Ministry of Education
& Higher Education

Palestine National STEM Education Framework

(2025-2030)

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Introduction

Vision

Palestine will benefit from an advanced education system, in which all Palestinian students can become scientifically literate, technologically proficient, and innovative problem-solvers as a way of life. An advanced education system will enable Palestinians to achieve justice and freedom and participate in and contribute to increasingly technical and global workplaces.

Mission

The Palestine National STEM Education Framework will provide an equitable, high-quality STEM education curriculum, career exploration, and opportunities that engage all students in the development of knowledge, skills, and dispositions necessary to thrive in an increasingly complex and technology-driven world.

Purpose

The purpose of this STEM Education framework is to establish a foundation that articulates the significance of STEM education in fostering a skilled, innovative, and adaptive Palestinian workforce that is equipped for future technological advancement and national development. This STEM Education Framework will also provide the Ministry of Education and Higher Education (MoEHE) with an overarching mechanism for aligning both formal, non-formal, and informal curricular and extracurricular activities within the Palestinian K-12 system.

The Palestine National STEM Education Framework facilitates the development of the STEM curriculum in Palestine. This STEM Education Framework is developed according to the parameters of the Theory of Change (ToC), which explains how and why a desired change is expected to happen in a particular context. The components of this framework have been identified following a comprehensive Situational Analysis of the current STEM education landscape in Palestine as part of Component 2 of SERATAC program

The Framework has the following intended outcomes:

Developing Discipline-Specific Competencies

- Establish core competencies in Science, Mathematics, Technology, and Engineering that align with global standards while addressing local priorities and challenges.

Enhancing Interdisciplinary and Transdisciplinary Learning

- Promote the integration of STEM disciplines and connections with non-STEM subjects, encouraging holistic problem-solving, critical thinking, and creativity.

Cultivating Skills and Habits of Mind

- Equip students with essential 21st-century skills such as critical thinking, collaboration, communication, and digital literacy to thrive in a rapidly evolving global and regional context.

Supporting Economic and Technological Growth

- Prepare students to engage in and drive local innovation, contributing to economic resilience and technological advancement in Palestine.

Promoting Social Equity and Inclusivity

- Ensure that STEM education is accessible to all students, regardless of gender, socio-economic background, or geographic location, to foster social cohesion and national development.

Theoretical underpinning

A Theory of Change (ToC) is a comprehensive framework used to describe how and why a desired change is expected to happen in a specific context. It maps the causal pathway from activities and outputs to the intended long-term outcomes and impact, identifying the underlying assumptions, risks, and external factors that can influence the change process. Weiss (1995) defined Theory of Change as a systematic method for identifying the components required to achieve a specific goal and their interrelationships, providing a basis for evaluation and strategic planning . ToC is often used to articulate and visualize the complexity of change processes, making it particularly useful in educational, social, and development programs (Anderson, 2005).

For the Palestinian National STEM Education Framework, the ToC outlines the pathway by which STEM education reforms will lead to a highly skilled, innovative, and adaptable workforce capable of driving national technological and economic growth. It begins by focusing on the Palestinian STEM curriculum, teacher capacity, and educational infrastructure (inputs facilitating short-term objectives), leading to improved STEM teaching practices and student engagement in interdisciplinary learning (activities and experiences facilitating medium-term objectives). This, in turn, will result in strengthened student competencies in Science, Mathematics, Technology, and Engineering (outcomes reflecting the long-term objectives), ultimately fostering a generation of critical thinkers, problem-solvers, and innovators who are prepared to contribute to Palestine's socio-economic development and technological advancements (impacts of alignment with the established vision). The framework's phased implementation ensures continuous evaluation, refinement, and sustainability, addressing local needs and aligning with global standards for STEM education.

The 4 Pillars of the STEM Education Framework

The Framework is designed around four pillars:

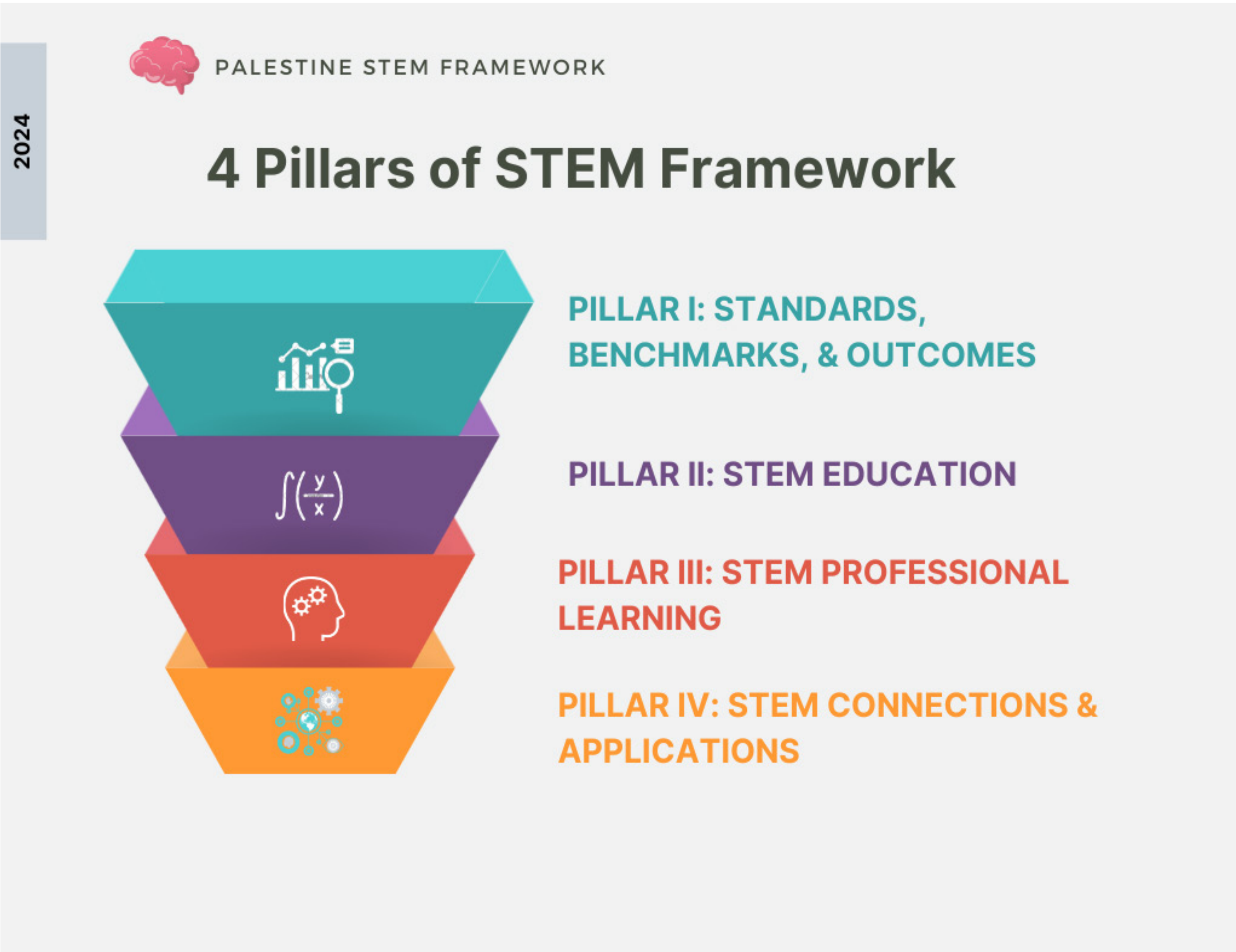
Pillar 1: Standards, Benchmarks, & Outcomes

Pillar 2: STEM Education

Pillar 3: STEM Teacher Professional Learning

Pillar 4: STEM Connections and Applications

Each pillar includes a brief description of its major components and details of a recommended approach. While each pillar and its recommendations are presented separately, the pillars are interrelated and impact one another.



Pillar I: Standards, Benchmarks, & Outcomes

This pillar discusses the alignment between the standards and benchmarks concerning assessments. Element One: Learning Goals and Outcomes

1.1. Expectations across grade levels.

Lower Primary (Grades 1-4). At the lower primary level, the focus is on fostering curiosity and basic proficiency in STEM subjects through hands-on learning and inquiry-based activities. Students should:

- Develop foundational knowledge in mathematics and science concepts.
- Engage in basic technologies and engineering activities to understand real-world applications.
- Cultivate critical thinking and observational skills.
- Participate in investigations.
- Learn to work collaboratively in group settings.
- Explore careers of interest or categories of careers relevant to the curriculum.

Upper Primary (Grades 5-9). At the upper primary level, students will transition to more complex problem-solving activities and begin exploring interdisciplinary projects. Students should:

- Apply principles of mathematics, scientific methods, and design processes to answer complex questions or to solve more advanced problems or challenges.
- Participate in integrative STEM projects that connect multiple disciplines, also including non-STEM subjects (e.g., Arts, Language, Civics/History).
- Begin using technology tools for data collection and analysis.
- Strengthen communication skills by presenting project findings.
- Explore specific careers relevant to the curriculum.

Secondary (Grades 10-12). Secondary students will be prepared for post-secondary education or technical careers, with an emphasis on specialized STEM pathways. Students should:

- Engage in in-depth research and project-based learning that addresses real-world challenges using scientific methods or engineering design processes.
- Develop expertise in selected STEM disciplines while maintaining interdisciplinary literacy.
- Explore career connections as part of every unit of study.
- Use advanced technology tools and software relevant to STEM careers.
- Develop leadership and collaboration skills through complex team projects.

1.2. Learning Goals and Outcomes

- **Critical Thinking and Problem-Solving.** The ability to identify and analyze complex problems, evaluate various solutions, and make reasoned decisions based on evidence. Critical thinking is fundamental for STEM professionals, as it enables them to approach technical challenges systematically and innovatively.

- **Creativity and Innovation.** The capacity to generate original ideas, think differently or unconventionally, and innovate solutions in a variety of different contexts. Creativity is a core component of STEM literacy, as it encourages students to be experimental, invent or innovate new prototypes, and iterate solutions until they arrive at competency level.

- **Collaboration and Teamwork**. The ability to work effectively and respectfully with diverse teams, sharing or distributing responsibilities, and contributing to a collective goal. Collaboration is considered a key predictor of success in STEM fields, where interdisciplinary teamwork is often required.

- **Digital Literacy and Technological Proficiency.** The ability to effectively use digital tools, software, and collaborative platforms to communicate, analyze data, and solve problems. Digital literacy is essential for STEM careers, as technological fluency is a prerequisite in fields such as data science, robotics, and computational biology.

- **Entrepreneurial Thinking.** The capacity to identify opportunities, take calculated risks, and drive innovation to create value in personal, professional, or societal contexts. Entrepreneurial thinking is crucial for fostering a growth mindset, resilience, and the ability to navigate complex business environments.

- **Global and Cultural Awareness.** Understanding diverse perspectives and being able to work effectively in multicultural and global environments. Global awareness and intercultural competence are important for STEM professionals who often collaborate with international teams or work in diverse communities.

- **Self-Management and Responsibility.** The ability to set goals, manage time effectively, demonstrate ethical behavior, and take responsibility for personal learning and development. Self-management skills are critical for success in the workplace, as they enable individuals to navigate complex work environments and take ownership of projects.

1.3. Core competencies

These competencies are to be incorporated throughout the curriculum. The same competencies are to be reinforced and scaffolded at different grade levels so that the Palestinian school graduate is equipped with these competencies by graduation.

Science. Science competencies focus on understanding and applying scientific concepts, conducting investigations, and reasoning based on evidence.

- **Scientific Inquiry and Investigation.** The ability to formulate research questions, design experiments, and use empirical evidence to support claims.

- **Conceptual Understanding.** Deep knowledge of core scientific concepts (e.g., energy, matter, force, and ecosystems).

- **Data Analysis and Interpretation.** The ability to collect, analyze, and interpret data using scientific methods and tools.

- **Modeling and Simulation.** Using models and simulations to represent natural phenomena and predict outcomes.

- **Scientific Communication.** The ability to clearly articulate scientific findings through written, oral, and visual presentations.

Mathematics. Mathematics competencies emphasize problem-solving, logical reasoning, and the application of mathematical principles.

- **Numerical and Algebraic Reasoning.** The ability to work with numbers and algebraic expressions to solve real-world and theoretical problems.

- **Spatial and Geometric Thinking.** Understanding geometric principles, shapes, and spatial relationships to describe and solve problems.

- **Data Literacy and Statistical Reasoning.** The ability to interpret data, understand statistical measures, and draw conclusions.

- **Mathematical Modeling.** Applying mathematics to develop models that describe, explain, and predict real-world situations.

- **Computational Thinking.** Using algorithms, programming, and computational logic to approach mathematical problems.

Technology. Technology competencies relate to understanding, creating, and using technological tools and systems.

- **Technological Literacy.** Understanding the nature, role, and scope of technology in society and its interaction with human life.

- **Design and Use of Technological Systems.** Ability to design, use, and evaluate technological tools and systems for problem-solving.

- **Digital Competency.** Proficiency in using digital tools and platforms, such as software applications, programming languages, and simulations.

- **Information and Communication Technology (ICT) Skills.** Using ICT tools to access, analyze, create, and communicate information effectively.

Engineering. Engineering competencies focus on applying scientific and mathematical knowledge to design and innovate solutions to real-world problems.

- **Engineering Design Processes.** Understanding and applying an engineering design process (define problem or challenge, research, develop solutions, model, prototype, testing, iteration, sharing).

- **Systems Thinking.** The ability to analyze complex systems and understand the interdependencies among components.

- **Innovation and Creativity.** The ability to think creatively to design innovative solutions that meet specific constraints and criteria.

- **Technical Skills.** Proficiency in technical areas such as prototyping, material science, mechanics, and electronics.

- **Problem-solving and Optimization.** Ability to evaluate multiple solutions and optimize designs based on constraints such as cost, safety, and efficiency.

Computer Science Skills. Physical computing with sensors and actuators driven by microcontrollers and microprocessors is an important part of Engineering. Increasingly, STEM +C is used to explicitly distinguish the importance of programming skills in all technical careers.

Element Two: Standards and Benchmarks

1.4. Interdisciplinary and Transdisciplinary Skills, Dispositions, Habits of Mind

Interdisciplinary and transdisciplinary competencies are essential for bridging the boundaries between STEM disciplines and other fields, allowing for the integration of knowledge, skills, and practices to address complex, real-world problems or challenges.

Skills

- **Critical Thinking and Problem-Solving.** The ability to analyze complex problems from multiple perspectives and develop creative solutions using a variety of disciplinary approaches.

- **Collaboration and Teamwork.** Capacity to work effectively in diverse teams, sharing responsibility, communicating ideas, and integrating different viewpoints.

- **Communication.** Proficiency in articulating and presenting ideas, findings, and solutions clearly and effectively across disciplines.

- **Research and Inquiry Skills.** The ability to conduct research, ask meaningful questions, and seek out interdisciplinary connections between STEM and non-STEM fields.

- **Adaptability and Flexibility.** The capability to adjust to new information, shifting contexts, and evolving challenges while maintaining focus on problem-solving.

- **Digital and Technological Integration.** Proficiency in using technology to gather, analyze, and synthesize information across disciplinary boundaries, and to automate important systems.

Dispositions

- **Curiosity and Inquisitiveness.** Eagerness to ask questions, explore new ideas, and investigate the unknown.

- **Persistence and Resilience.** Willingness to tackle challenging problems, learn from failure, and persevere in the face of obstacles.

- **Openness to New Ideas.** Readiness to consider and incorporate diverse perspectives, methods, and solutions.

- **Ethical Consideration and Responsibility.** Awareness of ethical issues related to the use and impact of STEM in society, and a commitment to responsible decision-making.

- **Lifelong Learning.** Commitment to continuous learning and self-improvement to stay abreast of new developments in multiple disciplines.

Habits of Mind

- **Systems Thinking.** The ability to see and understand the interconnectedness of systems, recognize patterns, and predict potential impacts of decisions.

- **Integrative Thinking.** Capacity to integrate ideas from various disciplines to form a holistic understanding of complex phenomena.

- **Design Thinking.** Utilizing iterative processes to empathize, ideate, prototype, and test innovative solutions for complex problems.

- **Evidence-Based Reasoning.** Making decisions and forming conclusions based on empirical evidence and logical reasoning.

- **Creative and Imaginative Thinking.** Using creativity and imagination to approach problems from unique angles and develop novel solutions.

1.5. Integrative STEM in Practice

In an integrative STEM context, students and educators are encouraged to move beyond learning restricted to an individual subject, and instead apply the competencies of science, mathematics, technology, and engineering together for deeper and broader understandings. This approach fosters the development of transdisciplinary skills where students use knowledge from all STEM fields (and sometimes non-STEM fields like arts or social sciences) to tackle real-world challenges that are complex and multidimensional, and also create new knowledge.

For example, students working on an interdisciplinary project such as designing an eco-friendly building will use:

- Mathematical Competencies to calculate the cost, area, and materials.

- Scientific Competencies to understand energy systems, environmental impacts and measuring energy efficiency.

- Engineering Competencies to create structural designs and optimize building systems.

- Technological Competencies to develop simulations or models and use digital tools for prototyping.

1.6. Competency-Based, Performance-Based, Project-Based Assessments

Competency-Based Assessments (CBAs) are practical, contextual, and aligned with the goals of college and career readiness. CBAs move away from traditional testing that mainly focuses on knowledge recall. Instead, they center on evaluating how well students can apply their learning in practical settings, reflecting real-world problem-solving.

On the other hand, Performance-Based Assessments (PBAs) are integral to evaluating student learning through practical, real-world applications. These assessments foster critical thinking, creativity, problem-solving, and decision-making, while providing students with opportunities to apply their STEM knowledge in collaborative and interactive settings.

Projects offer students opportunities to engage in interdisciplinary STEM learning over extended periods, often culminating in comprehensive project portfolios or capstone assessments. These projects encourage the application of theoretical knowledge to practical challenges, fostering a deep understanding of STEM disciplines. Project-Based Learning (PjBL) assessments focus on students engaging in long-term projects that require them to research, plan, execute, and present solutions to complex, real-world problems. Assessments are based on the process and the final product. Presentations are an important part of PjBL assessment.

- **Problem-Based Scenarios**

  Students tackle scenarios relevant to the Palestinian context, such as devising affordable and sustainable construction methods using locally available resources. They are evaluated based on their ability to research the issue, develop practical solutions, and articulate their findings.

  Example: Lower primary students (grades 1-4) might investigate the impact of waste on their local environment and propose waste management solutions, documenting their ideas and background research, experimental results, and conclusions.

- **Community Service-Learning Projects**

  Students engage in projects that serve the local community, applying STEM skills to benefit society. Projects could involve designing a water conservation system for a school or developing a digital literacy program for local community centers.

  Example: Secondary students (grades 10-12) could design and implement a small-scale renewable energy solution (e.g., solar water heater) for a community building, providing documentation and presenting their results to stakeholders.

- **Project Portfolios**

  Students work on interdisciplinary STEM projects such as building models, conducting experiments, or developing technology solutions. The portfolio documents the project lifecycle, offering a holistic view of student progress.

  Example: Upper primary students (grades 5-9) could design and prototype a water purification system to address local water scarcity issues.

- **Capstone Projects**

  These are culminating projects for students to demonstrate their mastery of STEM disciplines by integrating knowledge from multiple areas.

  Example: Secondary students could create a sustainable energy solution for a Palestinian community, incorporating physics, environmental science, and technology.

- **Design Challenges**

  Students work on specific design tasks such as robotics challenges or engineering design competitions. These activities encourage students to apply their learning in practical ways.

  Example: Students could design and program an autonomous robot to solve agricultural problems, like identifying and sorting healthy vs. diseased crops.

- **Competitions**

  These local, regional or national competitions engage students in applying their STEM knowledge to real-world challenges, often working in teams to develop solutions.

  Example: Participants in a regional science fair might develop innovative prototypes addressing environmental issues such as renewable energy or water conservation.

- **Expositions**

  Expositions or Expos appear similar to Competitions except they are less competitive or noncompetitive and all participants are encouraged to continue their explorations. Expos are structured to showcase and celebrate students› ideas and work (and products or outcomes) and provide supportive critical feedback to help students elevate their ideas and innovations.

  Example: Schools host an event where families can see the results of students’ independent (or group) projects, ask questions, give feedback, and see their students describing their work and interacting with other community members.

- **Role-Playing and Simulations**

  In these tasks, students assume roles such as engineers or policymakers to address STEM-related problems in simulated environments.

Example: Students acting as urban planners could propose a development plan for a Palestinian city that integrates sustainable practices and technological innovation.

- **Lab Practical Exams**

  These interactive assessments evaluate students’ ability to conduct experiments, interpret data, and draw conclusions in applied science contexts.

  Example: A physics practical exam could involve measuring and analyzing the motion of objects to understand principles like force and energy.

1.7. Digital and Technology-Enhanced Assessments

With the growing emphasis on digital literacy, technology-enhanced assessments can evaluate competencies in coding, data analysis, and digital communication.

- **E-Portfolios**

  Students create digital portfolios that showcase their learning over time. E-portfolios can include written assignments, multimedia projects, coding assignments, and reflections on their learning process. E-portfolios can be shared with broader, authentic audiences if allowable.

Example: For secondary students, an e-portfolio might include a programming project, documentation of a science experiment, and a reflective essay on a collaborative engineering project.

- **Computer-Based Simulations and Virtual Labs**

For subjects such as biology or chemistry, virtual labs can provide practical assessment opportunities, especially where resources are limited. These assessments can evaluate students' skills in conducting virtual experiments, interpreting data, and understanding scientific principles.

Example: A virtual biology lab could simulate genetic experiments where students manipulate DNA sequences and predict genetic outcomes.

1.8. Formative and Summative Assessments

Competency-based formative and summative assessments help monitor student progress and measure their understanding of key competencies over time.

- **Formative Assessments (Quizzes, Reflections, and Peer Reviews)**

  Continuous assessments such as quizzes, self-reflections, group discussions, and peer reviews can provide insights into students' learning and identify areas for improvement.

  Example: After a collaborative project, students participate in a peer review process where they evaluate their teammates' contributions and provide constructive feedback.

- **Summative Assessments (Competency Exams)**

  While the Tawjihi examination serves as a primary summative assessment in Palestine, additional competency exams tailored to specific STEM skills (e.g., coding challenges or scientific research presentations) can be developed to complement it.

  Example: Students could present a research project to a panel of experts or other students, or students engage in a coding challenge that assesses their computational thinking and programming skills.

1.8. Equitable Assessment Practices

Equitable assessment practices in STEM education go beyond simply using diverse assessment methods. They necessitate a thoughtful and comprehensive approach that considers the unique needs and contexts of all learners. This involves ensuring that assessments are free from bias, culturally relevant, and accessible to students from all backgrounds.

Key principles of equitable assessment:

- **Accessibility.** Assessments should be designed to be accessible to all students, regardless of their learning styles, disabilities, or learning needs. This might involve providing accommodations, such as extended time, assistive technology, or different assessment strategies, to ensure that all students have an equal opportunity to demonstrate their learning.
- **Relevance.** Assessments should be relevant to students› lives and experiences, reflecting their backgrounds and cultures. In the Palestinian context, this could mean incorporating local issues, challenges, and contexts into assessment tasks. For example, students might design a water conservation system tailored to the specific needs of their community, drawing on their knowledge of local resources and challenges.
- **Authenticity.** Assessments should reflect understanding of real-world tasks and problem-solving situations, allowing students to apply their learning in meaningful ways. This could involve engaging students in project-based assessments that address authentic community needs or using simulations that replicate real-world STEM careers.
- **Fairness.** Assessments should be free from bias, ensuring that all students have an equal opportunity to succeed based on their knowledge and skills, rather than their background or any irrelevant factors. This requires careful attention to the language, content, and format of assessments to avoid any unintentional disadvantages for particular groups of students.

Pillar 2: STEM Education Curriculum and Access

This pillar discusses the STEM learning pedagogies along with curriculum and extracurricular STEM learning.
Element One: Curriculum and Learning

2.1. High-Quality STEM Curriculum and Learning Resources

- **Curriculum Design.** The Palestinian STEM curriculum is structured around key competencies in Science, Mathematics, Technology, and Engineering, which are mapped to global standards while also being adapted to the local context. This ensures that students gain relevant knowledge and skills needed for the future technical workforce.
- **Resource Development and Adaptation.** It is essential to develop contextually relevant STEM resources, such as textbooks, digital content, and hands-on materials that reflect local needs and cultural perspectives. Resources should be accessible and inclusive, catering to diverse learners across urban and rural settings. That includes guidelines for developing unit and lesson plans that foster inquiry, critical thinking, and problem-solving.
- **Instructional Materials.** High-quality instructional materials including digital resources, laboratory equipment, and engineering kits, will be developed or adapted to support STEM learning. These resources will be curated to promote inquiry-based learning, problem-solving, and project-based activities.

2.2. Engaging STEM Learning Experiences

- **Interdisciplinary and Transdisciplinary Learning.** The framework promotes learning experiences that connect multiple STEM disciplines with real-world applications. This is achieved through project-based learning (PjBL), design-based challenges, and research projects that encourage students to explore complex problems and develop innovative solutions.

- **Authentic Learning Contexts.** Students will engage in STEM projects that address locally relevant issues, such as renewable energy generation and storage, water conservation, and sustainable agriculture, making learning more meaningful and applicable. For example, a project on designing water filtration systems can integrate principles from science, engineering, technology, and math (volume and flow rate).

- **Hands-On and Experiential Learning.** Practical, hands-on learning opportunities are essential for fostering STEM competencies. This includes laboratory experiments, field studies, and maker spaces where students can design, prototype, and test solutions.

2.3. Supporting Extracurricular Activities Related to STEM

- **STEM Clubs and Competitions.** Establish STEM clubs in schools and communities where students can engage in extracurricular projects, collaborate with peers, and participate in local and international competitions. Activities may include robotics competitions, science fairs, coding challenges, and environmental projects. Incorporating clubs as part of the extracurricular learning in schools requires the presence of a trained teacher, volunteering or paid; community support and potential parent volunteers; and access to resources. Invention (and Innovation) Education. Students may be given an object and then be challenged to think of as many uses as possible. Sharing ideas may reveal much overlap but also surprising alternative uses. Alternatively, students may be given a challenge or problem to solve and then encouraged to ideate possible solutions and then pick one to develop as a prototype and learn about protecting their intellectual property. After a first invention or innovation experience, students can be challenged to identify their own problem they wish to solve and then design a solution. Because inventions or innovations are inherently unique, teachers and schools can host expos to showcase student ingenuity.

- **Industry and Community Partnerships.** Partner from local industries, universities, and non-governmental organizations can provide mentorship, externships , internships, and project-based learning opportunities. These partnerships will allow students to apply their learning in professional settings and gain insights into STEM careers.

- **STEM Camps and Workshops.** Organize STEM camps, workshops, and seminars that focus on key topics such as artificial intelligence, renewable energy, and biotechnology. These activities provide additional platforms for students to explore advanced STEM topics and engage with experts in the field.

- **Work-Based Learning.** Work-based learning can begin in the lower primary grades with career exploration, guest speakers, field trips, and video clips. These experiences can be more exploratory and engaging within the curriculum in grades 5-9. For the upper grades, internships, internships, and mentorships can lead to apprenticeships and even cooperative education/employment in partnerships with businesses.

NOTE: Not all supporting extracurricular activities should be expected in all schools. Student interest, the school population age group, resources, and the school facility itself often dictate the type of clubs, activities, and initiatives at different schools.

Element Two: Equity, Inclusion, and Access

The Palestinian National STEM Education Framework is designed to provide an inclusive and equitable STEM education that addresses the diverse needs of all Palestinian students, including students with special needs, marginalized communities, and girls who are underrepresented in STEM disciplines and careers. To achieve this, the framework outlines specific strategies that foster inclusivity, promote equitable access, and ensure that all students feel a sense of belonging in STEM fields of study and careers.

2.4. Strategies for Inclusive STEM Education

- **Universal Design for Learning (UDL) and Differentiated Instruction**

  Incorporate UDL principles into curriculum and instruction, ensuring that learning materials, assessments, and activities are accessible to students with diverse learning needs, including those with disabilities and exceptional learners.

  Utilize differentiated instruction strategies in all classrooms and professional learning settings to provide multiple means of engagement, representation, and expression, allowing students to access and demonstrate their understanding of STEM concepts in ways that are meaningful to them.

- **Culturally Responsive and Contextually Relevant Curriculum**

  Design STEM curricula that reflect the socio-cultural context of Palestine, incorporating local examples, languages, and historical perspectives that resonate with students' lived experiences. This helps to validate their identities and promote a sense of relevance and belonging in STEM.

  Create project-based learning experiences that address community challenges, such as water conservation, energy efficiency, sustainable agriculture, and rebuilding and redesigning communities, making STEM learning relevant to students' daily lives and fostering a deeper connection to STEM disciplines.

- **Support for Students with Special Needs**

  Develop relevant STEM resources and instructional strategies that accommodate the diverse needs of students with physical, cognitive, and emotional disabilities. This includes providing assistive technologies, adapting to physical environments, and offering personalized support during STEM activities.

  Implement individualized education plans (IEPs) that include specific STEM learning goals and support services, ensuring that students with special needs have the resources and accommodations necessary to participate fully in STEM learning experiences.

- **Promoting Gender Equity in STEM**

  1. Implement targeted initiatives to encourage girls' participation in STEM activities and careers, such as mentorship programs, STEM clubs, and role model events featuring female STEM professionals.

  2. Create a safe and inclusive learning environment for girls, where they feel supported and encouraged to pursue their interests in STEM. This includes addressing gender biases in instructional materials, providing gender-neutral resources, and fostering a culture of respect and collaboration in STEM classrooms.

  3. Create programs specifically for girls, particularly in engineering, computer science, and invention education.

- **Family and Community Engagement**

Engage families and communities as partners in STEM education to reinforce learning and provide support beyond the classroom. Host community STEM events, workshops, and open houses to showcase student projects and encourage parental involvement.

Collaborate with local organizations, NGOs, and industry partners to provide extracurricular STEM activities, such as science fairs, coding clubs, and engineering challenges, and invention expositions (expos) that are accessible to all students regardless of their socio-economic background.

2.5. Barriers to Participation in STEM Education

The Situational analysis conducted under Component 2 of SERATAC identified several barriers to equitable participation in STEM education, particularly for girls, students with special needs, and students from rural communities. Addressing these barriers is crucial to ensuring that all students can succeed and excel in STEM fields.

Identified Barriers and Strategies to Overcome Them:

- **Gender Stereotypes and Cultural Expectations**

  Barrier: Gender stereotypes and cultural expectations often discourage girls from pursuing STEM subjects and careers, contributing to their underrepresentation in these fields.

  Strategy: Implement a gender-sensitive curriculum design that avoids reinforcing stereotypes and instead showcases the contributions of female scientists and engineers. Establish mentorship programs where female students are paired with female STEM professionals who can serve as role models and provide guidance and support.

- **Limited Access to STEM Resources in Underserved Areas**

Barrier: Students in rural and underserved areas often lack access to high-quality STEM resources, such as laboratories, digital tools, and trained STEM educators.

Strategy: Develop mobile STEM labs and digital learning hubs that can bring STEM experiences to remote areas. Leverage online platforms and open educational resources (OERs) to provide access to digital STEM content, simulations, and collaborative projects for students in these regions.

- **Socio-Economic Barriers and Resource Constraints**

Barrier: Many students, particularly those from low-income families, face socio-economic challenges that limit their ability to participate in extracurricular STEM activities, purchase STEM kits, or access private tutoring.

Strategy: Partner with NGOs, international organizations, and the private sector to provide scholarships, grants, and free access to extracurricular STEM programs. Establish community STEM resource centers where students can access equipment, materials, and mentorship at no cost.

- **Lack of Teacher Training and Professional Development**

Barrier: Many teachers lack the specialized training required to deliver high-quality STEM instruction that is inclusive and adaptable to diverse learners.

Strategy: Implement professional development programs that focus on inclusive STEM pedagogies, differentiation strategies, and the use of assistive technologies. Establish teacher-learning communities where educators can share resources, discuss challenges, and collaboratively develop solutions.

- **Social Perceptions and Limited Awareness of STEM Careers**

Barrier: Negative social perceptions about the difficulty of STEM subjects and limited awareness of STEM careers reduce student motivation and interest in pursuing STEM fields.

Strategy: Conduct awareness campaigns, career fairs, and STEM career exploration workshops to showcase the diversity of STEM careers and their impact on society. Use local success stories and testimonials from STEM professionals to inspire students.

Pillar 3: STEM Teacher Professional Learning

This pillar introduces strategies for STEM professional learning for pre-service and in-service teachers.

Element One: Teacher Preparation and Professional Learning

The successful implementation of the Palestinian National STEM Education Framework requires highly skilled and specially trained educators who are equipped to deliver high-quality STEM instruction. This requires a comprehensive approach to professional learning that differentiates between the needs of pre-service teachers (those still in training) and in-service teachers (currently teaching in classrooms). The following section outlines the strategies and structures for these groups, ensuring that they are adequately prepared to engage students in meaningful and effective STEM learning.

3.1 Pre-Service Teacher Preparation

Pre-service teacher preparation refers to the foundational training and education provided to future STEM teachers before they enter the classroom as full-time educators. This stage is critical for developing the core competencies and dispositions necessary for effective STEM teaching, and it involves collaboration with teacher training colleges, other higher education institutions, and other relevant stakeholders.

- **Goals of Pre-Service Teacher Preparation**

Equip future teachers with **deep content knowledge and pedagogical skills** in Science, Mathematics, Technology, and Engineering.

Develop **interdisciplinary and transdisciplinary teaching capabilities** that enable teachers to integrate multiple STEM subjects in meaningful ways.

Instill an **understanding of effective STEM instructional strategies,** including inquiry-based learning, project-based learning (PjBL), and design-based challenges.

- **Strategies for Pre-Service Teacher Preparation**

Collaborate with Palestinian universities and teacher training institutes to design STEM-focused teacher education programs. These programs should include specialized courses on STEM content, pedagogical strategies, and interdisciplinary teaching approaches.

Offer dual-subject certifications (e.g., Mathematics and Physics or Biology and Chemistry) to enhance teachers' versatility and ability to teach integrated STEM subjects.

Introduce teachers to Technical and Vocational Education and Training (TVET) courses and competencies to understand STEM education and TVET workforce connections.

Incorporate interdisciplinary projects and case studies into pre-service training, allowing future teachers to experience STEM teaching from an integrative perspective.

Provide opportunities for teaching practicums or internships in schools that have implemented the STEM Education Framework, enabling pre-service teachers to gain hands-on experience in delivering STEM lessons and managing classroom dynamics.

Include coursework on culturally responsive teaching and strategies for supporting diverse learners, including students with special needs and those from marginalized communities.

Train future teachers to develop and use inclusive instructional materials, promoting accessibility and belonging, ensuring that all students have equitable opportunities to engage in STEM learning.

Ensure that pre-service teachers are proficient in using educational technologies such as digital simulations, coding platforms, and collaborative tools. This includes integrating technology into lesson planning and classroom management, and understanding the possibilities of artificial intelligence in teacher efficiency.

Introduce modules on using online platforms and virtual learning environments to support hybrid and remote learning.

Foster professional dispositions such as a commitment to lifelong learning, curiosity, and openness to new teaching strategies and technologies.

Implement reflective practice modules where pre-service teachers analyze their teaching experiences, identify areas for growth, and develop plans for continuous improvement.

Establish partnerships with local and international educational institutions to provide additional resources, such as access to research, mentorship opportunities, and international exchange programs.

Create a pre-service STEM teacher network where future educators can share experiences, seek advice, and build professional relationships that support their development as STEM educators.

3.2. In-Service Professional Learning

In-service professional learning is designed to support the continuous development of current STEM educators. This form of professional learning is focused on enhancing teachers' existing knowledge and skills, fostering collaborative learning communities, and addressing emerging challenges in STEM education. The task of enhancing professional learning is not a solo task or a one-time event. Teachers will need to have a professional growth plan where their learning is self-monitored and supported by their department chair, school principal, content supervisor, and fellow communities of practice (CoP) colleagues. Professional learning is a journey that differs between individual teachers and continued support, mentoring, and coaching is a fundamental part of a teacher's learning.

- **Goals of In-Service Professional Learning**

Enhance the content knowledge, pedagogical skills, and interdisciplinary teaching capacity of in-service STEM teachers.

Support the implementation of the Palestinian National STEM Education Framework by providing ongoing professional development opportunities aligned with the framework's objectives and standards.

Promote a collaborative culture among educators, fostering the exchange of best practices and innovative teaching strategies.

- **Strategies for In-Service Professional Learning**

Conduct regular, school-based workshops and training sessions that cover key aspects of STEM instruction, such as project-based learning, inquiry-based teaching, and integration of digital tools in the classroom.

Offer advanced training on emerging topics such as artificial intelligence, the Internet of Things (IoT), robotics and automation, and biotechnology, preparing teachers to introduce these topics into the curriculum.

Establish professional learning communities (PLCs) within schools and across districts to encourage collaborative planning, reflection, and professional dialogue among STEM educators. PLCs can focus on specific topics such as curriculum alignment, interdisciplinary projects, or assessment strategies.

Facilitate cross-school networks where teachers can share resources, co-create STEM units, and support one another in implementing integrative STEM teaching.

Implement in-school mentorship programs where experienced STEM educators mentor novice teachers, providing guidance on instructional strategies, classroom management, and professional growth. STEM teacher leadership teams can combine experienced STEM teachers with highly engaged novice to develop future leaders.

Offer peer coaching opportunities where teachers observe one another's lessons, provide feedback, and work together to refine teaching practices.

3.3. Targeted Support for Implementation of STEM Education Framework

Provide targeted support for teachers during the implementation of the Palestinian National STEM Education Framework. This includes training on how to use newly developed STEM resources, how to integrate multiple disciplines, and how to assess student learning in practical, applied contexts.

Utilize digital platforms to offer blended learning options for in-service professional development, making training accessible to teachers in remote or underserved areas.

Provide online courses, webinars, and resources on specific STEM topics, allowing teachers to engage in self-paced learning and access expert-led sessions.

Promote reflective practice by teachers, encouraging documentation of their experiences, challenges, and successes in implementing STEM education.

Use broad categories of data, including student performance data, classroom observations, and teacher self-assessments to inform professional development activities and identify areas for further training.

Develop an Integrative STEM Professional Development Portal that offers resources, training schedules, and opportunities for teachers to engage in online communities of practice (CoPs).

Establish partnerships with higher education institutions and industry experts to provide specialized training, guest lectures, workforce information, and research opportunities.

Encourage collaboration between in-service and pre-service teachers through joint workshops, mentorship programs, and collaborative research projects, demonstrating continuing support for educators in the first five years of their profession.

Create a network of STEM education leaders and experts who can provide ongoing support, share innovative practices, and lead professional development initiatives through professional organizations, conferences, and online training.

Differentiate between teachers of different grade levels, recognizing that teachers of early grades are expected to have mastery of pedagogy, whereas teachers of upper grades are expected to have mastery of subject matter.

Emphasize both pedagogy and subject matter expertise for all teachers. Teachers of lower grades with minimal STEM subject-area experience may be reluctant to teach or overlook opportunities to teach important concepts to younger learners. In older grades, teachers with subject matter expertise without sufficient training in pedagogy may be no more effective in transferring understandings than a capable teacher with limited content mastery.

Pillar 4: STEM Connections and Applications

This pillar addresses the expected partnerships and collaborations between the MoEHE and the larger local and international community and industry for a successful STEM Education Framework implementation.

Partnerships and Collaboration

Partnerships and collaboration play a crucial role in enriching the Palestinian National STEM Education Framework and can significantly enhance STEM education quality and relevance when strategically implemented. While these partnerships are not core requirements for the initial implementation of the framework, they provide opportunities to leverage additional resources, expertise, and networks to expand the impact of STEM education in Palestine. This section outlines potential partnerships with various stakeholders, emphasizing how collaboration with these actors can contribute to achieving the framework's objectives.

4.1 Partnerships with the Private Sector and Industry

The private sector and industry are key partners in ensuring that STEM education aligns with workforce needs and prepares students for future employment. Collaborations with technology firms, engineering companies, and other STEM-related industries can provide resources, mentorship, and real-world learning opportunities for students and educators.

Examples of Collaboration:

Internships and Work-Based Learning Opportunities. Establish internships, externships, mentorships and apprenticeships where students can gain hands-on experience in industry settings. Companies like local tech firms or engineering companies can host students for short-term internships, offering exposure to professional environments and industry practices.

Industry-Sponsored Projects and Competitions. Partner with companies to sponsor STEM competitions, hackathons, and innovation challenges. These initiatives can encourage students to apply their STEM knowledge to real-world problems and gain recognition for their solutions.

Resource Support and Funding. Encourage companies to contribute resources such as laboratory equipment, technology tools, or funding for STEM labs and centers. Industry professionals can also serve as guest speakers, providing insights into STEM careers and the skills required in the job market.

Advisory Committees for Technical Courses. Business, industry, community groups and higher education representatives can support advisory committees for schools' Science, Technology and Engineering, and TVET coursework by validating the curricula and established competencies, identifying relevant skills, tools and equipment, and recommending academic pathway options.

4.2. Collaboration with Local NGOs and Community-Based Organizations

Local NGOs and community organizations are valuable partners in supporting STEM education outreach, especially in under-resourced and rural areas. These organizations can play a crucial role in increasing STEM awareness, providing additional learning opportunities, and advocating for inclusive and equitable education.

Examples of Collaboration:

Community STEM Events and Workshops. Collaborate with local NGOs (e.g., the Palestinian Science and Technology Promotion Association) to organize community-based STEM events such as science fairs, STEM or innovation expos, STEM camps, and workshops. These events can help engage students and families, promote STEM literacy, and spark interest in STEM careers.

Support for Marginalized and Underrepresented Groups. NGOs can work alongside schools to provide targeted support for students from marginalized communities, including girls and students with disabilities. This can include mentoring programs, scholarships, and advocacy for accessible learning environments.

Outreach and Awareness Campaigns. Partner with NGOs to run awareness campaigns that highlight the importance of STEM education and careers. These campaigns can help shift cultural perceptions and encourage broader participation in STEM fields.

4.3. Collaboration with Educational Institutions like Universities

Educational institutions, including universities and research centers, are critical partners in advancing STEM education through curriculum development, research, and professional development for educators. Collaborations with these institutions can provide access to expertise, resources, and advanced learning opportunities, including Lab School (demonstration school) partnerships.

Examples of Collaboration:

Joint Curriculum Development and Research Projects. Work with Palestinian universities such as Birzeit University and An-Najah National University to co-develop STEM curricula and research projects. This can include the integration of university research into school STEM programs and the adaptation of university-level STEM content for high school students.

Teacher Training and Professional Development. Collaborate with universities to offer professional development programs for in-service teachers. These programs can be combined with research and pilot projects (including Lab school collaborations), and they can focus on innovation and best practices in interdisciplinary teaching, inquiry-based learning, and the use of technology in STEM education.

Student Mentorship and University-Student Linkages. Establish mentorship programs where university faculty and university students mentor high school students, helping them conduct research projects and explore advanced STEM topics.

Museums and Cultural Institutions. Museums and similar institutions offer opportunities for educators to learn and utilize their artifacts and related resources highlighting contributions to technological and cultural advancement.

4.4. International Collaboration

International partnerships can provide additional resources, expertise, and opportunities for Palestinian students and educators to engage with global STEM initiatives. Collaborating with international organizations, universities, and networks can enhance the framework’s impact and align it with global STEM education standards.

Examples of Collaboration:

Partnerships with International STEM Organizations. Collaborate with organizations such as UNESCO, the World Bank Education Programs, and the International Society for Technology in Education (ISTE) to access technical support, professional development, and global STEM resources. These partnerships can also provide a platform for international exchange programs and joint research initiatives.

Participation in Global STEM Networks and Competitions. Engage with global STEM networks like the Global STEM Alliance and participate in international STEM competitions. This will allow Palestinian students to showcase their talents, learn from international peers, and gain exposure to global STEM trends and practices.

Access to Funding and Resources. Leverage international funding opportunities and grants to support the development and expansion of STEM programs in Palestine. This can include funding for STEM centers of excellence, digital learning platforms, and advanced STEM labs.

4.5. Cross-Cutting Theme: Career Counseling and Pathways

Career counseling is a cross-cutting component that bridges the collaboration between schools, industries, universities, and community organizations. Effective career counseling can help students understand the range of STEM careers available to them, the skills required, and the pathways to achieve their career goals. Partnerships and collaborations can support career counseling efforts by providing up-to-date information on industry trends, skill requirements, and job opportunities.

Recommendations for Strengthening Career Counseling:

Industry Collaboration for Career Awareness Programs. Partner with industry representatives to offer career awareness sessions, industry site visits, and career days where students can interact with professionals and learn about various STEM fields.

University Collaboration for Academic Counseling. Work with universities to provide academic counseling sessions that help students explore STEM degree options, admission requirements, and academic pathways.

Community and NGO Support for Mentorship Programs. NGOs and community organizations can help implement mentorship programs where students are paired with professionals who guide them through academic and career decisions.

4.6. Implementation and Scalability of Partnerships

While these partnerships and collaborations represent opportunities for enhancing the Palestinian National STEM Education Framework, they are not mandatory components for the initial implementation of the framework. Rather, they serve as aspirational goals and areas where additional impact can be achieved through strategic collaborations. The Ministry of Education and Higher Education (MoEHE) can use these partnerships as leverage points to scale and expand STEM initiatives over time.

The Way Forward

This STEM Education Framework provides a comprehensive roadmap for transforming STEM education in Palestine. To effectively translate this vision into reality, a strategic action plan focusing on key areas is essential. The STEM Education Framework also aims to create an advanced education system where Palestinian students become scientifically literate, technologically proficient, and innovative problem solvers, ultimately contributing to a skilled and adaptive Palestinian workforce. The framework is based on the Theory of Change (ToC), which outlines how STEM education reforms will lead to the desired outcomes.

The framework also stresses the importance of:

- **Equitable Assessment Practices:** The framework advocates for equitable assessment practices that are accessible, relevant, authentic, and fair for all students, regardless of their background or learning needs.

- **Addressing Barriers to Participation:** The framework acknowledges barriers to participation in STEM education, such as gender stereotypes, limited access to resources, mobility restriction due to Israeli occupation, and socio-economic challenges, and proposes strategies to overcome them.

- **Career Counseling and Pathways:** The framework recognizes the importance of career counseling in helping students understand STEM career options and pathways, emphasizing the role of partnerships in providing career awareness and guidance.

The framework will be supported by a national Implementation Strategy. The proposed Implementation Action Plan will be structured with six key components:

Curriculum Development and Implementation Planning according to recommended goals and objectives;

Teacher Professional Learning to ensure educators are prepared to participate competently and confidently;

Assessment and Evaluation planning, monitoring and assessing implementation progress according to goals, objectrics, established timelines, and metrics of success;

Partnerships and Collaboration that facilitates understanding, relevance, opportunities, and resources necessary for broader impacts;

Addressing Barriers to Participation that compromise access to programs, resources and other support important to success in STEM education and career pathways; and

Equity and Inclusion initiatives that demonstrate that all are encouraged, supported , and feel they belong in the programs and careers that interest them.

These components will be evident throughout three phases of implementation:

- **Short-Term Phase (1-2 years): Establishing the Foundation**

  Pilot Programs and Initial Rollout across different regions and at all grade levels, with support from regional and national STEM leadership teams.

Capacity Building and Professional Development through professional learning and a network of trained mentors and coaches.

Resource Development and Distribution including curriculum resources shared across platforms accessible to all STEM resources across all regions.

- **Medium-Term Phase (3-5 years): Scaling and Integration**

Expansion of Framework Implementation to additional schools, with adaptations from Phase I and support from universities, industries, and community organizations.

Curriculum Integration and Coherence across participating schools by aligning content, instructional strategies, and assessment strategies with new understandings.

Enhanced Professional Learning Opportunities for educators in STEM pedagogy, STEM professional learning communities (PLCs) and mentorship.

- **Long-Term Phase (5+ years): Full Implementation and National Adoption**

National-Level Adoption and Policy Integration in all Palestinian schools with necessary funding, resources, trained staff, and community partners.

Sustainability and Continuous Improvement through monitoring and evaluation of improved data while also facilitating innovation, and collaboration among Palestine's education professionals.

Glossary of STEM Education Terms

The following definitions are established (operationalized and sometimes called procedural) below to provide readers with a common interpretation of important terms used in this document.

Curriculum is the combined, planned academic experiences for learners. This is often inclusive of instruction to comprehensively describe how learning experiences are structured, organized, delivered or presented, and assessed.

Design-driven inquiry is a pedagogical strategy derived from engineering design processes in which learners use scientific methods or design processes to develop a prototype to address a need or a solution to a problem or challenge. Design processes vary in complexity from Ask→Imagine→Plan→Build→Share to more complex processes used in secondary, postsecondary, or professional science and engineering settings, featuring eight or more steps.

Engineering is the use of design-based solutions to solve problems. Design processes begin with identifying a problem and recognizing criteria and constraints for a solution, then brainstorming and researching, and then developing and testing models or prototypes.

Integration is the intentional cross-disciplinary, interdisciplinary, trans-disciplinary blending of traditionally distinct curriculum areas.

Integrative (or Integrated) STEM Education curricula feature instructional approaches that explore teaching and learning between/among any two or more of the STEM subject areas, and/or between a STEM subject and one or more other school subjects. Integrative STEM education sometimes implies a rigorous, interdisciplinary integration of academic concepts with real-world lessons that make connections between school, community, and work.

Mathematics, Math, or Maths is the study of relationships between things, real or imagined, based on logic. Sometimes these logic-based relationships are quantified with numbers, and numeracy and number-sense are important components of early (elementary) mathematics education as a foundation for later explorations in spatial and geometric thinking, data literacy and statistical reasoning, modeling and computational thinking.

Problem-based learning (PbBL) is a subset of PjBL in which students try to solve a problem or challenge, emphasizing innovation and design processes, and most resembling engineering. Increasingly, teachers implement project-based and problem-based similarly or simultaneously, and the only distinction is whether student projects are explicitly solving a problem.

Project-based Learning (PjBL) is curricula and instruction that emphasizes in-depth inquiry driven by relevant, driving questions (particularly in Science), student autonomy, opportunities for revision and reflection, and a public audience for the products of student projects.

Science is a process for answering questions based on observation and experimentation, or other means of identifying relationships (e.g., correlational, causal) between and among variables and outcomes. This term is also used to name the body of knowledge derived from such processes.

STEM is an acronym that refers to Science, Technology, Engineering and Mathematics. It was adapted by the U.S. National Science Foundation in Arlington Virginia to reflect a growing emphasis on the technical academic and professional disciplines worldwide. It is sometimes also used to refer to education programs and more recently, to a wide variety of aggregated technical topics, strategies and opportunities.

STEM education and more explicitly, integrative STEM education represent the educational initiatives that emphasize the intentional, interdisciplinary integration of science, technology, engineering and mathematics curricula with each other, and also with other traditional disciplines of social studies, reading and other language arts, world languages, health and physical education, and the visual and performing arts.

Technical and Vocational (Skilled Trades) courses are part of Career Education or Career and Technical Education (CTE) and are sometimes combined with Adult Education (CTAE) in the United States, and are known as TVET (Technical and Vocational Education and Training) by UNESCO, and TAFE (Technical and Further Education) in Oceana. These courses combine classroom training with hands-on skills training, frequently leading to certifications or professional licenses.

Technology is the term for any purposeful modification of the natural world. Technology is both a part of engineering and a product of engineering design processes, and therefore technology (tools or products) and engineering (processes) are often conflated. In such circumstances, principles of engineering and design are integrated in Technology courses. Technologies include such diverse products or tools as pencils, AutoCAD, tissues, probeware, microscopes, computers and mobile devices, engines, vehicles, satellites, and their many components or subparts.

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