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STEMSiL

WP4 - STEM co-creation labs and STEM projects

STEMSiL co-creation guide

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STEMSiL
STEM methodologies in Sign Languages

Content

Project Description

STEMSiL contributes to the inclusivity of STEM education, by aiming to support teachers, deaf students and Sign Language (SL) interpreters of primary and secondary education to improve their knowledge of STEM fields using Sign Language. STEMSiL will develop a new approach on teaching STEM in deaf education through a tailor-made methodology, a visual STEM lexicon in Sign Language, while also guiding students, teachers and SL interpreters to co-create real-life STEM projects.

The project activities will be research design activities including a study about STEM in deaf education, training of teachers and Sign Language interpreters on a tailor-made methodology, teaching methods and tools, development of an online platform and a visual STEM lexicon, co-creation labs and real-life STEM projects by deaf students, teachers and SL interpreters, campaigning videos developed by students and the implementation of multiplier events and a final conference.

STEMSiL endeavours to create an inclusive environment for deaf students by providing the school community with a study about STEM in deaf education and a tailor-made methodology for teaching STEM to deaf students. An online platform with a visual STEM lexicon in six EU Sign Languages (DE, GR, ES, PT, FR, IT) will also be developed, together with a STEM.

The project aims to achieve the following objectives:

- ✓ Analyse the current situation in STEM education within Deaf education and characteristics of deaf education and identify pertaining issues
- ✓ Develop new methods and tools for teachers and Sign Language interpreters to transmit the main STEM concepts into deaf education.
- ✓ Enhance awareness of European Sign Languages and of Deaf communities within the context of STEM education for deaf children at both elementary and secondary levels
- ✓ Promote the involvement of teachers, Sign Language interpreters and deaf students in real-life STEM projects.

Introduction

STEM education—encompassing Science, Technology, Engineering, and Mathematics—is vital for fostering innovation, critical thinking, and problem-solving skills in students. It prepares them for a future where these competencies are increasingly in demand. According to the U.S. Department of Education, students who engage in STEM learning are better equipped to succeed in a world that is becoming more technologically advanced and data driven.

Research shows that early exposure to STEM can spark a lasting interest and proficiency in these fields. For instance, a study by Tai et al. (2006) found that children who expressed interest in STEM careers by eighth grade were significantly more likely to pursue degrees in these areas. Furthermore, integrating STEM education with hands-on, project-based learning has been shown to enhance student engagement and understanding of complex concepts (Beers, 2011).

However, for Deaf students, accessing quality STEM education presents unique challenges. Traditional teaching methods often rely heavily on auditory information, which can create barriers for Deaf learners. Adapting STEM education to be more inclusive involves not only translating materials into Sign Language but also considering the cultural and linguistic nuances of Deaf communities. This ensures that Deaf students receive the same quality of education and opportunities as their hearing peers.

Deaf education must be tailored to address specific needs, such as ensuring clear communication and understanding through Sign Language. Research by Marschark and Hauser (2012) highlights that Deaf students often face additional hurdles in STEM subjects due to a lack of resources and appropriately trained teachers. Incorporating Sign Language into STEM instruction can help bridge this gap, making STEM fields more accessible and engaging for Deaf students.

Moreover, promoting STEM within Deaf education not only enhances academic and career opportunities but also empowers Deaf students by providing them with the tools to innovate and contribute meaningfully to society. Projects like STEMSiL aim to support teachers and interpreters in developing skills to convey STEM concepts effectively, fostering an inclusive learning environment where Deaf students can thrive.

The purpose of this guide is to provide educators, Sign Language interpreters, and community stakeholders with a comprehensive framework for organizing and implementing STEM co-creation labs tailored for Deaf students, promoting inclusive and effective STEM education through innovative methods, collaborative activities, and practical tools, thereby enhancing learning opportunities and career prospects for Deaf students in Europe.

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STEMSiL
STEM methodologies in Sign Languages

Ten Innovative teaching methods for STEM in Sign Languages - An overview of the STEMSiL Handbook

Effectively teaching deaf students in STEM requires innovative methods that make better use of teaching time through targeted integration of Sign Languages. Here are ten such methods, designed to achieve better academic results compared to traditional approaches with limited use of sign language in STEM classrooms. This collection is not exhaustive but serves as a useful starting point for STEM educators to explore the potential of incorporating Sign Languages in their teaching. These methods offer initial steps and ideas for more advanced teaching in Sign Languages. By experimenting with these techniques, teachers can adapt them to their students' needs, improve their own language skills, and enhance their STEM expertise. Let's explore these ten methods, which have the potential to transform STEM education for deaf students and strengthen connections between classroom practice and research.

1) Development and use of STEM syllabus in Sign Languages

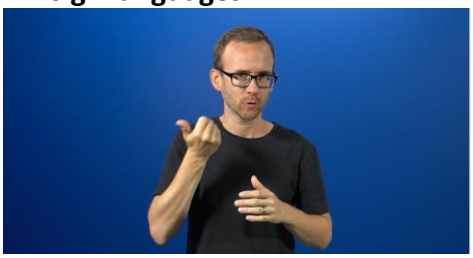
STEM curriculum in SL is needed to consider

- **deaf gain and deaf culture in STEM**
- **perceptive asymmetries,**
- **variety of linguistic repertoires,**

of deaf learners.

The handbook gives **examples** to give an idea for further curriculum development in SL.

2) Use of videoclips staring STEM experts in sign languages



CR: STEM Methodologies in Sign Languages, *STEMSiL*

Videoclips starring STEM experts

- provide Deaf role models for students,
- give students better understanding of benefits and requirements in STEM education and STEM career,
- offers signed samples of high linguistic quality which can be used to learn SL in STEM classroom.

3) STEM Concept Cards

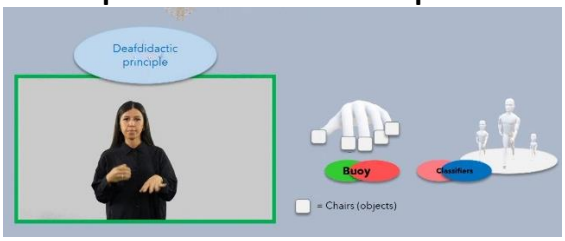
STEM Concept Cards can be used to explain selected STEM concepts. The aims are to

- introduce the view of students to diverse STEM concepts,
- help teachers, interpreters and researchers to develop learning materials which use STEM signs derived from the signs of the learners,
- help teachers, interpreters and researchers to understand how deaf students think and find ways for better communication of knowledge.

4) Adapting of STEM glossaries established by Deaf experts

CR: Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V.

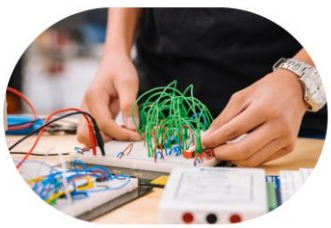
- explanation of concepts in SL
- adapting to the age, cultural and linguistic background of the learners,

<table>
<tr><td></td><td>- using examples, illustrations, dynamic animation, 3D-models and movements.</td></tr>
<tr><td>5) Linguistic and iconic strategies in the expression of STEM concepts
 

CR: Competence Center for Sign Language and Gesture SignGes

Inspired by linguistic research, special didactics of STEM-subjects and Deaf-Didactics we suggest to use of linguistic and iconic strategies to describe, to explain and to discuss STEM concepts and give concrete examples.</td><td>6) Visualizing materials used in the classroom – Use of visual cues
 
CR: STEM Methodologies in Sign Languages, STEMSiL

Deaf students are often considered as visual learners and use of visual tools is recommended for deaf classroom. However meaningful use of visualizations in STEM education requires embedding in signed, written or spoken explanations (texts, videos) adjusted to individual perceptual situations and linguistic repertoires of deaf learners.</td></tr>
<tr><td>7) Creation of Sign Language video clips explaining selected STEM concepts – Online presentation
To develop language skills and widen STEM knowledge and competences students can be asked to create their own videos in SL, where they document their own scientific experiments, internet or literature research, reflections, discussion of results, cooperation with their school mates and in case it is possible STEM experts outside of the school.</td><td>8) STEM dialogue in and outside the classroom: Short presentation and discussion

To support dialogue and cooperation between different schools, other educational and research organizations we suggest implementation of
- STEM-competitions,
- STEM-slams,
- STEM-summer camps.</td></tr>
<tr><td>9) Use of co-creation toolkit – with technology tools
 
Use of technology can help to connect teaching of different STEM subjects in SL through use of
- programming,
- lego creations,
- robotic,
- using technology to work with materials like wood, metals and so on.</td><td>10) Use of co-creation toolkit – without technology tools

As alternative to the experiments with use of technology we recommend conducting experiments which are used by hand crafts and requires direct contact with nature, materials or with each other.

That will give students the possibilities to derive vocabulary, explanations and iconic superstructures to describe the experiments directly from actions of the students, visible and tangible properties of the objects and core phenomena studied by the experiments.</td></tr>
</table>

The teaching methods presented are based on theoretical concepts, the experience of deaf and signing teachers, and input from deaf STEM experts and researchers. For more detailed theoretical and empirical foundations, we recommend consulting the project handbooks. After trying these methods, teachers are encouraged to provide constructive feedback and suggestions for improvement.

The transversal skills to be developed

In the context of the STEMSiL project, several **transversal skills** can be taught and assessed, both within the STEM concept and beyond. These skills are crucial for fostering a well-rounded learning experience that enhances critical thinking, collaboration, and problem-solving abilities. Here are the key transversal skills to be developed by the students:

1. Critical Thinking and Problem-Solving

- **Description**: The ability to analyse complex problems, think logically, and develop innovative solutions.
- **STEM Context**: Critical thinking is essential in interpreting scientific data, solving mathematical problems, or understanding engineering challenges. Students will need to assess information, identify patterns, and apply theoretical knowledge to real-world situations.
- **Assessment**: Provide students with STEM-related challenges and assess how they approach, analyse, and solve problems, ensuring they justify their reasoning.

2. Collaboration and Teamwork

- **Description**: The ability to work effectively with others towards a common goal, appreciating diverse perspectives and contributions.
- **STEM Context**: Many STEM projects involve group work, requiring students to collaborate, especially in co-creation labs where deaf students, teachers, and interpreters work together on projects.
- **Assessment**: Observe group dynamics, communication effectiveness (including the use of Sign Language), and the ability to work together to complete STEM tasks.

3. Communication Skills (including Sign Language Proficiency)

- **Description**: The ability to convey ideas clearly and effectively, both verbally and non-verbally, using appropriate modes of communication.
- **STEM Context**: Effective communication is essential for explaining STEM concepts and collaborating with others. For Deaf students, mastering both written and signed communication within STEM contexts is crucial.
- **Assessment**: Evaluate presentations, reports, and the use of Sign Language during collaborative projects or individual tasks.

4. Digital Literacy

- **Description**: The ability to use digital tools and technology efficiently to solve problems, gather information, and communicate.
- **STEM Context**: Digital literacy is critical when using educational software, simulations, and tools for data analysis in STEM. Deaf students may also use digital tools to enhance learning through visual resources and apps.
- **Assessment**: Assess proficiency in using digital platforms for research, communication, and project development (e.g., creating digital timelapses, using simulations for experiments).

5. Creativity and Innovation

- **Description**: The ability to think outside the box, generate new ideas, and apply them to solve problems creatively.
- **STEM Context**: Innovation is at the heart of STEM. Students are encouraged to come up with unique solutions to scientific problems or design engineering prototypes.
- **Assessment**: Assess students' originality in designing STEM solutions or their ability to modify existing tools/ideas to meet the project's needs.

6. Adaptability and Resilience

- **Description**: The capacity to adapt to new challenges and persevere through difficulties.
- **STEM Context**: STEM projects often involve trial and error. Being adaptable in the face of changing variables or failed experiments is an important skill.
- **Assessment**: Monitor how students respond to challenges in their projects, their flexibility in modifying their approaches, and their perseverance to achieve desired outcomes.

7. Leadership and Initiative

- **Description**: The ability to take the lead in a group, motivate peers, and take proactive steps towards completing tasks.
- **STEM Context**: Leadership is crucial in co-creation labs where students take ownership of projects and guide their peers. Deaf students can be empowered to lead discussions, organise teams, and make key decisions.
- **Assessment**: Evaluate how students take initiative in managing their STEM projects, lead discussions, and delegate responsibilities among peers.

8. Self-Regulation and Autonomy

- **Description**: The capacity to manage one's own learning process, including setting goals, planning, and evaluating progress.

- **STEM Context**: Self-regulation is essential in research and project-based learning. Students should be able to independently manage timelines, track progress, and adjust methods to achieve STEM goals.
- **Assessment**: Measure how students organise their projects, maintain focus, meet deadlines, and reflect on their learning journey.

9. Empathy and Social Awareness

- **Description**: The ability to understand others' feelings, perspectives, and needs, and respond with care.
- **STEM Context**: Empathy is particularly important in Deaf education, where students must navigate the challenges of inclusivity. In STEM, empathy can drive solutions that address real-world problems with a human-centric approach.
- **Assessment**: Assess students' interactions with peers, their consideration of community needs in STEM projects, and their collaboration with diverse groups.

10. Organisational and Planning Skills

- **Description**: The ability to manage time, resources, and tasks efficiently to achieve objectives.
- **STEM Context**: Managing a STEM project involves thorough planning, from conducting experiments to completing final presentations.
- **Assessment**: Evaluate the students' ability to create and follow detailed project timelines, their use of resources, and their efficiency in meeting project milestones.

11. Reflective Thinking

- **Description**: The ability to reflect on one’s actions and learning, analysing successes and failures for continuous improvement.
- **STEM Context**: Reflective thinking allows students to evaluate their approaches, learn from mistakes, and improve in future tasks or projects.
- **Assessment**: Use reflective activities, such as journaling or group discussions, to assess how students analyse their performance and growth throughout the STEM project.

These transversal skills not only strengthen students’ abilities in STEM fields but also equip them with essential life skills, fostering their growth as confident, collaborative, and critical thinkers.

Co-Creation's Theoretical Basis in STEMSiL

The concept of co-creation in the STEMSiL project is grounded in various pedagogies and educational methods that collectively form the theoretical basis for this approach. Specifically, the co-creation methodology integrates Collaborative Learning, Project-Based Learning, and Design Thinking. These methods support the development of novel teaching and interpreting strategies within Deaf education, ensuring an inclusive and effective learning environment for Deaf students in STEM.

Collaborative Learning

Collaborative learning involves creating knowledge through interaction among learners, where they share experiences and ideas. In a collaborative learning environment, participants engage in common tasks and depend on each other, fostering a sense of teamwork and responsibility. Collaborative learning activities include group projects, study teams, and joint problem-solving.

In the context of STEMSiL, collaborative learning will take place within co-creation labs where Deaf students, teachers, and Sign Language interpreters work together. These labs will facilitate the co-design and co-production of STEM projects, allowing participants to share their unique perspectives and skills. This collaborative effort aims to enhance understanding and application of STEM concepts in a way that is accessible and engaging for Deaf students.

Project-Based Learning

Project-Based Learning (PBL) guides learners to acquire skills and competencies by actively engaging in challenging, real-life projects. This approach promotes authentic learning through investigation, analysis, and collaboration, leading to the development of meaningful projects. PBL is student-centered and driven by intrinsic motivation, with collaboration and reflection being key components.

In STEMSiL co-creation labs, Deaf students will identify and lead STEM projects, working alongside teachers, Sign Language interpreters, and community stakeholders. By tackling real-world STEM challenges, participants will develop practical solutions and gain hands-on experience. This approach not only enhances STEM knowledge but also builds critical thinking, problem-solving, and teamwork skills.

Design Thinking

Design Thinking is a problem-solving methodology that originated in the business sector and has been adapted for educational purposes. It combines a human-centered perspective with logical and analytical research to create innovative solutions. The process is collaborative and involves cognitive, strategic, and practical procedures to design and develop projects.

In STEMSiL co-creation labs, an indicative Design Thinking process includes the following stages:

- **Empathize**: Understand the needs and experiences of Deaf students in STEM education.
- **Define**: Clearly articulate the challenges and opportunities in teaching STEM to Deaf students.
- **Ideate**: Generate creative ideas and potential solutions to address the defined challenges.
- **Prototype**: Develop tangible models or strategies for teaching STEM concepts in an inclusive manner.
- **Test**: Implement and evaluate the prototypes, refining them based on feedback and outcomes.

This iterative process ensures that the solutions are tailored to the unique needs of Deaf students and are effective in enhancing their STEM learning experience.

The Co-creation labs

A co-creation lab is a dynamic and collaborative learning environment where various stakeholders—including teachers, students, parents, Sign Language interpreters, STEM professionals, and community members—work together toward a shared goal. In the context of STEMSiL, the co-creation lab is pivotal for integrating STEM education within Deaf education. It is designed to foster collaboration and innovation, enabling participants to co-create knowledge, develop STEM competencies, and enhance understanding through hands-on projects.

In STEMSiL co-creation labs, participants will:

- ✓ Co-create STEM projects through collective problem-solving.
- ✓ Design and implement STEM projects offering practical and innovative solutions to educational challenges.
- ✓ Analyse the root causes of barriers in STEM education for Deaf students, adopting a multi-stakeholder perspective.
- ✓ Engage in co-creation activities through cross-generational collaboration.
- ✓ Utilize the Design Thinking process to generate creative and effective solutions.
- ✓ Share knowledge and experiences through online and offline collaborative communities of peers.

Expected Outcomes for Students Participating in Co-Creation Labs

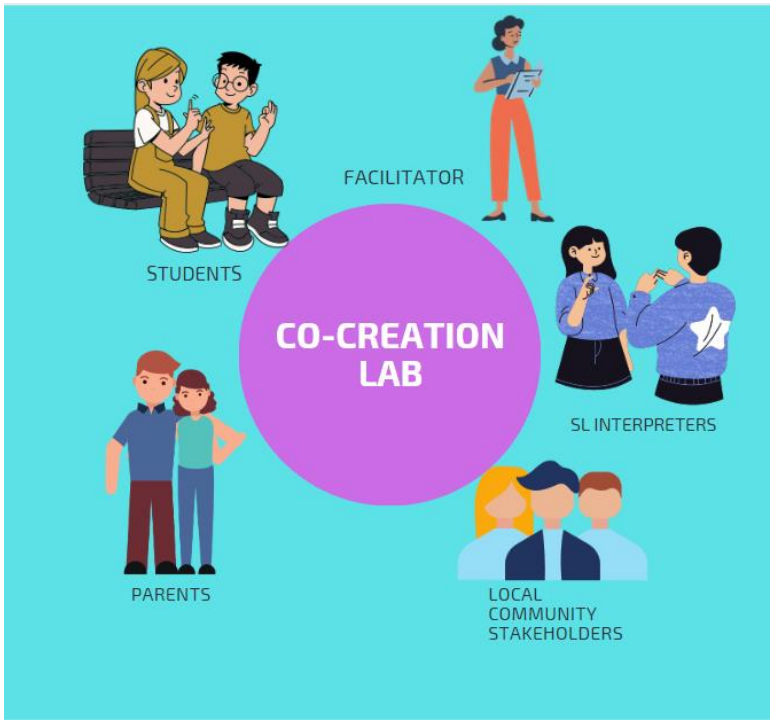
For Deaf students participating in the co-creation labs, the expected outcomes include:

- ✓ Developing a Clear Understanding of STEM Concepts: Through collaborative and hands-on activities, students will gain a deeper comprehension of STEM subjects.

- ✓ Increased Awareness of the Importance of STEM: Understanding the relevance and impact of STEM fields on society and future career opportunities.
- ✓ Feeling Valued and Heard: Creating an inclusive environment where Deaf students' contributions are recognized and appreciated.
- ✓ Motivation to Engage in STEM Activities: Encouraging active participation and sustained interest in STEM through engaging and relevant projects.
- ✓ Increased Sense of Autonomy, Confidence, and Empowerment: Empowering students by involving them in decision-making processes and project leadership roles.
- ✓ Developing Key Competences: Building skills such as creativity, problem-solving, empathy, and innovation through interactions with peers and adults.
- ✓ Enhanced Sense of Belonging, Ownership, and Agency: Fostering a strong community connection and a sense of responsibility towards their educational journey and outcomes.

The key actors of the co-creation labs

Co-creation labs within the STEMSiL project bring together a diverse group of stakeholders, including teachers, Deaf students, parents, Sign Language interpreters, STEM professionals, and local community members. This inclusive environment encourages a multi-actor perspective, where each participant contributes equally to the co-creation activities. The role of the teacher as a facilitator is crucial, guiding the process and ensuring that all voices are heard, while external stakeholders such as STEM professionals can act as mentors and catalysts for innovation.



The Facilitator of the Co-Creation Lab

The facilitator organizes, coordinates, and delivers the co-creation lab, playing a vital role in its success. Rather than leading or controlling, the facilitator's primary responsibility is to foster interactions and dialogue among participants, helping them achieve the lab's goals. This involves promoting group dynamics, encouraging critical reflection, and maintaining a balanced, non-biased approach during discussions.

In the context of STEMSiL, the facilitator will:

- ✓ Guide discussions and activities without dominating them.
- ✓ Ensure all participants, including Deaf students, feel valued and heard.
- ✓ Help keep the focus on achieving the learning objectives of the co-creation lab.
- ✓ Promote an inclusive environment that respects diverse opinions and contributions.

Students

Students are the central focus of the co-creation lab, as the primary goal is to help them develop competencies in STEM and foster a sense of innovation and agency. The number of students in each lab can vary, but it is generally recommended that the total number of participants not exceed 10, including students, to ensure effective collaboration. For larger groups, additional facilitators may be required. Involving students of different age groups can also enhance collaboration and learning outcomes.

In STEMSiL co-creation labs, students will:

- ✓ Actively participate in the co-design and co-production of STEM projects.
- ✓ Work in small groups of 2-3 to enhance collaboration and efficiency.
- ✓ Collaborate with adults (teachers, parents, stakeholders) for guidance and mentoring.
- ✓ Engage with local community actors or STEM professionals to gain practical insights and empathy regarding the challenges they are addressing.
- ✓ Develop a sense of autonomy, confidence, and empowerment through active involvement in the learning process.

The main philosophy of the co-creation lab is to shift the traditional teacher-student hierarchy, allowing students to take an active role in their learning journey. This approach empowers students to lead projects, engage deeply with STEM topics, and develop practical solutions to real-world challenges.

External Stakeholders

External stakeholders include individuals or institutions actively involved in society and the local community, such as social innovators, businesspeople, public authorities, NGOs, volunteers, and universities. These stakeholders play a crucial role in the co-creation labs by providing expertise, mentorship, and real-world perspectives.

In STEMSiL co-creation labs, external stakeholders will:

- ✓ Act as "fire-starters" to ignite students' interest in STEM topics.
- ✓ Serve as role models by sharing their knowledge and experiences in STEM fields.
- ✓ Help students understand community needs and characteristics and discuss potential solutions.
- ✓ Support students in designing their STEM projects and developing work plans or presentations.

The involvement of external stakeholders enriches the co-creation process, offering students valuable insights and practical guidance that enhance their learning experience and project outcomes.

Parents/Families

Parents are key actors in the co-creation lab, and their participation is highly recommended. Their involvement not only supports the students but also strengthens the connection between school and home environments.

In STEMSiL co-creation labs, parents will:

- ✓ Participate as equal partners in the design and implementation of STEM projects.
- ✓ Actively support their children's educational development.
- ✓ Help increase students' performance and positive attitudes toward STEM education through their involvement.

The collaboration between parents and students fosters a supportive learning environment and enhances students' engagement and success in STEM activities.

Teachers

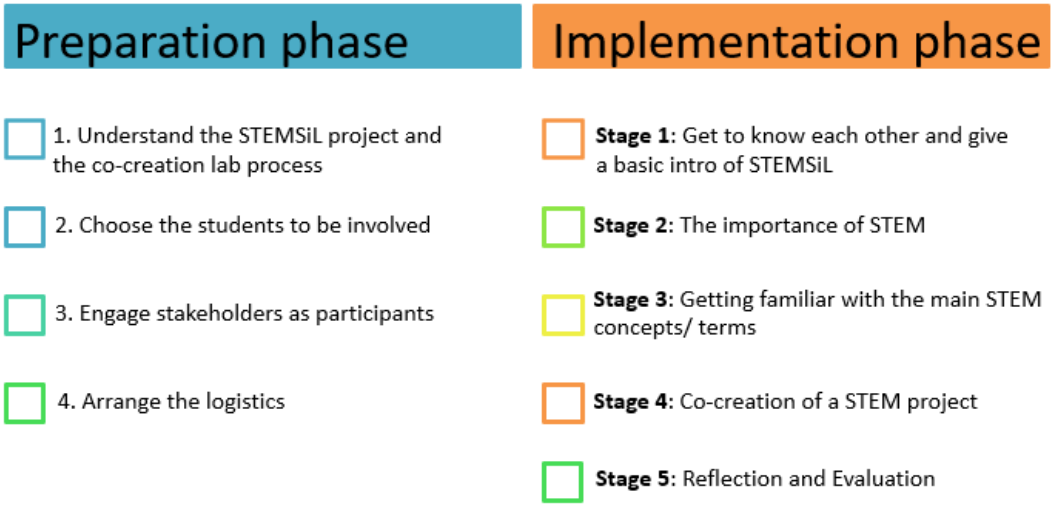
While the facilitator of the co-creation lab is typically a teacher, the involvement of additional teachers from various disciplines is beneficial. These teachers can provide broader perspectives and contribute to the co-creation process, enriching the learning experience for students.

In STEMSiL co-creation labs, teachers will:

- ✓ Collaborate with the facilitator to guide and support students.
- ✓ Bring their expertise from different subject areas to enhance the STEM projects.
- ✓ Help maintain an inclusive and engaging environment for all participants.

The phases and the steps of co-creation labs

After outlining the objectives, philosophy, and participants of the co-creation lab, we now turn to the detailed implementation process. This process is divided into two main phases: Preparation and Implementation.



Preparation phase

In the preparation phase, the facilitator works independently to understand the scope of the STEMSiL project, what a co-creation lab entails, and prepares for the implementation phase, where the actual co-creation will take place. This phase involves designing and developing the STEM projects and ensuring all necessary preparations are in place. The preparation phase includes the following steps:

Step 1: Understand STEM Education, Deaf Education, and the Co-Creation Lab Process

- **Read Relevant Material**: Familiarize yourself with the theoretical foundations and practical guidelines of the STEMSiL project. This includes understanding STEM education in the context of Deaf students, **the 10 Innovative teaching methods for STEM in Sign Languages (Handbook)** and the specific goals of the project.
- **Resources**: Review the **STEMSiL Handbook** and any available activities or guidelines. This will give you the confidence to introduce a novel teaching approach and effectively guide participants to achieve the learning objectives.

Step 2: Select the Students to Be Involved

- **Target Group**: Identify the students who will participate in the co-creation lab. Deaf students are the primary focus, as the goal is to develop their STEM skills and competencies.
- **Inclusive Approach**: It is recommended to adopt an inclusive approach, involving all students rather than a select group. However, if certain implementation stages seem challenging, some students may require additional support before the first lab session.

Step 3: Engage Various Stakeholders as Participants

- **Stakeholder Engagement**: The success of the co-creation lab relies on the active participation of diverse stakeholders. This includes teachers, Sign Language interpreters, parents, STEM professionals, and local community actors.
- **Preparation**: Prepare a list of potential participants and reach out to them in advance to gauge their availability and willingness to join. Highlight the benefits of their involvement in enhancing STEM education for Deaf students.

Step 4: Arrange the Logistics

- **Planning Sessions**: The co-creation lab will involve multiple meetings, so it is crucial to schedule appropriate dates and venues in advance. Sessions can take place in school classrooms, community centres, local clubs, or even online.
- **Communication**: Communicate all relevant information to participants via email or other means. This includes the venue, date, time, logistics, and content of each session.
- **Checklist**: Before each session, ensure the following:
    - ✓ Do all participants know the venue, date, and time of the co-creation lab meeting?
    - ✓ Are they all aware of the session's content and structure?
    - ✓ Is there any prior reading or work to be done?

By meticulously preparing for these steps, the facilitator can ensure a smooth and effective implementation of the co-creation labs, fostering an inclusive and engaging environment for Deaf students to thrive in STEM education.

Implementation phase

After completing the preparation phase, the facilitator is ready to initiate the co-creation lab with all participants and stakeholders. The implementation phase is where the co-creation process occurs, leading participants to collaboratively develop STEM projects that address

identified educational challenges. The following stages outline the detailed implementation process:

Stage 1: Get to Know Each Other and Introduce STEM Education and Deaf Education

- **Introduction Session**: Begin with activities that help participants get to know each other, creating a comfortable and inclusive atmosphere.
- **Overview**: Provide a basic introduction to the wider philosophy, scope, and practical application of STEM education, especially focusing on adaptations for Deaf students.
- **Icebreakers**: Use icebreaker activities (see below) to build rapport and ensure everyone feels valued and included.

Stage 2: Understanding the Importance of STEM and Deaf Education

- **Context Setting**: Explain the significance of STEM education and its impact on future career opportunities for Deaf students.
- **Methodology**: Introduce the methodology of co-creation and the 10 Innovative teaching methods for STEM in Sign Languages.
- **Discussion**: Facilitate a discussion on the unique challenges and opportunities in STEM for Deaf students, helping participants appreciate the context and importance of their work.

Stage 3: Investigation of Educational Challenges and Co-Development of Ideas and Solutions

- **Core Engagement**: Engage participants in identifying real-life educational challenges faced by Deaf students in STEM.
- **Empathy**: Introduce the concept of empathy, encouraging participants to consider the perspectives and needs of Deaf students.
- **Brainstorming**: Conduct brainstorming sessions where participants collaboratively generate ideas and potential solutions to the identified challenges.
- **Collaboration**: Ensure active participation from all stakeholders, including Deaf students, teachers, parents, and community members.

Stage 4: Co-Creation of the STEM Project

- **Idea Development**: Guide participants in refining their ideas and turning them into actionable projects.
- **Project Design**: Facilitate the co-design of STEM projects, incorporating feedback and insights from all participants.
- **Implementation Planning**: Assist participants in developing detailed implementation plans, including timelines, roles, and responsibilities.

- **Practical Application**: Support participants in carrying out their projects, whether they involve creating educational resources, conducting experiments, or organizing STEM events.

Stage 5: Reflection and Evaluation

- **Reflective Activities**: Conduct activities that allow participants to reflect on their experiences, discussing what they learned and how the process affected them.
- **Feedback Collection**: Gather feedback from all participants to evaluate the success and impact of the *co-creation lab* and of *the Ten Innovative teaching methods for STEM in Sign Languages*.
- **Impact Analysis**: Analyse the feedback to assess the overall effectiveness of the lab in enhancing STEM education for Deaf students.
- **Continuous Improvement**: Use the insights gained from reflection and evaluation to improve future co-creation labs, ensuring they are even more effective and inclusive.

Activities

Ice-breaking activities

Desert Island

Resources	None
Objective	Foster social communication and critical thinking skills among Deaf students while reflecting on personal priorities and preferences.
Instructions	**Group Formation:** Divide students into small groups of 3-4 participants. **Introduction:** Explain the scenario to the students. Instead of asking about a book, pose the question: "If you were stranded on a desert island, what one [alternative item] would you have with you?" Examples of alternative items could include a film, app, electronic device, non-electric item, item of clothing, drink, makeup, food, song, or TV series. **Discussion and Reflection:** • Encourage each group to discuss and decide on their chosen item. Facilitate discussions using Sign Language interpreters if necessary to ensure all participants are engaged. • Prompt students to reflect on why they chose that particular item. What makes it important or valuable to them in a hypothetical scenario like being stranded on a desert island? • Stimulate critical thinking by asking follow-up questions: How would this item help you survive or pass the time? How does it reflect your personal interests or priorities? **Presentation:** After discussion, invite each group to briefly present their chosen item to the whole class. This encourages students to practice social communication skills and articulate their thoughts effectively. **Reflection:** Conclude the activity with a reflection session where students can share insights gained from discussing their choices. Discuss common themes or differences in preferences among the groups.
Age	Suitable for all ages, with adaptations for younger or older students as necessary.

Time	Approximately 20-30 minutes, depending on the depth of discussion and number of groups participating.
Notes	Adapt the activity as needed to ensure accessibility for Deaf students. Consider using visual aids, written prompts, or tactile objects for those who may benefit. Emphasize inclusive participation and respect for diverse perspectives throughout the activity.

STEM Tower Challenge

Resources	– Building materials (e.g., spaghetti, marshmallows, toothpicks, tape, string) – Timer – Paper and markers
Objective	Foster social communication and critical thinking skills among Deaf students while reflecting on personal priorities and preferences.
Instructions	1. **Introduction:** Explain the purpose of the activity, which is to work together to build the tallest and most stable tower using the provided materials. This will encourage teamwork, problem-solving, and creative thinking. 2. **Form Teams:** Divide the participants into small teams of 3-4 people, ensuring a mix of Deaf and hearing participants if possible. 3. **Building Challenge:** Give each team an identical set of building materials. Explain that they have 15 minutes to construct the tallest tower they can using only the provided materials. 4. **Planning Phase:** Allow teams 5 minutes to discuss and plan their design before they start building. Encourage them to communicate their ideas effectively, using both verbal communication and Sign Language where applicable. 5. **Construction Phase:** Start the timer and let the teams begin building. Circulate around the room to provide encouragement and ensure everyone is participating.

	6. **Testing and Measurement:** After the 15 minutes are up, measure each tower to see which one is the tallest and check for stability by gently shaking the table or surface it is on. Announce the winning team. 7. **Reflection:** Gather all participants and ask each team to briefly describe their building process, the challenges they faced, and how they overcame them. This can help in reflecting on the importance of communication and collaboration in problem-solving.
Age	9+
Time	25-30 minutes
Notes	This activity is designed to foster collaboration, creative problem-solving, and effective communication among participants, setting a positive and engaging tone for the co-creation labs.

OPERA

Resources	A4 paper, pens
Objective	Enhance social communication, collaborative decision-making, and self-efficacy skills among Deaf students while fostering collective efficacy in developing STEM projects for their school or local community.
Instructions	**O - Own Thoughts (5 minutes):** • **Objective:** Students individually think about a problem related to STEM education or accessibility for Deaf students in their school or local community. They should make notes on their ideas. • **Adaptation:** Ensure students understand the concept of STEM and how it relates to their experiences as Deaf individuals. **P - Pair Discussion (5 minutes):**

- **Objective:** Pair up students to discuss their ideas with a focus on identifying a common problem or challenge they would like to address.
- **Adaptation:** Use Sign Language interpreters or visual aids to facilitate communication between pairs if needed.

E - Explain Ideas to Group (10 minutes):

- **Objective:** Each pair presents their chosen problem and proposed solution to the larger group. They should use one sentence to describe their idea and then affix it to a designated area (e.g., wall).
- **Adaptation:** Ensure all presentations are accessible through visual aids or written explanations if necessary.

R - Rating Ideas (10 minutes):

- **Objective:** Each student selects three ideas from the presented solutions that they find most compelling or feasible. They cannot vote for their own idea.
- **Adaptation:** Provide accessible voting methods such as writing down selections or using visual cues for voting.

A - Arrange into Themes (30 minutes):

- **Objective:** Group discussion to organize the remaining ideas into themes or categories based on commonalities or related issues.
- **Adaptation:** Facilitate discussions using group discussions facilitated by interpreters if necessary, ensuring everyone can participate fully.

Project Questioning (Throughout):

- **Objective:** Guide groups through questions that refine and develop their project ideas:
    - "What bothers you about STEM education as a Deaf student?"
    - "What changes can we make to improve STEM accessibility for Deaf students?"

	○ "Why did you select this project, and how will it benefit our school or local community?" ○ "How can your project help bridge gaps in STEM education for Deaf students?"
Age	Suitable for ages 9 and above, with adaptations in communication methods and complexity of project ideas based on age group.
Time	Approximately 1 hour, depending on the depth of discussion and number of ideas generated and discussed.
Notes	n/a

STEM projects co-creation

STEM Brainstorm

Resources	Whiteboard or large paper, markers, visual aids.
Objective	Encourage collaborative problem-solving and idea generation related to STEM concepts.
Instructions	**Introduction (10 minutes):** • **Objective:** Introduce the concept of STEM education and its relevance to everyday life. Discuss how STEM impacts various aspects of our world. • **Adaptation:** Use visual aids and demonstrations to ensure concepts are clear and accessible through visual means. **Brainstorm Session (20 minutes):** • **Objective:** In small groups, ask students to brainstorm STEM-related challenges or projects they would like to explore. Focus on issues that are relevant and interesting to Deaf students.

	• **Adaptation:** Use written prompts and visual cues to facilitate brainstorming. Encourage students to use Sign Language or written notes to communicate their ideas. **Presentation (15 minutes):** • **Objective:** Each group presents their chosen STEM challenge or project idea to the class. Use visual aids or written explanations to enhance understanding. • **Adaptation:** Allow flexibility in presentation styles, such as using multimedia presentations, posters, or interactive demonstrations. **Discussion and Feedback (15 minutes):** • **Objective:** Facilitate a discussion where students provide feedback and suggestions for each other's ideas. Encourage constructive feedback and critical thinking. • **Adaptation:** Use facilitated Sign Language interpretation or written notes to ensure all students can participate in the discussion. **Reflection (10 minutes):** • **Objective:** Conclude the activity with a reflection on the brainstorming process. Ask students to reflect on what they learned and how they can apply STEM concepts in their own lives. • **Adaptation:** Provide written prompts or visual reflection tools for students to express their thoughts.
Age	Suitable for all ages, with adaptations for younger or older students as necessary.
Time	Approximately 1 hour, depending on the depth of discussion and number of groups participating.
Notes	Adapt the activity as needed to ensure accessibility for Deaf students. Consider using visual aids, written prompts, or tactile objects for those who may benefit.

STEM Experiment Design

Resources	Basic science materials (e.g., beakers, measuring tools, materials for experiments), visual aids.
Objective	Develop skills in experimental design and scientific inquiry.
Instructions	**Introduction to Experiment Design (10 minutes):** • **Objective:** Introduce the concept of experimental design and the scientific method. Discuss the importance of planning and conducting experiments in STEM fields. • **Adaptation:** Use visual demonstrations and written explanations to clarify concepts. Allow students to ask questions and discuss in Sign Language. **Experiment Planning (30 minutes):** • **Objective:** In small groups, assign each group a simple STEM experiment related to everyday phenomena or scientific principles. • **Adaptation:** Provide written experiment instructions and visual step-by-step guides. Use tactile materials or demonstrations for hands-on understanding. **Experiment Execution (30 minutes):** • **Objective:** Conduct the experiments collaboratively in small groups. Encourage students to follow the experimental procedures and collect data accurately. • **Adaptation:** Use visual cues and written instructions. Provide support for data recording and analysis, ensuring clarity in communication through Sign Language or written notes. **Data Analysis and Presentation (20 minutes):** • **Objective:** Analyse the experiment results as a group. Discuss findings and conclusions based on collected data.

	• **Adaptation:** Use visual representations of data (graphs, charts) and written summaries. Allow students to present findings using Sign Language or visual aids. **Reflection and Discussion (15 minutes):** • **Objective:** Reflect on the experiment process. Discuss challenges faced, lessons learned, and potential improvements for future experiments. • **Adaptation:** Use facilitated discussion with Sign Language interpretation or written notes for feedback. Encourage all students to participate actively.
Age	Suitable for all ages, with adaptations for younger or older students as necessary.
Time	Approximately 1 hour, depending on the depth of discussion and number of groups participating.
Notes	n/a

STEM Innovation Challenge

Resources	Prototyping materials (e.g., LEGO bricks, craft supplies), visual aids.
Objective	Promote creativity and innovation in solving STEM-related challenges.
Instructions	**Challenge Introduction (10 minutes)** • Objective: Introduce a specific STEM challenge or problem relevant to Deaf students (e.g., improving accessibility in STEM learning). • Adaptation: Use visual explanations and written prompts to ensure understanding. Discuss the importance of innovation and creativity in solving challenges. **Design and Prototype (30 minutes)**

	• Objective: In small groups, task students with designing and creating a prototype solution to the STEM challenge using provided materials. • Adaptation: Provide visual examples and written guidelines for prototyping. Use tactile materials for hands-on creation. Support communication through Sign Language or written notes. **Prototype Presentation (20 minutes)** • Objective: Each group presents their prototype solution to the class, explaining its design and functionality. • Adaptation: Use visual aids and written descriptions to enhance presentations. Allow flexibility in presentation styles (e.g., multimedia, posters). **Feedback and Iteration (15 minutes)** • Objective: Provide constructive feedback on each prototype. Discuss strengths, weaknesses, and potential improvements. • Adaptation: Facilitate discussion using facilitated Sign Language interpretation or written notes for feedback. Encourage collaborative problem-solving. **Final Reflection (10 minutes)** • Objective: Conclude with a reflection on the innovation challenge. Ask students to reflect on their creative process, lessons learned, and the applicability of their solutions. • Adaptation: Use visual reflection tools and written prompts for students to express their thoughts and insights.
Age	Suitable for all ages, with adaptations for younger or older students as necessary.
Time	Approximately 1 hour, depending on the depth of discussion and number of groups participating.
Notes	n/a

Balloon-powered car

Resources	– Balloon-powered car STEM kits (including wheels, axles, straws, balloons, and car body materials) – Visual aids and diagrams for assembly – Instruction sheets with clear visual steps – Notebooks and pens for recording observations
Objective	Promote creativity and innovation in solving STEM-related challenges.
Instructions	**Introduction (5 minutes)** • **Objective:** Introduce the basic principles of forces and motion, explaining how the air from a balloon can propel a car forward. • **Adaptation:** Use visual aids, diagrams, and demonstrations to explain the concept. Show a short video with subtitles or Sign Language interpretation about how balloon-powered cars work. **Kit Exploration (5 minutes)** • **Objective:** Allow students to explore the contents of the STEM kit. Identify and name each component of the balloon-powered car kit. • **Adaptation:** Provide labelled diagrams and written descriptions of each component. Allow students to handle and examine the parts to understand their function. **Group Formation and Role Assignment (5 minutes)** • **Objective:** Divide students into small groups (3-4 students per group). Assign roles such as engineer, builder, tester, and recorder. • **Adaptation:** Ensure roles are clear and accessible through written instructions or Sign Language. Allow students to choose roles based on their strengths and interests. **Assembly Instructions (15 minutes)** • **Objective:** Guide students through the step-by-step assembly of the balloon-powered car using the kit.

	• **Adaptation:** Provide clear visual instructions and written steps. Use large posters or a projector to display each step. Sign Language interpreters can facilitate communication if needed. **Testing and Iteration (15 minutes)** • **Objective:** Test the balloon-powered cars to ensure they work correctly. Observe the cars' performance and make necessary adjustments. • **Adaptation:** Provide a checklist for testing and observation. Allow students to record their observations in notebooks or on tablets. Use visual cues to indicate successful performance or areas needing improvement. **Data Analysis and Presentation (10 minutes)** • **Objective:** Analyse the performance of the balloon-powered cars. Discuss what worked well and what could be improved. Prepare a short presentation to share findings with the class. • **Adaptation:** Use visual aids such as charts or graphs to help students analyse data. Encourage groups to create visual presentations, including diagrams, photos, or videos of their cars in action. Provide templates for organizing their findings. **Reflection and Discussion (10 minutes)** • **Objective:** Reflect on the learning experience and discuss the principles of forces and motion. Encourage students to think about other simple machines and mechanisms. • **Adaptation:** Use written prompts or visual reflection tools for students to express their thoughts. Facilitate a group discussion using Sign Language interpretation or written notes if needed.
Age	8+
Time	Approximately 1 hour, depending on the number of groups participating.
Notes	**Example Reflection Questions:** • What challenges did you face while building the balloon-powered car, and how did you overcome them?

	• How does the balloon power the car and make it move forward? • What other simple machines or toys use similar principles of forces and motion? • What improvements would you make to your car design for better performance?

Reflection Stage

Project Timeline

Resources	- Large pieces of paper - Glue or tape - Markers or pens
Objective	To provide students with an opportunity to reflect on their project journey, celebrate their achievements, and collaboratively plan future actions.
Instructions	**Preparation:** • Provide each group with several large pieces of paper, glue or tape, and markers or pens. • Ask the students to stick together the pieces of paper to create a long strip, which will serve as the timeline. **Creating the Timeline:** • Ask the students to draw a horizontal line across the paper. • On the left end of the line, mark the project start date. • In the middle, mark today's date. • Extend the line towards the right to represent the future. **Reflecting on the Past:** • Have each student add memorable events or milestones from the project along the timeline up to today's date.

	• Encourage them to think about key moments, such as important meetings, significant achievements, challenges they overcame, or memorable activities. **Discussing Special Events:** • Facilitate a discussion about some of the special events added to the timeline. • Ask questions such as: "What made this event special?", "How did this event impact our project?", and "What did we learn from this event?" **Planning for the Future:** • Ask each student to add their ideas and aspirations for the future of the project on the timeline. • Encourage them to think about what they want to achieve, any upcoming activities or goals, and how they envision the project evolving. **Discussing Future Plans:** • Discuss the future ideas added to the timeline. • Encourage students to explain why they chose these particular actions or goals. • Ask questions such as: "What steps do we need to take to achieve this?", "Who will be responsible for each task?", and "What resources will we need?" **Creating an Action Plan:** • Guide the students in creating a detailed action plan based on their future timeline. • Help them decide which actions to prioritize, how to implement them, and in what order they should be completed. • Ensure that all students have a role and feel responsible for the project's future progress.
Age	8+

Time	15-30 minutes
Notes	✓ This activity is ideally conducted at the end of a project to reflect on the journey and plan future actions. ✓ Encourage students to be creative with their timeline, using different colours and illustrations to represent different events and ideas. ✓ Ensure that the activity is inclusive and that all students, including Deaf students, are actively participating and contributing their thoughts and ideas.

Timelapse Your Activities

Resources	- Smartphone or tablet with a camera - Access to a timelapse application (optional) - Internet access for sharing online (if applicable)
Objective	To empower students to document and reflect on their project's progress through visual storytelling using digital tools, fostering digital literacy and reflective learning while enhancing social communication through online sharing.
Instructions	**Preparation:** • Ensure each group or individual has access to a smartphone or tablet with a camera. • If available, download a timelapse application that allows students to create timelapse videos. **Creating the Timelapse:** • Assign students to choose a specific activity or phase of their project to document using a timelapse. This could include brainstorming sessions, prototyping, testing, or presentations. • Instruct students to use their smartphone or tablet to capture photos at regular intervals during the chosen activity. If using a

	timelapse application, guide them through the process of setting up and recording the timelapse. • Encourage students to focus on capturing key moments and actions that highlight their project's progression. **Editing (if applicable):** • If using a timelapse application, help students edit and compile the photos into a timelapse video. Ensure they add any necessary captions or annotations to explain each step of the process. **Sharing Online:** • Discuss the option of sharing the timelapse video online, such as on the school's social media group, personal profiles, or a dedicated project page. Emphasize the importance of respecting privacy and obtaining permissions if sharing publicly. • Alternatively, if online sharing is not feasible, suggest creating a physical poster board with printed photos to showcase the timelapse sequence. **Reflection:** • After creating and sharing the timelapse, facilitate a reflective discussion with students. Ask them to describe their experience with the activity, what they learned from observing the timelapse, and how it helped them understand the progression of their project. • Encourage students to discuss any challenges they encountered during the timelapse creation and how they could improve their documentation in future activities.
Age	All
Time	Varies depending on the project's timeline and the length of the timelapse activity (approximately 40-60 minutes)
Notes	Ensure that Deaf students have access to visual cues and instructions throughout the activity. Provide alternative methods for sharing if online platforms are inaccessible or not preferred.

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