BE 21 SKILLED

PLAYBOOK

Training Students in 21st Century Skills

(STRATEGY / ACTION PLAN)

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Funded by the European Union

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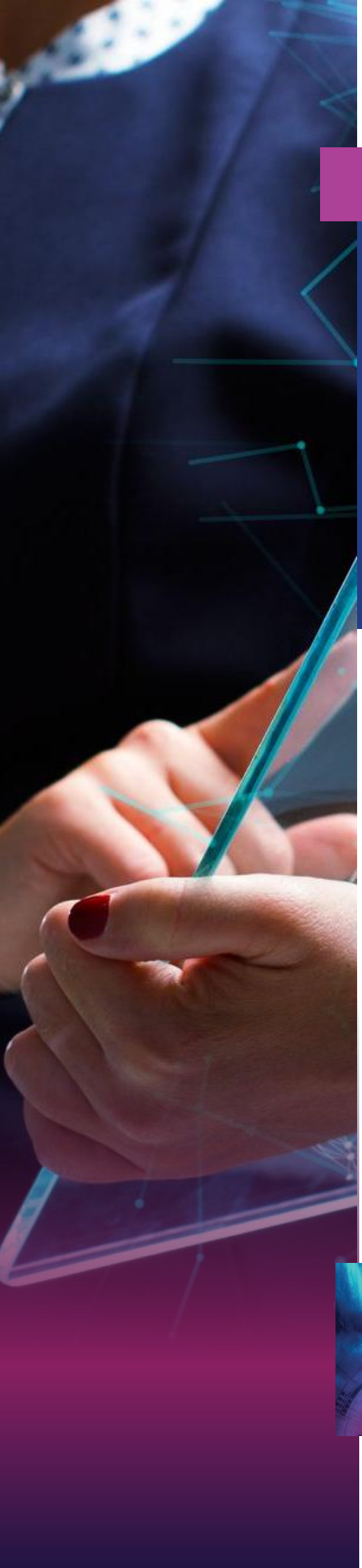


Introduction

STEM (science, technology, engineering, and mathematics) education focuses **on equpping students with the skills and knowledge to tackle real-world challenges**, adapt to rapid **technological advancements**, and contribute meaningfully to society.

Despite the potential of STEM education, fewer than one in 10 students across Europe graduate in a field related to natural sciences, maths, or statistics. In some countries such as Bulgaria, Cyprus, and Hungary, less than 3% of graduates emerge from these fields (Evagorou et al., 2024). Integrating 21st-century skills into STEM education enhances student outcomes in higher education by fostering critical thinking, problem-solving, collaboration, and adaptability, which are essential for navigating comples, real-world problems.

Likewise, in the rapidly evolving STEM labour market shaped by automation, the employees of the future will be distinguished by skills that cannot be performed by AI—namely, 21st-century skills also known as interpersonal or social skills.

Employers increasingly seek candidates who not only have technical knowledge but also excel in communication, collaboration, creative problem-solving, and emotional intelligence. To meet these demands, colleges and universities must integrate 21st century skills training content into their curricula.

This Student Playbook offers comprehensive guidelines for teachers to implement and evaluating effective 21st century skills training programs for STEM students. By focusing on practical application, inclusivity, and continuous improvement, this Playbook provides a roadmap for embedding 21CS into STEM education. The insights from pilot programs in Riga and Belgrade highlight the transformative potential of these strategies, particularly in supporting female students. Together, these efforts can bridge skill gaps, foster equity, and prepare the next generation of STEM professionals for a dynamic, inclusive future.

Purpose and Scope of the Playbook

The purpose of this **Playbook** is to offer comprehensive guidance on incorporating **21st century skills training into academic curricula**. It covers a wide range of topics, from understanding the importance of 21st century skills and assessing student needs, to designing interactive teaching methods and leveraging technology.

The Playbook is intended for use **by faculties and colleges across all STEM** disciplines, providing adaptable strategies that can be tailored to different educational contexts and student populations, including non-STEM disciplines. It builds on **Be21Skilled resources**:-

01

Regional Skill Councils Blueprint and Skill Panorama

A comprehensive set of tools for skill development, designed for both teachers and students. These tools focus on key competencies identified during the project's research phase.

02

BE-21-SKILLED Toolkit

A comprehensive set of tools for skill development, designed for both teachers and students. These tools focus on key competencies identified during the project's research phase.

03

BE-21-SKILLED Teacher Empowerment Program

A series of modules with integrated tools aimed at upskilling STEM educators in teaching 21CS effectively. This program enhances teachers' competencies in facilitating these skills among students

04

BE-21-SKILLED eCompass:

A digital, interactive platform consolidating project knowledge. It facilitates collaboration among project partners, Regional Skill Council members, and other stakeholders, while offering resources for ongoing development.

05

BE-21-SKILLED Student Pilot and Playbook

Practical, hands-on initiatives designed to develop students' 21CS. The insights gained from these pilots directly inform the Playbook's strategies and recommendations.

How to use the Student Playbook

The **Student Playbook** is your dynamic guide, based on **expansive pilots, to embedding 21st-century skills into academic curricula**. Organized into focused sections, it addresses **key aspects of 21CS training**, offering actionable insights and step-by-step strategies for success.

YOU WILL BENEFIT FROM

01

Comprehensive Navigation

Explore the entire Playbook to gain a well-rounded understanding of 21CS training by practitioners. Learn how pilot programs in Riga and Belgrade demonstrated the importance of starting with foundational skills like emotional intelligence and adaptability before progressing to complex team-based challenges.

02

Flexible Application

Each section is designed to stand alone, allowing educators to extract specific topics based on their immediate needs. Whether you're looking to refresh an existing course, design an interdisciplinary program, or revamp your teaching style, this Playbook adapts to your objectives. The pilot feedback emphasized the value of modularity, as educators in Riga adapted sections to fit diverse student demographics.

03

Empowering Resources

Use the Playbook to spark creativity, enhance student engagement, and elevate your teaching impact. In Belgrade, interactive simulations proved invaluable in fostering communication and problem-solving skills, underscoring the power of practical tools.

04

Tailored for Versatility

Whether you're a novice in 21CS integration or an experienced educator seeking innovative approaches, this Playbook caters to all expertise levels. Its modular structure ensures seamless implementation across diverse disciplines and contexts. The pilot programs revealed that mixed-gender teams particularly benefited from adaptable strategies, leading to greater collaboration and inclusion.

Reflection on how female STEM students can be approached with 21st century skills training

Recent studies and initiatives underscore the **importance of fostering 21st-century skills (21CS) among female STEM students to bridge gender gaps and prepare them for modern workplaces**. For instance, the World Economic Forum highlights that mentorship programs can significantly boost confidence, academic success, and career advancement for women in STEM World Economic Forum.

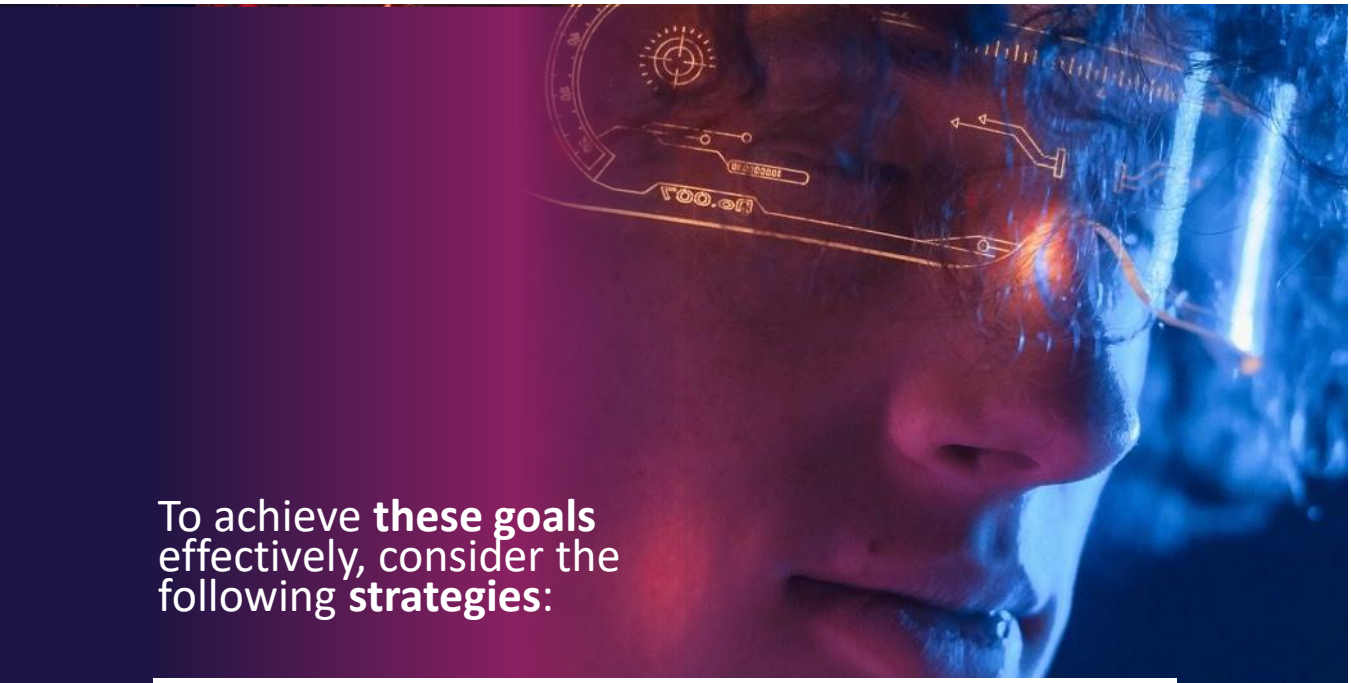
The findings of our pilot tests provide further evidence:

- **Riga Technical University (RTU):**
  Out of 385 participants, 146 were female students, representing approximately 38% of the cohort. Students came from studies in Management Engineering, Industrial Engineering and Management, Industrial Sustainability and Circular Economy, Integrated Management Systems, Logistics and Supply Chain Security, Entrepreneurship and Management, and others.
- **University of Belgrade (UB):**
  Out of 122 participants, 57 were female students, accounting for approximately 47% of the total.

These numbers highlight significant practice-based insights and reinforce the importance of creating inclusive environments that support diverse learning styles. We found that female STEM students often excel in key 21CS areas such as teamwork, communication, adaptability, and problem-solving. In our mixed-gender and interdisciplinary teams, female students showcased strong abilities in empathetic problem-solving and leadership, contributing to cohesive group dynamics and innovative solutions.

Our conclusion is that rather than tailoring training based on gender—which may inadvertently reinforce stereotypes—educators should focus on individual strengths and diverse learning styles. This inclusive approach ensures all students receive the support needed to thrive, regardless of gender. By creating equitable and collaborative training environments, educators prepare students for inclusive workplaces while empowering female STEM students to excel. Providing mentorship opportunities, showcasing the achievements of women in STEM, and implementing inclusive teaching practices are essential steps in ensuring that every individual's potential is realized.

Practical Tips for Implementation



To achieve **these goals** effectively, consider the following **strategies**:

01

Foster Mentorship Opportunities

- Partner with organizations like Women in STEM to connect female students with professional mentors.
- Establish peer mentorship programs where advanced students guide and support their juniors.

02

Showcase Role Models:

- Invite successful women in STEM fields to share their experiences through guest lectures and workshops.
- Highlight female achievements in STEM within course content and materials.

03

Create Inclusive Learning Spaces

- Design group activities that encourage balanced participation among all genders.
- Promote active listening and mutual respect in all classroom discussions and collaborations.

04

Integrate Real-World Applications:

- Use case studies and simulations to address challenges commonly faced in STEM industries.
- Encourage mixed-gender teams to tackle interdisciplinary projects, leveraging diverse perspectives.

Understanding the Needs of Students and the Job Market

01

1.1 Industry Consultation

Understanding the 21st-century skills needs of students and the job market begins with direct engagement with industry experts, alumni, and career advisors. By consulting these stakeholders, educators can ensure their training aligns with current labor market expectations and future trends.

ACTION STEPS

01 Organize Industry Panels

- Invite professionals from diverse STEM industries to share insights into the 21CS they value most in employees.
- Highlight specific examples of how these skills drive success in the workplace.

02 Conduct Alumni Surveys

- Design targeted surveys to gather feedback from alumni on the 21CS that have been most beneficial in their careers.
- Use this data to refine curricula and emphasize skills that directly impact employability.

03 Engage Career Advisors

- Meet regularly with career advisors to stay informed on evolving job market trends.
- Collaborate to identify industry-specific 21CS needs that align with regional and global priorities.

Examples from Riga and Belgrade Regional Skill Councils

- **Riga:**
  The Sectoral Skill Councils facilitated dialogues between educators, industry leaders, and policymakers. These councils identified emotional intelligence, adaptability, and teamwork as critical 21CS for success in STEM fields, particularly in roles requiring interdisciplinary collaboration.

- **Belgrade:**
  Consultations with industry representatives revealed an urgent need for graduates to excel in problem-solving and digital literacy. The skill councils also stressed the importance of effective communication skills to bridge gaps in increasingly diverse and international STEM workplaces.

1.2 Aligning Training with Industry Trends

In addition to consultations, educators should utilize labor market data and trend analyses to anticipate future skill demands. Integrating this forward-looking approach into 21CS training ensures students are equipped not only for today's job market but also for emerging roles in STEM.

ACTION STEPS

01

Analyze Regional and Global Market Reports

- Review reports from organizations like the World Economic Forum and OECD to identify high-demand skills in STEM sectors.
- Adapt training materials to reflect the integration of emerging technologies and sustainable practices.

02

Conduct a thorough analysis of students' current 21st century skills by:

- Surveying students, reviewing feedback from previous courses, and assessing outcomes of existing training programs. This allows for better planning and customization of the training

03

Collaborate with Regional Networks

- Partner with regional skill councils to maintain an up-to-date understanding of local labor needs.
- Incorporate insights from these collaborations into workshops and project-based learning activities.

04

Promote Lifelong Learning

- Embed skills like self-management and adaptability into training modules to prepare students for continuous professional growth.
- Provide resources that encourage graduates to pursue additional certifications or advanced degrees in response to changing industry landscapes

Multidisciplinary and Practical Application of Learning

02

2.1 Strategic Planning

Integrating 21st-century skills into existing STEM curricula requires thoughtful planning and alignment with course objectives. Insights from the pilot programs in Riga and Belgrade emphasize the importance of embedding these skills within practical, real-world learning experiences to maximize impact.

ACTION STEPS

01

Curriculum Mapping

- Identify where 21CS can be naturally integrated into existing STEM courses. For example, engineering programs can include modules on teamwork, leadership, and problem-solving within project-based courses.
- Use findings from industry analysis to prioritize skills most in demand by regional industries, such as adaptability and critical thinking.

02

Module Development

- Encourage educators to incorporate resources from the BE-21-SKILLED Teacher Empowerment Program (**Teacher Empowerment Program Modules**), which offers robust, ready-to-use materials tailored for STEM disciplines. These can be edited to suit specific purposes.
- Leverage pilot-tested strategies, such as simulations and case-based learning, to actively engage students and deepen their understanding of 21CS.

03

Project-Based Learning

- Design interdisciplinary projects that require students to collaborate and apply 21CS in real-world contexts. For instance, Belgrade's pilot highlighted the value of mixed-gender teams working on sustainability challenges.
- Incorporate iterative feedback cycles to allow students to refine their skills throughout the project.

04

Faculty Training

- Provide professional development sessions for educators to enhance their ability to teach and assess 21CS effectively. Our educators in the pilot programs gained hands-on experience implementing these skills in classroom settings.
- Encourage cross-departmental collaboration to create cohesive, interdisciplinary teaching approaches.

2.2 Multidisciplinary Approach

A multidisciplinary approach harnesses the strengths of diverse expertise, perspectives, and problem-solving methodologies, making it a powerful strategy for enhancing 21st-century skills in STEM.
By integrating knowledge and practices across disciplines, this method replicates real-world work environments, where collaboration between different domains is essential for innovation and success. Of note, it …

- **Encourages Diverse Thinking:**
  Exposure to different fields broadens students' horizons, encouraging them to approach problems with a holistic mindset. As seen in the Riga pilot program, engineering students collaborating with environmental science peers gained a deeper understanding of sustainability challenges, fostering creative solutions that integrated technical precision with ecological awareness.
- **Replicates Real-World Dynamics:**
  Modern STEM workplaces demand collaboration across disciplines, such as engineers working with biologists on medical devices or environmental scientists designing data models with computer scientists. The Belgrade pilot demonstrated how cross-disciplinary projects on renewable energy helped students navigate complex issues while building teamwork and communication skills crucial for their future careers.
- **Develops Teamwork and Leadership Skills:**
  Projects involving multiple disciplines require students to adapt their communication styles to effectively collaborate with peers from different backgrounds. By participating in integrated workshops during the Riga pilot, students honed their ability to lead diverse teams and mediate between conflicting ideas to achieve common goals.
- **Fosters Innovation:**
  Cross-disciplinary collaboration often leads to groundbreaking ideas, as combining diverse knowledge pools sparks innovation. For example, Belgrade's interdisciplinary projects on eco-friendly manufacturing brought together biology and engineering students to create practical, sustainable solutions, highlighting the creative potential of collaboration.
- **Enhances Problem-Solving:**
  Tackling challenges from multiple perspectives provides richer, more comprehensive solutions. The pilot in Riga included simulations of crisis management scenarios, which required logistics and mechanical engineering students to integrate their expertise to design efficient, adaptive responses to natural disasters.

HOW TO MAXIMIZE THE BENEFITS OF A MULTIDISCIPLINARY APPROACH

01

Interdepartmental Collaboration:

Foster partnerships between departments to design integrated courses and projects. Use regular interdepartmental meetings to identify overlapping objectives and build joint curricula.

02

Real-World Problem Scenarios:

Develop case studies and projects rooted in actual industry challenges. For instance, sustainability, renewable energy, and disaster management are ideal themes that require collaboration across STEM fields

03

Leadership and Communication Focus:

Train students to assume leadership roles in multidisciplinary teams, ensuring all voices are heard and valued. Encourage peer-to-peer teaching, where students share knowledge from their respective fields.

04

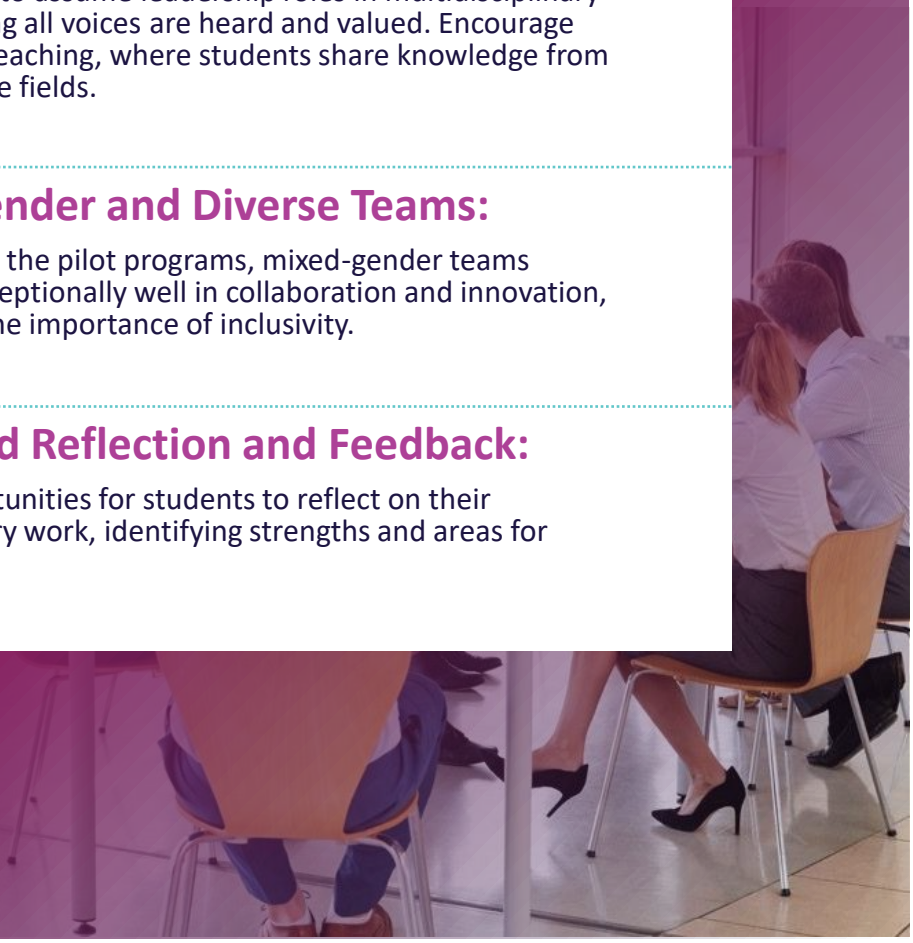
Mixed-Gender and Diverse Teams:

As observed in the pilot programs, mixed-gender teams performed exceptionally well in collaboration and innovation, emphasizing the importance of inclusivity.

05

Structured Reflection and Feedback:

Provide opportunities for students to reflect on their interdisciplinary work, identifying strengths and areas for improvement



ACTION STEPS

01

Interdepartmental Meetings

- Organize regular meetings with educators across STEM and non-STEM departments to discuss opportunities for collaborative projects. In Riga, such meetings led to the successful integration of sustainability-focused challenges involving engineering and environmental science students.

02

Integrated Projects:

- Develop projects that require input from multiple disciplines. For example, in Belgrade, students from engineering and biology collaborated to design eco-friendly manufacturing processes, combining technical and scientific expertise with problem-solving skills.

03

Cross-Departmental Workshops:

- Host workshops that unite students from various disciplines to tackle common challenges. In Riga, workshops focused on crisis management and innovation, helping students from logistics, engineering, and business backgrounds work together to create cohesive solutions.

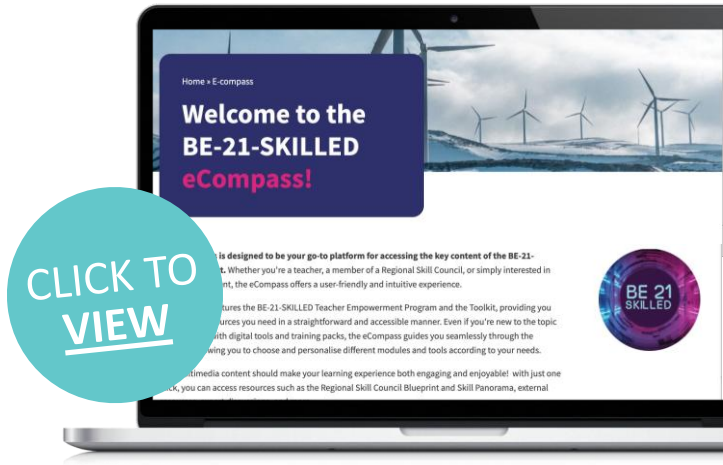
Examples from Pilots

- **Riga:**
  Students from mechanical engineering and logistics collaborated on a project addressing supply chain efficiency during natural disasters. This collaboration emphasized teamwork, adaptability, and critical thinking.
- **Belgrade:**
  Biology and engineering students worked on interdisciplinary projects related to renewable energy, fostering leadership and communication as students navigated complex, multi-faceted problems.

2.3 Practical Application of Learning

Providing opportunities for students to practice 21st-century skills (21CS) in real or simulated settings bridges the gap between theory and practical application.

Insights from the Riga and Belgrade pilot programs emphasize the value of hands-on learning in developing critical skills such as problem-solving, teamwork, and adaptability. Incorporating tools like the **BE-21-SKILLED eCompass** fosters an interactive and immersive environment, allowing students to engage deeply with real-world scenarios.



Why Practical Application is Powerful

- **Real-World Readiness:**
  Practical exercises expose students to real-life challenges, preparing them to handle complexities in STEM careers.
- **Skill Reinforcement:**
  Applying theoretical knowledge in real scenarios helps students internalize 21CS, making them confident and proficient in applying these skills.
- **Immediate Feedback:**
  Simulations and projects provide opportunities for iterative learning, enabling students to refine their skills based on constructive feedback.

ACTION STEPS FOR PRACTICAL LEARNING

01

Workshops and Simulations:

- Design interactive workshops that replicate workplace scenarios, such as crisis management or team-based problem-solving.
- In the Belgrade pilot, simulations focused on renewable energy planning allowed engineering and biology students to collaborate on feasible, eco-friendly solutions.
- Utilize the **eCompass platform** to guide students through virtual simulations tailored to their disciplines.

02

Project-Based Learning (PBL):

- Implement interdisciplinary projects that align with real-world STEM challenges.
- For example, in Riga, students collaborated on disaster-response supply chain designs, integrating mechanical engineering with logistics and teamwork skills.
- Encourage mixed-gender and diverse teams to foster creativity and diverse problem-solving approaches.

03

Real-World Assignments:

- Partner with industry leaders to design assignments based on current challenges in STEM fields.
- During the Riga pilot, students tackled assignments related to sustainability, emphasizing adaptability and systems thinking.
- Include reflective components to encourage students to evaluate their learning experiences and identify areas for growth.

How the BE-21-SKILLED Toolkit Enhances Practical Learning

- The **BE-21-SKILLED Toolkit** provides ready-to-use resources for developing practical workshops, simulations, and PBL activities.
- Modules on self-management, perseverance, and critical thinking are particularly effective for creating impactful exercises.
- Teachers can access adaptable lesson plans and interactive resources through the **Teacher Empowerment Program**.
- Teachers can direct students directly to the Student Empowerment Program, access via **Develop your skills as students - Be21 Skilled.** This Program is structured to guide students through each of six 21C critical skill areas, providing practical exercises, real-world examples, and interactive activities to ensure students gain a deep, career ready understanding.

Examples from PILOTS

- **Riga:**
  Riga: Students used simulations to address logistics challenges during natural disasters. These exercises enhanced their teamwork and adaptability under pressure.
- **Belgrade:**
  Interdisciplinary workshops on renewable energy solutions allowed students to integrate knowledge from engineering and biology, emphasizing leadership and innovation

Interactive Teaching Methods

03

3.1 Workshops and Simulations

Interactive teaching methods, such as workshops and simulations, play a pivotal role in developing 21st-century skills (21CS) by providing students with hands-on, immersive learning experiences. These approaches enable students to bridge the gap between theoretical concepts and practical application, fostering critical thinking, collaboration, and problem-solving skills

Why Workshops and Simulations are Effective:

- **Practical Application:** Students can apply theoretical knowledge to real-world challenges in a controlled environment.
- **Engagement:** Interactive settings actively involve students, increasing motivation and retention.
- **Feedback and Reflection:** Immediate feedback during debriefing enhances learning and highlights areas for improvement

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01

Scenario Development:

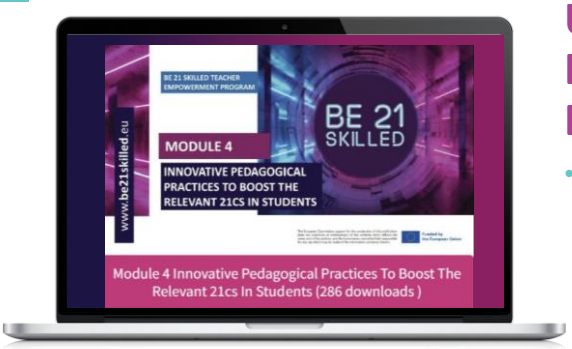
- Design scenarios that mimic real-world STEM challenges, reflecting industry-relevant problems. **The Be21 Skilled Toolkit** is packed with problem based tools that can assist

02

Learning from Belgrade:

- Simulations focused on renewable energy projects allowed students from engineering and biology to collaboratively solve complex, interdisciplinary problems

03



Use Module 4 of the BE-21-SKILLED Teacher Empowerment Program:

- Ready-to-use resources on creating impactful, scenario-based learning activities. Download from **Teacher Empowerment Program - Be21 Skilled**

04

Facilitator Training:

- Train educators to guide workshops and simulations effectively, emphasizing active listening and adaptive teaching techniques. Insights from Riga: Faculty training sessions incorporated role-playing exercises, enabling teachers to better facilitate dynamic classroom discussions and manage diverse teams.

05

Debriefing Sessions:

- Integrate structured debriefing sessions after each workshop or simulation to help students analyze their performance. Encourage reflection on teamwork, decision-making, and problem-solving processes.

06

Pilot feedback:

- Riga highlighted how structured debriefs improved student understanding of supply chain management during disaster simulations.

Leverage the BE-21-SKILLED eCompass:

Use the eCompass platform to enhance workshops and simulations with digital tools that track progress and foster collaboration- access via **E-compass - Be21 Skilled**

The platform's resources, including customizable simulation templates, can be adapted to specific STEM disciplines.

Examples from PILOTS

- **Riga:**
  Crisis management workshops enabled engineering and logistics students to collaborate on supply chain optimization during natural disasters. Students practiced adaptability and systems thinking under simulated high-pressure conditions.
- **RTU's Design Factory (Riga):**
  Workshops conducted in the LEGO Lab and Design Factory provided students with spaces to experiment and innovate, helping them translate abstract ideas into tangible prototypes.
- **Belgrade:**
  Renewable energy simulations brought together biology and engineering students to design sustainable solutions, emphasizing leadership and interdisciplinary problem-solving.

Benefits of Workshops and Simulations

- **Boosts Teamwork:**
  Students learn to navigate group dynamics and contribute effectively to collaborative projects.
- **Encourages Creativity:**
  Interactive settings inspire out-of-the-box thinking, essential for tackling complex problems.
- **Develops Real-World Skills:**
  Practical exercises mirror workplace challenges, preparing students for future STEM careers.
- **Inclusive Learning:**
  Mixed-gender and diverse teams, as demonstrated in the pilots, foster richer learning experiences by integrating varied perspectives

3.2 Group Projects and Discussions

Group projects and discussions are powerful tools for fostering collaboration, communication, and critical thinking.

These methods encourage active engagement, allowing students to work together, share diverse perspectives, and collectively solve problems. The pilot programs in Riga and Belgrade demonstrated that well-structured group activities can enhance learning outcomes by simulating real-world teamwork scenarios.

Why Group Projects and Discussions are Effective

- **Encourages Peer Learning:** Students benefit from each other's strengths, creating an environment of mutual support and learning
- **Builds Interpersonal Skills:** Collaborative projects improve communication, conflict resolution, and leadership abilities.
- **Simulates Workplace Dynamics:** Real-world STEM careers demand teamwork across disciplines, which group activities effectively replicate.

ACTION STEPS FOR IMPLEMENTATION

01

Project Guidelines:

- Create clear, structured guidelines for group projects to ensure equitable participation and accountability.
- For example, in Riga's pilot, logistics and engineering students were assigned distinct but complementary roles in a disaster-response project, fostering collaboration and clear role distribution.

02

Discussion Facilitation:

- Design discussions around open-ended, real-world problems to stimulate critical thinking.
- In Belgrade, facilitated discussions on renewable energy innovations encouraged students from engineering and biology backgrounds to explore creative solutions collaboratively.

03

Peer Feedback:

- Implement mechanisms for peer feedback to help students reflect on their contributions and learn from each other.
- Use rubrics from the **Teacher Empowerment Program** to standardize feedback and focus on specific 21CS like communication and adaptability.

04

Leverage Digital Tools:

- Use the **eCompass platform** to facilitate group activities, track progress, and provide instant feedback. The platform's collaborative tools enhance coordination and engagement among students

Examples from Pilots

- **Riga:**
  A group project on supply chain optimization required interdisciplinary collaboration between logistics and mechanical engineering students. Teams presented their solutions to a simulated crisis, which tested their adaptability and leadership under pressure.

- **Belgrade:**
  Group discussions on eco-friendly manufacturing brought together engineering and biology students, promoting diverse perspectives and fostering a deeper understanding of sustainability challenges.

Benefits of Group Projects and Discussions

- **Promotes Collaboration:**
  Encourages teamwork and ensures every student contributes meaningfully.
- **Enhances Problem-Solving Skills:**
  Tackling complex problems as a group leads to innovative solutions.
  .
- **Boosts Communication:**
  Structured discussions improve clarity, confidence, and the ability to articulate ideas.
- **Fosters Inclusivity:**
  Mixed-gender and interdisciplinary groups, as demonstrated in the pilots, lead to richer, more inclusive learning experiences.

3.3 Role-Playing and Case Studies

Role-playing and case studies are transformative tools for simulating real-world scenarios, enabling students to practice 21st-century skills (21CS) such as decision-making, critical thinking, and collaboration in a controlled and supportive environment.

Insights from the pilot programs in Riga and Belgrade underscore the effectiveness of these methods in fostering practical, actionable learning outcomes.

Why Role-Playing and Case Studies are Effective

- **Real-World Context:**
  Students engage with authentic challenges that mimic workplace dynamics.
- **Active Learning:**
  Immersive experiences help students internalize lessons more effectively than traditional methods.
- **Skill Application:**
  These exercises bridge the gap between theory and practice, enabling students to refine their interpersonal and technical skills.

ACTION STEPS FOR IMPLEMENTATION

01

Case Study Selection:

- Choose case studies that are directly relevant to STEM fields and illustrate critical 21CS such as adaptability, systems thinking, and ethical decision-making. In the Belgrade pilot, a case study on renewable energy integration challenged students to balance technical feasibility with environmental impact, fostering critical analysis and teamwork.

02

Role-Playing Scripts:

- Develop detailed role-playing scenarios that reflect common workplace challenges, such as project management, stakeholder negotiations, or crisis response. During Riga's pilot, role-playing activities simulated disaster-response scenarios, requiring logistics and engineering students to collaborate under pressure.

03

Assessment Criteria:

- Create clear and comprehensive rubrics to evaluate student performance, focusing on skills like communication, problem-solving, and leadership. Leverage **the Teacher Empowerment Program** for templates and resources to assess these competencies effectively.

04

Debriefing and Reflection:

- Incorporate structured debriefing sessions after each exercise to help students reflect on their performance and identify areas for growth. Use feedback loops to encourage continuous improvement and deeper learning.

05

Leveraging Technology:

- Use the **eCompass platform** to enhance role-playing and case studies with interactive features like real-time feedback, performance tracking, and virtual simulations. Incorporate digital tools to create dynamic scenarios that adapt based on student input, offering a more personalized learning experience

Examples from Pilots

- **Riga:**
  Logistics students collaborated with engineering peers to simulate supply chain responses during a natural disaster. This exercise tested their ability to adapt under time constraints while maintaining clear communication
- **Belgrade:**
  A renewable energy case study required interdisciplinary teams to present actionable solutions to a panel of mock stakeholders, simulating real-world decision-making processes

Benefits of Role-Playing and Case Studies

- **Enhances Critical Thinking:**
  Encourages students to evaluate complex problems from multiple perspectives.
- **Builds Confidence:**
  Safe, simulated environments allow students to practice skills without fear of failure.
- **Promotes Teamwork:**
  Collaborative exercises strengthen group dynamics and leadership capabilities of failure.
- **Prepares for the Workforce:**
  Realistic scenarios equip students with practical tools to navigate professional challenges.

Providing Feedback

04

4.1 Constructive Feedback

Feedback is a foundational element in effective 21st-century skills (21CS) education, fostering growth, self-awareness, and continuous improvement. Constructive feedback helps students understand their strengths, identify areas for development, and refine their skills for future challenges

The Riga and Belgrade pilot programs highlighted the critical role of structured and actionable feedback in enhancing student performance and engagement.

Constructive feedback emphasizes actionable insights and positive reinforcement to help students build on their strengths while addressing weaknesses. By embedding robust feedback practices into STEM education, educators can create a supportive learning environment that drives continuous improvement and prepares students for the collaborative and adaptive nature of modern workplaces. The key is to ensure feedback is timely, specific, and focused on behaviors and outcomes rather than personal attributes.

Why Constructive Feedback Matters

- **Encourages Growth:** Students are empowered to make improvements when feedback is actionable and supportive.
- **Promotes Engagement:** Regular and meaningful feedback keeps students motivated and invested in their learning process.
- **Builds Confidence:** Positive reinforcement helps students recognize their progress and strengths.

ACTION STEPS FOR IMPLEMENTATION

01

Feedback Framework:

- Develop a standardized framework for providing feedback that is specific, actionable, and focused on observable behaviors.
- For example, in the Riga pilot, structured feedback rubrics were used to evaluate teamwork and problem-solving during simulations, providing students with clear benchmarks for success

02

Regular Check-Ins:

- Schedule periodic feedback sessions to discuss student progress. Use one-on-one meetings or group debriefings to address challenges and celebrate achievements.
- Belgrade's pilot incorporated mid-project feedback sessions where facilitators provided guidance on leadership and collaboration in interdisciplinary teams.

03

Feedback Training:

- Train faculty on effective feedback delivery, emphasizing constructive language and actionable suggestions. Incorporate modules from the **BE-21-SKILLED Teacher Empowerment Program** to enhance educator proficiency in giving impactful feedback.

04

Immediate Post-Activity Feedback:

- Provide feedback immediately after activities like role-playing or group projects to maximize relevance and retention.
- In Riga, students received real-time feedback during crisis management simulations, enabling them to adjust their strategies dynamically.

Leveraging Technology

- Use platforms to deliver feedback digitally, allowing students to track their progress over time.
- Utilize performance dashboards and analytics to provide data-driven insights into student development.

Examples from Pilots

- **Riga:**
  Structured feedback rubrics in disaster response projects enabled students to identify specific areas for improvement, such as decision-making and time management.

- **Belgrade:**
  Facilitators conducted reflective discussions post-renewable energy case studies, helping students connect their technical solutions to real-world implications and improve their presentation skills.

Benefits of Constructive Feedback

- **Improves Skill Development:**
  Targeted feedback accelerates mastery of critical 21CS like communication, adaptability, and leadership.
- **Enhances Motivation:**
  Regular and constructive feedback keeps students engaged and motivated to improve.
- **Promotes Reflective Learning :**
  Students develop self-awareness and critical thinking by reflecting on their feedback.

4.2 Self-Assessment and Peer Review

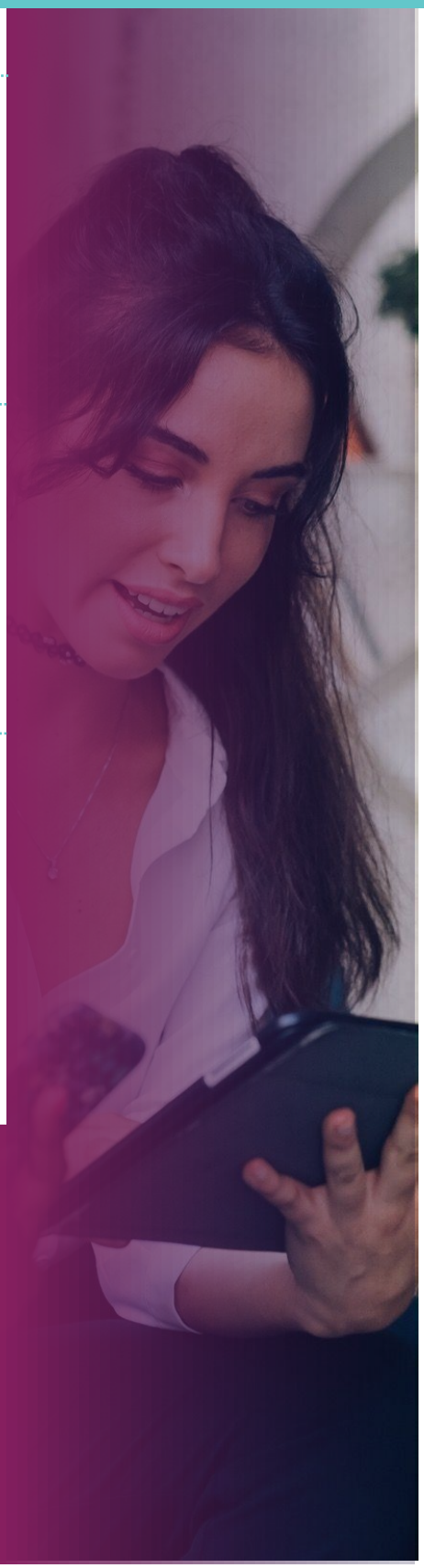
Encouraging self-assessment and peer review empowers students to take ownership of their learning journey, fostering reflection, accountability, and collaborative growth

The pilot programs in Riga and Belgrade highlighted the importance of these practices in enhancing critical thinking, self-awareness, and interpersonal skills.

Why Self-Assessment and Peer Review are Powerful

- **Promotes Self-Reflection:**
  Students critically evaluate their own contributions, identifying strengths and areas for improvement
- **Fosters Collaboration:**
  Peer reviews encourage constructive dialogue, improving teamwork and communication skills.
- **Enhances Accountability:**
  Transparent feedback systems promote responsibility and mutual respect among peers.

ACTION STEPS FOR IMPLEMENTATION



01

Self-Assessment Tools:

- Provide structured templates or rubrics for students to assess their performance.
- In the Riga pilot, self-assessment tools helped students evaluate their decision-making and adaptability during logistics simulations.
- Utilize resources from the **BE-21-SKILLED Toolkit** to create effective self-assessment frameworks

02

Peer Review Guidelines:

- Establish clear guidelines for conducting peer reviews, ensuring feedback is constructive and objective.
- During Belgrade's interdisciplinary workshops, peer reviews focused on evaluating leadership, creativity, and technical contributions within mixed-gender teams

03

Reflection Sessions:

- Organize facilitated reflection sessions where students can discuss their self-assessments and peer reviews.
- Use these sessions to highlight lessons learned and set actionable goals for future improvement.
- In Belgrade, post-project reflection sessions allowed students to explore how diverse perspectives enhanced problem-solving outcomes.

Leveraging Technology

Integrate digital tools to streamline self-assessment and peer review processes, enabling students to track their progress and receive feedback efficiently. Free-access external tools that could be utilized for delivering feedback and tracking student progress effectively include:

01

Google Workspace (Docs, Sheets, Forms):

- **Use Case:** Create templates for self-assessment, peer reviews, and progress tracking
- **Example:** Google Sheets can function as a simple dashboard to track individual and group performance metrics over time.
- **Benefit:** Accessible, collaborative, and integrates seamlessly with most educational workflows. Use analytics features to identify trends in student performance and provide targeted support

02

Padlet:

- **Use Case:** Facilitate peer feedback and collaborative reflection by allowing students to post feedback and insights on shared boards.
- **Example:** During Belgrade's pilot, Padlet could have been used for interdisciplinary teams to share reflections on renewable energy projects in real time.
- **Benefit:** Promotes transparency and inclusivity in group discussions.

03

Mentimeter:

- **Use Case:** Conduct quick polls and surveys for real-time feedback on lessons or project phases.
- **Example:** Use in workshops to gauge understanding of critical concepts and identify areas needing further explanation.
- **Benefit:** Increases engagement and provides instant insights for educators.

04

Edmodo:

- **Use Case:** Deliver feedback directly to students through a classroom communication platform.
- **Example:** Instructors in STEM courses could use Edmodo to upload assessments, track progress, and foster interaction between peers and facilitators.
- **Benefit:** Secure and easy-to-navigate platform for students and teachers.

Examples from Pilots

- **Riga:**
  Self-assessment tools enabled engineering students to reflect on their technical and interpersonal skills during disaster response projects, identifying key areas for growth.
- **Belgrade:**
  Peer reviews in renewable energy case studies encouraged students to recognize and appreciate each team member's unique contributions, fostering a culture of mutual respect and collaboration.

Benefits of Self-Assessment and Peer Review

- **Improves Critical Thinking:**
  Students learn to evaluate their work and others' with a focus on quality and impact.
- **Encourages Growth Mindset:**
  Constructive feedback builds resilience and a willingness to improve.
- **Strengthens Team Dynamics:**
  Transparent peer review systems promote trust and effective communication within groups.

By embedding **self-assessment** and **peer review** practices into **STEM curricula** educators **empower** students to become **active participants** in their own **learning journey**, equipping them with the **skills necessary** for **continuous improvement** and **success** in **collaborative**, **real-world environments**.

Promoting Self-Reflection

5.1 Written Reflections and Journals

Journaling can be incorporated into STEM lessons to support complex problem-solving, experiments, or projects. At the start of the class, students can reflect on their previous achievements, challenges, and goals through journaling. Educators should encourage regular self-reflection through written reflections and journals to deepen students' self-awareness and growth.

ACTION STEPS

01

Reflection Prompts:

- Provide prompts to guide students in their written reflections. For instance, students could be asked to reflect on challenges faced, lessons learned, and strategies employed to persevere.

02

Reflection Schedule:

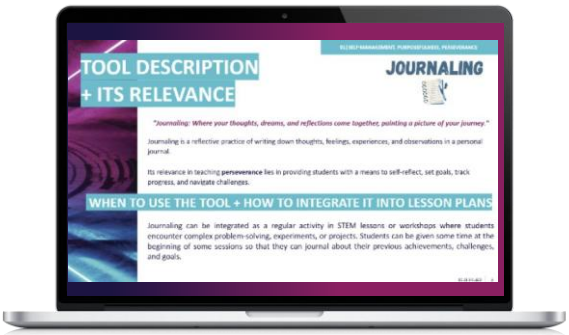
- Set a regular schedule for students to submit their reflections.

03

Review Process:

- Review and provide feedback on students' reflections to guide their self-awareness and growth

For full details about journaling, please refer to this link



5.1 Group Discussions and Debriefing

Facilitated group discussions and debriefing sessions provide students with opportunities to reflect on their experiences, share insights, and learn from their peers.

These activities promote collective growth and reinforce key 21CS such as communication, empathy, and teamwork. The pilots in Riga and Belgrade demonstrated how structured discussions significantly enhanced collaborative learning and critical thinking.

Why Group Discussions and Debriefing are Effective

- **Encourages Diverse Perspectives :**
  Students gain new insights by engaging with their peers' viewpoints.
- **Reinforces Learning:**
  Reflecting together consolidates understanding and connects theory to practice.
- **Builds Emotional Intelligence:**
  Discussions cultivate active listening and empathy, essential for modern STEM professionals.

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ACTION STEPS

01 Debriefing Structure:

- Develop a consistent format for debriefing sessions to ensure productive discussions.
- For instance, in Riga, disaster-response simulations were followed by structured debriefings that focused on team dynamics and decision-making processes

02 Facilitation Skills:

- Train facilitators to guide discussions effectively, emphasizing neutrality and encouraging equal participation.
- Belgrade's facilitators used prompts that highlighted the importance of interdisciplinary collaboration, fostering more inclusive discussions

03 Reflective Questions:

- Prepare reflective questions to stimulate critical thinking and in-depth discussions. Examples include:
  - "What challenges did your team encounter, and how were they addressed?"
  - "How did diverse perspectives contribute to your project's outcome?"
- Use feedback from students to refine and expand the question bank over time

Leveraging Technology

- Use platforms like **Padlet** or **Mentimeter** to capture group reflections in real-time.
- You can use Google Jamboard for real-time collaborative brainstorming and reflections. It allows for visual, interactive boards that students can update dynamically.

Examples from Pilots

- **Riga:**
  During a logistics exercise, students engaged in post-simulation debriefings where they reflected on supply chain decision-making and adaptability under pressure.
- **Belgrade:**
  Group discussions on renewable energy highlighted the value of interdisciplinary input, leading to innovative approaches and enhanced teamwork.

Benefits of Group Discussions and Debriefing

- **Strengthens Peer Learning:**
  Students learn from each other's experiences, broadening their perspectives.
- **Promotes Critical Reflection:**
  Group activities encourage students to analyze their own and others' contributions critically.
- **Enhances Collaboration:**
  Discussions foster a sense of shared responsibility and mutual respect within teams.

Using Technology

06

6.1 Online Platforms and Virtual Workshops

Leveraging technology is crucial for delivering impactful 21CS training in a digital age.

The Be 21 Skilled eCompass and other tools can enhance interactivity, streamline collaboration, and support real-time progress tracking, enabling educators to create innovative, flexible, and impactful learning environments that prepare students for the digital and collaborative demands of modern STEM careers. Online platforms and virtual workshops are powerful tools for fostering 21CS. They provide flexible, accessible, and scalable solutions for educators and students, enabling meaningful learning experiences regardless of physical location.

Action Steps for Effective Implementation

01 Platform Selection:

- Choose platforms that support interactive learning and seamless collaboration.
- **Examples:**
  - **Zoom:** Ideal for virtual workshops with breakout rooms for group discussions.
  - **Google Workspace:** Includes tools like Google Meet, Docs, and Jamboard for collaborative activities.
  - **Microsoft Teams:** Offers integrated solutions for project management and communication.

02 Virtual Workshop Design:

- Develop engaging and interactive virtual workshops that replicate real-world scenarios.
- Example from Belgrade: A renewable energy workshop conducted virtually encouraged interdisciplinary teamwork and problem-solving, with students presenting their solutions via shared screens.
- Leverage the eCompass platform for workshop templates, feedback tools, and progress tracking.

03 Tech Support:

- Provide robust technical support to ensure smooth operation of online training sessions.
- Offer pre-session training for students and educators on using selected platforms effectively.
- **Example from Riga:** Pre-workshop tech orientation sessions improved student confidence in using virtual collaboration tools during disaster simulation exercises

Enhancements Using eCompass

- **Dynamic Dashboards:**
  Enable students and teachers to visualize progress and identify skill gaps.
- **Interactive Simulations:**
  Host simulations that adapt to student input, providing a
- **Real-Time Feedback:**
  Use integrated tools to deliver immediate, actionable feedback during workshops.
- **Scalable Tools:**
  The eCompass platform supports both small group activities and large-scale workshops, ensuring adaptability for various educational contexts.

Benefits of Online Platforms and Virtual Workshops

- **Increased Accessibility :**
  Allows students from diverse locations to participate in high-quality training.
- **Scalable Learning:**
  Facilitates large-scale training sessions while maintaining interactivity.
- **Flexible Formats:**
  Supports asynchronous and synchronous learning, catering to varied student needs.
- **Enhanced Engagement:**
  Interactive features like polls, breakout rooms, and shared workspaces keep students actively involved

6.2 Digital Self-Assessment Tools

Digital self-assessment tools are essential for empowering students to evaluate their own progress in mastering 21CS. By fostering self-awareness and accountability, these tools encourage students to take ownership of their learning journey while providing educators with valuable insights into their development.

ACTION STEPS FOR IMPLEMENTATION

01

Tool Identification:

- Select tools that align with the desired skills and learning outcomes. Examples include:
  - **Kahoot!:** Use for interactive quizzes that assess knowledge and skills in real time.
  - **Edmodo:** Facilitate self-assessments and track learning milestones.
  - **Google Forms:** Create customized self-assessment surveys to evaluate specific skills

02

Instructional Guides:

- Provide clear tutorials and resources to help students navigate the self-assessment tools effectively.
- **Example:** Use video demonstrations or step-by-step guides to introduce tools like the eCompass dashboard.

03

Progress Tracking:

- Utilize digital tools to monitor student growth over time, identifying patterns and areas for improvement.
- **Example**: In Riga, self-assessment data collected was used to tailor feedback during disaster simulation projects.

04

Integration with Curriculum:

- Embed self-assessment tasks into regular coursework to make reflective practices a core part of the learning process.
- **Example** from Belgrade: Students assessed their teamwork and leadership skills post-renewable energy projects using structured digital templates.

Benefits of Digital Self-Assessment Tools

- **Encourages Self-Reflection:** Promotes deeper understanding of personal strengths and areas for growth.
- **Enhances Engagement:** Interactive tools make self-assessment more engaging and less intimidating.
- **Supports Personalized Learning:** Provides insights that help educators tailor support to individual needs.
- **Fosters Lifelong Learning:** Equips students with the skills to independently assess and adapt throughout their careers.

6.3 Virtual Simulations

Virtual simulations offer immersive and interactive environments where students can practice 21CS in realistic, risk-free scenarios.

These tools allow students to engage with complex challenges, refine their decision-making abilities, and build confidence in a controlled digital setting.

ACTION STEPS FOR IMPLEMENTATION

01 Simulation Software Selection:

- Choose simulation platforms that align with educational goals and subject matter. Examples include:
  - **Unity Simulations:** Ideal for custom STEM-related scenarios like environmental modeling.
  - **Labster**: Provides virtual lab simulations for biology, chemistry, and engineering courses.

02 Scenario Development:

- Create realistic, goal-oriented scenarios that replicate workplace challenges or STEM applications.
- **Example:** In Riga, disaster-response simulations included supply chain disruptions, requiring students to apply critical thinking and teamwork to resolve issues effectively

03 Performance Feedback:

- Use simulation analytics and facilitator observations to provide actionable feedback.
- **Example:** In Belgrade, simulation debriefs highlighted students' leadership and adaptability during renewable energy problem-solving exercises

04 Integration with Curriculum:

- Embed simulations into STEM coursework to provide hands-on applications of theoretical knowledge.
- **Example:** Use simulations in capstone projects to evaluate students' readiness for real-world STEM roles.

Benefits of Virtual Simulations

- **Enhances Engagement:**
  Immersive simulations capture students' attention and promote active learning.
- **Develops Problem-Solving Skills:**
  Students tackle realistic challenges that require critical thinking and strategic planning.
- **Improves Collaboration:**
  Group simulations foster teamwork and communication under dynamic conditions.
- **Risk-Free Learning:**
  Students can experiment and learn from mistakes without real-world consequences.

Connecting with the Real World

07

7.1 Guest Lecturers from the Industry

By integrating guest lectures into STEM education and prioritizing the inclusion of female role models, educators can provide students with a richer, more dynamic learning experience that bridges the gap between academic preparation and professional success.

Inviting guest lecturers from the industry bridges the gap between classroom learning and real-world applications. Industry professionals provide valuable insights into how 21st-century skills are used in practical settings, inspire students with real-life success stories, and enhance their understanding of the professional landscape. Incorporating female role models as guest lecturers further enriches these sessions, offering inspiration and relatable experiences for female STEM students.

Why Guest Lecturers are Powerful

- **Real-World Perspective:** Students gain first-hand knowledge of how 21CS like collaboration, adaptability, and problem-solving are applied in various industries.
- **Networking Opportunities:** Interactions with industry professionals can open pathways for mentorship and internships.
- **Motivation and Inspiration:** Hearing success stories and challenges from the field can ignite student enthusiasm and ambition.
- **Representation Matters:** Female guest speakers showcase successful career paths for women in STEM, breaking stereotypes and fostering confidence among female students.

ACTION STEPS FOR IMPLEMENTATION

01

Guest Speaker Roster:

- Develop a diverse roster of guest speakers from various STEM fields and industries.
- **Example:** During the Riga pilot, professionals from logistics and disaster management shared insights into real-world crisis response scenarios.
- Prioritize including accomplished female professionals to serve as role models, inspiring students to pursue ambitious goals

02

Lecture Topics:

- Collaborate with guest speakers to ensure topics align with 21CS training objectives.
- **Suggested topics:**
  - "Adapting to Technological Change in STEM Fields"
  - "Collaboration Across Disciplines: Real-World Case Studies"
  - "Leadership in STEM: Overcoming Challenges and Driving Innovation"
- **Example:** In Belgrade, renewable energy experts highlighted how interdisciplinary teamwork contributed to sustainable solutions, reinforcing the importance of collaboration.
- Invite female professionals to discuss gender equity in STEM and share strategies for overcoming challenges.

03

Interactive Sessions:

- Encourage guest speakers to engage students through Q&A sessions, live demonstrations, or interactive case discussions.
- Example: A Q&A session in Riga allowed students to inquire about career trajectories, skills development, and industry challenges.
- Use platforms like Padlet or Mentimeter to collect questions in advance or during the session to ensure active participation.

04

Feedback and Reflection:

- After each session, organize group discussions or written reflections to consolidate learning and gather student feedback.
- Example: In Belgrade, students reflected on how guest lectures reshaped their understanding of interdisciplinary problem-solving and adaptability in real-world contexts.
- Incorporate reflections on how female speakers influenced their perspectives, especially among female students

Leveraging Technology

- Use platforms like Zoom or Microsoft Teams to host virtual guest lectures, expanding access to professionals from diverse locations.
- Record sessions and share them on eCompass for students to revisit and reflect on key takeaways.

Benefits of Guest Lecturers from the Industry

- **Enhances Learning Relevance:** Connects academic concepts to their real-world applications.
- **Builds Professional Awareness:** Introduces students to the expectations and culture of various industries.
- **Encourages Lifelong Learning:** Highlights the importance of continuous skill development and adaptability.
- **Fosters Networking:** Provides students with connections that may lead to mentorship, internships, or job opportunities.
- **Empowers Female Students:** Female speakers demonstrate the possibilities for women in STEM, inspiring confidence and ambition.

7.2 Field Trips and Internships

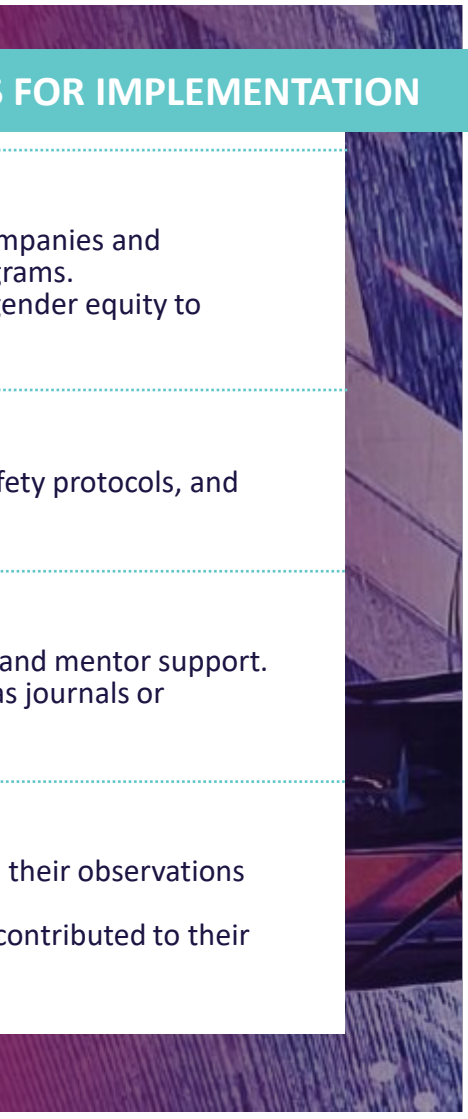
Field trips and internships provide invaluable opportunities for students to experience real-world applications of their learning.

Which will enhance their understanding of workplace dynamics, and develop essential 21CS. These experiences bridge the gap between academic concepts and practical implementation, fostering career readiness and adaptability.

Why Field Trips and Internships Matter

- **Hands-On Experience:**
  Students gain first-hand exposure to workplace environments, technologies, and processes.
- **Career Insights:**
  These experiences help students explore potential career paths and understand industry expectations.
- **Skill Development:**
  Activities during internships or field trips enhance teamwork, problem-solving, and communication skills

ACTION STEPS FOR IMPLEMENTATION



01 Partnership Development:

- Establish partnerships with local, regional, and global companies and organizations willing to host field trips or internship programs.
- Emphasize opportunities with organizations promoting gender equity to provide female students with inclusive role models.

02 Logistics Planning:

- Plan field trips meticulously, including transportation, safety protocols, and alignment with course objectives.

03 Internship Programs:

- Develop structured internships with clear learning goals and mentor support.
- Ensure internships include reflective components, such as journals or discussion sessions, to consolidate learning.

04 Post-Experience Reflection:

- Facilitate debriefing sessions where students can discuss their observations and identify key takeaways.
- Encourage students to reflect on how their experiences contributed to their understanding of 21CS and career goals.

Benefits of Field Trips and Internships

- **Real-World Exposure :**
  Provides students with tangible insights into industry operations and challenges.
- **Inspires Career Aspirations:**
  Allows students to envision potential career paths and gain clarity on their interests.
- **Builds Professional Skills:**
  Encourages adaptability, teamwork, and problem-solving in authentic settings.
- **Empowers Female Students:**
  Inclusive internships and role models inspire confidence and ambition among female students.

7.3 Volunteering and Community Engagement

Volunteering and community engagement provide students with meaningful opportunities to develop 21CS while making a positive societal impact.

These activities cultivate empathy, leadership, and teamwork by addressing real-world community needs.

Why Volunteering is Powerful

- **Fosters Social Responsibility:**
  Students gain a deeper understanding of their role in addressing societal challenges.
- **Enhances Interpersonal Skills:**
  Engaging with diverse communities builds communication and cultural competence.
- **Promotes Teamwork and Leadership:**
  Community projects often require collaborative problem-solving and initiative.

ACTION STEPS FOR IMPLEMENTATION

01

Volunteer Opportunities:

- Identify and promote volunteer opportunities that align with students' interests and career aspirations.
- **Example:** In Riga, students, based on their pilot experience, could volunteer in disaster preparedness initiatives, applying critical thinking and adaptability in real-world scenarios.

02

Community Projects:

- Collaborate with local organizations to design community engagement projects requiring teamwork and innovation.
- **Example:** Based on their pilot, in Belgrade, students could partnered with environmental organizations to develop sustainable practices for waste management, showcasing leadership and creativity.

03

Reflection on Experience:

- Organize reflection sessions where students can discuss their volunteering experiences, share challenges, and celebrate achievements.
- Encourage students to connect their experiences to broader societal and professional contexts.

Benefits of Volunteering and Community Engagement

- **Develops Social Awareness:** Students gain insights into societal challenges and their potential to make a difference.
- **Strengthens Collaboration:** Community projects enhance teamwork and leadership capabilities.
- **Promotes Lifelong Skill:** Activities build communication, adaptability, and problem-solving skills that extend beyond the classroom.
- **Encourages Empathy and Inclusion:** Volunteering fosters understanding and respect for diverse perspectives.

By integrating field trips, internships, and volunteering into STEM education, educators provide students with well-rounded, impactful learning experiences that not only develop 21CS but also inspire them to contribute meaningfully to their communities and industries

Adapting to Individual Student Needs

08

Adapting teaching methods to individual student needs is crucial for fostering engagement and success in STEM education. Recognizing that students learn in diverse ways, educators can design tailored strategies to effectively integrate 21st-century skills such as critical thinking, problem-solving, collaboration, and digital literacy into their teaching practices. For female students, this includes creating supportive environments that address the impact of underrepresentation and stereotypes in STEM.

8.1 Recognizing Different Learning Styles

To cater to diverse learning preferences and competence levels, educators should adapt training methods that resonate with students and align with the practical demands of STEM fields. This personalized approach boosts engagement and ensures all students, regardless of their starting points, develop essential 21CS.

Why Recognizing Learning Styles Matters

- **Enhances STEM Engagement:** Tailored teaching methods make abstract STEM concepts more accessible and relatable.
- **Improves Skill Acquisition :** Students develop critical thinking, collaboration, and technical skills more effectively when teaching aligns with their natural learning preferences.
- **Promotes Equity:** Addressing varied learning needs ensures that no student is left behind, fostering inclusivity.

01

Learning Style Assessments :

- Use tools like VAK (Visual, Auditory, Kinesthetic) or STEM-specific diagnostic assessments to identify students' learning styles.
- Example: In Riga, self-assessment questionnaires revealed preferences for visual aids and hands-on experimentation among engineering students, leading to the incorporation of diagrams, schematics, and interactive prototypes.

02

STEM-Specific Adaptive Teaching Methods:

- Develop diverse teaching methods tailored to STEM contexts, including:
  - **Project-Based Learning (PBL)**: Engage students in solving real-world STEM challenges requiring teamwork and creative problem-solving.
    - **Example**: In Belgrade, interdisciplinary PBL projects on renewable energy combined analytical thinking and practical teamwork, catering to both visual and kinesthetic learners.
  - **Simulations and Labs:** Offer virtual and physical simulations for hands-on learning, emphasizing experimentation and iterative problem-solving.
    - **Example:** Disaster-response simulations in Riga engaged kinesthetic learners by replicating real-world logistics scenarios.
  - **Interactive Lectures:** Use multimedia tools to present complex STEM concepts, appealing to auditory and visual learners.
- Integrate these methods with 21CS objectives, such as ethical decision-making, sustainability, and innovation.

03

Resource Provision:

- Provide additional resources for students who need extra support or challenge, such as:
  - Interactive STEM tutorials (e.g., Labster for virtual labs, PhET simulations for physics and chemistry).
  - Enrichment opportunities like advanced coding exercises or research projects.
  - Access to the **BE-21-SKILLED Toolkit** for self-paced learning modules.
- **Example**: Riga's LEGO Lab enabled students to engage in hands-on experimentation and creative problem-solving. By leveraging tactile, visual, and kinesthetic learning approaches, the lab supported students with diverse learning preferences and encouraged collaboration in designing innovative prototypes.

04

Accessibility for Disadvantaged Learners:

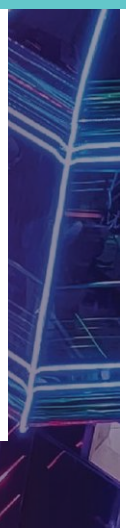
- Provide ease of access supports for students with disabilities, such as:
  - Screen readers, subtitles, or alternative formats for course materials.
  - Adaptive lab equipment for hands-on STEM experiments.
- Offer flexible deadlines and asynchronous learning options for students facing socio-economic challenges or limited internet access.

Additional Strategies for Female Students in STEM

- **Safe Learning Space:**
  Create environments where female students feel supported and free from bias, fostering open participation.
- **Highlighting Role Models:**
  Include female guest speakers or case studies of successful women in STEM to inspire and motivate
- **Mentorship Programs:**
  Pair female students with mentors who can guide and encourage them in navigating STEM challenges.

Benefits of Adapting Teaching to Diverse Needs

- **Enhances Engagement:**
  Students connect better with STEM content presented in formats they find relatable.
- **Boosts Confidence:**
  Tailored activities help students feel supported, encouraging them to take on more complex challenges.
- **Facilitates Deeper Learning:**
  Adaptive teaching fosters curiosity and persistence, essential traits for STEM professionals.
- **Fosters Inclusion:**
  Accommodating diverse learning styles and needs ensures all students have equal opportunities to excel.



By recognizing and addressing the diverse learning styles and challenges of all students, including female and disadvantaged learners, STEM educators can create an inclusive environment that nurtures every student's potential. This equips them with the skills and confidence needed to thrive in modern, technology-driven workplaces

8.2 Individualized Learning Plans

Individualized learning plans (ILPs) ensure that each student receives personalized support to develop their 21CS effectively. By tailoring goals, resources, and strategies to individual needs, ILPs help students overcome barriers and maximize their potential in STEM education

Why Individualized Learning Plans Matter

- **Addresses Unique Needs:** Supports students with varying skill levels, learning preferences, and career aspirations.
- **Encourages Accountability:** Empowers students to take ownership of their learning journey.
- **Promotes Lifelong Learning:** Instills habits of goal-setting, reflection, and self-directed growth.
- **Integrates AI for Precision:** Employing AI-powered tools streamlines the personalization process, ensuring plans are tailored to evolving needs.

ACTION STEPS FOR IMPLEMENTATION

01

Goal Setting:

- Collaborate with students to establish SMART goals (Specific, Measurable, Achievable, Relevant, Time-bound) for 21CS development.
- **Example:** A student interested in robotics could set a goal to enhance problem-solving and coding skills through project-based activities.

02

Personalized Resources:

- Use AI-driven platforms like Adaptive Learning Systems to recommend resources based on student performance and preferences.
- **Examples of Tools**:
  - **Khan Academy:** Offers personalized learning pathways for STEM topics.
  - **EdPuzzle:** Provides interactive video lessons with AI-based progress tracking.
- **Example:** AI-based systems can be integrated to guide students toward relevant STEM tutorials and projects.

03

Progress Reviews:

- Utilize AI-powered dashboards to analyze student data, identify learning gaps, and adjust ILPs in real time.
- Example: AI tools can be used to provide detailed insights into team dynamics during group projects, allowing facilitators to target leadership skills development.

04

Support for Disadvantaged Learners:

- Integrate AI tools to identify specific challenges faced by disadvantaged learners, such as lack of access or learning difficulties, and provide adaptive solutions.
- Example: Flexible AI-powered learning schedules in Belgrade supported students balancing external responsibilities with academics.

Benefits of Integrating AI into ILPs

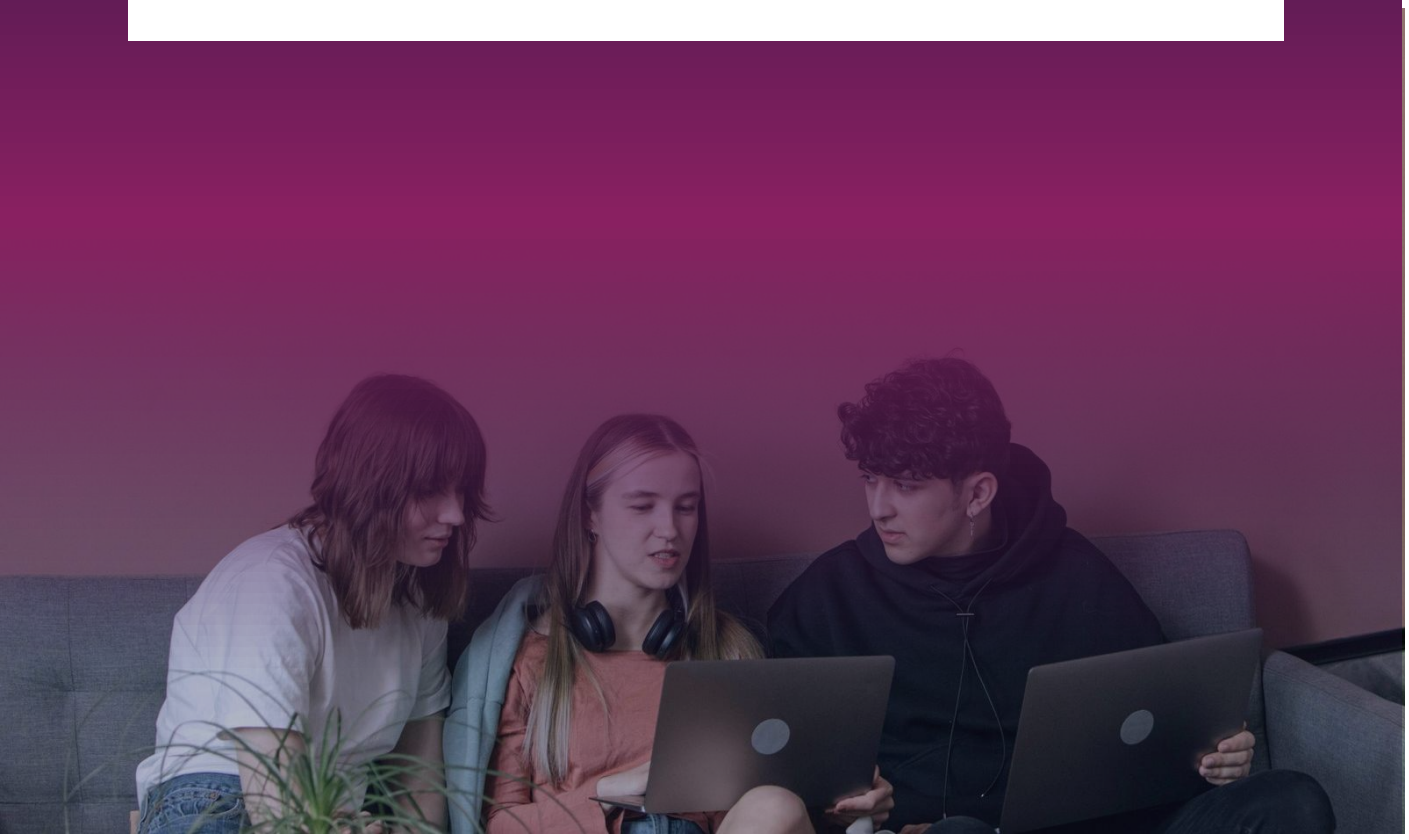
- **Enhances Precision:**
  AI tools provide data-driven insights to tailor plans more effectively.
- **Improves Engagement :**
  Adaptive platforms ensure that students receive content that aligns with their interests and learning styles.
- **Streamlines Educator Workloads:**
  Automated progress tracking allows educators to focus on direct student interactions.
- **Promotes Equity:**
  AI ensures that all students, regardless of background, receive personalized support.

8.3 Mentorship Programs

Mentorship programs play a vital role in supporting STEM students by providing guidance, encouragement, and real-world insights from experienced professionals. A well-structured mentorship program helps students develop 21CS, explore career pathways, and build confidence in their abilities.

Why Mentorship Programs Matter

- **Provides Guidance:** Mentors offer practical advice and knowledge, helping students navigate academic and professional challenges.
- **Inspires Confidence :** Hearing success stories and receiving personal encouragement from mentors empowers students to aim higher.
- **Builds Networks :** Mentorship connects students to professional communities, opening doors to opportunities and collaborations.
- **Supports Female Students:** Female mentors can serve as powerful role models, inspiring and encouraging female students to pursue and excel in STEM careers.



ACTION STEPS FOR IMPLEMENTATION

01

Mentor Recruitment:

- Partner with industries, alumni networks, and professional organizations to recruit mentors with diverse expertise and backgrounds. Example - partnerships with renewable energy firms could provide students with mentors experienced in interdisciplinary project management.
- Prioritize recruiting female mentors to inspire and support female STEM students.

02

Mentor Matching:

- Match students with mentors based on their interests, career goals, and learning needs. Example - engineering students can be paired with mentors specializing in logistics and innovation, aligning to academic projects.
- Use AI-powered platforms, such as MentorcliQ or Chronus, to streamline the matching process by analyzing student profiles and mentor expertise.

03

Mentorship Guidelines:

- Provide clear guidelines to mentors and mentees, outlining expectations, goals, and the frequency of interactions.
- Include training sessions for mentors to enhance their ability to support and guide students effectively.

04

Inclusive Support:

- Ensure mentorship opportunities are accessible to all students, including disadvantaged learners, by addressing barriers such as scheduling conflicts or technology access. Conder virtual mentorship options to connect students with professionals, expanding their exposure to diverse expertise.

Benefits of Mentorship Programs

- **Enhances Professional Awareness:**
  Students gain insights into industry expectations and trends.
- **Fosters Confidence:**
  Personal guidance encourages students to overcome challenges and pursue ambitious goals.
- **Builds Networks:**
  Mentors connect students to valuable professional contacts and communities.
- **Promotes Equity:**
  Inclusive mentorship programs ensure all students, especially female and disadvantaged learners, have equal access to guidance and support.

Monitoring and Evaluation

Robust monitoring and evaluation practices ensure the effectiveness and continuous improvement of 21CS training programs. These processes provide insights into student progress, program success, and areas for enhancement.

9.1 Continuous Evaluation

Regularly monitoring and evaluating the success of 21CS training allows educators to assess its impact and adapt to evolving needs.

ACTION STEPS

01

Evaluation Plan:

- Develop a comprehensive evaluation plan that incorporates multiple assessment methods, including surveys, performance metrics, and peer feedback.
- **Example:** The QA survey at Riga Technical University reported an average satisfaction rating of 4.2/5.

02

Data Collection:

- Collect data regularly using diverse tools such as online forms, learning management systems, and classroom observations.
- **Example:** In Belgrade, 78% of students expressed strong agreement that teamwork-focused activities were among the most valuable components of the training.

03

Analysis and Reporting:

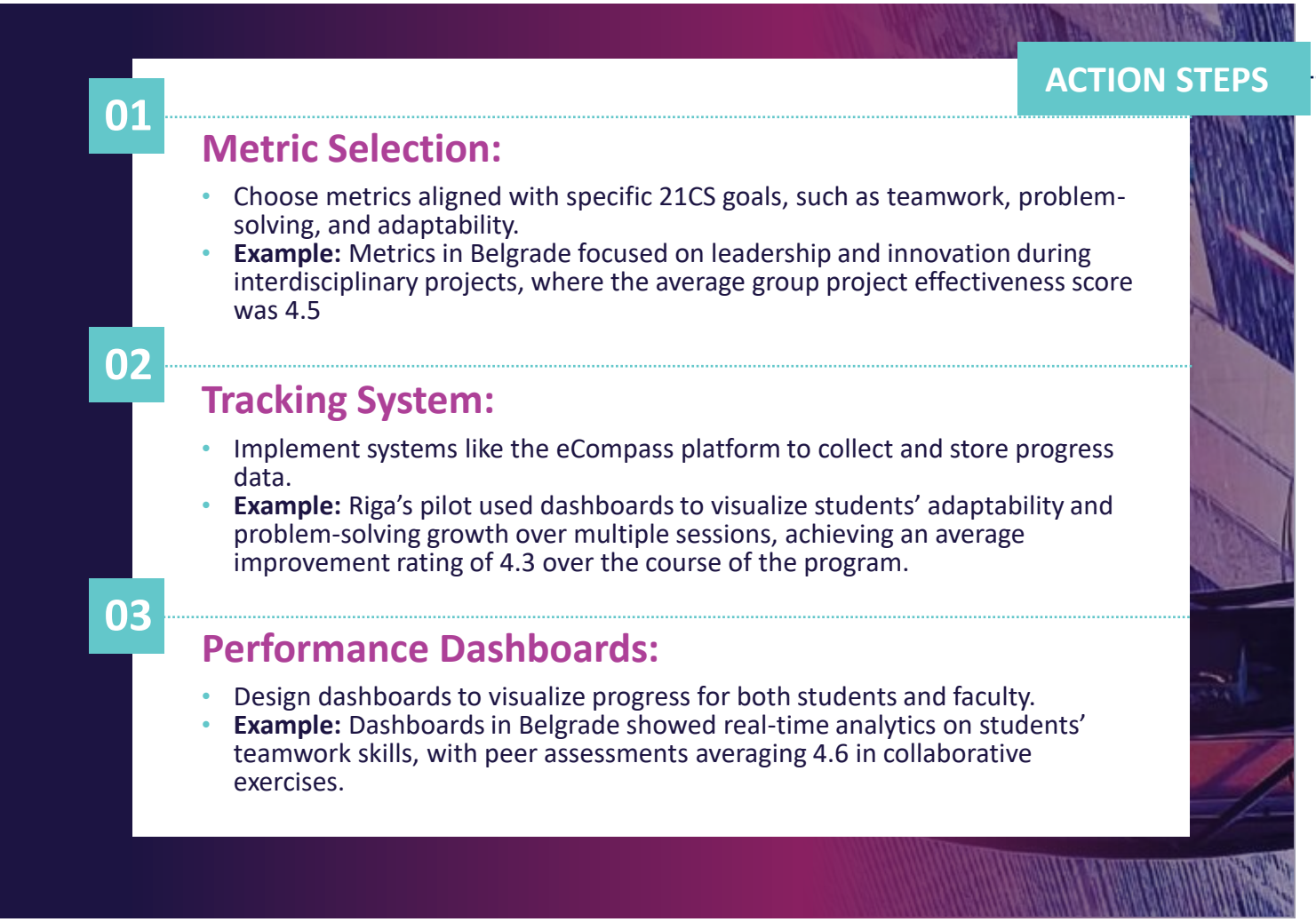
- Analyze collected data to identify trends, strengths, and gaps in skill development.
- Share findings with stakeholders, including faculty, industry partners, and students, to foster transparency and collaborative improvements

Benefits of Continuous Evaluation

- **Improves Training Relevance:** Ensures that programs address current industry and student needs.
- **Enhances Accountability:** Provides clear benchmarks for success.
- **Promotes Adaptability:** Enables timely adjustments based on data insights.

9.2 Use of Metrics Tools

Metrics tools help educators track and visualize students' progress in acquiring 21CS, providing actionable insights for improvement.



ACTION STEPS

01

Metric Selection:

- Choose metrics aligned with specific 21CS goals, such as teamwork, problem-solving, and adaptability.
- **Example:** Metrics in Belgrade focused on leadership and innovation during interdisciplinary projects, where the average group project effectiveness score was 4.5

02

Tracking System:

- Implement systems like the eCompass platform to collect and store progress data.
- **Example:** Riga's pilot used dashboards to visualize students' adaptability and problem-solving growth over multiple sessions, achieving an average improvement rating of 4.3 over the course of the program.

03

Performance Dashboards:

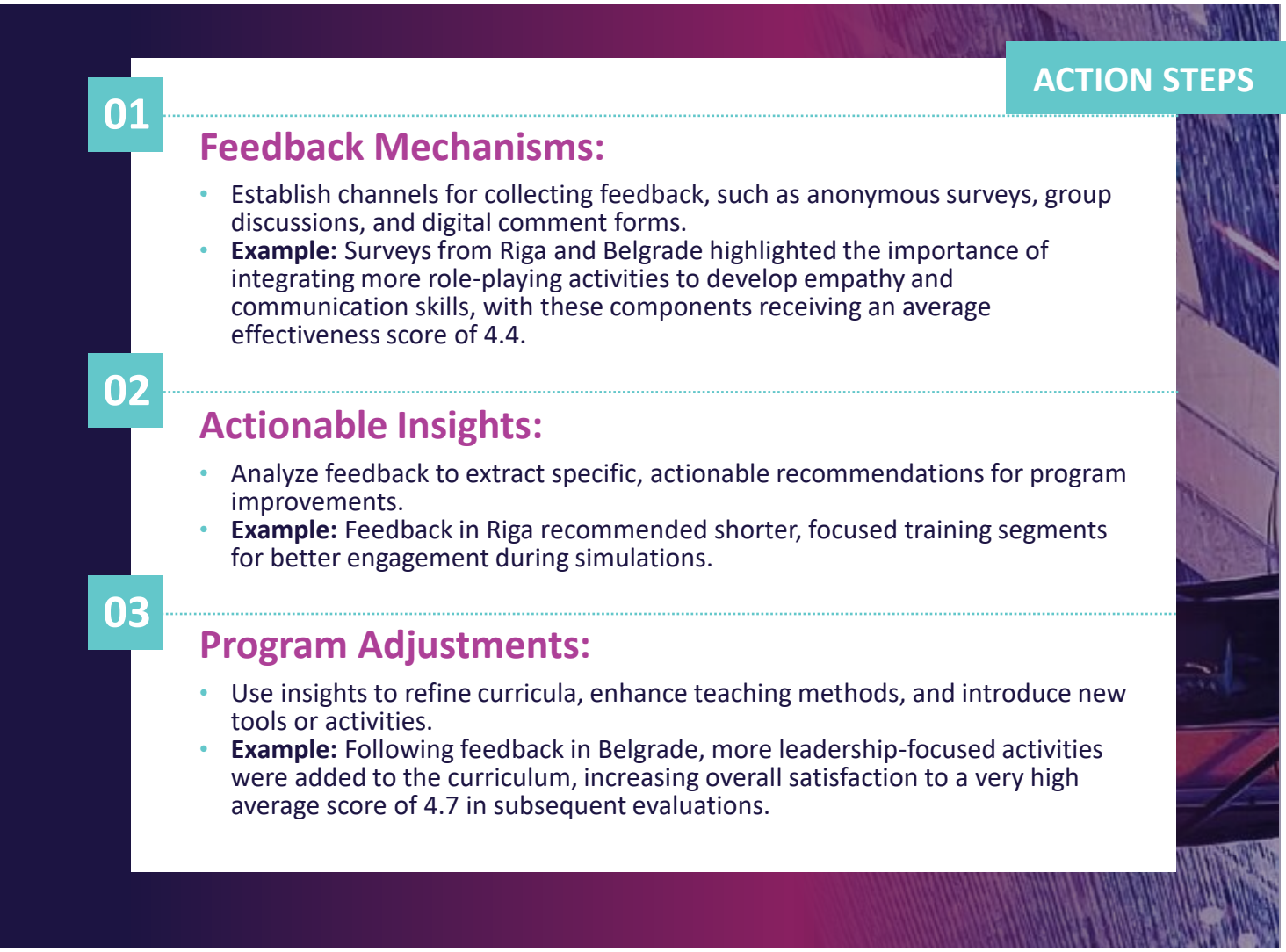
- Design dashboards to visualize progress for both students and faculty.
- **Example:** Dashboards in Belgrade showed real-time analytics on students' teamwork skills, with peer assessments averaging 4.6 in collaborative exercises.

Benefits of Metrics Tools

- **Enhances Transparency:** Students and educators gain clear insights into progress.
- **Supports Data-Driven Decisions:** Facilitates targeted interventions based on concrete evidence.
- **Promotes Engagement:** Students are motivated by visualizing their achievements.

9.3 Adapting Based on Feedback

Feedback from students, mentors, and industry partners is invaluable for refining and evolving 21CS training programs.



ACTION STEPS

01

Feedback Mechanisms:

- Establish channels for collecting feedback, such as anonymous surveys, group discussions, and digital comment forms.
- **Example:** Surveys from Riga and Belgrade highlighted the importance of integrating more role-playing activities to develop empathy and communication skills, with these components receiving an average effectiveness score of 4.4.

02

Actionable Insights:

- Analyze feedback to extract specific, actionable recommendations for program improvements.
- **Example:** Feedback in Riga recommended shorter, focused training segments for better engagement during simulations.

03

Program Adjustments:

- Use insights to refine curricula, enhance teaching methods, and introduce new tools or activities.
- **Example:** Following feedback in Belgrade, more leadership-focused activities were added to the curriculum, increasing overall satisfaction to a very high average score of 4.7 in subsequent evaluations.

Benefits of Feedback Integration

- **Promotes Responsiveness:** Ensures programs evolve to meet emerging needs.
- **Fosters Collaboration :** Encourages active involvement from students and stakeholders.
- **Drives Continuous Improvement :** Keeps training programs innovative and impactful.

Conclusions

10

Conclusions

The **BE-21-SKILLED Student Playbook** offers a **comprehensive** and **actionable strategy** to integrate **21st-century skills** into **STEM education**. By focusing on **inclusivity**, **adaptability**, and **practical application**, it prepares students to **participate in** and **lead** the **STEM industries** of tomorrow, equipping **educators** and **students** alike to rise to the challenges of a **rapidly evolving global landscape**.

Based on our student pilots in Riga and Belgrade, this Playbook is based on program experience involving a total of 385 participants at Riga Technical University (RTU), where 146 (38%) were female students, and 122 participants at the University of Belgrade (UB), of which 57 (47%) were female students.

This diversity underscored the importance of creating equitable and supportive environments for STEM education. Integrating 21st century skills training in STEM academic offerings universities and colleges is crucial for preparing students for success in the modern work environment. Teachers can significantly enhance student competencies by incorporating these skills into the curriculum, using interactive teaching methods, providing feedback, and promoting self-reflection. Connecting with the real world, using technology, adapting to individual student needs, and continuously monitoring and evaluating the success of the training are key elements for creating an effective and sustainable 21st century skills development program.

Educators play a vital role in this process, and their engagement and dedication contribute to creating new generations of professionals ready to face the challenges and seize the opportunities presented by the contemporary world.

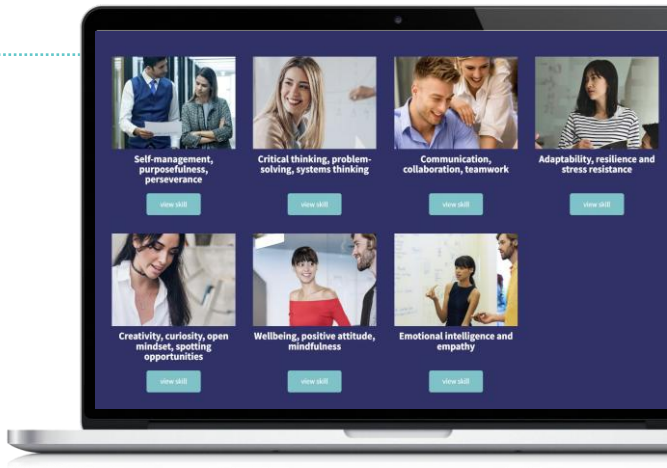
Applying 21st-Century Skills in STEM Higher Education:

Lessons Learned from Student Pilot and Scientific Evidence

By using and adapting our an effective 21st century skills training program, emphasize engagement, real-world application, and a supportive learning environment. Here are some refined strategies based on insights from student pilot trainings:

01

Start by selecting the specific 21st century skills you want to develop, such as communication, teamwork, adaptability, and problem-solving. These skills should be tailored to match the needs of the group or organizational objectives, with clear goals for participants to achieve by the end of the session. To make this easier, in our Be21Skilled Toolkit, we have categorised these skills into 7 areas - **Toolkit - Be21 Skilled**



02

Next, structure an agenda that combines theory with hands-on participation. Since 21st-century skills are best learned through practice, they incorporate interactive elements like role-playing, simulations, and group exercises, allowing participants to apply what they're learning immediately. Keep sessions in short, focused segments to simplify complex ideas, and add regular breaks to maintain energy and focus.

03

Use a variety of instructional methods to accommodate different learning styles and reinforce key concepts. Role-playing activities can foster empathy and problem-solving skills, group discussions can promote knowledge-sharing, and case studies can illustrate real-world applications. Include time for self-reflection and self-assessment to help participants identify their strengths and areas for improvement.

04

A supportive and inclusive environment is crucial. Set ground rules that promote respect, active listening, and openness to encourage a safe space for participants to share experiences and challenges. Constructive feedback is vital to help participants improve in a positive, motivational atmosphere

05

To solidify learning, encourage real-world practice of these skills. Through implementing project-based learning (PBL) and real-world challenges, our pilots observed that students demonstrated 21st-century skills such as teamwork and communication and also became more engaged in the piloting. This approach highlighted the value of integrating interdisciplinary projects to enhance student outcomes (National Academies of Sciences, Engineering, and Medicine, 2018). Assign exercises that participants can implement in their daily routines, such as practising active listening in meetings or taking on small leadership roles. Follow-up sessions are an excellent way for participants to reflect on and

06

Finally, evaluate the program's effectiveness. Gather feedback through surveys or discussions to identify what participants found valuable and where they encountered difficulties. Use this input to set improvement goals and continuously enhance the training content and delivery.

While our **conclusion** is that rather that tailoring **training** based on **gender** - which may inadvertently reinforce **stereotypes** - **educators** should focus on **individual strengths** and **diverse learning styles**. We would encourage.

- Addressing gender stereotypes and biases in STEM classrooms by using inclusive language, female role-models come to the fore and emphasize the achievements of women in STEM.
- Challenging stereotypes, female students learn to question assumptions, think critically about societal norms, and approach problems with an open and inclusive mindset.
- Creating safe spaces where female STEM students can discuss academic challenges and receive mentorship (UNESCO, 2015) can be powerful. By fostering an environment where students feel supported and encouraged to share their challenges and experiences, they build interpersonal skills, enhance peer-to-peer learning, and strengthen their ability to work effectively with others. Additionally, mentorship can cultivate leadership skills, as students learn to navigate challenges, seek guidance, and potentially mentor others in the future. These interactions also foster communication skills and empathy, which are crucial for success in both academic and professional settings
- Collaborating with professional associations, such as the Association of Women in Science, or other relevant associations, to offer mentorship programs that connect female STEM students with women in STEM careers (Eccles, 2015).

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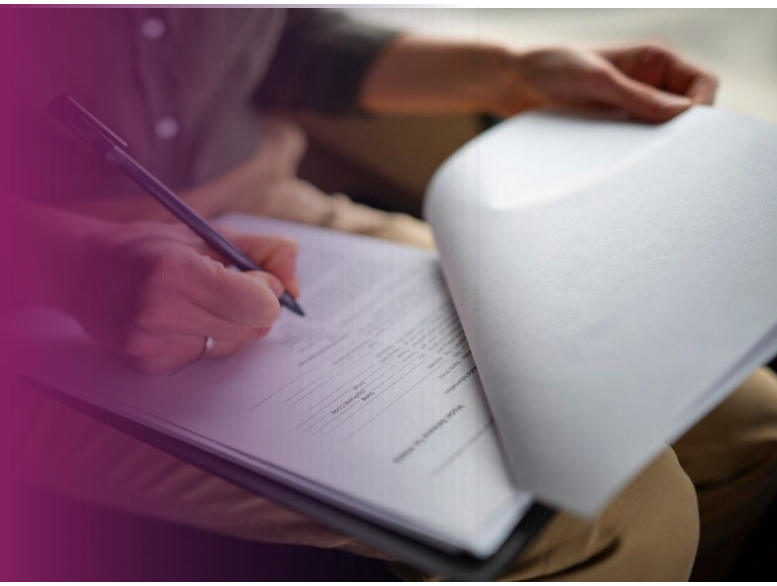

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