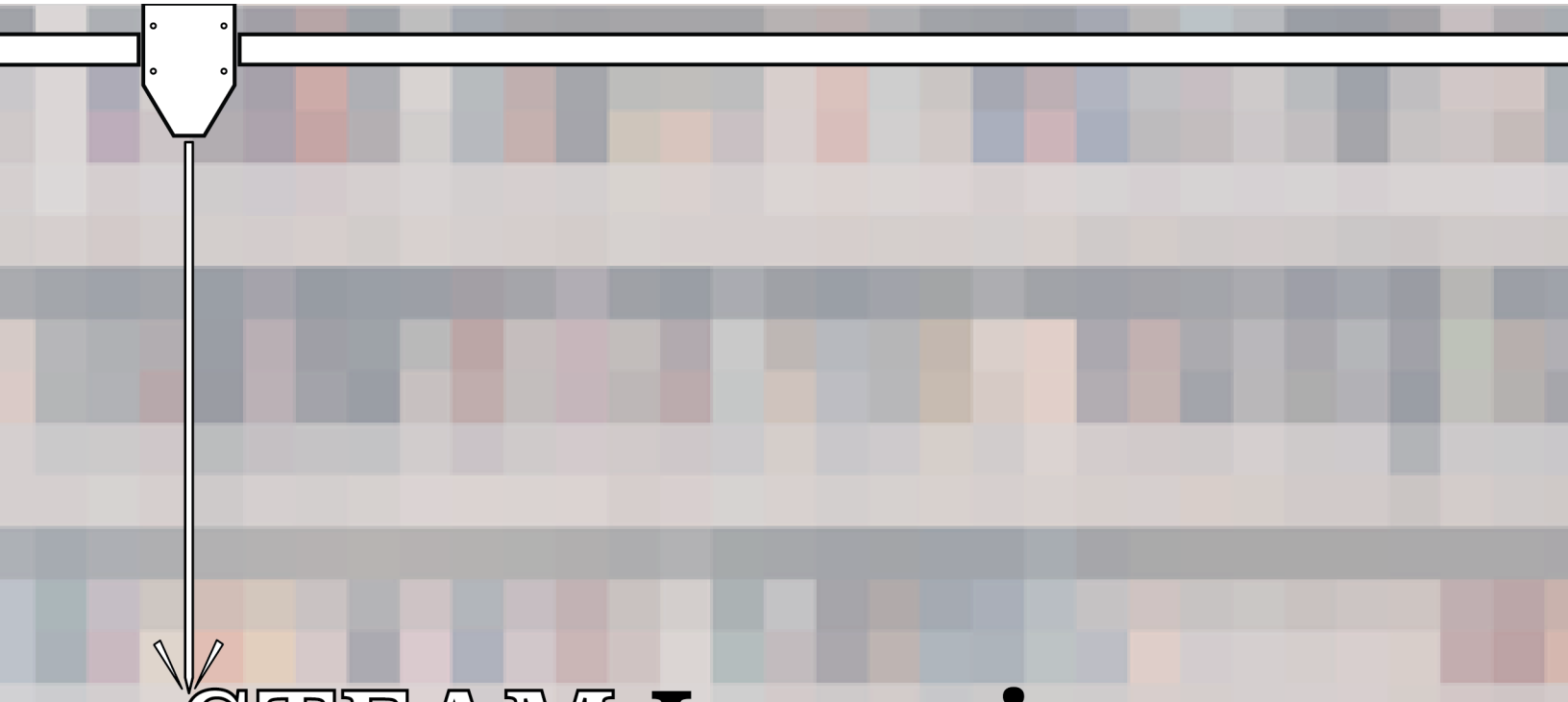

STEAM Learning Architecture:

A Framework for Educational Innovation

pK-12
Open Learning

STEAM Learning Architecture:

A Framework for Educational Innovation

A project of pK-12 at MIT Open Learning

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Preface

The original version of this Learning Architecture was developed as part of the collaborative effort between MIT, the Ministry of Education, Culture, Science and Technology (MoECST) of Belize, and the Inter-American Development Bank (IDB) to open Itz'at STEAM Academy (ISA), a new high school in Belize City, Belize. The school is designed to be an innovative model for the country and the wider Caribbean region, with an explicit focus on STEAM and hands-on learning. The iteration of this document produced for ISA (previously known as the Curriculum Architecture: Approaches to Teaching and Learning) was written as a foundational framework intended to guide the subsequent development of the school's program and curriculum.

The co-design process undertaken in the initial development of this document included visiting and studying innovative schools and consulting with expert practitioners across the field of education. In generalizing the Learning Architecture for a wider audience, additional resources and programs were studied both to expand the points of reference and to include undergraduate learners. The resulting document is a broader framework intended to be used by any educational innovator who wants to design new, STEAM-focused learning experiences and environments.

Executive Summary

The educational landscape for young learners around the world is varied, expansive, and deeply in need of innovative approaches, programs, and environments that challenge and demonstrate alternatives to the prevailing industrial model of school. As technology progresses and societies become more complex, learners require more from education than just receiving information to demonstrate memorization – they need to be prepared for the jobs of the future, meaningful careers, and to become active, engaged members of their communities. Learners need to be adaptable, ready for change, and empowered to think in new ways. To do this, learning environments must place learners first.

The STEAM Learning Architecture is a framework for educational innovation that puts learners at the center, prioritizing pedagogical approaches that focus on development of the whole person academically, socially, and personally. It addresses both how people learn and how to design powerful, learner-driven educational experiences. The framework embraces a wide-ranging view of what PreK through undergraduate education is capable of, promoting, among other concepts:

- a **transdisciplinary** approach to teaching and learning
- understanding **culture** as a key part of social and emotional learning
- **hands-on, project-based** learning as a primary pedagogical method
- robust and intentional use of open-ended **technologies,** both analog and digital
- **educators as designers** of learning experiences
- **experimentation and iteration** as a fundamental practice for both learners and educators
- that **learning happens everywhere**, not just inside the classroom
- building **real-world experiences**, like internships, career pathways, and applied projects into educational programs

Structurally, the Learning Architecture begins with a set of three foundational pillars that ground the rationale of the framework: Social, Emotional, and Cultural Learning; Transdisciplinary Academics; and Community Engagement. It then describes how to select and develop key learning areas, identifies and explains core practices that support the foundational pillars, presents strategies for implementing competency-based learning and assessment, and culminates with recommendations and best practices for designing and implementing new learning experiences. The sections are:

1. **Foundational Pillars**
   The foundational pillars are the Learning Architecture's three core elements, informing all practices, activities, and program elements for a learning environment.

2. **Key Learning Areas**
   The key learning areas are the major categories of learning within which an educational institution situates its program and learning experiences. This section includes an example set of key learning areas and describes how they can be used in different ways.
3. **Core Practices**
   The core practices are the pedagogical, social and emotional, and learning science methodologies supported by the foundational pillars. This section describes those practices and gives examples of how they might be implemented.
4. **Competency-Based Learning and Assessment**
   The assessment section describes an overall approach to assessing growth and development. It describes how learners are evaluated and progress through an educational program.
5. **Program Design Approach**
   The program design approach describes principles and best practices for creating new materials, courses, and projects, both through iteration on existing curriculum and the development of new program elements.

The framework is, above all else, intended to be contextualized for different populations and environments. It provides a specific point of view about ways of thinking and ways of implementing, but it is adaptable and simply theoretical without application to real learners, educators, and experiences.

Introduction

The STEAM Learning Architecture provides an overall approach to teaching and learning for educational innovation. Designed primarily for high school and undergraduate settings, the Learning Architecture is intended to guide the development of new learning environments, including schools and educational institutions, in and out of school educational programs, career development programs, and others. It presents a holistic vision of how learners will grow personally, academically, and as active citizens in their communities, providing an infrastructure on which to build an innovative and contextually relevant program, readily customizable for different applications.

The Learning Architecture prioritizes student-centered, hands-on learning, rooted in the Constructionist theory that the most powerful learning occurs through discovery, exploration, and creation. In contrast to more traditional education, which focuses on internalization and memorization of disciplinary knowledge, this framework encourages learners to pursue areas of interest in their own way and at their own pace, leading to meaningful and transformative learning experiences.

In practice, educational innovators should interpret the Learning Architecture with specific environments and circumstances in mind, refining it to fit individual needs and aligning with appropriate frameworks, careers, and towards job readiness to create meaningful and transformative experiences for learners.

Foundational Pillars

The STEAM Learning Architecture is a guide for educational institutions to prepare young people with the knowledge, skills, and integrated experiences to design and build sustainable futures for themselves and their communities. Achieving this requires a new, forward-looking approach to learning that prioritizes real-world experiences, community connections, and hands-on, creative learning. This document provides a set of tools, methods, and conceptual lenses through which educators and students can develop truly innovative and impactful programs to meet these goals.

The foundation of the Learning Architecture is a set of three pillars that guide student growth and development: Social, Emotional, and Cultural Learning; Transdisciplinary Academics[1]; and Community Engagement. These pillars, derived from active, hands-on pedagogies, are based on the practices of looking inward, looking outward, and creatively developing new projects and ideas[2]. The premise is that meaningful, real-world learning is situated in a deep understanding of oneself, one's community, and the larger contexts within which they lie. Through these practices, students will be able to see and understand contemporary issues from multiple perspectives, work collaboratively, be challenged to think in new ways, and engage in projects that positively impact their communities.

Various innovative schools and educational organizations around the world[3] with unique curricular models have key learning areas[4] and program elements that resonate with the practices described above, largely grouped into three main categories: social and emotional learning, an interdisciplinary or transdisciplinary approach to academics, and intentional engagement with the wider community. An analysis of these models, including meetings and

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[1] Interagency Working Group on Convergence, Federal Coordination In STEM Education Subcommittee Committee On Stem Education of the National Science and Technology Council. (2022).

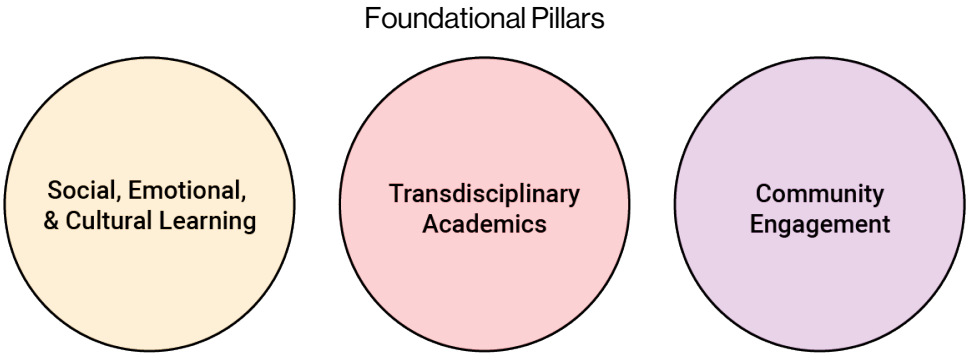
Convergence Education: A Guide to Transdisciplinary Stem Learning And Teaching. p.19
https://www.whitehouse.gov/wp-content/uploads/2022/11/Convergence_Public-Report_Final.pdf

[2] The curriculum foundation practices are based on a structure developed by the Global Citizenship Experiences (GCE) Lab School (https://gcelabschool.org/) that outlines the three phases of investigation in their mastery projects: Internal Investigation, External Investigation, and Action Projects.

[3] Though there are many innovative schools around the world, a specific subset in was chosen to study because they: were accessible to the authors via meetings and/or visits, are public or serve underserved groups, represent curricular models not seen elsewhere, have strong internship and/or mentorship programs, and/or are focused on preparing students for future careers and jobs.

[4]The term "key learning areas (KLAs)" is adopted from UNESCO's Prototype of a National Curriculum Framework. It states: "in an effort to 'de-clutter' and reduce 'curriculum overload' of the curriculum, an increasingly common practice is to group 'similar' subjects into broader subjects, sometimes referred to as Key Learning Areas (KLAs), and to develop a single syllabus to cover what was previously a number of subjects…As well as simplifying the curriculum, this KLA approach encourages teachers and students to see the connections between subjects rather than viewing each subject as a discrete area of learning. It also provides teachers with opportunities to enrich learning for students by developing classroom activities which show the connection of these broad areas to real situations."

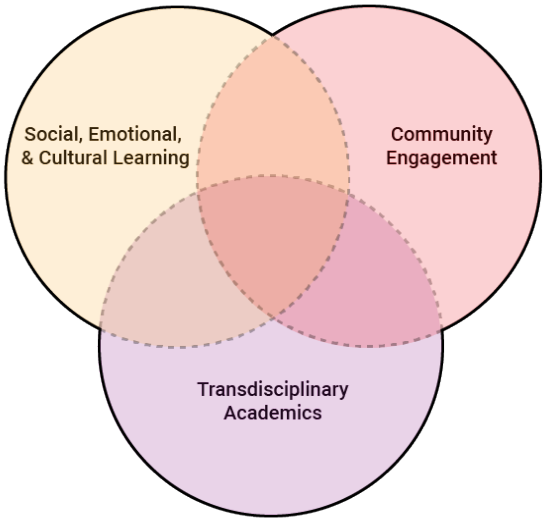
site visits with schools, educational leaders, foundations, nonprofit organizations, and community stakeholders, and reviews of academic literature, provided the background and context to use these three groupings as the basic foundation of the Learning Architecture (LA).



The three foundational pillars: Social, Emotional, and Cultural Learning; Transdisciplinary Academics; and Community Engagement.

Adapting these ideas for the context of the LA results in the core foundational pillars that govern the framework's overall approach to curriculum and program development. Here, the typically used phrase social and emotional learning instead becomes *social, emotional, and cultural learning* to reflect the balance between students' self-identity both within their individual cultures and beyond, as citizens of the world. The educational approach is transdisciplinary, as indicated in the *transdisciplinary academics'* pillar. Ideas and concepts are taught through broad lenses and big questions that span and synthesize traditional disciplines. *Community engagement* signifies a relationship with the community in which students are both learning and giving back. The ensuing foundation presents a unique approach to learning that emphasizes thoughtful collaboration as students engage with large societal issues that face them both today and in their futures.

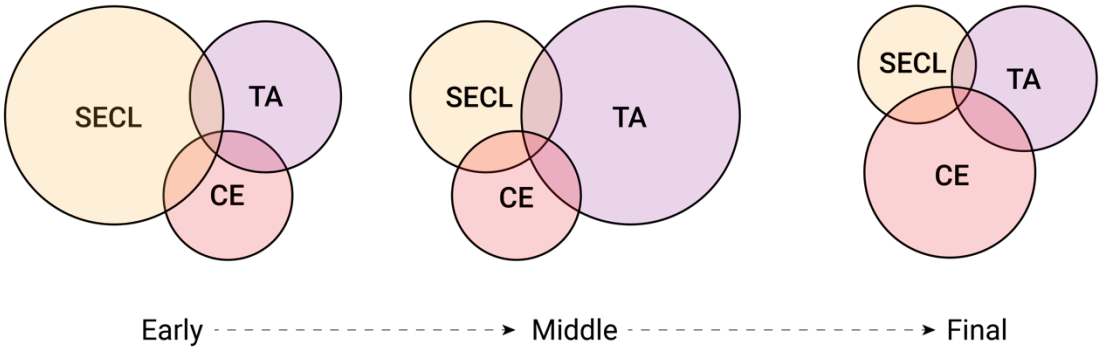
Foundational Pillars in Practice



The foundational pillars foundation function as a three-part Venn diagram, placing importance on the areas of overlap.

In practice, the foundational pillars function as a three-part Venn diagram: all program elements, curriculum, and competencies fall within at least one of the three areas, while most fall within more than one. Over time, the relationships between the pillars are intended to shift with the student's growth and educational trajectory. As students progress through an educational program or learning experience, certain pillars become more dominant than others, providing a range of emphases in different areas, and ultimately leading to a holistic experience of all three.

Shifting Emphasis Over Time



The emphasis on the foundational pillars shifts over the course of a learner's trajectory.

From a high-level perspective, as learners are transitioning into a program, the pillars are weighted towards Social, Emotional, and Cultural Learning; once they are more established, the focus shifts to Transdisciplinary Academics, with an emphasis on skills development and acquisition of knowledge; towards the end of a program, as learners gain proficiency in

more areas and spend time preparing for their next steps, they direct their efforts outside of campus through Community Engagement.

Further describing each of the pillars in depth shows how they are intended to function in practice and aid in the development of each learner's individual attributes, skills, and knowledge in different ways. The following section goes into greater detail about what each pillar means and gives examples of program elements for each one.

Social, Emotional, and Cultural Learning

Through Social, Emotional, and Cultural Learning (SECL), students will develop the reflective and interpersonal skills that allow them to approach different people and situations with empathy, openness, and a willingness to self-reflect. A focus on these skills will:

- Help students develop social and emotional maturity and a growth mindset.
- Give students the tools to effectively collaborate with one another and proactively drive their own learning.
- Through self-reflection, allow students to understand their own best work practices, their creative processes, and their academic interests (and how to evaluate them).
- Aid in developing a strong culture of community support, including an emphasis on peer mentorship, peer-to-peer teaching and learning, and a foundation of trust between students and educators.
- Support the development of Global Competence.[5]
- Promote the development of noncognitive factors that lead to academic success:[6]
    - Academic Behaviors
    - Academic Perseverance
    - Academic Mindsets
    - Learning Strategies
    - Social Skills

Program elements within the SECL pillar could include, but are not limited to:

- Advisory: A consistent block of time in which a small group of students meets with an educator for academic and personal guidance, exploration, and development.
- Peer Mentorship: Older students guiding younger students through different experiences as a way to form trusting relationships and encourage a strong student culture.
- Student-led community building activities: Student-led activities, both within the

[5] The OECD PISA Global Competence Framework states that, "global competence is the capacity to examine local, global and intercultural issues, to understand and appreciate the perspectives and worldviews of others, to engage in open, appropriate and effective interactions with people from different cultures, and to act for collective well-being and sustainable development."

[6] Farrington, C., et al. (2012). Teaching Adolescents to Become Learners, The Role of Noncognitive Factors. Chicago, IL: University of Chicago Consortium on School Research.

educational environment and in the wider community, that are developed and executed by students, fostering a sense of agency, ownership, and pride as students create meaningful connections between themselves and others.
- Culture building and sharing activities: Activities designed to build, enhance, and support the development of the self within the context of their school, community, country, and global communities.
- Diversity, equity, and inclusion initiatives: Activities, projects, and curricula designed to foster a sense of belonging and inclusion for all students, regardless of race, gender, sexual orientation, religious beliefs, or cultural, social, linguistic[7], or economic status.
- Regular community meetings: Assemblies that bring the entire community together for announcements, performances, presentations, discussions, and culture building.

Transdisciplinary Academics

STEAM, an acronym for science, technology, engineering, art, and mathematics, is an inherently transdisciplinary approach to the development of skills and the acquisition of knowledge. Beyond the disciplines in its name, STEAM embodies processes, methods, and attitudes that focus on both interdisciplinary and transdisciplinary approaches to learning. It also implies that digital technologies are an important part of the educational experience as powerful tools that enable discovery, creativity, and new connections within the curriculum. STEAM encourages flexibility, exploration, and dynamic and imaginative perspectives on academic content.[8]

[7] Benson, C. (2016). Addressing Language of Instruction Issues in Education: Recommendations for Documenting Progress (Education Monitoring Report). Paris: UNESCO. http://unesdoc.unesco.org/images/0024/002455/245575E.pdf.

[8] Keane, L. & M. Keane. (2016). STEAM by Design. Design & Technology Education, 21(1), 61–82.

Transdisciplinarity[9]

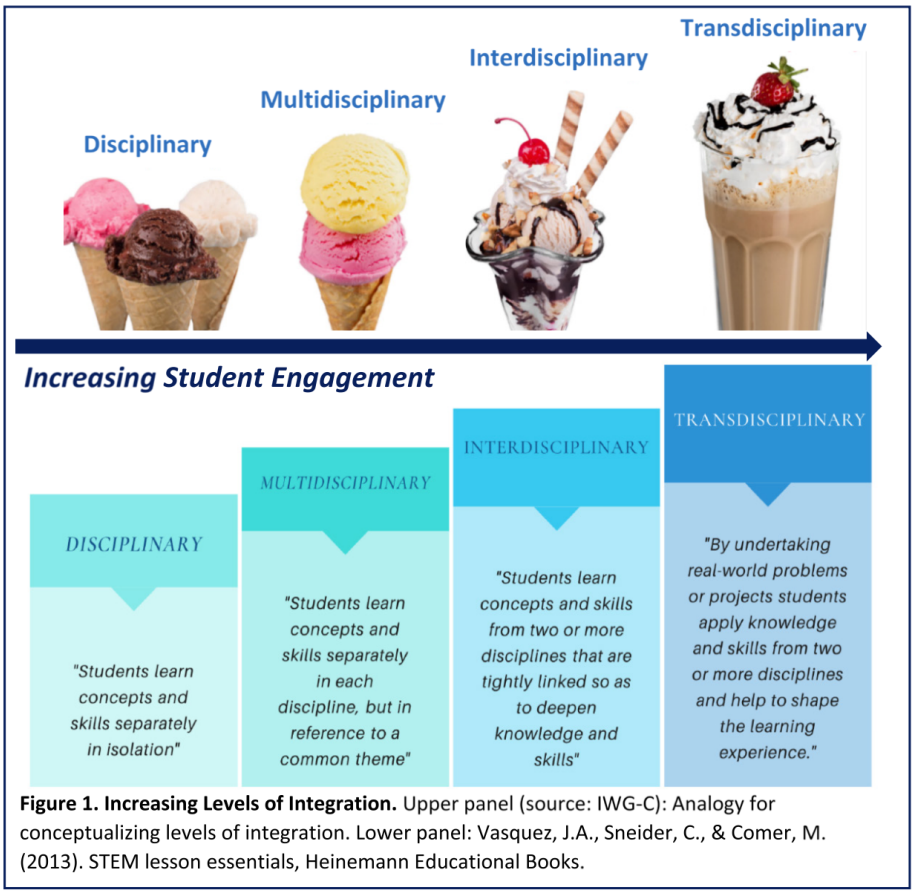


Figure 1. Increasing Levels of Integration. Upper panel (source: IWG-C): Analogy for conceptualizing levels of integration. Lower panel: Vasquez, J.A., Sneider, C., & Comer, M. (2013). STEM lesson essentials, Heinemann Educational Books.

Differences in approach between disciplinarity, multidisciplinarity, interdisciplinarity, and transdisciplinarity.

Transdisciplinarity, as shown in the diagram above, requires stretching beyond the confines of traditional disciplines and encouraging students to engage with complex questions in a convergent way. Tied closely to convergence education, which is defined "as driven by compelling or complex socio- scientific problems or topics, where learners apply knowledge and skills using a blended approach across multiple disciplines (i.e., transdisciplinary) to create and innovate new solutions," a transdisciplinary approach is ideal for tackling "[s]ocio-scientific problems or topics [that] are real-world, socially-relevant, informed by science, and often include an ethical component, with examples such as climate change, energy security, biotechnology, infectious disease, and water scarcity."[10] These topics are

[9] Diagram source: Interagency Working Group on Convergence, Federal Coordination In STEM Education Subcommittee Committee On Stem Education of the National Science and Technology Council. (2022). Convergence Education: A Guide to Transdisciplinary Stem Learning and Teaching. p.19 https://www.whitehouse.gov/wp-content/uploads/2022/11/Convergence_Public-Report_Final.pdf

[10] Interagency Working Group on Convergence, Federal Coordination In STEM Education Subcommittee Committee On Stem Education of the National Science and Technology Council. (2022). Convergence Education: A Guide To

some of the most pressing issues of our time, and learners today need to have the capacity to address them with creative and relevant solutions.

UN Sustainable Development Goal 4, Target 4.7, aims to prepare students to address global challenges towards sustainable development and is critical to the transdisciplinary, STEAM-based approach emphasized in this framework. UN SDG Target 4.7 states that:

> "by 2030... all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development."[11]

To achieve this goal, learners require a synthesized approach that crosses disciplinary boundaries through the perspectives of big concepts or questions. The Institute for the Future's report on *Future Work Skills* notes that, "many of today's global problems are *just too complex to be solved by one specialized discipline* (think global warming or overpopulation). These *multifaceted problems require transdisciplinary solutions.* While throughout the 20th century, ever-greater specialization was encouraged, the next century will see transdisciplinary approaches take center stage".[12] Developing such transdisciplinary ways of problem solving will better prepare students for the realities of the modern world, future careers, and the skills increasingly required to address major systemic challenges.

With a strong focus on real-world connections and the UN Sustainable Development Goals, academics should be both problem-based and project-based, with an emphasis on constant and persistent inquiry, regardless of disciplinary lens. Appropriate for all learners, this encourages innovative and creative thinking across all topics, while ensuring that the academic knowledge is highly relevant and rooted in real-world issues.

Program elements within the Transdisciplinary Academics pillar could include, but are not limited to:

- Courses co-designed by educators from different backgrounds.
- Courses that explore big questions through the transdisciplinary lenses of STEAM.
- Courses developed with input from local industries and organizations[13], whose work could help formulate different project directions or potential career pathways for students.

Transdisciplinary Stem Learning And Teaching. p.9 https://www.whitehouse.gov/wp-content/uploads/2022/11/Convergence_Public-Report_Final.pdf

[11] See https://sdgs.un.org/goals/goal4

[12] Davies, A., Fidler, D., & M. Gorbis. (2011). Future Work Skills 2020. Institute for the Future for the University of Phoenix Research Institute. https://www.iftf.org/futureworkskills/.

[13] Similar to Dearborn STEM Academy

- Student-driven, project-based curriculum with real world applications for projects and activities.
- Flexible program modules that can be combined and modified to reflect and adapt to local and global issues.

Community Engagement

Engaging with members of different communities is critical as learners develop a greater understanding of the environments they live in and the challenges being faced by societies around the world. A focus on community engagement provides students with real-world experiences by working on projects that generate tangible, positive outcomes for those around them. Learners make new connections and understand the relevance of learning while demonstrating personal and academic growth. Further, working outside the classroom helps uncover new interests and develop plans for future jobs, careers, and education.

Program elements within the Community Engagement pillar could include, but are not limited to:

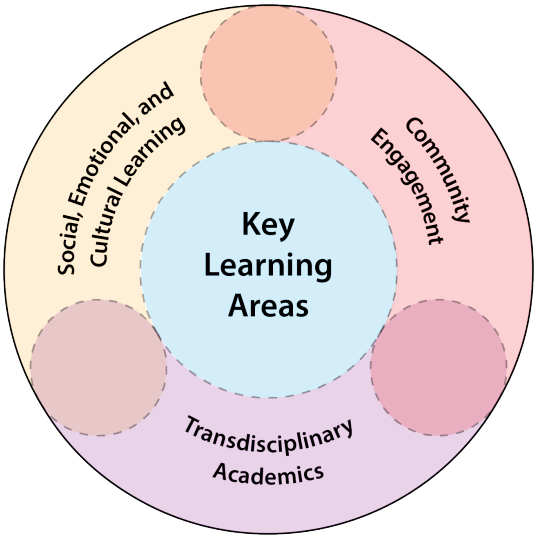
- Internships: experiences of different lengths in which students work with a partner organization in a meaningful way to help achieve a desired outcome under the guidance of a mentor.
- Career shadowing: time spent with a professional in a particular field to understand what it would be like to pursue that career path.
- Industry and community-aligned projects: project prompts for classes developed with community or industry partners as clients or collaborators.
- Certificates or micro-credentialing: short courses students can take outside of school to gain a certificate or credential in a particular area.
- Matching students with community mentors: connecting students with mentors in their communities whose interests align with theirs to provide guidance and feedback on projects or career pathways.
- Community member-led workshops and classes: short workshops or classes led by outside experts in specialized areas.

These three pillars (SECL, transdisciplinary academics, and community engagement) serve as the curricular and pedagogical foundation of the Learning Architecture, laying the groundwork for the approach to key learning areas, core practices, assessment, and program development. The next section, Key Learning Areas, describes how broad areas of learning can be designed through the lenses of the foundational pillars.

Key Learning Areas

Key Learning Areas (KLAs) are the major categories of learning within which an educational program[14] situates its learning experiences. Broad by nature, KLAs are designed to generate creative exploration, both in content and pedagogical approach, and are intended to be representative of current local and global contexts. They are the lenses through which students experience learning and make progress towards completion of a program.

Relationship Between KLAs and Foundational Pillars



KLAs are informed by and align conceptually with the three foundational pillars.

The KLAs are situated within the three foundational pillars: social, emotional, and cultural learning (SECL), transdisciplinary academics, and community engagement, and therefore lean towards particular areas and types of learning. Certain key learning areas may align with the foundational pillars, while others will not. For example, traditional approaches to teaching "literature" or "biology" as siloed subjects would not be appropriate in this model because the academic approach is transdisciplinary.

Analyses of a number of curricular approaches at innovative schools and programs have provided model KLAs that would fit within the structure of this Learning Architecture. For example, a more fitting approach than "literature" or "biology" would be the Humanities or

[14] UNESCO defines an educational program as a "coherent set or sequence of educational activities designed and organized to achieve predetermined learning objectives or accomplish a specific set of educational tasks over a sustained period. Within an educational programme, educational activities may also be grouped into sub-components variously described in national contexts as 'courses', 'modules', 'units', and/or 'subjects'. A programme may have major components not normally characterized as courses, units, or modules – for example, play-based activities, periods of work experience, research projects and the preparation of dissertations." See https://uis.unesco.org/en/glossary-term/educational-programme#

STEAM KLAs at Global Citizenship Experience (GCE) Lab School[15], which are taught through transdisciplinary academics and community engagement. Students pursue research and develop projects around specific topics related to Sustainable Development Goals, while also traveling off campus once a week to meet with local businesses and organizations in related industries.

Another model is the Living Machines thread in MIT's New Engineering Education Transformation (NEET) program[16], "an interdisciplinary project-centric apprenticeship focused on biotechnology." Living Machines integrates life sciences, biotechnology, engineering, and design in an applied, hands-on way that focuses on solving cutting edge problems in interdisciplinary teams. Students work with industry partners on topics that span disciplines, approaching higher level questions through a combination of perspectives.

There are many possible KLAs (and approaches to program design) that could fit within this Learning Architecture. Decisions about which to include may change over time, but each KLA should be measured against a school's mission, vision, and values, graduate profile, and its curriculum pillars when assessing what would be an appropriate fit.

[15] See https://gcelabschool.org/our-approach/curriculum/pbl-courses/

[16] https://neet.mit.edu/threads/lm

Example Set of Key Learning Areas

An example of a set of Key Learning Areas designed for an innovative new high school in Belize, Itz'at STEAM Academy[17], is described below. Though these KLAs were designed specifically for Itz'at, they were developed with the understanding that they could be used in other contexts around the world. Itz'at's vision is to graduate "young people prepared with knowledge, skills, and integrated experiences in science, technology, engineering, arts, and mathematics to build a sustainable future for themselves and their communities."[18] As such, these KLAs are focused around STEAM and sustainable futures. Itz'at's KLAs are:

- Sustainable Environments
- Global Humanities
- Quantitative Reasoning
- Arts and Fabrication
- Healthy Living
- Real World Learning

All of the KLAs place an emphasis on local perspectives, representing local environments, cultures, histories, and innovations through projects and explorations designed by the school's teachers. Additionally, students will be challenged to address global issues from wider perspectives, to more deeply understand how what they are learning impacts other communities around the world. To help better understand the relationship between Key Learning Areas and traditional disciplines, each section includes a list of possible disciplines that could be incorporated into each area.

Sustainable Environments

Sustainable Environments is a KLA with an emphasis on sustainability. Using the word "sustainable" in its name indicates a focus on the UN Sustainable Development Goals. The definition of "environment" encompasses both *"the complex of physical, chemical, and biotic factors (such as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival"* and *"the aggregate of social and cultural conditions that influence the life of an individual or community"*[19]. Using the word "environment" points to the study of the physical world and also acknowledges the importance of community engagement as we recognize our profound interconnections within these ecological systems. Viewing the sciences through this lens allows for

[17] The Itz'at STEAM Academy formerly known as the STEAM Lab School is an initiative of the Belizean Ministry of Education, Culture, Science and Technology (MoECST) to provide a new, transformative secondary school education for students in Belize. Developed in partnership with MIT and the Inter-American Development Bank, the Itz'at STEAM Academy will open its doors to an initial cohort in September 2023, and will grow over time to its full capacity of 300 students by 2026. More information can be found at https://www.itzat.edu.bz/

[18] Belize STEAM Laboratory School Mission, Vision, Values

[19] See https://www.merriam-webster.com/dictionary/environment

transdisciplinary approaches that engage students in big questions about the future of our world while also encouraging active participation as citizens in a wider community, rooted in the development of greater social emotional awareness of what it means to be human within these living systems.

Possible disciplinary connections include: ecology, biology, anatomy, chemistry, physics, engineering, anthropology, architecture, urban studies, sociology, economics, writing, world history, Belizean Studies, math, and statistics.

Global Humanities

Global Humanities is a KLA with an emphasis on local and global perspectives. The use of the term "global" is adopted from "Global Competence" as defined by OECD, which states that *"Global competence is the capacity to examine local, global and intercultural issues, to understand and appreciate the perspectives and worldviews of others, to engage in open, appropriate and effective interactions with people from different cultures, and to act for collective well-being and sustainable development."* (OECD, 2018) Ideas of global citizenship and global worldview provide an important lens for students when studying human society and culture (locally, regionally, and globally), allowing them to engage with the human experience from others' perspectives. The term "humanities" specifies a focus on the combined subjects that encompass the humanities as a general discipline, which include, but are not limited to: history, philosophy, literature, languages, social sciences, writing, art, design and communication.

Possible disciplinary connections include: Belizean Studies, literature, writing, languages and cultures, world history, design, economics, philosophy, media studies, civics, political science, anthropology, geography, archeology, and sociology.

Quantitative Reasoning

The Quantitative Reasoning KLA focuses on math practice and skills with real world applications. Quantitative reasoning is a "*secondary school students' ability to reason and solve sophisticated quantitative problems, their basic understanding of the scientific method, and their ability to communicate at a substantial level about quantitative issues in everyday life."*[20] This KLA combines the skills needed to analytically evaluate problems using mathematical and computational thinking, as well as the tools to express and describe concepts and phenomena.

Possible disciplinary connections include: data analysis, geometry, algebra, calculus, physics, statistics, programming languages, algorithmic thinking, logic, and engineering.

Arts and Fabrication

Arts and Fabrication is a wide-ranging KLA designed to engage students in expressive and

[20] See http://www.nnn-us.org/What-is-Numeracy

creative thinking and production, including fine arts and the practice of making things. The word "arts" refers to all creative art forms, including visual arts (painting, drawing, sculpture, etc.), digital arts, music, and performance. Fabrication is *"the action or process of manufacturing or inventing something,"*[21] and places emphasis on the physical, hands-on process of producing something new. Arts and Fabrication is not only focused on developing the skills and capacity to make things, but also emphasizes being able to generate clear concepts around what is being produced, for who, and why. While this KLA will function as an independent learning area, it will also provide students with the skills, knowledge, and tools to work on projects in other KLAs.

Possible disciplinary connections include: 2D design, 3D design, digital design, audio and visual production, digital fabrication, analog fabrication, woodworking, fine arts, music, photography, performing arts, architecture, engineering, industrial design, and human-centered design.

Healthy Living

The Healthy Living KLA is designed to engage students in topics around healthy lifestyles, health-related issues, physical fitness and development, emotional literacy and wellbeing, self-development, and public health. Gaining aptitude in these areas is important for students both as they encounter SECL curriculum in other KLAs and as they participate in internships and other work outside of campus. Healthy Living will teach students how to take care of their minds, bodies, and other aspects of their lives thoughtfully and with care.

Possible disciplinary connections include: physical education, nutrition, community activism, financial literacy and personal economics, public health, and health and wellness education.

Real World Learning

The Real World Learning KLA is "an approach to learning that involves schools working with community partners and industry experts to engage students in authentic, relevant problems, projects, and experiences that develop career awareness and readiness."[22] This KLA focuses on real-world experiences and gives students the agency to lead projects and initiatives of their choosing. It relies on students' self direction, initiative, and capacity to engage in work and projects outside of the classroom. It can include, but is not limited to: internships, career shadowing, capstone projects, volunteering, and independent study.

Key Learning Area Implementation

Questions many educators grapple with, especially those advancing innovative programs that challenge traditional models of education, are which and how many key learning areas to include and, subsequently, how they function in relation with other elements of the

[21] See https://www.lexico.com/en/definition/fabrication

[22] See https://realworld.digitalpromise.org/getting-started/

learning experience. Determining KLAs, however, does not necessarily dictate how they are implemented. Often, these decisions are accompanied by conversations and co-design exercises around the mission and goals of the program and learners' aspirations in order to arrive at a practical implementation strategy. Beyond the learning goals of the KLA, consideration should be given to the effort required to design and implement the KLA, its format, how much time is devoted to each area over the course of an entire program, and how learners can demonstrate successful outcomes and make meaningful progress.

KLAs are broad categories of learning that help learners and educators view knowledge and experiences through a particular lens, and implementing them has the potential to take many different forms. A key point is that KLAs can be, but are not limited to, functioning as blocks in a course schedule. In practice, there may be classes or learning experiences that are offered under each KLA and also those that span more than one KLA. The format should be determined by each institution individually. Some examples of how KLAs could function include:

- As subject areas. For example, instead of taking a course in English or History, a student would take a course in a KLA like Global Humanities. A student could also take a course that spans more than one KLA; for example, Global Humanities and Arts and Fabrication.
- As thematic arcs for a course of study. For example, a school at the secondary level could choose to focus entire semesters around individual KLAs, aligning all (or a subset of) courses towards that KLA. At the tertiary level, students could pursue a major, minor, or certificate in one or more KLAs.[23]
- As credit areas. For example, a program could require students to obtain a certain number of credits in each KLA as part of a completion requirement. The program would have courses that fall within one or more KLA, and students would receive a certain amount of credit towards those KLAs through different courses.

[23] See MIT NEET: https://neet.mit.edu/faq

Core Practices

The core practices of this Learning Architecture are a set of processes and methods for implementing student-centered teaching and learning. Grounded in the previously described foundational pillars[24], Transdisciplinary Academics (TA), Social, Emotional, and Cultural Learning (SECL), and Community Engagement (CE), this set of practices emphasizes exploration, hands-on learning, and equity in a supportive, open-minded environment.

Student-centered learning is a cross-cutting pedagogical approach, rooted in the science of how people learn[25][26][27], that ties together an educational organization's core practices. An aspirational model around the world, and contrary to more conventional teaching methods, student-centered learning pays careful attention to the learner's interest, prioritizing their voice and decisions about their own learning. Edith Ackerman, a prominent educational researcher and developmental psychologist, wrote that "learning is much less about acquiring information or submitting to other people's ideas or values, than it is about putting one's own words to the world, or finding one's own voice, and exchanging our ideas with others."[28] This understanding of the way people learn is central to the LA core practices. Understanding that true learning is facilitated through a student's discovery and development of their own ideas and collaboration with peers underscores the importance of student-centered learning as the practice that informs all others.

Beyond student-centered learning, the core practices are categorized according to their alignment with the three foundational pillars. Combined, these practices are an essential guide for teaching, learning, and program development.

[24] See section on Foundational Pillars.

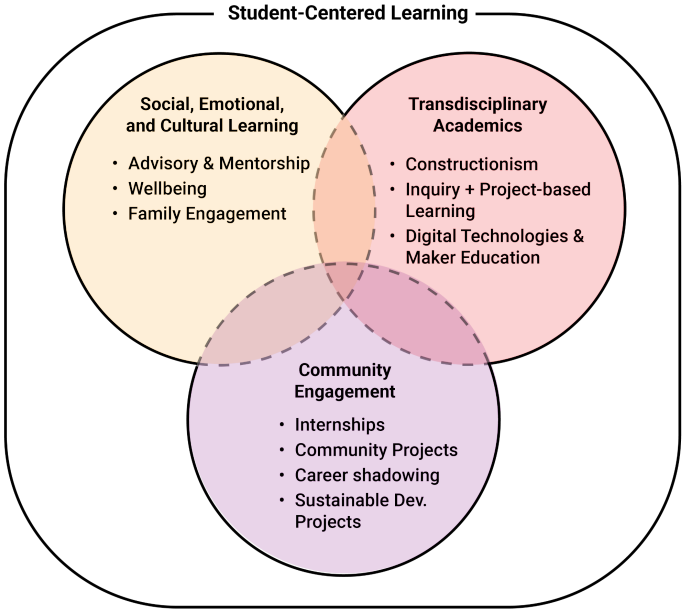
[25] See https://aurora-institute.org/blog/the-learning-sciences-supports-the-shift-to-student-centered-learning/

[26] Lee, E. & Hannafin, M.J. (2016) A design framework for enhancing engagement in student-centered learning: own it, learn it, and share it. Education Tech Research Dev 64, 707–734. https://doi.org/10.1007/s11423-015-9422-5.

[27] Sarma, S. E., & Yoquinto, L. (2020). Grasp: The science transforming how we learn. Doubleday.

[28] Ackermann, E. (2011) Piaget's Constructivism, Papert's Constructionism: What's the difference?

Student-Centered Learning is the Essential Core Practice



Student–centered learning underlies all other core practices.

Student-Centered Learning (SCL)

To better engage young people as active owners of their own education, a student-centered approach is vital. In a student-centered environment, beyond organizational efficiency or teacher objectives, the students' learning is the most important consideration. XQ, an organization dedicated to rethinking high school, writes that "[i]n student-centered learning, students' interest drives education. Student-centered learning gives students the opportunity to decide two things: what material they learn and how they learn it. (This concept is also sometimes referred to as personalized learning.)...SCL engages students as leaders and decision-makers in their own learning...Classroom roles shift in SCL, as students take on leadership and teachers move away from being the sole deliverers of content."[29]

Student- or learner-centered education encourages students to lead their own learning journey, to participate actively in shaping and guiding discussions, to explore topics that interest them, to lead the design of concrete projects or public displays, and most importantly, to be more aware of their own learning journey. The implementation of such an approach needs to fit within the 'necessary' constraints of any system, but should challenge 'unnecessary' constraints, providing an opportunity to rethink the existing educational system. Notably, the role of the teacher in this journey is very important. The teacher plays the role of coach, facilitator, and advocate, creating an environment where students feel

[29] See https://xqsuperschool.org/rethinktogether/what-is-student-centered-learning/

comfortable asking questions, sharing their ideas, and receiving feedback that encourages them on their learning journey.

STEAM education, which is inherently hands-on and exploratory, relies heavily on this understanding of learning. A 2018 report from MIT, "The Global State of the Art in Engineering Education,"[30] identifies that a key challenge for engineering education, specifically, and STEM education more broadly, is integrating "student-centered learning with a curriculum oriented to the pressing challenges of the 21st century – societal, environmental, and technological." Many educators now argue for a balanced approach to STEM education that encourages greater focus on problem-solving, creativity, communication, self-direction, and collaboration, rather than select STEM content[31] in science, technology, engineering, and math. Embedding project-based learning through real-world challenges is an actionable way to implement student-centered learning in a STEAM or STEM-based learning environment.

Core Practices: Transdisciplinary Academics

The practices under the Transdisciplinary Academics pillar are largely centered around pursuing big questions through projects and hands-on learning. Learning by doing, especially when it is student-driven, is a fundamental part of a student's experience. This creates both relevance and meaning for students, allowing them to pursue learning through a process of exploration, experimentation, and discovery. The processes and methods described below are a set of the essential components necessary to generate the learning environment envisioned.

Constructionism

Constructionism is built on Jean Piaget's theory of constructivism, which asserts that learning is an active process in which learners are continuously building mental models and theories about their surrounding world. Seymour Papert, the creator of the constructionist learning theory, argues that learning is more effective when learners are actively engaged in the construction of concrete artifacts that they can interact with and share with others. He writes, "Constructionism... shares constructivism's connotation of learning as 'building knowledge structures' irrespective of the circumstances of the learning. It then adds the idea that this happens especially felicitous in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe."[32]

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[30] This study considers the global state of the art in engineering undergraduate education. It was undertaken to inform Massachusetts Institute of Technology's New Engineering Education Transformation (NEET) initiative. https://jwel.mit.edu/assets/document/global-state-art-engineering-education

[31] Hunter-Doniger, T. & Sydow, L. (2016) A Journey from STEM to STEAM: A Middle School Case Study. The Clearing House Journal of Educational Strategies, Issues and Ideas. 6 (23); p 159-166.

[32] Harel, I., and Papert,S. (1991) Constructionism, Ablex Pub. Corp., Norwood, NJ.

Further, constructionism promotes the potential held by technology in the education field, asserting that technology is a powerful tool for learning in educational environments. Papert explains that children learn with particular effectiveness when they are engaged in constructing personally meaningful artifacts such as computer programs, animations, or robots.[33] He also states that the computer should be seen as more than just a tool, but as a potential carrier of new ways of thinking about teaching, learning, and education. Interventions afforded by constructionism take into consideration the local knowledge and culture, particular interests, and different learning styles, and therefore have the potential of leading to appropriate actions in education.

The theory and practice of constructionism are key elements that underlie the following sections on inquiry and project-based learning, use of digital technologies, and fabrication and maker education.

Inquiry and Project-Based Learning

Educational environments should inspire and capture the imagination of each student from the moment they arrive on campus. Empowered to see themselves as makers, builders and creators with the agency and skill to shape the world around them, students engaged in inquiry and project-based learning environments are driven to be owners of their own learning.

Inquiry-based learning experiences encourage all learners (including those not planning STEAM or STEM-related careers) to gain a deeper understanding and appreciation of the ideas, practices, and possibilities in today's society. Research[34] supports the idea that meaningful learning experiences should be rooted in design and inquiry-based thinking, as students work on problems authentically connected to the real world that are responsive to meaningful contexts and values within their communities. This type of learning engages students in a kind of cognitive apprenticeship as they learn from others' models and, in turn, model their own ideas. In this design-oriented approach, students internalize the values of experimentation, productive failure, collaboration, and an adaptive mindset. Throughout the process, students are asked to share their work with others and reflect on the social, cultural, and personal contexts of their work.

One of the most critical aspects of STEAM education is a project-based pedagogical approach. Project based learning, often shortened to PBL, is sometimes used interchangeably with problem-based learning (also shortened to PBL). Both approaches overlap and are teaching methods that foster learning and developing 21st century skills

[33] Papert, S. (1980). Mindstorms—Children, Computers and Powerful Ideas. New York: Basic Books, Inc. https://dl.acm.org/doi/pdf/10.5555/1095592.

[34] Barron, B. (2006). Interest and Self-Sustained Learning as Catalysts of Development: A Learning Ecology Perspective. Human Development. 49. 193-224.

through problem-solving and applying knowledge in real world settings.[35] Project-based learning can include problem-based learning, but not all projects need to begin with the definition of a problem; projects can also be framed as challenges or open-ended explorations of a topic. The emphasis in PBL (referencing both project or problem-based learning in all subsequent references to PBL) is not on lecture-based education, but on fostering long-term retention of knowledge and understanding through skills development. PBL is often used as shorthand for a teaching method that presents students with real-life problems they must solve. In its focus on real-world problems, PBL can bring reality to students' learning – a welcome change from traditional teaching that can often feel too abstract and disconnected from students' real-world needs. This is both motivating and addresses the challenge of transfer – allowing students to more easily transfer what is learned in the classroom to practical applications in the world.

A critical element of project-based learning in a STEAM environment is the use of digital and physical tools and technologies for developing prototypes. The importance of incorporating different kinds of creation and fabrication methods as core practices for learning is described in the following sections.

Digital Technologies and Maker Education

Seymour Papert, referenced earlier and one of the foremost influences on educational technology, "focus[ed] on the study, invention, and creative use of digital technologies to enhance the ways that people think, express, and communicate ideas, and explore new scientific frontiers."[36] His early understanding of the transformative potential of technology as a tool for thinking and learning laid the groundwork for the design and use of technology today. For Papert, "computer programming and debugging can provide children a way to think about their own thinking and learn about their own learning."[37] Programming toolkits, environments and platforms can empower young people to develop games, programs, and apps worth making: novel, digital solutions to problems faced every day in their lives, their communities, and the world. These approaches can guide the thoughtful integration of digital technologies in educational settings.

The physical tools and technologies that complement and work alongside their digital counterparts allow students to develop tangible prototypes of project ideas. Creating physical artifacts of learning empowers students to work simultaneously with their hands and minds, encouraging discovery through prototyping, testing, and observing their ideas.

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[35] Capraro, M. R., & Slough, W. S. (2013). Why PBL? Why Stem? Why Now? An Introduction to Stem Project-Based Learning: An Integrated Science, Technology, Engineering, and Mathematics (Stem) Approach. In Capraro, M. R. & Morgan, J. R. (Eds.), Project-Based Learning: An Integrated Science, Technology, Engineering, and Technology (STEM) Approach (pp.1-6). Rotterdam, The Netherlands: Sense Publishers. https://doi.org/10.1007/978-94-6209-143-6_1

[36] MIT Media Lab's vision for education: https://www.media.mit.edu/about/lab-faqs/

[37] Harel, I., & Papert, S. (Eds.). (1991). Constructionism. Ablex Publishing.

While digital technologies are often essential tools in maker practices, especially in digital fabrication and electronics, prototyping can also be low-fidelity and done entirely with hand (or analog) tools. Maker education includes all modalities, methods, and processes for making things.

The tools and technologies used for fabrication are typically found in makerspaces. Also referred to as hackerspaces, shops, Fab Labs, etc., makerspaces are communal workshops that allow for the development of ideas through physical prototyping. Equipment in a makerspace can range from basic craft supplies and sewing machines, to simple hand tools, to more advanced equipment like laser cutters, 3d printers, and CNC machines.

The true value of a makerspace lies in its ability to instill a sense of confidence and ownership of learning in its users. Whether working on a class project or building something for fun, a well-established makerspace nurtures the curiosity of its participants and empowers them to take on new challenges. These qualities closely match principles from Papert's thoughts on Constructionism as mentioned above, writing that "[learners] will do best by finding for themselves the specific knowledge they need; organized or informal education can help most by making sure they are supported morally, psychologically, materially, and intellectually in their efforts."[38] The ethos of a makerspace is held up by these concepts, providing a supportive learning environment and that encourages learners of all types to pursue their ideas in their own ways. Often, learners are able to step into roles as collaborators, mentors, and, eventually, instructors, promoting ownership of the space and the projects they pursue within it.

Core Practices: Social, Emotional, and Cultural Learning

Social, emotional, and cultural learning impacts every learner at every stage of their educational journey. While much of the learning around SECL can be woven into a larger education program and/or the culture of a school, the core practices that promote this pillar are made explicit in three key ways: through advisory and mentorship, a focus on wellbeing, and a targeted approach to family engagement[39]. Incorporating these practices into every learner's educational experience provides the social and emotional foundation needed to build a strong sense of community and establish a truly student-centered learning environment.

Mental Health and Wellbeing

Physical, physiological, and interpersonal wellness are essential for optimal learning. Physical health through adequate exercise, nutrition, and sleep are fundamental building blocks that are often taken for granted, or that can feel outside of a school's purview.

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[38] Papert, S. (1993) The Children's Machine: Rethinking School in the Age of the Computer. New York :Basic Books. https://learn.media.mit.edu/lcl/resources/readings/childrens-machine.pdf

[39] This is particularly important for young learners.

Exercise is a simple yet important method of enhancing aspects of children's mental functioning, pivotal in cognitive and social development. For example, research[40] finds that adding physical activities daily increases children's cognitive functioning, particularly in executive function. Ensuring student nutrition is another step. Conversely, sleep deprivation strongly impairs cognition, motor performance, and mood.[41] Addressing student health requires both in and out of school support. Educational institutions should work with a community of parents, guardians, counselors, and health professionals to encourage students' physiological readiness to learn: sleep, nutrition, and mental disposition, including feelings of safety and security at school.

Focusing on educators and staff wellbeing is also a critical component of a healthy school environment. Considerations must be made for supporting educators by allowing them adequate time for professional development and coaching, the ability to be flexible and adapt strategies as needed in the classroom**,** and by creating a culture of strong relationships. Fostering learner and educator wellbeing – from physical and psychological health to creating generative and safe school climates – benefits not only individual student outcomes, but the health of the educational ecosystem.

One approach to addressing school-wide wellbeing and mental health is the Compassionate Systems framework, developed through a collaboration of MIT J-WEL[42] and Peter Senge and Mette Böll, founders of the Center for Systems Awareness and MIT Systems Awareness Lab.[43] The Compassionate Systems framework is a set of educational tools and approaches, rooted in decades of socioemotional learning and mindfulness research, designed to help students and adults cultivate enduring compassion and capacity for care amidst the complexities of the modern education environment. Drawing from social and emotional learning models, the fields of organizational learning and science of learning, and developments in the field of complexity science and the study of systems, the Compassionate Systems framework offers models of thinking and teaching that help educators and students apply skills of compassion, relationship building, and systems thinking to nurture their own wellbeing and address important issues both inside and outside the classroom.

Advisory and Mentorship

As part of an overall focus on student wellbeing, intentional and structured advisory and mentorship programs can be deeply beneficial to student development, academically,

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[40] Davis, C.L., et al. (2007). Effects of Aerobic Exercise on Overweight Children's Cognitive Functioning: A Randomized Controlled Trial. Research Quarterly for Exercise and Sport; 78: 510–519.

[41] Pilcher, J. J., & Huffcutt, A. J. (1996). Effects of Sleep Deprivation on Performance: A Meta-Analysis. Sleep: Journal of Sleep Research & Sleep Medicine. 19(4), 318–326. https://doi.org/10.1093/sleep/19.4.318.

[42] See https://jwel.mit.edu/

[43] See https://systemsawareness.org/

socially, and personally.[44] . From the early years of secondary school through university programs and careers, creating formal structures for these kinds of support systems can have longstanding positive impact.

Advisors, peer advisory groups, and mentors have the potential to give meaningful shape and guidance to each student's educational experience. Research at the secondary school level has shown that individual development towards successful outcomes (both in school and out) is "nurtured in the context of strong, supportive, and sustained developmental relationships with adults and peers....[Further,] the iterative and fundamentally relational processes of experiencing, interacting, and reflecting represent a critical engine for children's development and as such are the core of the conceptual model linking experiences and relationships with outcomes."[45] Research published by OECD in their Dream Jobs Report[46] on the future of work for young people cites the influence of a trusted adult or career advisor as a critical factor in motivating students to stay engaged in school.

Similar outcomes occur at the university level as well, especially through hierarchical and peer mentoring. Regarding undergraduate mentoring, a paper written by administrators at Wake Forest University states, "[m]entoring of undergraduates occurs at that interesting intersection where a youth population is asked to consider adult questions and make adult choices; therefore, it must focus on several interrelated outcomes: socialization to higher education both socially and academically, exploration and development of the potential self, and identification of a future path that aligns with that potential self. Mentoring is particularly well-suited to this work as "consistent support creates a safe climate in which students can take risks and do the work of developing personally and professionally".[47] Through effective mentoring relationships, students learn key skills about building networks and the importance of lifelong learning and development, skills that will serve them well in this uncertain, interconnected world."[48] Beyond the personal, social, and academic development of individual students, mentoring also work to build community and culture within the institution, promoting friendships and connections between members of the community and creating stronger ties between individuals and their environment.[49] The

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[44] McWilliams, A., and Beam, L. (2013). Advising, Counseling, Coaching, Mentoring: Models of Developmental Relationships in Higher Education. The Mentor: An Academic Advising Journal (Vol. 15). https://journals.psu.edu/mentor/article/view/61280/60913

[45] Nagaoka, J., et al. (2015). Foundations for Young Adult Success: A Developmental Framework (pp.2,5)

[46] https://www.oecd.org/berlin/publikationen/Dream-Jobs.pdf

[47] Johnson, W. & Rose, Gail & Schlosser, Lewis. (2008). Student–Faculty Mentoring: Theoretical and Methodological Issues. p.49.

[48] McWilliams, A., & Beam, L. (2013). Advising, Counseling, Coaching, Mentoring: Models of Developmental Relationships in Higher Education. The Mentor: An Academic Advising Journal, Vol. 15. https://journals.psu.edu/mentor/article/view/61280/60913

[49] Yomtov, D., et al. (2017). *Can Peer Mentors Improve First-Year Experiences of University Students?* Journal of

experiences and perspectives of a mentor or older student can be invaluable to a younger or less experienced student, who may need guidance navigating the many aspects of academic life, including social situations, academic trajectories, relationships with teachers, professors, and other adults, and internship and career plans, among countless others. Perpetuating a sense of belonging by fostering these relationships through the institution can be an important and influential aspect of student life.

From the institutional perspective, advisory and mentorship programs require consistency and sufficient professional development and support for advisors and mentors, whose resilience in the face of challenging circumstances is vital.[50] Ensuring that advisors and mentors are prepared to take on an advisory group or mentee, including the potential complications that may arise within it, is critical to the health and longevity of the overall system. Putting structures in place to provide a steady, safe place to explore, reflect, and seek help when needed will help build an educational culture where learners feel committed and supported.

Family Engagement

Engaging students' families in the learning environment, especially at the primary and secondary levels, is a productive way to ensure that a student is surrounded by caring adults inside and outside of school. According to youth.gov, a website of the US government dedicated to youth development and programming, the benefits of family engagement at school are wide ranging. Among the many positive outcomes listed, youth.gov notes that "family engagement in schools contributes to positive student outcomes, including improved child and student achievement, decreased disciplinary issues, improved parent-teacher and teacher-student relationships, and improved school environment… [Further], parent involvement leads to positive benefits for students, parents, and schools, including improved academic performance and improved parent-teacher relationships. Students whose parents were involved in school during their elementary years experienced lower rates of high school dropout, were more likely to complete high school on time, and had higher grades."[51]

The role of parents, guardians, and/or families in learning environments varies by institution, and formalizing the obligations of that role is not a common practice. Schools in the Big Picture Learning network, including The Met, "institutionalize"[52] the roles of parents and guardians, forming strong relationships and setting clear expectations for family

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College Student Retention: Research, Theory & Practice, Vol. 19(1) 25–44. https://files.eric.ed.gov/fulltext/EJ1138947.pdf

[50] Benson, J., & Poliner, R. E. (2013). Designing advisories for resilience. Educational Leadership, 71(1), 50-55.

[51] https://youth.gov/youth-topics/impact-family-engagement#_ftn1

[52] Arnold, K., & Mihut, G. (2020). Postsecondary outcomes of innovative high schools: The big picture longitudinal study. Teachers College Record, 122(8), 1-42. https://www.tcrecord.org/Content.asp?ContentId=23342.

involvement in school activities. Parents or guardians attend meetings with students and advisors around individualized learning plans and college applications, and are encouraged to attend exhibitions of student learning. Developing the relationship between school staff and families and identifying expectations for family involvement promotes a more supportive school environment for students.

Core Practices: Community Engagement

Complementing the focus on student development personal and academic perspectives, the LA also promotes learning environments that have a deep commitment to partnering with the local community. This serves to both engage students as self-directed learners beyond the classroom and allows an institution to participate meaningfully as a partner organization in a larger ecosystem. Students form connections between what is happening inside and outside the classroom, aligning and merging ideas while always understanding the underlying relevance and applicability of what they are learning.

Internships

Integrated internships within an academic program are an important aspect of community engagement. Internships with industry and community organizations can build in complexity and scope as a learner progresses through a program, ultimately allowing for exploration of potential career pathways and next steps after graduation.

Internships guided by school advisors and industry mentors are the primary mode of learning at The Met High School, one of the schools studied in the development of the Learning Architecture and the founding school in The Big Picture network. In reflecting on the impact of ongoing, intensive internship experiences over the course of four years in high school, The Big Picture Longitudinal Study (BPLS) found that, "[e]ven more important than school-based self-reflection projects, the ability to name and follow one's passions is cultivated in the process of deciding upon, carrying out, and publicly presenting the products of student Learning Through Internships experiences…Students attributed a variety of skills to their Learning Through Internship (LTI), including navigating and succeeding in a professional environment, interacting and working with adults, being independent and responsible for their work, and gaining hard and soft skills specific to jobs in their interest areas."[53] The Met is an example of a highly successful internship program and demonstrates the power internships can have not only in helping students identify passions and interests, but also in developing social and professional competencies in ways that go beyond what is possible at school.

Action Learning, an approach pioneered by the MIT Sloan School of Management that emphasizes learning by doing and linking theory (coursework) to practice, is another useful

[53] Arnold, K. & Mihut, G. (2020). Postsecondary Outcomes of Innovative High Schools: The Big Picture Longitudinal Study. Teachers College Record, Volume 122.

model to reference in the development of an internship program. It bridges core concepts and theories from curriculum – school-based experiences, learning, and content – with students' internship experiences in industry and their community. Action Learning's goal is to "immerse students in real-life business situations that equip them with problem-solving skills, adaptability, and a team mindset that they can apply to their own organizations and careers."[54] In doing so, students participating in Action Learning engage with companies and organizations on real challenges they face currently, gaining invaluable preparation as future business professionals.

A third example, MIT's Undergraduate Research Opportunities Program (UROP), allows MIT undergraduates to participate in research and projects across the university through paid, credit, or volunteer positions. UROPs provide students with practical, hands-on experiences that help build skills and competencies that are readily transferrable to future academic research, off-campus internships, or jobs. MIT Professor Bryan Bryson, who mentors UROP students working on resesarch in his lab, is profiled in the 2022 UROP Impact Report, stating, "UROP, he says, provides the 'training wheels of research' by giving students both unique resources and opportunities, as well as the chance to build their confidence and believe in themselves. 'In the classroom, you either have the answer or you don't,' he says. 'But research is a totally different ball game. It's about grit, creativity, and a willingness to embrace risk. You're also mixing with a set of people who have an unabashed curiosity, and a fierce belief in the possibility of the impossible. So UROP is a perfect storm for a program that really launches careers.'" [55]

As seen in the examples described, successful internship programs exemplify how a learning environment connects classroom, industry, and community, providing learners with opportunities to further apply the knowledge, skills, and attitudes developed at school in real life situations. Activities in classes, in conjunction with real-world learning experiences, should be designed to enable learners to build the broad habits of mind and practical and general competencies that are needed to prepare them for the workplace, including:

- independence and control of their own learning,
- the creative confidence to approach challenges fearlessly,
- adaptability to changing circumstances and new ways of thinking,
- perseverance to overcome challenges despite inevitable roadblocks,
- the self-confidence to explain, demonstrate, and promote their original ideas,
- and the ability to work collaboratively with diverse teams.

While developing and refining these work-related skill sets, participating in a series of internships (or apprenticeships or work-based learning programs) also enables learners to jointly solve problems and learn to be socially responsible while making a positive

[54] For more information see: https://mitsloan.mit.edu/action-learning

[55] See: https://urop.mit.edu/wp-content/uploads/2023/05/UROPImpactReport_2022_AC.pdf

contribution in their community.

Community Partnerships

In addition to internships, schools and programs can also create opportunities for students to connect with community and industry through projects and activities. Developing community partnerships breaks down walls between the typically separate spheres of 'school' and 'work', providing students with firsthand knowledge of career pathways, professional roles, specialized language, and workplace and community norms and cultures from a range of organizations.

Tying classroom learning to real world problems and ideas through community partnerships embeds relevance into the curriculum from the outset, obviating the need for students to make abstract connections between school and life.[56] Programs like NEET (New Engineering Education Transformation)[57] at MIT exemplify this way of learning by designing entire learning experiences around partnerships that align student projects with current work and research happening in industry. Coursework is directly linked to outside organizations, companies, and researchers as clients, collaborators, and mentors; students are also encouraged to pursue research with experts across MIT and are supported in securing summer internships with corporate partners and sponsors of the NEET program. NEET "value[s] opportunities for students to learn the arts of discovery and making in a manner that is aligned with real-world challenges, driven by students' passions and interests, and supported by instructors, professors, and experts in the MIT community."[58] Demonstrating this, students in the Digital Cities thread "learn how to identify communities in need, formulate problem statements, build computational tools, and develop urban policy and interventions with and on behalf of clients."[59] They do this by working collaboratively with external clients and partners on solutions that will have a positive civic impact.

Other programs at the secondary level engage the outside community in a number of creative ways, including:

- Designing projects around real world issues different outside partners face in their day-to-day work (GCE Lab School, NuVu, The Met)
- Including community, higher education, and industry partners in the curriculum design process for topics that align with specific careers, ensuring that students are learning the most relevant information to pursue next steps in that field (Dearborn STEM Academy)
- Using cultural institutions and other urban spaces as classrooms (Cosmo Schools)

[56] See: https://ablconnect.harvard.edu/authentic-learning

[57] See: https://neet.mit.edu/

[58] See: https://neet.mit.edu/about#waysofthinking

[59] See: https://neet.mit.edu/threads/dc

- Visiting, interviewing, and collaborating with outside partners to ensure students see the professional world in action and are able to understand their project context concretely (GCE Lab School, NuVu, The Met)
- Engaging outside partners as clients for student projects (NuVu)
- Inviting outside experts to the school to work directly with students on specific projects and topics (NuVu, Dearborn STEM Academy)
- Creating expert-in-residence programs for industry experts to work at the school temporarily as educators (Dearborn STEM Academy)
- Offering teacher externship programs for educators to spend time with industry partners to develop skills and knowledge that can be brought back to the school (Dearborn STEM Academy)

At all levels, students may also interact with industry professionals and outside experts as project coaches, guest lecturers and panelists, and judges for presentations and competitions. Through targeted community partnerships, students are encouraged to dive deeply into areas of interest, broadening their knowledge of professions and industries, piquing interest in potential careers, and providing ways to explore and develop new skills and ideas.

University Partnerships, Credits, and Credentials

Partnerships with outside organizations have the potential to offer learners opportunities beyond what is possible in secondary school by allowing them to earn university credits or professional level certificates or credentials. Many schools provide options for upper secondary school students to enroll in courses at local universities, but some creatively venture beyond usual practices to reach students in non-traditional ways. Some examples are detailed below:

- Luker Foundation[60] in Manizales, Colombia, works with schools and universities in their region to serve underprivileged students in both urban and rural areas who do not typically pursue tertiary education due to economic hardship or academic underperformance. Through their program, Universidad en Tu Colegio (University in Your School)[61], universities partner with local schools to offer courses in technical fields that can lead to in-demand, high paying jobs. Instructors and professors from partner universities travel to schools to teach the courses on campus. Students who enroll in the two-year program (offered in their last two years of high school, 10th and 11th grade) graduate with university credits and often qualify for entry level jobs that can help support them financially while they continue their education.
- The Met High School[62], referenced earlier in the section on *Internships*, creates

[60] See: https://fundacionluker.org.co

[61] See: https://educacion.fundacionluker.org.co/universidad-en-tu-colegio/

[62] See: https://www.themethighschool.org

pathways for students to pursue areas of interest that can lead to credentialling and entry-level jobs after graduation. Through their Real World Learning program, students can choose to do internships, take courses at local community colleges or universities, and/or begin professional certification programs in areas like healthcare, data science, and others.

- Cesde[63], a network of technical schools across Colombia, presents a model for students seeking alternatives to a traditional university degree. Focused on social mobility for those from low-income backgrounds, Cesde offers 18-month certificate programs in technical subspecialties across Healthcare, Business, and Creativity and New Technologies that relate directly to industry needs. Students are able to graduate with a credential that opens the door to new opportunities that they would not otherwise have had access to.
- Dearborn STEM Academy, also referenced in previous sections, has a strong focus on both college and career readiness, anchored in their Career Pathways. At Dearborn, upper level high school students have the option to enroll in Early College, where they can take courses at local universities and community colleges in place of certain high school classes. Advisors at Dearborn monitor student progress and provide ongoing support for those in the program. Students are able to graduate with college credits that will help them make progress towards a tertiary degree.
- Dearborn, together with a local career-focused technical and trade school, Franklin Cummings Tech, has also been designated by the Commonwealth of Massachusetts as a STEM Tech Career Academy. Through the partnership, "all Dearborn seniors are automatically accepted into the college [Franklin Cummings Tech], providing a direct path to college for students who may be facing structural barriers that impede their access to higher education." [64] The free six-year program is an innovative way for students earn a post-secondary credential while continuing to receive support from their high school.

The programs described, and others like them, are often transformative, providing the tools and resources for students to pursue jobs and career pathways that may previously have been unattainable. Students may go on from these programs to earn university degrees, though many will not; for all students, the exposure to new possibilities and areas of interest can lay the groundwork for their next steps in life professionally, academically, and personally.

[63] See: https://www.cesde.edu.co

[64] See: https://www.bpe.org/stem-tech-career-academy/

Competency-based Learning and Assessment

Incorporating competences and competency-based learning into a learning experience, educational framework, program, or curriculum indicates a focus on *knowledge application* and *student-centered learning*, emphasized in the previous section as the Learning Architecture's primary core practice. In a competency-based learning environment, learners work towards the ability to demonstrate understanding and development of a skill, concept, or body of knowledge in a relevant context, rather than concentrating on repetition and memorization. Learners advance at their own pace as they show understanding or mastery, proving resonance on a deeper level than rote learning. Defining areas of competence in education, the UNESCO International Bureau of Education states (emphasis added):

> "An area of **competence is defined as a combination of knowledge, skills and attitudes appropriate to the context**. Competence indicates the **ability to apply learning outcomes adequately in a defined context (education, work, personal or professional development)**. Competence is not limited to cognitive elements (involving the use of theory, concepts or tacit knowledge); it also encompasses functional aspects (involving technical skills) as well as interpersonal attributes (e.g. social or organizational skills) and ethical values (CEDEFOP, 2011). **Competences can be domain-specific, e.g. relating to knowledge, skills and attitudes within one specific subject or discipline, or general/transversal because they have relevance to all domains/subjects**. In some contexts, the term 'skills' (in a broader sense) is sometimes used as an equivalent of 'competences.'"[65]

The use of competency in a learning environment can take many forms across primary, secondary, and tertiary education, from use as a general tool to measure student growth to the use of a competency-based assessment system. However, authentically building the use of competence into learning experiences requires integrating competency-based educational practices, which encourage equity, exploration, curiosity, and continued learning without the penalization of the traditional definitions of failure[66]. CompetencyWorks[67], an educational research and development initiative, defines **competency-based education** as the following:

> 1. Students are empowered daily to make important decisions about their learning experiences, how they will create and apply knowledge, and how they will demonstrate their learning.

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[65] UNESCO International Bureau of Education. (2017). UNESCO Prototype of a National Curriculum Framework. https://unesdoc.unesco.org/ark:/48223/pf0000260045, p.18.

[66] Getting Smart. (2018). Show What You Know: A Landscape Analysis of Competency-Based Education. XQ Institute. https://xqsuperschool.org/reports/competency-based-education-cbe/.

[67] See: https://aurora-institute.org/our-work/competencyworks/competency-based-education/

2. Assessment is a meaningful, positive, and empowering learning experience for students that yields timely, relevant, and actionable evidence.
3. Students receive timely, differentiated support based on their individual learning needs.
4. Students progress based on evidence of mastery, not seat time.
5. Students learn actively using different pathways and varied pacing.
6. Strategies to ensure equity for all students are embedded in the culture, structure, and pedagogy of schools and education systems.
7. Rigorous, common expectations for learning (knowledge, skills, and dispositions) are explicit, transparent, measurable, and transferable.

It is important to note that even though the list above is presented as a comprehensive set of practices that should all be enacted together, there are many ways to implement them. Each learning environment is unique and requires an individualized approach to a competency-based system[68]. Many incorporate elements of the Competency Works definition or interpret pieces in their own way to suit their particular learners and program. Whatever system or method is designed, the practices used should be established and rooted foundationally from the beginning. As stated in an article by reDesign, *"In competency-based models, the entire system must change. Students advance... when they are ready, not when an arbitrary academic calendar suggests that they should be."*[69]

Implementation Strategies

Implementing competency-based learning strategies is fundamentally about empowering students to become owners of their learning. While educators may use a variety of tools and techniques to create a competency-based learning environment, ultimately students must feel comfortable and confident enough to chart their own paths at their own pace. KnowledgeWorks, a foundation dedicated to educational research and policy, describes practices typical in competency-based k-12 classrooms in the following scenario:

> "In a personalized, competency-based classroom, teachers are moving between groups of learners, facilitating discussions, helping students explore and set goals, or may be engaged in more direct instruction with a few students at a time. Their classrooms may offer flexible seating and students participate in decisions about how and where they learn. They may be working independently or grouped based on what they're working on. Just as the teacher supports their students to take risks and try new things without fear of failure, they're supported in turn by district leaders who foster a collaborative school culture. Everyone is working together, every step

[68] Getting Smart. (2018). Show What You Know: A Landscape Analysis of Competency-Based Education. XQ Institute. https://xqsuperschool.org/reports/competency-based-education-cbe/

[69] reDesign. (2016). What IS the difference between competencies and standards? https://www.redesignu.org/what-difference-between-competencies-and-standards/

of the way."[70]

Just as students must feel ownership and freedom of choice in their learning, educators should also feel empowered to modify learning environments and pedagogical approaches as necessary. Allowing educators the flexibility to adapt to the needs of different learners is critical for supporting the culture of a competency-based system.

In postsecondary environments, similar principles apply, but implementation strategies differ depending on the population of learners being served. Unlike competency-based systems in primary or secondary learning environments that are often adopted as part of a philosophical approach to learning, CBE (competency-based educational) programs at the postsecondary level are typically more practical in nature. The majority of learners enrolled in postsecondary CBE programs are nontraditional students who require a flexible educational model due to competing priorities like work and family. The benefit of CBE for these learners is clear, allowing them to focus on demonstration of competencies rather than seat time to earn credit. According to a report on postsecondary CBE models in the US, "Students can currently receive federal financial aid under two types of CBE models. The first is a course-based model with credit equivalency. In this approach, student competencies are built into particular courses and then mapped back to credit hours... This was the original CBE model and is still the most popular. The second model, direct assessment, abandons consideration of credit hours altogether in favor of a direct measure of student learning such as projects, papers, examinations, presentations, performances, and portfolios."[71] CBE programs reduce the typical barriers to educational success, allowing learners to demonstrate their abilities and progress in differentiated and individualized ways.

Assessment

In a student-centered, competency-based learning environment, *"[a]ssessment is a meaningful, positive, and empowering learning experience for students that yields timely, relevant, and actionable evidence."*[72] Often, this requires adopting a different mindset about what assessment means than we typically see in traditional educational settings. Assessment should put learners at the center, seamlessly embedding evaluative practices as a part of the learning process, rather than functioning as an arbitrary, add-on measurement activity at the end of a learning period. Meaningful assessment encourages learners to show progress both individually and collectively, creatively, and with intention.

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[70] See: https://knowledgeworks.org/resources/role-teacher-personalized-competency-based-classroom/

[71] McClarty, K. & Gaertner, M. (2015). Measuring mastery: Best practices for assessment in competency-based education. American Enterprise Institute for Public Policy Research. https://files.eric.ed.gov/fulltext/ED557614.pdf

[72] Levine, E. & Patrick, S. (2019). *What Is Competency-Based Education? An Updated Definition.* Vienna, VA: Aurora Institute. https://aurora-institute.org/wp-content/uploads/what-is-competency-based-education-an-updated-definition-web.pdf.

The use of competency-based assessment practices, which measure the demonstration of learning outcomes and consider the pace and direction of each student, is encouraged as an alternative to more traditional methods. It is important to note that in primary and secondary environments, which tend to offer a more generalized education, the competencies assessed can be both transversal and domain specific, while in postsecondary programs, which specialize in specific degrees, credentials, and industry-approved certifications, learners are more likely to be evaluated solely on domain specific competencies. Strong learner profiles, which are more commonly seen in postsecondary institutions, allow educators to more easily develop targeted competency-based assessments that meet the aspirations of the learner. Less specific, or more aspirational learner profiles (often called graduate profiles in secondary institutions), require a more complex approach, especially when assessing transversal competencies. For example, a primary or secondary learner may be assessed on transversal competencies like collaboration, communication, or agency, while a postsecondary learner in an accounting program may be assessed on the domain-specific competencies required to process financial data. Both learners can demonstrate progress towards their learning goals through hands-on, project-based work in student-centered environments, even though different types of competencies are being evaluated. Depending on the context, both types of competencies serve important purposes and can provide meaningful assessments learners at different levels and in a range of educational programs.

The table below demonstrates some of the differences in tracking (an ongoing and consistent record of student progress) and supporting systems between traditional and competency-based programs across all levels of education.

Traditional vs. Competency-based Tracking and Supporting Systems[73]

Traditional Systems	Competency-based Systems
Designed to track progress in courses in a predetermined amount of time (10 month school year).	Designed to track progress and growth in competencies over time (e.g., 4 years, all K-12).
Gradebook is for a specific course and a specific teacher.	"Gradebook" is for the student and any teacher can contribute ratings from any learning experience.

[73]https://aurora-institute.org/cw_post/transparently-tracking-and-communicating-progress-and-growth-in-competency-based-schools/

Course is based on seat time (e.g., semester, full year) and grades and credits are awarded based on completing all work in that class assigned by that teacher.	Competencies can be tracked individually or grouped into portfolios and credit is awarded when the proficiency and evidence requirements are met. Evidence can come from any learning experience.
System is configured to reset each school year so courses and data can not remain into the following school year.	System is configured to allow both acceleration in competencies as well as more time in competencies beyond the traditional school year.
Letter or percentage grades do not give information about what was learned and what was not. Inferences can be made that an 80% or a B means a student has learned most things, but the system does not include specifics.	Both performance level and growth are visible and reflect real-time levels so you can pinpoint exact areas of strength and weakness by skill, competency, and competency area.
Course-based grade given after fulfilling seat time requirement. No opportunity for acceleration or crediting through growth measures.	Portfolio system allows credit to be given when students have completed a portfolio at the minimum growth or performance level regardless of seat time. Opportunities for acceleration and crediting through growth measures.
Uses an uncertain mix of assessment, achievement, perceived effort, and behavior to determine the final grade. May use late penalties and extra credit.	Measures achievement only. Work habits, project quality, etc. are assessed and credited separately. No penalties or extra credit given.
Based on a variety of assessment methods (quizzes, tests, homework, projects, etc.). One grade/entry is given per assessment.	Based on performance assessments and one rating is given per skill per assessment based on continua.

To implement the principles that enable a competency-based system of tracking and evaluation, assessment tools can include, but are not limited to: narrative evaluation, student portfolios, formative and summative assessments, and capstone (or thesis) projects.

Narrative Evaluation

Narrative evaluation is an assessment tool that provides students with written feedback on progress, strengths, and areas for improvement. Students can also complete narrative self-evaluations. As students advance through an educational program, a compiled narrative of individual growth and development arises, allowing educators, advisors, and students

themselves to monitor and evaluate progress. Documented benefits of this feedback method include[74]:

- Both students and parents receive more detailed information about particular progress;
- Future educators have a more detailed picture of a student's performance;
- Learning is emphasized, rather than the accumulation of points to achieve a grade;
- Students are described as individuals using words rather than through the use of abstract numbers or letters;
- The relationship between the educator and the student may improve.

Portfolios

The use of portfolios to document a learner's work can be instrumental for embedded, ongoing assessment. Portfolios can take many forms: as tools for documenting process and understanding, as a communication tool between students and educators, and to demonstrate progress at the end of a learning cycle. Periodically, students can curate their portfolios to share publicly or for a summative assessment. Consistently documenting their efforts, especially moments of productive failure, provides students and educators with concrete evidence of learning and improvement. The case for portfolios as an assessment tool is not new. In 1993, the US Department of Education Office of Research[75] published the following,

> "Portfolios, collections of student work representing a selection of performance, are being used in classrooms today in the tradition of the visual and performing arts in which they serve to showcase a student's best pieces and the student's evaluation of the strengths and weaknesses of the pieces. Portfolios are useful as a support to new instructional approaches that emphasize the student's role in constructing understanding and the teacher's role in promoting understanding. Although there is no single way to develop portfolio programs, in all such programs students are expected to collect, select, and reflect on their work. Research supports the finding that student awareness of work and of evaluation strategies is enhanced through portfolios. The use of portfolios is not without drawbacks, primarily in the time and effort required, but these are generally seen to be worthwhile burdens."

Portfolios can also be used as a graduation requirement. In California, the Los Angeles Unified School District (LAUSD) expects students in the Linked Learning Pathway to complete a portfolio containing artifacts of learning, paired with a presentation "in which

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[74] Vorenkamp, E. (2020). Narrative Reporting. Michigan Assessment Consortium. https://www.michiganassessmentconsortium.org/wp-content/uploads/ALD-Narrative-Reporting.pdf.

[75] S Sweet, D. & Zimmermann, J. (1993). Student Portfolios: Classroom Uses. Office of Research Education Consumer Guide, no. 8; pp 2-5. https://files.eric.ed.gov/fulltext/ED366634.pdf

students 'defend' their knowledge, their dedication to community, and their ability to set and achieve measurable and actionable goals" to members of their community in order to graduate.[76]

Formative and Summative Assessment

Assessment and learning are integrated and reciprocal. Formative assessment allows educators to check for student understanding and adapt instruction to better meet individual needs. A 1998 research review on formative assessment found that formative assessments are a highly effective way to improve student learning across ages, subject areas, and geographies.[77] It notes that formative assessment should include timely feedback on the quality of student work and advice on how it can be improved, along with student self-assessment and reflection. It states, "when anyone is trying to learn, feedback about that effort has three elements: recognition [of] the desired goal, evidence about the present position, and some understanding of a way to close the gap between the two. All three must be understood to some degree before he or she can take action to improve learning."[78]

Education expert Margaret Heritage describes three broad categories of formative assessment[79]:

1) on-the-fly assessment that often occurs when a teacher listens to a group discussion and notices a misconception. The teacher can quickly change direction and provide quick remediation;
2) planned-for interaction in which the teacher decides before how they will elicit student thinking and what evidence they hope to gather by doing so;
3) Curriculum-embedded assessments, which are ongoing and embedded, such as a portfolio or notebook that is part of regular classroom activity.

Classroom dialogue, both between educators and learners and among learners, can provide educators with important formative evidence. This is especially true when educators employ cooperative learning strategies (ie, turn-and-talks, think-pair-share[80]) to ensure that all students can focus and express their ideas[81]. Formative assessment can also take a more playful approach, incorporating fun and authentic assessments that allow students to

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[76] See https://achieve.lausd.net/Page/11477.

[77] Black, P., & Wiliam, D. (1998). Assessment and classroom learning. Assessment in Education: principles, policy & practice 5, no. 1: 7-74.

[78] Black, P., & Wiliam, D. (2010). Inside the black box: Raising standards through classroom assessment. Phi Delta Kappan 92, no. 1: 81-90.

[79] Heritage, M. (2007). Formative assessment: What do teachers need to know and do? Phi Delta Kappan 89, no. 2: 140-145.

[80] See: https://publications.ici.umn.edu/ties/foundations-of-inclusion-tips/turn-and-talk-in-the-inclusive-classroom

[81] Black, P., & Wiliam, D. (2010). Inside the black box: Raising standards through classroom assessment. Phi Delta Kappan 92, no. 1: 81-90

demonstrate their abilities in different ways. Some strategies that go beyond more common techniques of formative assessments include:

- Beyond Rubrics[82], a toolkit (which includes self-assessment) for capturing qualitative and quantitative evidence during the process of making.
- Metarubric[83], a learning experience designed to give players an experience creating and using rubrics for open-ended work.
- Playful Learning Assessment Tool[84], a tool for assessing playful learning.
- Game-based assessment tools that make it possible for students and teachers to understand learning outcomes in an engaging and robust way.[85]

Using multiple strategies for formative assessment ensures that students will receive feedback from educators (teachers, advisors, mentors) and from each other at multiple points during the learning process. Summative assessment, by contrast, is used to evaluate a student's overall progress cumulatively:

> "Assessment is a term that covers any activity in which evidence of learning is collected in a
> planned and systematic way, and is used to make a judgment about learning. If the purpose is to help in decisions about how to advance learning and the judgment is about the next steps in learning and how to take them, then the assessment is formative in function. If the purpose is to summarize the learning that had taken place in order to grade, certificate or record progress, then the assessment is summative in function. "[86]

Summative assessment is typically used to evaluate student learning at the end of an instructional unit or learning period. Examples include: a midterm exam, a final project, a paper, a senior recital or a capstone project.[87] Educators can use completed projects, reports, reflections and self-evaluations, and student performance on presentations as summative assessments. Summative assessments can provide insight for educators about what teaching methods and curricular materials worked well and what needs to be changed for the future; provide information for students and educators about what skills, competencies and information transfer they are progressing towards proficiency or mastery in; and, provide a reporting structure for external stakeholders. Together, formative

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[82] https://makered.org/beyondrubrics/overview/

[83] https://playful.mit.edu/projects/metarubric/

[84] https://pz.harvard.edu/resources/pedagogy-of-play-playbook-resources

[85] https://education.mit.edu/project/shadowspect/#overview

[86] Harlen, W. & Deakin Crick, R. (2002). A systematic review of the impact of summative assessment and tests on students' motivation for learning (EPPI-Centre Review, version 1.1*). In: Research Evidence in Education Library. Issue 1. London: EPPI-Centre, Social Science Research Unit, Institute of Education.

[87] Eberly Center at Carnegie Mellon University. What is the Difference Between Formative and Summative Assessment? https://www.cmu.edu/teaching/assessment/basics/formative-summative.html

and summative assessments allow educators, learners, and others involved to understand how a learner is progressing and what they will need to succeed moving forward.

Capstone Project

Capstone (or thesis) projects give students an opportunity to demonstrate academic rigor, innovative thinking, and mastery of concepts, topics, and skills of their choosing. Through a thesis project, students engage in a "culminating set of experiences that captivate, encapsulate, synthesize, and demonstrate learning."[88] Depending on context, projects can be done either individually or collaboratively, featuring each student's work in a personalized way. Additional benefits to thesis (or capstone) projects include: improving self-confidence through significant self-driven work, developing professional skills and competencies, honing academic focus and career direction, and growth of personal and professional relationships, among others.

[88] Rowles, C., Koch, D., Hundley, S. & Hamilton, S. (2004). Toward a Model for Capstone Experiences: Mountaintops, Magnets, and Mandates. Assessment Update 16, no. 1.

Design Approach

The design approach is the final component of the Learning Architecture, combining the theory, practices, and methods detailed in previous sections into an actionable set of practices to create new learning experiences. To begin, the Learning Architecture identifies five main design principles, adapted from the principles for curriculum design outlined in the whitepaper by Project NEI, "Ideas for Designing An Affordable New Educational Institution"[89]. They are:

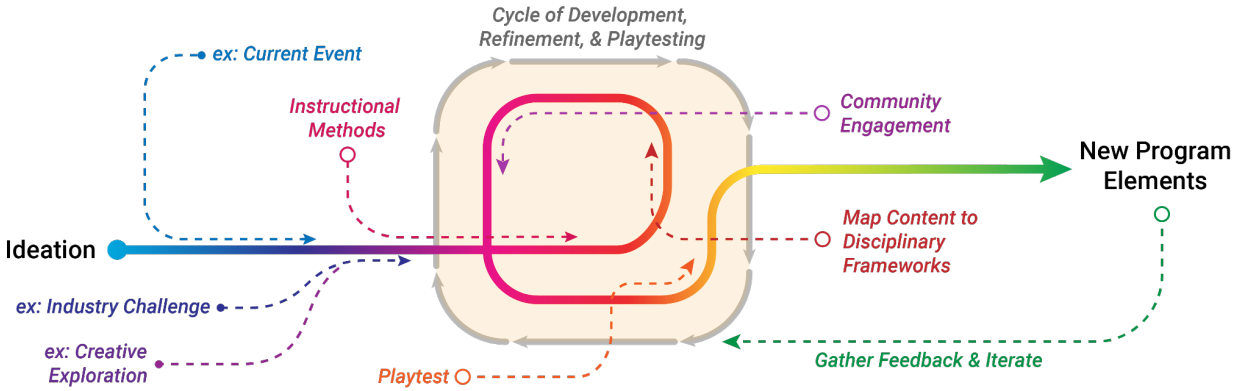
1. Less is more. In other words, a focus on proficiency in key concepts, rather than on overloading the curriculum, is beneficial for students in the long term.
2. The program should be built around extensive periods of time that allow learners and educators to dive deeply into transdisciplinary questions, areas of interest, and hands-on projects.
3. Community partnerships and other forms of community engagement are incorporated into the program from the very beginning.
4. Whereas the traditional academic institution may offer a vast choice of courses, a more modest choice of courses, but freedom within the courses through project work better supports hands-on, student-centered learning and unique, personalized learning experiences.
5. Learning experiences should be designed to support competences that are well defined, explicit, and help learners progress towards holistic developmental goals.

These principles function as a set of guidelines to facilitate the overall design of a program. In educational settings where new programmatic and curricular elements are regularly developed and iterated on, the principles above are a decisive way to evaluate whether new material or experiences fit within the framework of this Learning Architecture.

Creating new learning experiences is an iterative cycle that requires ongoing research and development to refine over time. Beginning with brainstorming and ideation (including adapting existing material), designers then prototype, build, and test their concepts, continuously iterating and modifying to best fit the needs of their students and support intended outcomes.

[89] Sarma, S., et al. (2022) Ideas for Designing an Affordable New Educational Institution [White paper]. Project NEI and MIT J-WEL. https://www.projectnei.com/

Design Cycle



The design cycle is a nonlinear process that begins with ideation and continues in perpetuity through cycles of playtesting, gathering feedback, and refining.

Designing educational experiences is not always a straightforward process, requiring dedicated time, resources, knowledge, and creativity to implement successfully. Synthesized and drawn from research on innovative schools, programs, and practitioners[90], the best practices for design that follow are important to keep in mind when developing new learning experiences. They are organized into five broad categories: Designing Learning Experiences; Approaches to Teaching and Learning; Community and Outside Engagement; Supporting the Design Process; and Ongoing Development.

Designing Learning Experiences

Designing learning experiences focuses on the origination of new ideas. When designing a new experience, class, or program element, creator(s) should begin from a big picture perspective, considering large, integrative themes, questions, or concepts that are: interesting and relevant to learners and the local context, have a STEAM lens, align with the program's KLAs, and can be mapped to relevant disciplinary frameworks. For example, designers could look at major issues that are being dealt with locally and nationally, issues important to students, new research in areas of interest, future initiatives in the region over the next 5-10 years, global challenges being posed in different industries, or creative explorations on a particular theme, among countless others. The perspective taken on a given topic can vary based on the age and/or level of the learners the experience is being designed for. In earlier years, when the program has a greater emphasis on social, emotional, and cultural learning,[91] a class about food may be taught through a more personal lens, focusing on the individual, familial, and ritualistic aspects of food in our lives. A class in the later years, however, when students are more deeply immersed in transdisciplinary academics, may approach the topic of food through a scientific

[90] See the References and Resources section.

[91] See the Foundational Pillars section.

exploration of sustainable agriculture practices and bioengineering. In all instances, the ability for learners to engage with a topic in a way that is meaningful to them and aligns with their own interests[92] is critical.

Approaches to Teaching and Learning

Approaches to Teaching and Learning encompasses the pedagogical approaches covered in the Transdisciplinary Academics section of Core Practices (see section 5), including the use of project and inquiry based learning, constructionism, and hands-on making and fabrication (both digital and physical). It is important to note that teaching, learning, and projects are not separated from one another– teaching and learning happen *through* projects, which should always be meaningful and relevant to students. Project scope and frequency can vary and should be determined by the designers based on topic and flow. Educators should also stay abreast of new developments in approaches to teaching and learning informed by emerging science in learning and development, incorporating them when relevant.

Community and Outside Engagement

As designers build out new program elements, consideration should be given to how learners can engage with the outside community to link the work happening inside the institution with relevant work or events in the outside world. As noted earlier in the Core Practices section on Community Partnerships, this can happen through industry or organizational partnerships for project development, off campus experiences that allow learners to meet with experts, conduct field research or see things in action, or working on a project located at a specific site. At Dearborn STEM Academy, for example, curriculum designers collaborate with a panel of experts from industries corresponding to the school's career pathways to align class content with the most relevant topics in the field. This is one way of engaging external partners that ensures real world applicability without requiring an ongoing time commitment from partners. MIT's Terrascope[93] program provides another approach, offering students the opportunity to design solutions to complex, real-world problems facing individuals and communities around the world. Through courses like *Design for Complex Environmental Issues*, students "engage with real clients, learn their needs and priorities, and in consultation with them design, prototype and fabricate solutions."[94] However they choose to work with the outside community, program designers have the opportunity to think creatively about how they can collaborate with external partners to explore pertinent topics and develop relevant experiences for learners.

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[92] See the Core Practices section on Student-Centered Learning.

[93] See https://terrascope.mit.edu/

[94] See https://terrascope.mit.edu/portfolio_page/1-016/

Supporting the Design Process

The way designers engage in designing new program elements depends on the environment and conditions that enable the content they develop to be successful, meaningful, and relevant. A sustainable, well-designed program should incorporate the following:

- **Co-design**
  New curriculum and program elements co-designed by educators with different disciplinary expertise, allowing for a truly transdisciplinary approach that explores a large question or concept from multiple perspectives.
- **A Live Curriculum**
  The curriculum should be considered “live” by the educator(s), meaning that it can be adapted and changed depending on circumstances in the classroom and in the outside world. Educators should be empowered with the flexibility to modify content, duration, and projects and activities as needed.
- **An Experimental Ethos**
  Iteration, experimentation, and considering new perspectives and approaches to both instruction and content should be welcomed and encouraged. Designers should feel inspired to design new program elements and iterate on existing ones creatively.
- **Meaningful Support Time for Collaboration**
  To effectively codesign new program elements and support the implementation of existing ones, educators should be given appropriate resources and ample time together for collaboration and co-design. This is especially important if they are co-facilitating different parts of a curriculum and need to align with each other to iterate and adjust as needed.
- **Professional Wellbeing**
  Developing new program elements and continuously iterating for improvement can be a strain for educators, especially when they are also program designers. Acknowledging this, allocating the time and physical space for work to happen, creating opportunities for professional development and mentorship, and making space for feedback will provide the appropriate conditions for success.

Ongoing Development

Ongoing processes that support the development of learning experiences and their iteration over time are an important factor in an educational institution that regularly incorporates new elements. Three primary ways of approaching this emerged out of the research and analysis done on existing curriculum development practices. The first is the

use of existing Open Educational Resources (OER)[95] that are remixed to suit the particular needs of the educator and the institution. OER content exists under a Creative Commons License, in which anyone can use or adapt content, as long as credit is given to the creator.[96]

The second is the use of data collection systems to gather qualitative and quantitative data about learning, including whether learning experiences have been successful and impactful. This can be done through assessments, portfolios, educator reflections, and student feedback. In turn, these inputs feed the cycle of iteration, providing direction on what can be improved for the future.

The third, and perhaps most important, process for ongoing development is playtesting. Playtesting is a practice in which educators and designers test new program elements with real users (learners) before deploying it in a "real" setting. Through playtesting, educators can test how program elements and projects will work in different situations, practice teaching techniques, and refine their delivery to be more effective. Participants can also give feedback in real-time about what is successful and what is not, an invaluable tool when designing something new.

In putting this set of best practices to use, designers and educators will have a set of tools and principles to guide them in developing new learning experiences.

[95] https://www.oercommons.org/

[96] https://www.oercommons.org/about

Conclusion

The Learning Architecture offers practitioners interested in transformation in education a framework to anchor their thinking about possible and desirable futures. Responding to critical challenges currently faced in education, including relevance and applicability, preparation for life and careers, thinking beyond short term outcomes, mental health and wellbeing, and cost, among others, it:

- Presents three foundational pillars that bring together the experiences of learners beyond academics, adding social, emotional, and cultural learning and community engagement to transdisciplinary academics to form a three part Venn diagram.
- Puts learners at the center and responds to their needs by bringing together evidence-based approaches and practices that support the learning journey. As practitioners use this document, they can continue to customize and extend what works best in local contexts.
- Proposes key learning areas (KLAs) as major categories of learning within which the program and learning experiences are anchored and provides examples of how they are used at the high school and university levels. The transdisciplinary nature of these KLAs fosters creative exploration, both in content and pedagogical approach, and represents current local and global contexts.
- Integrates competency-based learning and assessment with the understanding that there are multiple methods and levels of implementation. A competency-based approach can range from focusing on the development of competencies at the level of the graduate profile, to embedding competency development into learning experiences, to tracking and reporting on competencies for learners and other stakeholders.
- Proposes an approach for the design and implementation of learning experiences that combines the theory, practices, and approaches presented in the document into an actionable set of principles.

In coalescing these ideas to rethink education, this framework posits that fundamentally, educators are designers. To create powerful learning experiences and environments for learners, educators must have the agency, training, and tools to innovate—not only in their classrooms, but within the larger educational ecosystem. The idea of educators as designers is not a new one; many people have framed the educator's role this way. This document, however, attempts to go further, providing a fuller context of what that means systemically for learners, educators, and approaches to teaching and learning in an educational setting. It offers a vision with the learner at the center, helps organize different elements of the educational landscape, and shows how to connect those elements to create large scale, meaningful change in education.

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