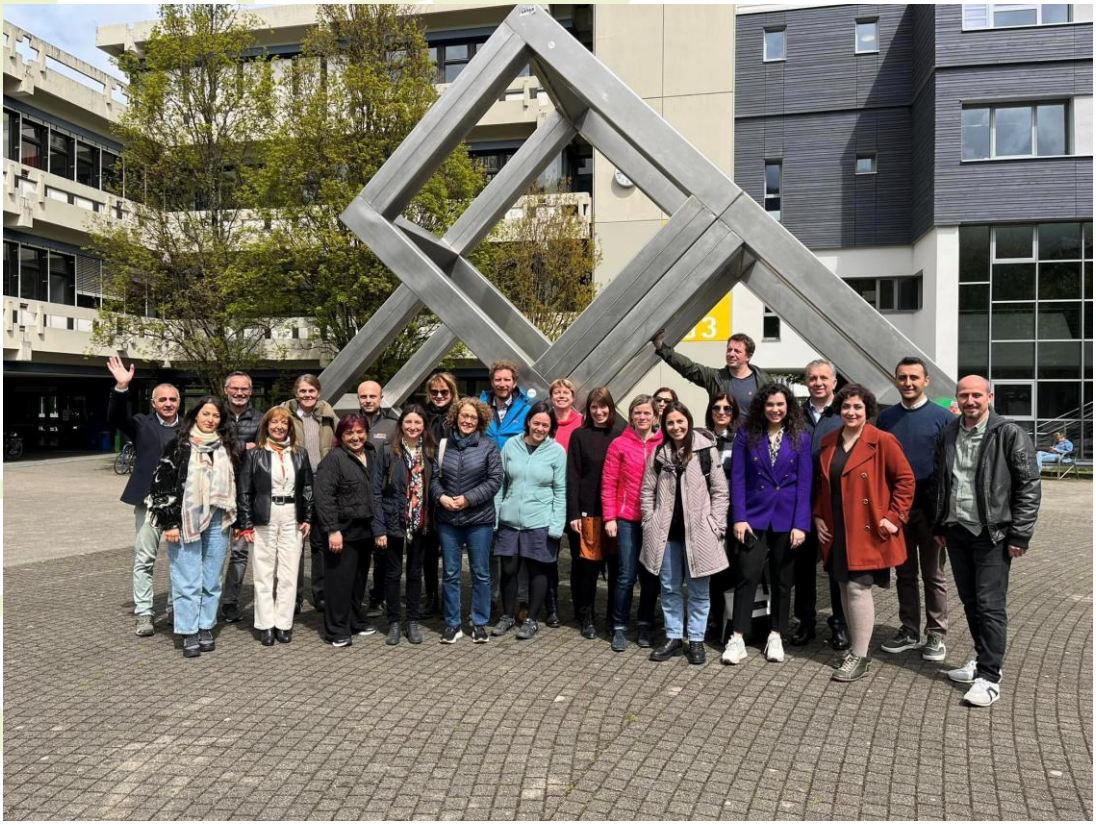
1. OBJECTIVES AND METHODOLOGY

Objectives for Mentoring within the ICSE Science Factory

The main aim of the ICSE Science Factory is to foster improved science education for all citizens by establishing new partnerships within local communities- bringing together teachers, students, scientists, researchers, innovators, and professionals from industry. To achieve this overarching goal, the project focuses on three key objectives:

- Objective 1: collaborative science learning opportunities for all citizens on a local level that show the relevance of science for real-life challenges and add to a lifelong learning continuum
- Objective 2: raise the interest in science studies and science careers of young people (of all gender and with a particular focus on girls/women).
- Objective 3: Foster networking and the sharing and applying of research findings amongst teachers, researchers, and professionals across different enterprises as well as local communities to create, circulate and use science to benefit society.

Mentoring is a key foundation of the ICSE Science Factory and an essential element in achieving the project's aims, especially Objective 3, which focuses on building strong networks for sharing and applying scientific knowledge across schools, research institutions, enterprises, and local communities.



ICSE Science Factory international consortium meeting, Freiburg, Germany (2023)

In this context, mentoring is not limited to traditional one-on-one relationships. Rather, it is understood as a dynamic and reciprocal exchange of knowledge, experience, and support across

different disciplines, age groups and professional roles. Whether it's a scientist guiding students through real-life problems as part of lighthouse activity, a teacher learning from a researcher during local partner conventions, or a STEM professional sharing their career path as part of interactive career talk activity, mentoring strengthens the collaboration between project participants and brings science closer to society.

At the same time, a structured and intentional mentoring process - especially from the project's full partners towards associated partners (and beyond, to all participating parties) is essential for building trust, enabling cooperation, and ensuring the quality and consistency of project activities. It is the foundation that allows different participants to work together effectively, co-create meaningful activities, and collectively contribute to the project's goals.

Timeline for Establishing Mentoring Relationship with Local Partners

The important role that mentoring plays in the success of the ICSE Science Factory project was recognised from the very beginning, with its foundations laid in the project proposal and during the first project meeting. The development of the conceptual framework and guidelines for encouraging mentoring (Figure 1) was a continuous process throughout the entire duration of the project. The guidelines were regularly updated and revised to reflect the experiences and feedback of the partners. Sharing experiences among all full partners provided a valuable opportunity for mutual learning.

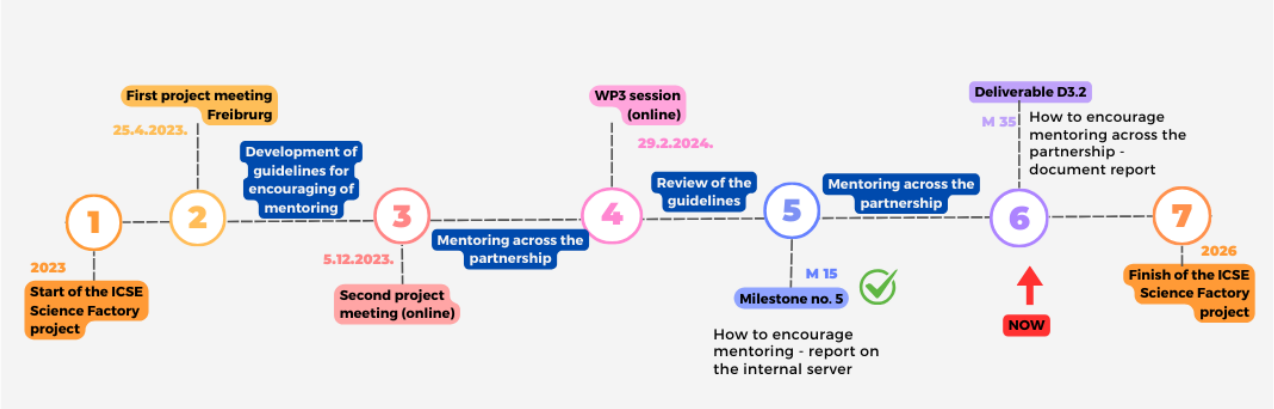


Figure 1. Timeline of developing guidelines for mentoring across the partnership

The connection to existing research literature has been explored (see Appendix 2 for a list of selected research papers on mentoring), which showed that mentoring has mostly been considered in the academic world between an advisor and their student.

To foster the networking and sharing and applying of research findings across different stakeholders and community members a vital exchange as equal partners is vital. Following the project proposal, organization of such networks of partners has been compared to the approach of a Community of Practice (CoP), to guide the networking and strive for the creation of new partnerships (McDermott & Archibald 2010, Wenger 2000, Wenger, McDermott & Snyder 2002, Dubé, Bourhis & Jacob 2005, Lave & Wenger 1991).

1. CoPs are a group of individuals participating in a joint activity and experiencing/jointly creating their shared identity through engaging in and contributing to their common practices (here: lighthouse activities, supported open schooling activities, interactive career talks and local fairs).
2. CoPs evolve around a common domain of knowledge (here: science, its applications relevant for societies and careers), thus a common ground which inspires members to participate, and which guides their learning.
3. CoPs use a common practice around which the community develops and carries out activities (here: activities for the lifelong learning of the community, joint real-life problem-solving activities between partners and community members, sharing and applying research findings, and sharing solutions to community challenges).
4. CoPs promote that members learn from each other and develop their personal/professional skills through the process of sharing information and experiences (here: e.g. by collaboratively offering activities or sharing experiences on the conventions and fairs).
5. CoPs are coined by a positive social atmosphere and common code of conduct (here: open science, creating partnerships, gender equality and tackling global challenges as health, digitalisation and "green" issues)
6. CoPs create opportunities for exchange within and outside the CoP (while the members and their knowledge are the CoP's most valuable resource, COPs are not "locked inside" and consider it beneficial to look beyond their boundaries (here: e.g. through our local fairs, European project conference).
7. CoPs allow for different levels of participation, for example, (a) core group members who participate intensely in the community, this group typically takes on leadership roles in guiding the group (here: our core consortium partners); (b) active group members who attend and participate regularly, however, not at the level of the leaders (here: our local attached partners) and (c) peripheral group members who, while they are less active in the community, still learn from their level of involvement (here: community members participating in activities).

Fundamental to the functioning of the local partnerships as CoPs is a friendly, open, and constructive atmosphere of working. Therefore, regularly monitoring ways of working and evaluating whether they meet everybody's needs is an imperative strategy for creating sustainable local partnerships. In the first stage ("piloting phase"), which has been mostly set in the first year of the project, the full partners have discussed the possible strategies to coordinate the local partnerships and prepare local conventions. It was established that the operationalization of mentoring relies on several enabling dimensions:

- **Role Clarity and Trust**
  - Defined responsibilities among schools, enterprises, municipalities, and universities.
  - Trust-building through repeated collaboration.

- **Platforms and Networks**
  - Formal and informal spaces (conventions, fairs, incubators, websites) amplify mentoring opportunities.

Funded by the European Union

- **Communication and Accessibility**
  - Dedicated contact points (email, websites, newsletters).
  - Open, approachable communication styles.

- **Inclusivity**
  - Attention to diverse stakeholders (teachers, students, enterprises, local communities, seniors in nursing homes).
  - Potential for stronger gender and diversity dimensions in future.

The roles of various types of partners were established through local conventions and further navigated by the national full partners. In practice, significant responsibility has fallen on the schools, which were securing the environment for the activities, and the teachers that were coordinating their students. The role of enterprises and academic institutions was mostly based on securing speakers and moderators for the activities. The national full partners were selecting other local partners, were organizing local conventions, were mentoring the experts based on the initial version of guidelines, were gathering data based on observation and feedback from the participants and were monitoring and evaluating the progress of activities.

The data has been discussed at international project meetings and then streamlined by work package coordinators into new versions of the guidelines. The main input for the conceptual framework and new versions of the guidelines was based on the reported cases of good practice and comments how to improve the collaboration.

Simplified, the **PROCESS OF MENTORING** can be described in the following five steps.

1. **Initiation**
   - A “mentor initiator” (often universities or full partners) introduces concepts and connects actors.

2. **Co-Creation & Engagement**
   - Jointly identifying needs, co-designing activities, and building ownership.

3. **Implementation & Support**
   - Ongoing scaffolding, guidance, and responsiveness during activity delivery.

4. **Reflection & Exchange**
   - Cross-country sharing, evaluation checkpoints, and peer-to-peer learning.

5. **Institutionalization & Sustainability**
   - Embedding practices in school curricula, enterprise policies, or community routines.

This approach has enabled common understanding of the framework and the guidelines. Based on the discussions among the partners, challenges of mentoring were identified, and the expected outcomes were defined. It was expected that mentoring will impact:

Funded by the European Union

- **Individual growth** (teachers' professional development, students' sense of belonging in science).
- **Institutional strengthening** (schools adopting open schooling, enterprises creating engagement roles).
- **Community impact** (mutual learning between citizens and experts, outreach to remote areas).
- **Systemic collaboration** (cross-sectoral partnerships sustained beyond the project).

Finally, the analysis of national cases of examples of effective mentoring has been used as a methodological approach towards identifying common and unique strengths. The descriptions of the cases have been formulated by the national full partners focusing on a specific theme that has shown to be prominent in a certain country. These case studies serve as evidence of success adding qualitative value to the evaluation work package and the final version of future recommendations.

2. Fostering Collaboration and Growth: Mentoring Stories from the ICSE Science Factory

Mentoring within a complex, multi-stakeholder project like ICSE Science Factory is far from a linear or static process. Mentorship in this project is a dynamic and evolving process involving the active collaboration of diverse groups- including students of different ages, teachers, scientists, university and research institute staff, STEM-related businesses, parents, local community members, project coordinators, and other participants. Each of these actors brings unique roles, motivations, and perspectives, creating a rich ecosystem of collaboration and mutual learning.

In this chapter, we delve into how mentoring actually unfolded in practice throughout the ICSE Science Factory project. By examining various concrete situations and contexts where mentorship emerged, we aim to offer a vivid and practical insight into the forms mentoring can take within such a dynamic environment. We present four cases that show different approaches to collaboration and growth across the ICSE Science Factory partner countries. These examples demonstrate effective mentoring strategies that support both individual development and community engagement, particularly empowering young people. The ICSE Science Factory mentoring approach was designed on three levels: (1) supporting schools, (2) fostering collaboration across partnerships, and (3) engaging communities. The following mentoring experiences illustrate how these principles unfolded in practice, often in unexpected and context-sensitive ways.

Mentoring Through Co-Creation: Building Open Schooling Projects Together

One of the most illustrative examples of embedded mentoring within the ICSE Science Factory project comes from a series of Open Schooling Activities (OSAs) conducted in collaboration with schools. Through this example, it becomes clear how mentoring can organically develop across different phases of a project, from initial planning to implementation and dissemination, when dialogue, co-creation, and sustained support are at the core of the process. The context in which

Funded by the European Union

these activities took place was Cyprus, but the mentoring practices observed are broadly applicable and offer transferable lessons for other settings.

An effective model of mentoring was demonstrated through a collaborative process of developing and implementing Open Schooling Activities (OSAs) in cooperation with local schools. From the start, the approach intentionally positioned teachers and students not as passive recipients but as equal partners in designing educational experiences. This enabled the emergence of mentoring relationships that were built on mutual learning, trust, and continuous exchange.

The process began with **on-site visits** by the ICSE Science Factory team to participating schools. During these meetings, the goals of the project were introduced, with a special emphasis on open schooling as an approach that connects classroom learning to real-world scientific and societal challenges. Teachers and students were introduced to the idea that science education can be interdisciplinary, community-oriented, and problem-based, shifting the focus from rote learning to active engagement with meaningful issues.

A key feature of the mentoring process was the **co-creation of project themes**. Instead of providing fixed topics, the project team facilitated brainstorming sessions where students and teachers identified local or global issues they found relevant. This participatory process, supported through mentoring, allowed schools to develop ownership over the activities. Topics were selected democratically, further strengthening engagement and authenticity.

Throughout the **implementation phase**, mentoring continued in various forms. Teachers received pedagogical support tailored to their context, and scientific or technical assistance was provided based on the chosen topic. For example, project mentors helped connect schools with domain experts or provided access to necessary equipment such as sensors. This responsive support helped reduce implementation barriers and ensured that the OSAs remained both feasible and impactful. Students were also mentored beyond classroom boundaries. They were given opportunities to present their work at conferences and science fairs, where they received feedback and recognition. These experiences contributed to developing their communication and critical thinking skills while reinforcing their sense of belonging in scientific spaces.

Teachers, on the other hand, reflected on how this process influenced their professional growth. Many reported that the open schooling model, combined with sustained support, renewed their enthusiasm for teaching and strengthened student-teacher relationships. Mentoring, in this case, was not one-directional but rather a collaborative process of professional exchange and growth.

This example illustrates how mentoring can be naturally integrated into open schooling when collaboration is central and all participants are viewed as contributors. It shows how sustained, adaptive, and context-sensitive support enables meaningful learning experiences, benefiting students, educators, and the broader community.

Key lessons include:

- **Mentoring flourishes through co-creation**: Positioning teachers and students as equal partners fosters ownership, trust, and authentic engagement.

Funded by the European Union

- **Dialogue and participatory processes matter**: Brainstorming and democratic topic selection ensure relevance and strengthen commitment.
- **Support must be adaptive and context-sensitive**: Tailored pedagogical, scientific, and technical guidance helps overcome implementation barriers.
- **Mentoring extends beyond the classroom**: Opportunities to present work in public settings strengthen students' skills, confidence, and sense of belonging.
- **Mentoring fosters professional growth for teachers**: Sustained support renews motivation, enhances pedagogical practices, and improves teacher-student relationships.
- **Collaboration creates mutual learning**: Mentorship is not one-directional but a continuous exchange where all participants contribute and benefit.

Mentoring Through Collaboration: Connecting Schools with Experts, Institutions, and Communities

In Turkey, mentoring emerged through collaboration, shared problem-solving, and trust-building among schools, universities, municipalities, ministries, non-government organisations (NGOs), companies, and communities. These partnerships show that mentoring often takes the form of dialogue, mutual learning, and adapting to real-world challenges. What makes these experiences especially valuable is that mentoring was not only about guiding teachers or students, but also about helping external partners understand open schooling and find their own role in it.

Mentoring in Turkey within the ICSE Science Factory project unfolded through a series of collaborations that connected schools with universities, municipalities, ministries, NGOs, companies, and local communities. Unlike cases where mentoring is tied to a single activity, here it took shape across multiple entry points and stories, always adapting to the specific partners involved. What defined the process was its reciprocity: while schools and students received guidance and resources, external partners such as NGOs, ministries, and enterprises were also mentored in understanding the principles of open schooling and how to align their expertise with educational needs.

Concrete projects served as the starting point for mentoring relationships. In the *Un Kurdu* (mealworm) project, students worked with Ankara University to test protein levels in eggs, learning the basics of scientific inquiry while mentoring researchers in how science can connect with classrooms and communities. In *Bilinçli Spor Yapma* (Conscious Sport), seventh graders created QR-coded exercise videos for a fitness club. Here, professionals mentored students on safe use of equipment, while the students in turn helped community members better understand fitness practices.

NGOs and municipalities also played a central role. *Tohumluk Vakfı* was guided to adapt its rural outreach to educational needs, while Gölbaşı Municipality provided infrastructure and learned how school projects could feed into local policy. Families were drawn into activities such as composting, often after being mentored by their own children, showing how small-scale exchanges can expand the project's impact.

Across these varied contexts, mentoring was always two-way, partners supported schools, but also discovered new ways of applying their expertise through collaboration with teachers and students.

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

Key lessons include:

- **Real-life problems drive engagement:** Projects on recycling, food safety, and sports health created shared ownership among partners.
- **Sustainability requires multi-actor support:** Schools alone cannot carry projects: municipalities, NGOs, and companies need to actively contribute.
- **Communication builds participation:** Projects explained clearly to families and communities attracted stronger involvement.
- **Mentoring is mutual:** Universities, ministries, NGOs, and schools all learned from one another, making partnerships more resilient and meaningful.

Mentoring in Practice: Open Schooling Through Molecular Cuisine in Nursing Homes

In Germany, mentoring within the ICSE Science Factory project can be observed clearly through one particular example of Open Schooling: the "Molecular Cuisine in Nursing Homes" projects led by the University of Education Freiburg. This case is not the only form of mentoring in the German context, but it illustrates especially well how guidance and support can shape collaboration between schools, universities, companies, and community institutions.

By looking at this activity through the lens of mentoring, we see how external expertise helped schools and teachers embrace an unfamiliar concept, how coordination enabled smooth cooperation among diverse actors, and how students were supported in applying their knowledge in real-life settings. This example demonstrates mentoring as a catalyst for Open Schooling, transforming an abstract idea into a meaningful learning process with tangible benefits for both learners and society.

The projects involved vocational schools, nursing homes, the company Würzteufel, and the Freiburg university team. Each actor contributed different strengths: the university provided scientific knowledge, methodological guidance, and coordination; schools brought motivated teachers and students; the nursing homes offered authentic contexts; and the company supported with specialized tools and resources. This constellation created a fertile ground for mentoring relationships to emerge.

From the outset, the schools needed strong mentoring. Open Schooling was a new and unfamiliar concept, and the university acted as the main initiator and guide. Teachers were supported in adapting their schedules, accessing new materials, and embedding the activity into their curricula. In one case, a teacher even attended additional training in Switzerland, an effort that was encouraged and scaffolded through the project. These mentoring enabled schools to take ownership of the project while still relying on external expertise.

Students, too, were mentored through hands-on engagement. They learned about dysphagia and adapted nutrition, practiced preparing meals with molecular cuisine techniques, and then served them directly to elderly residents, either in their schools or in the professional kitchens of nursing homes. These encounters were deeply educational: students were guided not only in technical skills but also in how to interact with seniors with care and empathy. In return, the students themselves acted as mentors to the seniors by introducing innovative ways of preparing and enjoying food.

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

Special mentoring moments became turning points. In both projects, the shared meals between students and seniors stood out as highlights. They demonstrated how structured support and careful coordination can lead to warm, meaningful exchanges that benefit everyone involved. Teachers reported renewed motivation, students gained confidence and professional insight, and community partners saw the direct social impact of their engagement.

Key lessons include:

- **Mentoring as initiation:** Open Schooling often requires a determined initiator who introduces the concept and guides others in the early stages.
- **Mentoring teachers is essential:** Continuous support helps teachers integrate demanding projects into already full schedules and curricula.
- **Partnerships need structure:** Clear responsibilities, reliable communication, and flexibility (e.g., alternative plans) are crucial for success.
- **Collaboration enriches learning:** Involving external partners such as companies and care institutions adds depth, but also requires strong coordination and mentoring.
- **Shared experiences build trust:** Highlights like joint meals show the power of mentoring to transform projects into moments of genuine connection between students, professionals, and community members.

Mentoring as a Two-Way Process: Expanding Networks and Building Collaboration

In Croatia, mentoring within the ICSE Science Factory project unfolded through a variety of activities and partnerships. It is a story of building networks, expanding collaborations, and shaping new forms of cooperation. What stands out is how mentoring was not a one-way process, but rather mutual guidance and learning, where schools, universities, companies, research institutions, NGOs, and local communities inspired and mentored one another.

Sensors for Happier Plants – Mentoring turned outward

Through the workshops *Sensors for Happier Plants*, colleagues from the Faculty of Electrical Engineering and Computing (FER) and an agronomist partner collaborated directly with schools and students. Although their initial collaboration had been at the university level, this project encouraged them to step into classrooms and design workshops for children.

The mentoring process was twofold: schools and students learned from scientific experts, while the experts themselves learned how to adapt content for younger audiences. Motivated by the project experience, the partners then expanded mentoring “outward”, preparing open-access materials now available on the national ICSE Science Factory website, accessible to teachers, students, and the wider public.

Mali tehnopolis Samobor – Building bridges

From the start, local full partners collaborated with *Mali Tehnopolis Samobor*, an entrepreneurial incubator. Their role went beyond providing infrastructure and hosting events—they acted as mentors in network-building, linking schools and universities with local businesses.

One such encounter brought together FER’s *Startup incubator SPOCK* and local entrepreneurs, creating an exchange of experience and expertise. In this way, mentoring was not only about knowledge transfer, but also about enabling meaningful cross-sector dialogue.

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

Ruđer Bošković Institute – Learning from established practices

Through the bridge of *Mali Tehnopolis*, the project engaged the Ruđer Bošković Institute, Croatia's largest multidisciplinary research center. Beyond collaborating with experts (e.g. in AI and medicine), the Institute itself became a mentor by example: showcasing how to systematically organize and sustain community outreach and science popularization.

For the ICSE Science Factory network, this was a valuable form of reverse mentoring—learning from an institution that has long mastered community engagement, while also laying foundations for long-term cooperation and exchange.

School leadership in Open Schooling – OŠ Silvije Strahimir Kranjčević

A standout example comes from the primary school *Silvije Strahimir Kranjčević*. Here, teachers, guided by mentoring support, went far beyond isolated activities. They transformed their entire school year by embedding Open Schooling projects into the curriculum across multiple classes.

They organized their own school-wide science fair, with external partners serving as the evaluation jury, and participated in the ICSE Public Science Fair. In this case, mentoring clearly spread from project coordinators to teachers, and from teachers to the entire school community, ensuring sustainability by institutionalizing Open Schooling practices.

Mentoring through companies – Globallogic and VIDI

Collaboration with companies demonstrated another layer of mentoring. At a partner meeting focused on STEM enterprises, *Globallogic* was introduced to schools, leading to hands-on workshops with Micro:bits. Similarly, media-tech company *VIDI* partnered in organizing the Public Science Fair, dedicating an entire section to digitalization in schools.

In both cases, ICSE SF acted as a mentor and platform provider, guiding companies on how best to channel their interest in community engagement into school-based educational formats.

Reaching remote communities – Dugi Otok and Telašćica Nature Park

A particularly unique case was the inclusion of *Dugi Otok* and its Elementary school *Petar Lorini*, together with *Telašćica Nature Park*. The geographical distance and insularity created specific mentoring needs. To address these, the team organized a multi-day event that combined partner meetings, workshops, lectures, and student activities.

Here, mentoring was again mutual: while schools and students received training and exposure to scientists, the project partners themselves learned from the local community. Through activities at the Park's education centre, local experts introduced environmental knowledge and ecological practices, offering reverse mentoring to university and business partners. Informal exchanges further deepened understanding of the challenges and specific needs of island communities.

Responding to teachers' needs – AI in education

Finally, mentoring in Croatia was visible in the project's responsiveness to teachers' expressed needs. When educators requested training on AI in education, a partner meeting was reorganized to include two expert lecturers. This ensured that mentoring was not a fixed process but an adaptive dialogue, enabling teachers to later transfer new competencies into their Open Schooling projects.

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

Key lessons include:

- **Mentoring as a network-building process:** Partners often acted as connectors, showing that mentoring can expand beyond individuals to whole systems.
- **Mentoring is reciprocal:** Local schools, remote communities, and major institutions alike both gave and received guidance.
- **Sustainability through integration:** Embedding Open Schooling into school curricula is a powerful way to make mentoring effects last.
- **Responsiveness matters:** Mentoring thrives when it listens to community needs and adapts accordingly.
- **Platforms amplify mentoring:** Creating spaces (fairs, partner meetings, incubators) enabled mentoring to reach far beyond initial project partners.

Conceptual Framework for Mentoring in Cross-Sector Partnerships

Mentorship in ICSE Science Factory is not a linear, hierarchical transfer of knowledge, but a reciprocal, adaptive, and co-creative process involving schools, universities, enterprises, communities, and students. It is sustained by trust, collaboration, and responsiveness to context-specific needs.

Based on the experiences and feedback from the local initiatives and networks in the partnering countries, we have formulated the following **CORE PRINCIPLES OF MENTORING**.

1. **Reciprocity**
    - Mentorship is mutual: schools, enterprises, scientists, and communities mentor and learn from each other.
    - Example: In Turkey, NGOs and municipalities not only guided schools but were also mentored in open schooling approaches.
2. **Co-Creation**
    - Mentorship emerges through shared design and implementation of activities.
    - Students and teachers are positioned as equal partners in creating meaningful educational projects.
    - Example: In Cyprus, project themes were co-created democratically by students and teachers with mentoring support.
3. **Responsiveness**
    - Mentorship adapts to expressed needs and evolving contexts.
    - Example: In Croatia, when teachers requested AI training, mentoring shifted to meet that need.
4. **Sustainability**

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

- Mentorship leads to lasting practices by embedding outcomes into curricula, institutional networks, and public resources.
- Example: In Germany, vocational schools integrated open schooling projects into formal schedules with long-term partnerships.

The conceptual diagram shows how the four core principles relate to one another and to the wider mentoring environment. It highlights the connections with platforms and networks, role clarity and trust, communication and accessibility, and inclusivity.

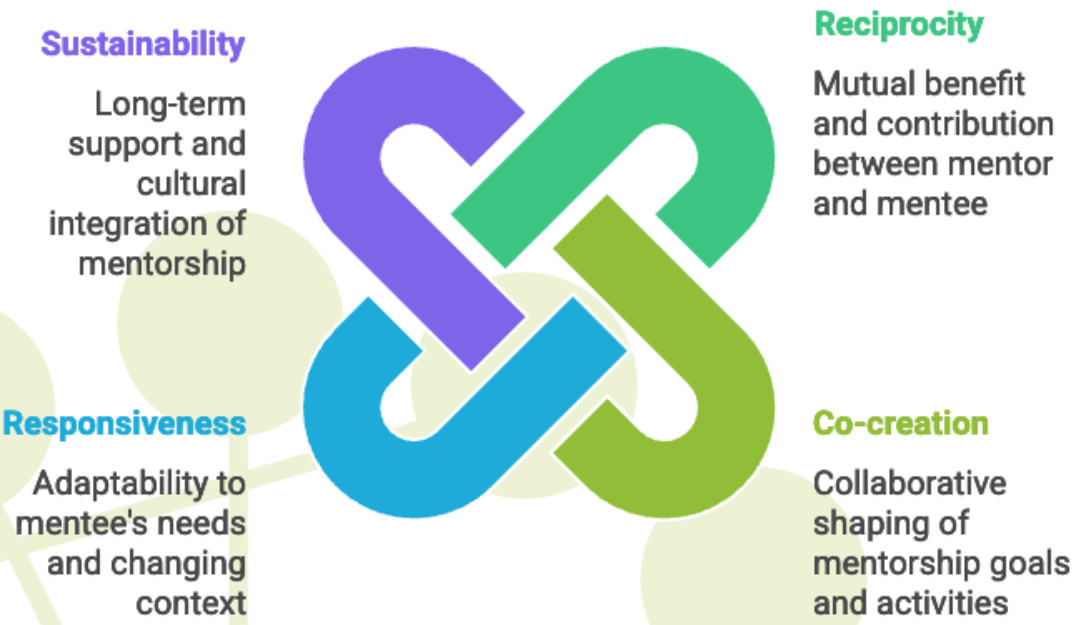


Figure 2: Core Principles of Mentoring in ICSE Science Factory

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

3. Guidelines for Encouraging Mentoring Across the Partnership

General Guidelines for Establishing Mentoring Relationship with Local Partners

To support the promotion of the project and its activities, announce upcoming events, showcase examples of open schooling initiatives, and distribute relevant materials, each partner country should launch **a national website** dedicated to the ICSE Science Factory project.

In addition, to facilitate communication between local partners and all interested stakeholders, a dedicated **mentoring email address** should be established in each country. This can either be a general project email address covering all activities or a specialized address used exclusively for mentoring-related communication. Through this channel, community members can request information, seek guidance, or receive project support. Inquiries can then be forwarded to relevant experts as needed.

The list of national ICSE Science Factory websites is provided in Appendix 1.

Guidelines for Mentoring Schools

The aforementioned support should then be implemented consistently. The support schools most often need relates to planning, organizing, and carrying out open schooling activities. Effective mentoring can help schools build confidence and capacity in implementing these activities. Mentoring can be achieved through the following strategies:

- **Organizing professional development seminars** aimed at familiarizing school leaders and teachers with the concept and benefits of open schooling;
- **Facilitating practical workshops** on open schooling, where teachers work collaboratively in small groups to design projects that are relevant to their communities and students;
- **Presenting concrete examples of support** that schools can expect when implementing open schooling activities, such as:
    - Help in identifying and refining a project topic;
    - Assistance in connecting with local experts or professionals;
    - Support in organizing a lecture or workshop (e.g., a lighthouse activity) on a specific topic, or arranging an interactive career talk that corresponds with the chosen project theme;
    - Procurement or loan of specific materials or equipment needed to implement the project;
    - Guidance on how to effectively share and disseminate the project results to appropriate target audiences;
- **Offering access to a network of professionals and specialist** (e.g., scientists, university faculty, engineers, entrepreneurs, etc.) who can act as mentors or collaborators in project implementation;
- **Utilizing existing partner networks**, such as teaching associations, continuing professional development programs, or local education initiatives, to connect schools with mentoring opportunities;
- **Establishing a clear communication channel**, such as a designated mentoring email address or a point-of-contact person, to provide ongoing support and respond to questions;

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

- Promoting **peer-to-peer learning** as a meaningful form of mentoring (e.g., experienced teachers supporting colleagues by sharing their own open schooling experiences);
- **Encouraging reflective practices**, such as group feedback sessions or mentoring journals, to help teachers evaluate their experiences and refine future approaches.

To ensure success, the above-mentioned forms of support should be implemented in a continuous and structured way, with regular follow-up to maintain momentum and provide timely assistance as needed.

Members of the international consortium engaging in STEM activities with pupils at a partner elementary school, Zagreb, Croatia (2024)

Guidelines for Enterprises

Suggestions for establishing effective and sustainable mentoring relationships with enterprises include the following:

- **Establish direct contact**: Initiate contact with an enterprise (e.g., HR department, learning and development team, or CEO) to explore a cooperation agreement:
  - Arrange **individual or small-group** meetings with company representatives to present the core idea of the project and outline various ways in which the company, or individual employees, can contribute.
  - **Clearly explain** potential forms of collaboration, such as providing scientific advice and support for open schooling projects, acting as (co-)leaders in lighthouse activities, participating in interactive career talks, or offering opportunities for internships and job shadowing.

Funded by the European Union

  - Provide **concrete and tailored requests**, specifying exactly what kind of support is needed (e.g., for a particular open schooling activity, career talk, or LHA), how many hours it may require, and the type of involvement (e.g., expertise, time commitment, or financial support).
  - **Develop and distribute** concise, visually engaging brochures aimed at employees with a STEM background, clearly outlining how they can get involved and the potential benefits of participation (e.g., visibility, impact, networking).
- **Target enterprises strategically**, based on the identified needs of project partners (e.g., schools or student groups).
- **Leverage existing contacts and networks** to approach enterprises more efficiently:
  - Project partners, such as technical schools, often already collaborate with enterprises on internship programs.
  - Use visibility opportunities through **existing public events** (e.g., local fairs, job fairs, career days, STEM academies, science festivals, etc.).
  - Reconnect with companies that participated in previous collaborative projects or **signed letters of intent**, as they already showed interest in engagement.
  - **Assign a local contact person** (from the school or coordinating organization) to maintain communication with enterprises and follow up regularly.
- **Maintain regular communication** – Once collaboration is established, it is important to maintain contact through periodic updates, invitations to events, or newsletters, and **acknowledge the enterprise's contribution publicly** whenever possible.

Guidelines for Mentoring Community Members

Community members are invited to actively participate in the ICSE Science Factory project by getting involved in its key activities, such as **lighthouse workshops**, **career talks**, and **science fairs**. These activities offer valuable opportunities for two-way engagement between the public and STEM professionals.

Mentoring within this target group should be facilitated through **dedicated interaction timeslots** embedded in the activities mentioned above. These open periods are intended for informal and direct communication between community participants and experts (e.g., scientists, representatives from local institutions, and enterprise professionals). During these times, community members are encouraged to ask questions, explore potential collaborations, and seek information, guidance, or support.

To make these mentoring moments more effective, the following additional recommendations are suggested:

- **Clearly announce and promote these mentoring times in event schedules and invitations**, so participants are aware of when and how they can engage with experts.
- **Encourage experts to adopt an open and approachable communication style**, particularly when speaking with individuals unfamiliar with science or STEM fields.
- **Designate moderators or facilitators to help initiate conversations** between community members and experts, especially for participants who may feel hesitant to engage.

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

- **Offer printed or digital materials with key contacts, FAQs, or examples of past collaborations**, helping participants understand the types of support available and how to follow up after the event.

These mentoring opportunities allow for the creation of more inclusive, collaborative, and sustainable partnerships between science and society.

Guidelines Across Different Groups of Partnership

Mentoring across different partnership groups is realized through collaborative engagement in project activities such as **lighthouse workshops**, **open schooling projects**, and **career talks**. These formats naturally bring together various stakeholders and provide a platform for mutual learning, support, and exchange of expertise.

Mentoring is further encouraged during the process of **building and maintaining the local partnership network**, where every joint activity involving multiple stakeholders becomes an opportunity to foster mentoring relationships, whether formal or informal.

Dedicated mentoring sessions are also integrated into larger events such as **local partnership conventions**, where partners can reflect on their experiences, share good practices, and strengthen cooperation. These moments allow for deeper peer-to-peer learning and support between different sectors (e.g., education, academia, industry, and community organizations).

The role of ICSE Science Factory full partners is to coordinate and support mentoring efforts across groups. This includes:

- **Facilitating collaboration** between schools and experts from scientific, academic, and professional fields;
- **Ensuring that schools** implementing open schooling projects **are connected with suitable mentors** based on project themes and needs;
- **Encouraging all stakeholders**, especially professionals in enterprises and research institutions, **to take on active mentoring roles** in ways that are manageable and meaningful for them;
- **Providing orientation or brief training sessions for mentors**, especially those new to working with schools or young learners, to help them feel prepared and confident in their role.

It is also recommended to maintain a mentoring contact person or team within each full partner organization to oversee and coordinate mentoring efforts across the partnership. These structured yet flexible approaches help ensure that mentoring becomes an integral and sustainable part of the ICSE Science Factory partnership network, ultimately contributing to stronger collaboration and greater impact.

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

Suggestions for Continuous Monitoring of the Mentoring Process

To ensure a long-term and seamless communication and coordination among various stakeholders—which is essential for successful mentoring and the effective implementation of project activities—the following steps are recommended:

- **Regular work meetings** among ICSE Science Factory local full partners are desirable. Additionally, to facilitate timely exchange of information and to monitor progress effectively, it is recommended to establish a shared digital planner or project management tool accessible to all partners.
- **Assign dedicated person(s) responsible for coordinating activities** and acting as the main liaison between different stakeholders to maintain smooth communication and follow-up.
- **Create and regularly update a comprehensive list of all attached partners**. Distribute a periodic newsletter or bulletin to keep partners informed about ongoing and upcoming project activities, while also encouraging their active participation by inviting them to share ideas, feedback, and needs for future activities.
- **Seize all possible opportunities to strengthen the partnership network**, such as joint organization of events, collaborative participation in conventions and fairs, and fostering a shared identity by emphasizing the sense of belonging to the ICSE Science Factory project.
- **Leverage social media platforms as an effective mentoring tool** across all partner groups (schools, enterprises, community members). For example, regularly posting updates about lighthouse activities, accompanied by brief descriptions and visual content, can help schools and other partners to showcase their involvement and reach a wider audience.
- **Implement periodic evaluation checkpoints** (e.g., quarterly surveys or feedback sessions) to assess the effectiveness of mentoring activities, identify challenges, and make necessary adjustments to the mentoring strategy.
- **Encourage open and transparent communication channels** where partners can raise concerns or suggestions related to mentoring and collaboration.

ICSE Science Factory International Consortium meeting in Lisbon, Portugal (2024)

4. Reflections and the way forward

The ICSE Science Factory has shown that *encouraging mentoring across the partnership* was not only a guiding principle, but a concrete and successful practice. Across different countries, mentoring unfolded in diverse yet complementary ways, through co-creation of Open Schooling projects, cross-sector collaboration, mutual exchange between schools and institutions, and the integration of new expertise into classrooms and communities.

Partners consistently emphasized that the most fulfilling aspects of mentoring were:

- **reciprocity**, where schools, researchers, companies, and communities all learned from one another,
- **network-building**, where mentoring acted as a bridge connecting different sectors and creating long-term collaborations,
- **responsiveness**, as partners adapted activities to the real needs of teachers, students, and local communities,
- **sustainability**, with mentoring effects extended through integration into school curricula, open-access resources, and institutional practices.

Looking across the mentoring, experiences illustrated through examples from Cyprus, Turkey, Germany, and Croatia, a clear picture emerges: while the concrete situations described here highlight different aspects of mentoring, similar practices were present and developed across all countries. The forms of mentoring, whether through co-designing projects in classrooms, supporting teachers in adopting new methods, or bridging institutions and local communities, were not isolated or country-specific, but part of a shared pattern of mutual, adaptive, and transformative collaboration.

Through these experiences, the project demonstrated that effective mentoring is not a one-way transfer of expertise but a dynamic, evolving process of dialogue, trust, and shared growth. In this sense, the ICSE Science Factory has succeeded in fostering mentoring practices that are not only impactful within the project's timeframe, but also capable of leaving lasting value for schools, institutions, and communities.

The speciality of *Encouraging Mentoring across the Partnership* has shown itself to be successful within the ICSE Science Factory, with several key practices standing out as particularly impactful:

- **Mentoring was reciprocal** – schools, researchers, companies, and communities not only shared knowledge with one another but also learned from each other in the process.
- **Mentoring supported network-building** – partners acted as connectors across sectors and institutions, leading to long-term collaborations and new forms of partnership.
- **Mentoring was responsive** – activities were adapted to the concrete needs of teachers, students, and communities (e.g., organizing AI-in-education workshops at teachers' request).
- **Mentoring ensured sustainability** – impacts were extended by integrating Open Schooling into school curricula, developing open-access materials, and adopting best practices from established institutions.
- **Mentoring benefited from platforms** – events such as fairs, partner meetings, or incubators provided spaces where mentoring could expand beyond initial project partners.

ICSE International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

- **Mentoring created meaningful exchanges** – from co-creating projects to shared meals between students and seniors in nursing homes, these moments showed the power of mentoring to foster connection and shared achievement.
- **Mentoring thrived through co-creation** – positioning teachers and students as equal partners fostered ownership, trust, and authentic engagement.
- **Mentoring benefited from participatory processes** – democratic topic selection and collaborative planning strengthened commitment and ensured relevance.

While the mentoring dimension of the ICSE Science Factory has brought many fulfilling experiences and established lasting collaborations, it has also revealed challenges that point to important lessons for the future. For example, during the *Interactive Career Talk* activities, many scientists and professionals were highly motivated to engage with young people, yet lacked prior experience in communicating effectively with this audience. Teachers, by contrast, were well prepared for such interaction due to their training and classroom expertise. Coordinators sometimes faced uncertainty about how much guidance to provide to guest speakers, whether to step in with practical advice on structuring presentations, encouraging dialogue, or sustaining students' interest. In response, the project developed the leaflet included in *D3.1 Best Practice Interactive Career Talk*, thereby extending mentoring support into future events of this type.

More demanding still were activities such as Open Schooling projects, which required significant time, coordination, and resource investment. Here, the involvement of teachers, researchers, and especially companies often proved challenging. Teachers could clearly see the value of these collaborations for their students, but rigid school schedules and the lack of recognition for extra work made participation difficult to sustain.

For scientists and professionals, participation often relied on personal networks or prior collaborations, limiting the pool of contributors. The case of companies highlighted a deeper issue: although many expressed interest and even signed letters of support, their role within the project was often not fully fulfilled.

While some companies were willing to contribute, by sending staff to career talks or supporting workshops, these engagements were difficult to reconcile with their internal structures. Employees had to prepare, communicate with organizers, and dedicate time during working hours, which was not always recognized or compensated within the company framework, especially in companies without an established educational or community engagement role, where such contributions are harder to acknowledge and integrate into regular responsibilities. In some cases, companies pursued only activities aligned with their own interests, making it harder to adapt to the needs of schools or the project as a whole.

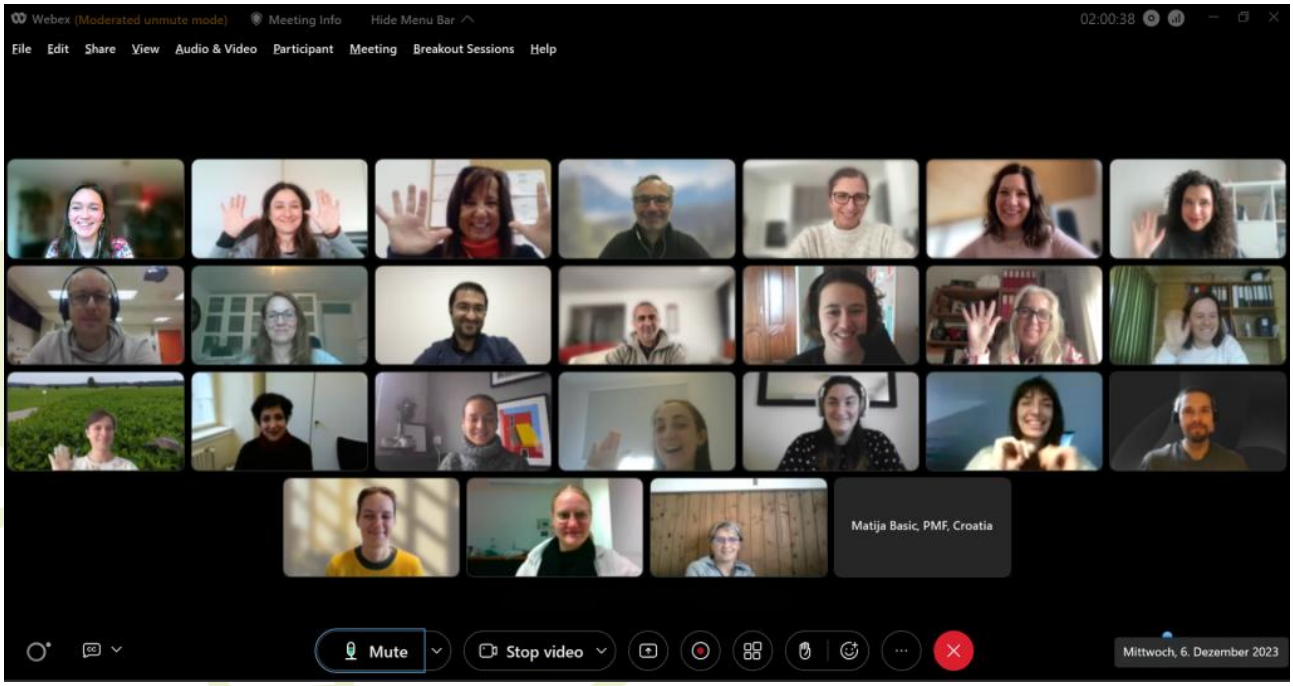
Municipalities and local institutions faced similar challenges: despite offering broad endorsement, their concrete involvement was limited when responsibilities were not clearly assigned.

These experiences point to a broader structural challenge within the ICSE Science Factory: when diverse actors, universities, schools, teachers, students, researchers, enterprises, and local communities, come together, the roles, benefits, and incentives for each partner are not always

Funded by the European Union

clear. This lack of clarity can make even highly motivated partners hesitant or inconsistent in their engagement.

At the same time, the project's positive examples of co-creation showed that when roles are jointly defined and ownership is shared, mentoring becomes more impactful and sustainable. A valuable next step would therefore be a dedicated project exploring precisely this issue*: how to design multi-actor collaborations in education so that each stakeholder has a clearly defined role, with transparent responsibilities, tangible benefits, and adequate recognition or compensation.* Building such a framework would not only address the challenges faced in the ICSE Science Factory but also provide a sustainable model for future large-scale initiatives involving schools, companies, and communities.



Online meeting of the ICSE Science Factory international consortium (2023)

International Centre for STEM Education
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
Funded by the European Union

Appendices

Appendix 1. The list of national Websites

Country	Website Address
Croatia	https://sciencefactory.math.hr/
Cyprus	https://pure.unic.ac.cy/en/projects/icse-science-factory
Germany	https://icse.ph-freiburg.de/icse-science-factory/
Portugal	https://icsesf.ie.ulisboa.pt/
Turkey	https://hstem.hacettepe.edu.tr/tr/icse_science_factory-41
International website	https://icse.eu/international-projects/icse-factory/

Appendix 2. Selected research references related to mentoring

Diekman, A. B., Ward, R. M., Yezierski, E. J., & Bretz, S. L. (2025). Developing identity via intentional interdisciplinary engagement: exploring new mentoring models for STEM graduate students' professional development. *Mentoring & Tutoring: Partnership in Learning*, 1–21. https://doi.org/10.1080/13611267.2024.2441125

Hernandez, P. R., Patterson, M. S., Nyanamba, J. M., Adams, A. S., Barnes, R. T., Bloodhart, B. P., Burt, M. A., Clinton, S., Pollack, I. B., & Fischer, E. V. (2023). Webs of science: mentor networks influence women's integration into STEM fields. *Frontiers in Ecology and the Environment*. https://doi.org/10.1002/fee.2666

Pichon, H. W., Way, S., & Arnett, S. M. (2025). Understanding the "Why" of STEM Faculty Mentors and How They Engage in High Context Teaching and Mentoring Strategies. *Journal of Hispanic Higher Education*. https://doi.org/10.1177/15381927251356595

White-Lewis, D. K., Romero, A. L., Gutzwa, J. A., & Hurtado, S. (2022). "Moving the Science Forward": Faculty Perceptions of Culturally Diverse Mentor Training Benefits, Challenges, and Support. *CBE-Life Sciences Education*, *21*(1). https://doi.org/10.1187/cbe.21-08-0217

Markle, R. S., Williams, T. M., Williams, K. S., deGravelles, K. H., Bagayoko, D., & Warner, I. M. (2022). Supporting Historically Underrepresented Groups in STEM Higher Education: The Promise of Structured Mentoring Networks. *Frontiers in Education*, *7*. https://doi.org/10.3389/feduc.2022.674669

Flores, B. C., Boklage, A., Borrego, M., Landgren, E., Vielma, K., & Chavez, E. L. (2024). *Inclusive Mentoring in Engineering and Science: An Evolving Workshop Model (Experience)*. https://doi.org/10.18260/1-2--47601

Funded by the European Union