VERSION JAN 31, 2024

PYTHAVERSE COCREATE FRAMEWORK

EMPOWERING CREATORS: HARNESSING AI, IOT, ROBOTICS, AND THE METAVERSE WITH PYTHAVERSE COCREATE LEARNING COMPETENCIES

TABLE OF CONTENTS

pythaverse
My Digital Twin

EXECUTIVE SUMMARY

Brief Overview of the Framework

WHAT IS PYTHAVERSE?

Pythaverse is an educational platform that focuses on integrating advanced technologies like Artificial Intelligence (AI), the Internet of Things (IoT), Robotics, and the Metaverse into K-12 learning environments. The core mission of Pythaverse is to revolutionize the educational landscape, making it more technologically advanced, holistic, inclusive, and forward-thinking.

The platform is designed to empower learners to become not just users of technology, but innovators and creators in their own right. It emphasizes a dynamic and interactive process of education that encourages creativity, critical thinking, and the practical application of knowledge. Pythaverse aims to bridge the gap between traditional education methods and the rapidly evolving digital world, ensuring students are equipped with the skills needed to thrive in the 21st century.

Key objectives of the Pythaverse Platform include holistic development, innovation and creativity, accessibility and inclusivity, adaptability and future-readiness, collaboration and co-creation, and practical application. By aligning education closely with technological advancements and global workforce demands.

WHAT IS PYTHAVERSE COCREATE FRAMEWORK?

The Pythaverse COCREATE Framework is a model in educational competencies , thoughtfully designed to integrate cutting-edge technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), Robotics, and the Metaverse within K-12 learning environments. This strategic fusion aims not only to boost student engagement and enhance educational outcomes but also to prepare students for the future, empowering them to be innovators and creators.

The Pythaverse COCREATE Framework serves as the theoretical and structural backbone for the Pythaverse platform, guiding its educational philosophy, content, methodologies, and technological integrations. The platform operationalizes the framework's concepts, making them accessible and practical for its users.

Structured to offer a layered and comprehensive learning experience, the framework covers a wide spectrum of digital and collaborative competencies. It is methodically organized into various proficiency levels, ranging from introductory to advanced, ensuring a progressive and inclusive educational journey for all students.

The framework's primary pillars encompass Responsible Citizen Competencies, Digital Twin Technology Competencies, and Co-Creation Competencies. Each of these areas is carefully crafted to support the allround development of students, equipping them with the necessary skills to thrive in today's dynamic digital world.

WHY PYTHAVERSE COCREATE FRAMEWORK?

The Pythaverse COCREATE Framework was driven by the necessity to adapt education to the rapidly evolving landscape of AI and digital technology. Recognizing that traditional educational models were becoming insufficient for equipping students with essential 21st-century skills, the framework aims to bridge the growing skills gap in the modern workforce.

It focuses on fostering holistic development, including critical thinking, ethical judgment, and emotional intelligence, alongside technical proficiency. The urgency to prepare students not just as users but as responsible innovators and leaders in technology was a key motivator. This framework is a response to the imperative need for education that empowers students to drive technology, rather than being passively driven by it, in an increasingly interconnected and technologically advanced world.

HOW WE BUILD THE PYTHAVERSE COCREATE FRAMEWORK?

As the authors of the Pythaverse COCREATE Framework, our journey began nearly two decades ago with a team of dedicated educators and technologists from various countries in South East Asia. Our collective endeavor was driven by a critical question: How can we promote human values over technology in a pragmatic way within the realm of STEM education?

Throughout the development of this framework, we have been fortunate to receive invaluable advice from esteemed Pythaverse advisers. Their insights have been instrumental in shaping our vision, particularly in areas like sharing social responsibility, making elite education more accessible, and incorporating cognitive science into educational technologies.

> ***"Every society will become better if the citizens are well aware of their responsibility toward society. The maturely responsible citizens pave the way for many outstanding members in their society think and act globally for a better world. The education not only in developing countries but also in under-developed areas of developed countries in 21st century and afterward will benefit from global volunteerism, transnational digitalization and sharing economy on international scale."***
>
> Mr. Nguyen Quang Thach, a distinguished UNESCO Literacy Award Winner and an esteemed advisor for Pythaverse, is renowned for his significant contributions to literacy and education.

Our work involved an extensive review process, during which the draft of the framework was circulated among a wide array of experts in South East Asia. Their feedback was pivotal in enhancing our focus on core values over technologies. They provided profound pedagogical insights and practical implementation advice, allowing us to refine our approach and ensure the framework's relevance and effectiveness.

The final version of the Pythaverse COCREATE Framework, therefore, is not just a product of our team's expertise but also a reflection of the collective wisdom and contributions of a broader community of educators and experts. It represents a harmonious blend of technological competencies with a strong emphasis on humanistic principles, tailored to meet the educational needs of the digital age.

Importance and Relevance in the Current Educational Landscape

In today's rapidly evolving world, where technology plays a pivotal role in every aspect of life, traditional educational models are increasingly falling short in preparing students for the future. The COCREATE Framework addresses this gap by offering a curriculum that goes beyond traditional academic learning. It emphasizes the development of technical skills, ethical understanding, creative problem-solving, and adaptability, making it highly relevant and crucial in the current educational landscape.

This framework is not just about imparting knowledge; it's about shaping learners who are technologically adept, socially responsible, innovative, and adaptable to the ever-changing technological advancements. The COCREATE Framework aims to bridge the gap between the skills taught in traditional educational settings and those required in the modern workforce. It prepares learners for future careers, many of which are closely intertwined with emerging technologies, and equips them with the skills necessary to excel in a technology-centric world.

By aligning education closely with technological advancements and global workforce demands, the COCREATE Framework sets a new standard in educational paradigms. It represents a significant step towards redefining how learning is approached in the digital age, creating a generation of learners equipped to navigate and contribute positively to a technology-driven future.

BACKGROUND

The Evolving Landscape of Education and Technology

In recent years, the landscape of education has undergone significant transformation, driven by rapid advancements in technology. Traditional educational models, once effective, are increasingly challenged by the pace of change in the digital age. Technologies such as AI, IoT, Robotics, and the Metaverse are not just reshaping industries but are also altering the way we live, communicate, and learn. This evolution demands a new approach to education, one that goes beyond rote learning and passive absorption of information.

The need for a new learning framework arises from the necessity to integrate these technological advancements into the educational curriculum. The goal is to create learning environments that are dynamic, interactive, and aligned with the skills and competencies required in the 21st century. It's about preparing students not just to use technology, but to understand it, innovate with it, and apply it responsibly in various aspects of life.

The Gap Between Traditional Education and Modern Workplace Requirements

The traditional education system, largely unchanged for decades, often focuses on memorization and standardized testing, leaving little room for creativity, critical thinking, and practical application of knowledge. This approach is increasingly proving inadequate in preparing students for the modern workforce. Today's job market demands not just academic knowledge but a suite of skills including digital literacy, creative problem-solving, adaptability, and continuous learning.

The gap between what is taught in schools and the skills needed in the workforce is widening. Many graduates find themselves ill-equipped for the demands of modern careers, particularly those in technology and innovation-driven fields. This gap is not just a challenge for individuals but also for economies and societies, as they strive to stay competitive in a global, technology-driven marketplace.

A new learning framework, like the COCREATE Framework, seeks to address these challenges. It aims to realign education with the realities of the digital age, ensuring that students are not just consumers of technology but active creators and innovators. This framework is an answer to the urgent need for an educational system that prepares learners for the complexities of the modern world, equipping them with the skills, knowledge, and mindset to thrive in a rapidly changing technological landscape.

THE NEED FOR A NEW LEARNING FRAMEWORK

Urgent need for Advancing STEM Education

Traditional approaches to STEM (Science, Technology, Engineering and Mathematics) education have focused predominantly on building students' technical skills within siloed subject areas. However, in an increasingly interconnected world, where solutions span global supply chains and diverse teams, this limited approach is proving inadequate. STEM learning must equip students not only with core technical abilities, but also with the critical thinking, creativity, and cultural awareness to apply these skills to real-world problems.

Enhancing STEM Education for Co-Creation with Technology in the AI Era

As we venture further into the age of Artificial Intelligence, the traditional approach to STEM education requires a significant evolution to not only understand technology but to co-create with it. This necessitates an educational transformation that encompasses:

- **Practical Application in the AI Context**: Traditional STEM curriculums often lack emphasis on how theoretical concepts apply in the realm of AI. For instance, teaching algorithms or data structures can be more engaging when linked to how they underpin AI technologies in areas like healthcare or environmental management.
- **Interdisciplinary Collaboration with a Tech Focus**: The integration of AI and technology in real-world problems requires a fusion of disciplines. Projects that combine STEM with arts, humanities, and social sciences can lead to more innovative AI applications, reflecting the multifaceted nature of real-world issues.

- **Fostering Innovation in Technology**: Moving beyond basic technological literacy, education should inspire students to use tools like coding and data analysis creatively. For example, students could use machine learning algorithms not just for data processing, but to create new forms of art or to solve complex societal issues.
- **Global Perspectives in Tech Solutions**: Understanding the global impact of AI and technology is crucial. Discussing diverse international approaches to AI ethics or data privacy can prepare students for the global stage of tech development and application.
- **Problem-Solving with AI and Environmental Considerations**: STEM subjects should directly address how AI can be leveraged to tackle urgent societal and environmental challenges, such as climate change or sustainable urban development.
- **Co-Creation with Emerging Technologies**: Emphasizing a co-creative approach with technology, where students are not mere users but active creators and innovators. This could involve designing AI-based solutions to community problems or developing new technologies that address local needs.

By integrating these elements, STEM education can evolve to meet the demands of the AI era, preparing students to not only understand but also creatively contribute to and ethically shape the future of technology.

The Value of a Co-Creation Approach

As AI, machine learning and intelligent systems are integrated across industries, future careers will involve closer human-technology collaboration.

Students must be equipped not just to use technology, but to co-create and innovate alongside it. Nurturing co-creation competencies from a young age, such as design thinking, solution prototyping and user-centricity, will enable more organic symbiosis with emerging technologies. Exposure to real-world problem scenarios where AI and automation play crucial roles will prepare learners to fully leverage these tools as partners rather than replacements.

With resilient mindsets rooted in creative confidence, adaptability and cognitive flexibility, students can enhance technology for societal benefit rather than compete against it. The intentional development of co-creation abilities ensures students can thrive in AI-powered workplaces and lead cutting-edge innovation.

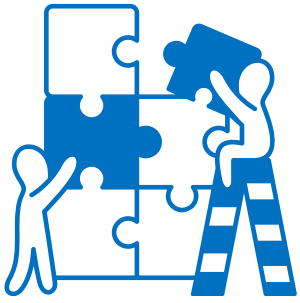
Preparing Students for the Future

As the world becomes more interconnected, today's students will participate in global teams tackling complex problems. Careers now span international supply chains– technical skills must align with the ability to operate cross-culturally.

The Pythaverse COCREATE Framework

The Pythaverse COCREATE Framework brings together STEM foundations with global competencies and co-creation opportunities.

This forward-looking model equips learners to apply technical knowledge innovatively on the global stage. It nurtures adaptable, solution-focused individuals ready to overcome modern challenges.

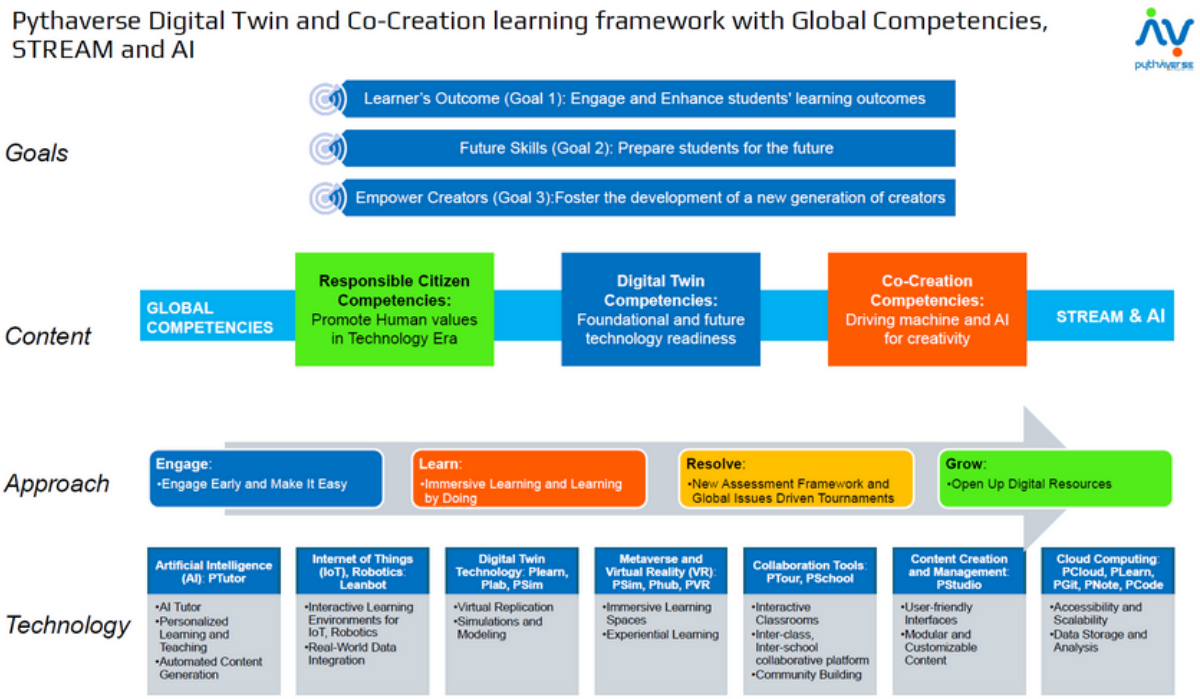


OVERVIEW OF PYTHAVERSE PLATFORM AND ITS MISSION

The Core Mission of the Pythaverse Platform

The core mission of the Pythaverse Platform is to revolutionize the educational landscape by seamlessly integrating advanced technologies such as AI, IoT, Robotics, and the Metaverse into the learning experience. Pythaverse is dedicated to fostering an educational environment that is not only technologically advanced but also holistic, inclusive, and forwardthinking. The platform's mission centers around empowering learners to become not just users of technology but innovators and creators in their own right.

At the heart of Pythaverse's mission is the belief that education should be a dynamic, interactive process that encourages creativity, critical thinking, and practical application of knowledge. The platform aims to bridge the gap between traditional education methods and the rapidly evolving digital world, ensuring that students are equipped with the necessary skills to thrive in the 21st century.



Objectives of the Pythaverse COCREATE Framework

1. Fostering Holistic Development: Cultivate an education model that harmoniously combines technical proficiency with critical thinking, creativity, ethical judgment, and emotional intelligence, aiming to shape individuals who are both technologically skilled and ethically grounded.

2. Encouraging Innovation and Creativity: Establish an educational environment that nurtures innovation and creative problem-solving, motivating learners to think creatively and approach challenges with innovative solutions.

3. Ensuring Accessibility and Inclusivity: Strive to make quality, technology-focused education universally accessible, breaking down barriers related to geography and socio-economic status to include diverse learners from various backgrounds.

4. Maintaining Adaptability and Future-Readiness: Commit to regularly updating the educational content to reflect the latest technological advancements and industry trends, thereby preparing learners for careers deeply integrated with advanced technologies.

5. Promoting Collaboration and Co-Creation: Advocate for and implement collaborative learning experiences, where students, educators, and industry experts engage in mutual knowledge exchange and co-create solutions, particularly emphasizing human-machine collaboration, especially with AI technologies.

6. Bridging Theory with Practice: Actively work to close the gap between theoretical learning and real-world application by providing experiential learning opportunities like simulations and project-based learning, ensuring students not only learn about technology but also understand its practical application.

CORE PRINCIPLES AND PHILOSOPHY OF THE PYTHAVERSE COCREATE FRAMEWORK

The Pythaverse COCREATE Framework is founded on principles and philosophies that prioritize holistic development and rational agency, particularly crucial in the digital era.
In Educational theory, Bloom's Taxonomy provides a structured way of looking at cognitive development, progressing from basic knowledge acquisition to complex critical thinking and creative skills. While its relevance remains undisputed in traditional educational settings, the advent of the AI era necessitates adjustments to this model. The rapid evolution of technology, particularly AI, challenges educators to rethink how cognitive skills are taught and assessed.

In response to these challenges, the Pythaverse COCREATE Framework integrates Joscha Bach's stages of lucidity. This integration is crucial for several reasons:
1. Complementing Bloom's Taxonomy with Emotional and Cognitive Maturity: While Bloom's Taxonomy excellently outlines cognitive development, the stages of lucidity add layers of emotional and self-awareness development. This is especially pertinent in an AI-dominated era where machines can replicate many cognitive skills.
2. Enhancing Creativity and Higher-Order Thinking: The AI era demands creativity and higher-order thinking skills that transcend mere technical prowess. The stages of lucidity, particularly the 'Self Authoring' and 'Enlightened Mind' stages, align with Bloom's highest level of creating. They emphasize the need for deep self-awareness and a nuanced understanding of the world, going beyond what AI can achieve.
3. Preparing for Ethical Challenges: AI brings complex ethical dilemmas. The 'Rational Agency' stage in the stages of lucidity, aligning with Bloom's analyzing and evaluating stages, emphasizes independent thought and responsibility for one's actions, essential for navigating these challenges.
4. Fostering Lifelong Learning and Adaptability: In an ever-changing technological landscape, the ability to continually learn and adapt is crucial. The stages of lucidity encourage ongoing personal and intellectual growth, aligning well with the progressive nature of Bloom's Taxonomy.

Stages of Lucidity and the Importance of Helping Students to Have Rational Agency

In the stages of lucidity model[1], these are the stages:

1. Reactive Survival (Infant Mind): This initial stage is characterized by innate reflexes and basic learning processes forming the foundation of consciousness and perception.

2. Personal Self (Young Child): Here, the development of a personal identity begins, with the mind distinguishing itself from its external environment.

3. Social Self (Adolescence, Domesticated Adult): This stage involves developing a social identity, understanding social emotions, and assimilating societal ideas and morality.

4. Rational Agency (Epistemological Autonomy, Self-Directed Adult): Individuals gain the ability to think independently, develop their own belief systems, and take responsibility for their emotions and desires.

5. Self Authoring (Full Adult, Wisdom): This stage involves a deeper understanding of one's motivations and the formation of a more mature, self-authored identity.

6. Enlightened Mind: A stage characterized by profound insight into the nature of perception, motivation, and consciousness, often associated with advanced meditation practices.

7. Transcendent Mind: This final stage involves surpassing conventional consciousness and exploring more expansive forms of sentience and agency.

In the AI era, adapting Bloom's Taxonomy becomes crucial, particularly when integrated with Joscha Bach's stages of lucidity. This combination within the Pythaverse COCREATE Framework offers a comprehensive framework for cognitive and emotional development, emphasizing the need for higher cognitive and emotional maturity, especially in creative processes:

[1] https://joscha.substack.com/p/levels-of-lucidit

1. Reactive Survival (Infant Mind) and Bloom's Remembering Stage: This stage, focusing on basic learning processes and memory formation, aligns with Bloom's initial stage of remembering, highlighting the unique human capacity for emotional and contextual memory, beyond AI's data storage capabilities.
2. Personal Self (Young Child) and Bloom's Understanding Stage: As learners develop a personal identity, they begin to understand their environment. This corresponds with Bloom's understanding stage, underscoring the significance of individual perspectives and interpretation, a facet where AI lacks depth.
3. Social Self (Adolescence, Domesticated Adult) and Bloom's Applying Stage: The development of social identity and emotional intelligence is crucial in this era. It aligns with Bloom's applying stage, emphasizing human skills in applying knowledge in social and emotional contexts, beyond the scope of AI.
4. Rational Agency (Self-Directed Adult) and Bloom's Analyzing and Evaluating Stages: Independent thinking and emotional self-regulation correspond with analyzing and critically evaluating information in Bloom's taxonomy, skills essential for ethical decision-making in AI-mediated environments.
5. Self Authoring (Full Adult, Wisdom) and **6. Enlightened Mind with Bloom's Creating Stage**: In the AI era, the creating stage takes on new significance. It involves not just generating ideas but also deep self-awareness (Self Authoring) and insight into perception and consciousness (Enlightened Mind), highlighting the unique human contribution in innovation.
7. Transcendent Mind: Going beyond traditional educational frameworks, this stage invites exploration beyond conventional consciousness, essential in comprehending and navigating the complex realms introduced by AI.

Adapting Bloom's Taxonomy with the stages of lucidity for the AI era within the Pythaverse framework stresses the importance of a holistic educational approach. This approach balances technical skills with deep cognitive and emotional development, preparing learners to engage with AI not merely as users but as conscious, ethically aware contributors to a technologically advanced world.

The framework is designed to guide learners through various stages of lucidity, with a special emphasis on achieving Stage 4 - Rational Agency. This stage is essential for navigating challenges such as digital information overload, global crises, rapid technological advancements, and social and political polarization.

Helping students reach Stage 4 - Rational Agency - is particularly crucial now for several key reasons:

- **Digital Information Overload:** In the age of the internet and social media, students are bombarded with vast amounts of information, necessitating the ability to discern credible sources and form independent judgments.
- **Global Challenges:** The world faces complex global challenges like climate change and pandemics, requiring individuals who can think critically, evaluate information objectively, and contribute to informed decision-making.
- **Technological Advancements:** As technology, especially in AI and data science, rapidly evolves, students need to develop a rational and ethical framework to navigate these advancements responsibly.
- **Social and Political Polarization:** In an era of increasing polarization, the ability to think independently and engage in rational discourse is vital for maintaining a healthy and values-driven society.

Fostering Rational Agency equips students not only with critical thinking skills but also with the resilience and adaptability needed in today's fast-changing and often uncertain world. This development is integral for preparing them to be responsible, informed, and proactive citizens.

Foundational Principles and Philosophies

In order to do that, the Pythaverse COCREATE Framework is built upon a set of foundational principles and philosophies that guide its approach to education in the digital era. These core principles are integral to achieving the framework's mission and objectives:

- **Holistic Development:** Pythaverse places a strong emphasis on the holistic development of learners. This involves nurturing not just technical proficiency but also fostering critical thinking, creativity, ethical judgment, and emotional intelligence. The framework aims to develop well-rounded individuals who can navigate the complexities of the modern world with a balanced perspective.
- **Learner-Centered Approach:** The framework adopts a learner-centered approach, prioritizing the needs, interests, and learning styles of individual students. This philosophy ensures that education is personalized, relevant, and engaging, catering to the diverse backgrounds and aspirations of learners.
- **Innovation and Creativity:** Encouraging innovation and creativity is a cornerstone of the Pythaverse philosophy. The framework seeks to inspire learners to think outside the box, approach challenges with a solution-oriented mindset, and harness their creative potential to innovate and solve real-world problems.

- **Emmerging Technology Integration:** Integral to the framework is the seamless integration of advanced technologies like AI, IoT, Robotics, and the Metaverse. This principle is about more than just using technology; it's about understanding its implications, creating with it, and applying it responsibly in various domains.
- **Ethical and Responsible Use:** Ethical considerations and the responsible use of technology are central to the Pythaverse philosophy. The framework instills in learners a deep understanding of the ethical implications of technology, emphasizing digital citizenship, data privacy, and sustainable practices.
- **Adaptability and Resilience:** In a rapidly changing technological landscape, adaptability and resilience are crucial skills. The framework encourages learners to be flexible, embrace change, and develop the resilience needed to navigate and thrive in an ever-evolving world
- **Collaboration and Interdisciplinary Learning:** Pythaverse values collaboration and interdisciplinary learning. The framework promotes teamwork, cross-disciplinary problem-solving, and collaboration between students, educators, and industry experts, facilitating a rich exchange of ideas and perspectives.

- **Continuous Learning and Improvement:** The philosophy of continuous learning and improvement permeates the framework. Pythaverse encourages a mindset of lifelong learning, where students are motivated to continually acquire new skills, update their knowledge, and adapt to new challenges.
- **Global Perspective and Cultural Awareness:** Recognizing the interconnectedness of our global community, Pythaverse integrates a global perspective and cultural awareness into its curriculum. This principle is about preparing learners to operate in a diverse, multicultural world and to understand the global implications of technological advancements.

These principles and philosophies collectively shape the Pythaverse COCREATE Framework, ensuring that it not only imparts knowledge and skills relevant to the digital age but also nurtures the values and mindsets needed for learners to become responsible, innovative, and adaptable individuals in a rapidly changing world.

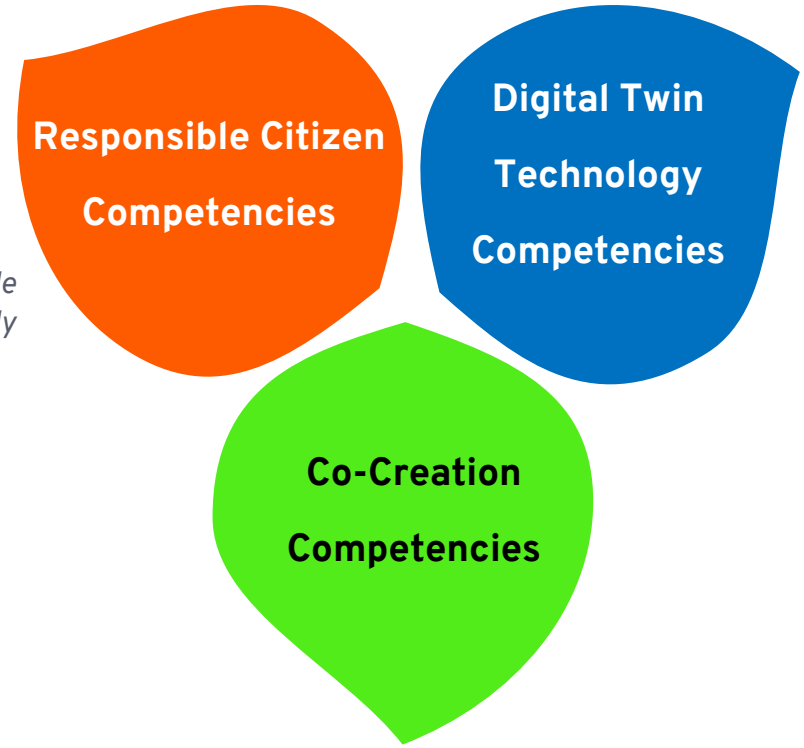
PYTHAVERSE COCREATE FRAMEWORK STRUCTURE

The Pythaverse COCREATE Framework is composed of several interrelated components, each designed to offer a comprehensive and integrated approach to modern education. This structure ensures a balanced development of skills and competencies essential for the digital age.

Competency Areas

The framework is structured around key competency areas, each focusing on specific skill sets:

Focuses on ethics, digital citizenship, intellectual property, and sustainability. It aims to develop learners who are ethically responsible and environmentally conscious.



Centers on skills in applied mathematics, science, engineering design, and system integration. It prepares students for technical proficiency in emerging technologies.

Focuses on integrating design thinking, AI, and interdisciplinary insights for innovative problem-solving. It aims to harmonize emotional intelligence, ethical judgment, and rationality, grounded in resilience for effective collaboration.

The Pythaverse COCREATE Framework is structured around three primary pillars: Responsible Citizen Competencies, Digital Twin Technology Competencies, and Co-Creation Competencies. These areas were chosen for their relevance and importance in the current educational landscape and are vital for equipping students with the necessary skills to thrive in today's dynamic digital world.

Competency Areas

1. Reason for Choosing These Three Groups:

- Responsible Citizen Competencies are crucial for ensuring that individuals can work effectively in teams, communicate well, and navigate the ethical dimensions of technology.
- Digital Twin Technology Competencies reflect the growing importance of foundational and emerging technologies in shaping the future, emphasizing the need for technical proficiency and adaptability.
- Co-Creation Competencies highlight the significance of AI and design thinking in innovation, stressing the need for skills that can leverage these technologies for creative and ethical problem-solving.

2. Relationship Between the Three Groups:

- Comprehensive Skill Integration: Responsible Citizen Competencies establish foundational ethics and teamwork, Digital Twin Technology Competencies build technical expertise, and Co-Creation Competencies merge these for innovative and ethical technology use.
- Future-Ready Adaptation: The groups collaboratively prepare individuals for a tech-driven future, focusing on ethical collaboration, technical proficiency, and innovative problem-solving in AI and design.

3. Opportunities and Impacts of These Groups:

- Collaboration and Innovation: Enhances teamwork and creative problem-solving, leading to effective, innovative solutions in various fields.
- Technological Readiness: Prepares individuals for emerging tech trends, ensuring adaptability in future job markets and tech advancements.
- Ethical Tech Practices: Promotes responsible use of technology, contributing to socially responsible and ethical technological developments.
- Creativity in Tech: Fuses technical skills with creativity, fostering innovative solutions to technological challenges.

Levels of Progression

The framework is tiered into different levels of progression, from introductory to advanced, allowing learners to advance at their own pace. Each level builds upon the previous one, gradually increasing in complexity and depth.

Responsible Citizen Competencies, Promote Human Values in Technology Era	**Digital Twin Technology Competencies,** Foundational and Future Technology Readiness	**Co-Creation Competencies:** Driving Machine and AI for Creativity
Collaboration and Teamwork • Collaboration • Communication • Conflict Resolution • Global Mindset • Interpersonal Skills • Leadership **Creative and Critical Thinking** • Critical Thinking • Curiousity and Inquisitiveness • Innovation and Design Thinking • Systems Thinking **Ethics - Human Values** • Adaptability and Flexibility • Cultural Competency • Digital Citizenship • Intellectual Property • Self-directed Learning • Sustainability	**Core Technological Skills** • Coding and Programming • Cybersecurity Fundamentals • Data Analysis • Computational Thinking • Digital Literacy • Technical Tools Proficiency **Emerging Technologies** • Artificial Intelligence and Machine Learning • Blockchain and Web3 • Internet of Things (IOT) • Quantum Computing • Robotics **Technical Proficiency** • Abstract Reasoning • Analytical Reasoning • Applied Mathematics and Science • Critical Thinking • Engineering Design • Experimental Design • Problem-Solving • Project Management • Quality Assurance • Scientific Inquiry • System Integration	**AI Driving** • Causal Reasoning • Innovative Application • Prompt Engineering • Understanding AI Application **Design Thinking** • Complex Problem Solving • User-centered design • Self-Reflection **Ethical Judgement and Complexity Handling** • Ethical Reasoning • Managing Complexity **Interdisciplinary Knowledge** • Cross-disciplinary skills **Resilience and Resolve** • Resilience • Resolve • Emotional Regulation • Mindfulness

Example:

In this structure:

- "Domain" denotes a broad area of knowledge or skill.
- "Subcategory" is a specific area within the domain.
- "Proficiency Level" indicates the degree of expertise within the subcategory.

Levels of Progression

Category 1: "Digital Twin Technology Domain"
This category encompasses a broad spectrum of knowledge and skills associated with Digital Twin technologies. It represents a comprehensive field of study and practice that includes the understanding and application of digital replicas of physical systems. It's the overarching category that defines the scope of competencies necessary for students to engage with and master digital twin concepts and practices.

Subcategory A: "Foundational Tech Literacy"
Within the Digital Twin Technology Domain, Foundational Tech Literacy acts as a specific subcategory that focuses on the essential skills and knowledge required as a base for further technological education. This includes understanding basic principles of how technology works, its uses, and its implications. It is the groundwork upon which more advanced digital twin technology skills are built.

Proficiency Levels within Foundational Tech Literacy:

Proficiency Level 1: "Introductory Computational Thinking"
This level represents the initial stage of competence where students start to develop an understanding of computational concepts. They learn to identify problems that can be solved computationally and begin to formulate basic solutions. It is about building a mindset that allows for approaching problems in a systematic way that can be translated into computer programs or simulations.

Proficiency Level 2: "Intermediate Computational Thinking"
At this stage, students build upon the introductory concepts and start applying their computational thinking skills to more complex problems. They delve deeper into algorithmic thinking, data representation, and begin to understand the efficiency of different computational methods. This level is about enhancing skills and starting to see the broader applications of computational thinking.

Levels of Progression

Proficiency Level 3: "Advanced Computational Thinking"
The highest proficiency level within this subcategory is where students achieve a sophisticated understanding of computational thinking. They can now tackle complex and abstract problems, develop advanced algorithms, and understand the nuanced interactions between different components of a digital twin system. They are prepared to apply these skills to real-world scenarios, innovate within the field, and contribute to advancements in digital twin technology.

In this structure, each term defines a clear and distinct level of the educational framework. "Domain" sets the stage for a wide-ranging skill set, "Subcategory" narrows down to the specific foundational skills, and "Proficiency Level" delineates the depth of expertise or development within those foundational skills. This organized hierarchy facilitates a clear educational pathway, allowing for both breadth and depth of learning in the complex field of Digital Twin Technology.

Characteristics of PYTHAVERSE COCREATE FRAMEWORK

Interdisciplinary Approach

An interdisciplinary approach is a core aspect of the framework. It encourages the integration of knowledge and skills from various disciplines, fostering a holistic understanding and application of learning.

Project-based Learning

The framework heavily emphasizes project-based learning. This approach allows students to apply their learning in practical, real-world scenarios, fostering deeper understanding and retention of knowledge.

Technology Integration

Advanced technologies are integrated throughout the curriculum. This includes the use of AI for personalized learning, IoT for interactive experiences, and the Metaverse for immersive learning environments.

Assessment and Evaluation

The framework employs innovative assessment and evaluation methods. These are designed to measure not just academic proficiency but also practical skills, creativity, and ethical understanding.

Continuous Feedback Mechanism

A continuous feedback mechanism is incorporated, involving students, educators, and industry experts. This ensures the framework remains relevant, effective, and aligned with the latest educational and technological trends.

Professional Development for Educators

The framework includes comprehensive professional development for educators, ensuring they are equipped to effectively deliver the curriculum and adapt to evolving educational technologies.

Global and Cultural Awareness

Global and cultural awareness is woven into the curriculum, preparing students to operate in a diverse and interconnected world, and to understand the global impact of technological advancements.

Adaptability and Future Readiness

The framework is designed to be adaptable, with regular updates to include the latest technological advancements and industry trends, ensuring learners are prepared for future challenges and opportunities.

This structured approach allows the Pythaverse COCREATE Framework to provide a balanced, comprehensive educational experience. It prepares students not only for academic success but also equips them with the necessary skills, mindsets, and ethical understanding to thrive in a rapidly evolving digital world.

TARGET AUDIENCE AND APPLICABILITY

The Pythaverse COCREATE Framework is designed with a diverse target audience in mind, ensuring its applicability across various contexts. The primary beneficiaries and applicability contexts include:

Continuous Feedback Mechanism

The core target audience of the framework is students in the K-12 education system. The framework is tailored to cater to their evolving educational needs, providing them with essential skills and knowledge that align with the demands of the digital age.

Educational Institutions

Primary and secondary schools, as well as higher education institutions, can adopt this framework to modernize their curriculums. It offers these institutions an opportunity to integrate cutting-edge technologies and innovative teaching methodologies into their educational offerings.

Educators and Teachers

Educators and teachers are crucial beneficiaries, as the framework provides them with the tools and methodologies to deliver more effective, engaging, and relevant education. It equips them to handle the challenges of teaching in a technology-driven environment.

Curriculum Developers and Educational Policymakers

The framework serves as a guide for curriculum developers and educational policymakers in designing and implementing contemporary educational programs that are aligned with future workforce requirements.

Parents and Guardians

Parents and guardians looking for comprehensive education that prepares their children for the future can find value in the Pythaverse COCREATE Framework. It assures a well-rounded education that balances academic learning with essential life skills.

Community and Non-Profit Organizations

Community centers and non-profit organizations involved in education can use this framework to provide technology education and training, especially to underrepresented or disadvantaged groups.

Industry Partners and Employers

Businesses and organizations can use the framework for employee training and development, particularly for roles that require proficiency in emerging technologies.

Self-motivated Learners

Individuals seeking personal and professional development in the realm of technology, digital creation, and innovation can leverage this framework to enhance their skills and knowledge.

International and Multicultural Education Systems

The framework's global perspective makes it applicable across different countries and cultures, providing a universal approach to education that transcends geographical boundaries.

Technology Enthusiasts and Aspiring Innovators

Those with a keen interest in technology and innovation can benefit from the framework's focus on practical application, project-based learning, and exposure to advanced technologies.

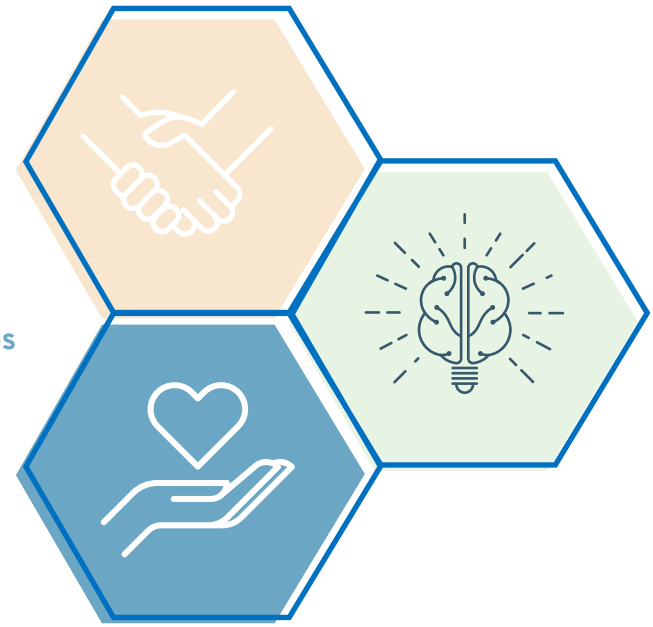
The applicability of the Pythaverse COCREATE framework extends beyond traditional educational settings, offering a versatile and comprehensive educational tool that caters to a wide array of learners and educators. Its adaptability to different learning environments and cultural contexts makes it a valuable resource in shaping future-ready individuals.

DETAILED COMPETENCY OVERVIEW

The Pythaverse COCREATE Framework is structured around three core competency areas, each tailored to equip learners with essential skills and knowledge. Here's a detailed overview of each:

Collaboration and Teamwork
Collaboration
Communication
Conflict Resolution
Global Mindset
Interpersonal Skills
Leadership

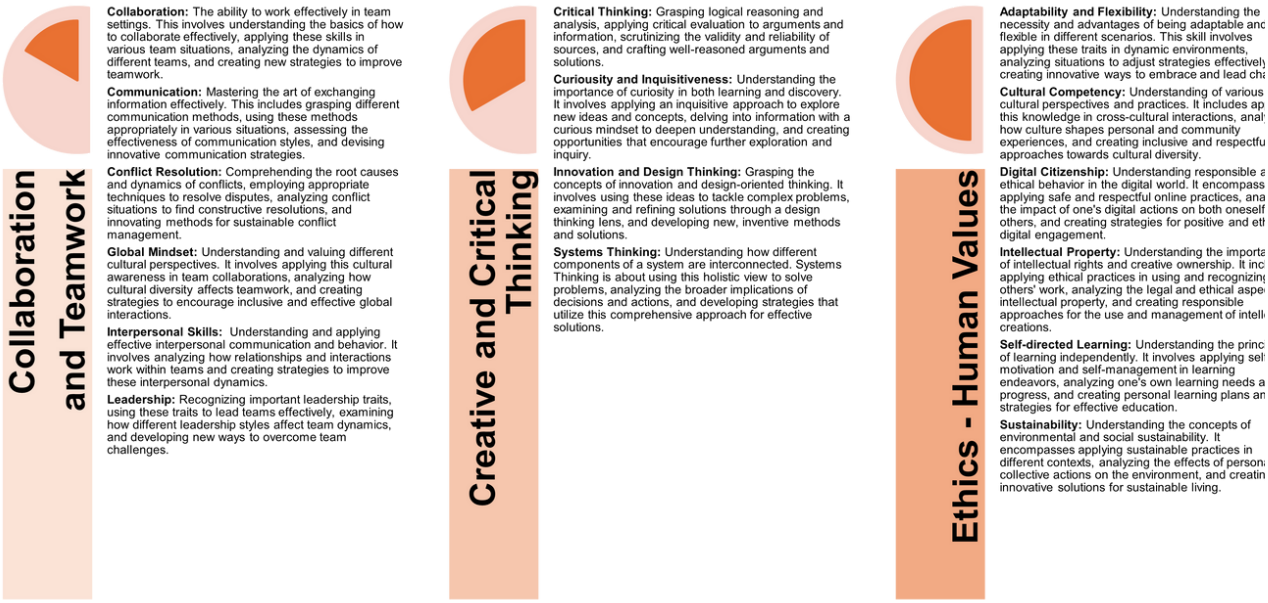
Ethics - Human Values
Adaptability and Flexibility
Cultural Competency
Digital Citizenship
Intellectual Property
Self-directed Learning
Sustainability



Creative and Critical Thinking
Critical Thinking
Curiousity and Inquisitiveness
Innovation and Design Thinking
Systems Thinking

RESPONSIBLE CITIZEN DOMAIN COMPETENCIES

> ***... The impact of the COCREATION framework in the education and training of students for the IR 5.0 workforce must be preceded by the formation of human values that promote the universal good, which must compel normal institutions to train teachers that shape the mind and character of the youth to prepare them for the IR 5.0 workforce. The Pythaverse principles of COCREATION contribute to the training of such teachers, as educating the youth in the 21st century must make humans the masters of AI and ML, and not vice-versa***
>
> **Gerardo Ma. de Villa, O.S.B. Rector/President, San Beda College Alabang, The Philippines**



Key Areas of Focus

- **Collaboration and Teamwork:** Focuses on developing skills for effective team interaction, understanding team dynamics, and creating innovative solutions in group settings.
- **Creative and Critical Thinking:** Emphasizes the ability to engage in reflective, independent thinking and applying creative problem-solving skills across various domains.
- **Ethics - Human Values:** Concentrates on understanding ethical principles, applying them in diverse scenarios, and creating solutions for ethical challenges.

Learning Outcomes at Different Proficiency Levels

- **Introductory:** Grasps fundamentals of collaboration, team roles, logical reasoning, critical analysis, and understanding ethical online behavior and digital citizenship.
- **Intermediate:** Applies collaborative and communication skills in team settings, along with critical thinking and digital citizenship in various contexts.
- **Advanced:** Innovates in team productivity and communication strategies, develops complex problem solutions, and promotes ethical digital citizenship practices.

Real-World Applications

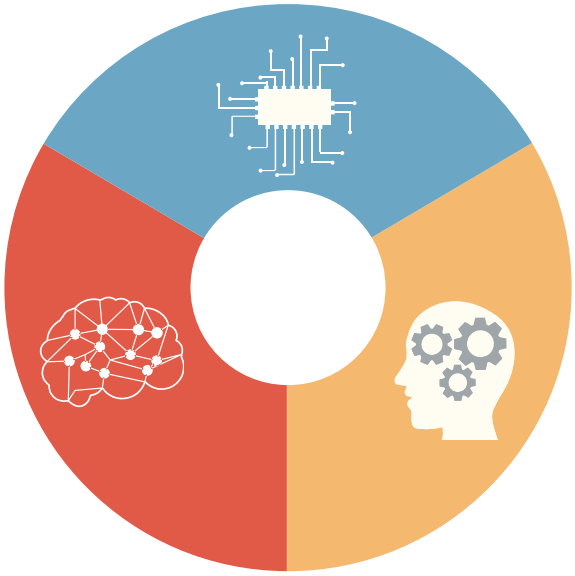
- Applying ethical decision-making in tech development and usage, ensuring technologies serve societal good.
- Collaborating on international projects, leveraging global cultural insights for more inclusive solutions.
- Leading organizations or initiatives with a strong foundation in soft skills and ethical leadership, fostering positive social impact.

Core Technological Skills

Coding and Programming
Cybersecurity Fundamentals
Data Analysis
Computational Thinking
Digital Literacy
Technical Tools Proficiency

Emerging Technologies

Artificial Intelligence and Machine Learning
Blockchain and Web 3
Internet of Things
Quantum Computing
Robotics



Technical Proficiency

Abstract Reasoning
Analytical Reasoning
Applied Mathematics and Science
Critical Thinking
Engineering Design
Experimental Design
Problem-Solving
Project Management
Quality Assurance
Scientific Inquiry
System Integration

DIGITAL TWIN TECHNOLOGY DOMAIN COMPETENCIES

"Essentially, a Digital Twin is a 'convergent environment' rather than a specific 'Technology'."

Dr. Ton Quang Cuong, Head of the Department of Educational Technology - University of Education, Vietnam National University, Hanoi, Vietnam

Key Areas of Focus

- **Core Technological Skills:** Focuses on understanding key technology concepts and applying practical tools. It involves analyzing the impacts of technology and creating innovative technological solutions.
- **Emerging Technologies:** Concentrates on advanced technologies like AI and Machine Learning, Blockchain, IoT, Quantum Computing, and Robotics. It includes cultivating an understanding of these technologies, applying innovative solutions, analyzing their impacts and applications, and creating cutting-edge technological advancements.
- **Technical Proficiency:** Involves developing skills in understanding technical concepts, applying specialized techniques, analyzing technical systems, and creating innovative solutions across various proficiencies like System Integration, Scientific Inquiry, Engineering Design, and more.

Learning Outcomes at Different Proficiency Levels

- **Introductory:** Focuses on understanding key technology concepts, fundamental aspects of AI, ML, Blockchain, IoT, and Quantum Computing, and the basics of scientific inquiry, system integration, and programming languages.
- **Intermediate:** Involves applying technical tools in practical projects, utilizing AI and ML techniques, and applying mathematical and scientific knowledge coupled with critical thinking in technical problem-solving.
- **Advanced:** Concentrates on creating innovative technical applications and tools, developing advanced AI/ML and blockchain/Web3 solutions, and formulating sophisticated system integration strategies and research methodologies.

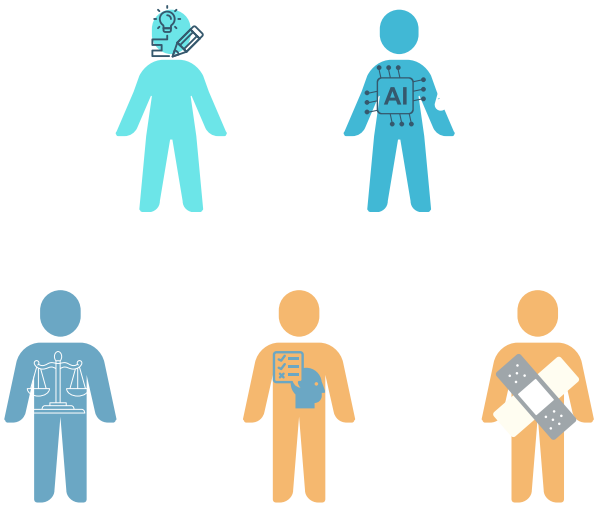
Real-World Applications

- Designing and managing digital twin systems in sectors like manufacturing, healthcare, and urban planning.
- Applying core technological skills to develop innovative solutions to real-world problems.
- Conducting cutting-edge research, contributing to the development of emerging technologies.

Design Thinking
Complex Problem Solving
User-centered design
Self Reflection

Ethical Judgement and Complexity Handling
Ethical Reasoning
Managing Complexity

Interdisciplinary Knowledge
Cross-disciplinary Skills



AI Driving
Causal Reasoning
Innovative Application
Prompt Engineering
Understanding AI Application

Resilience and Resolve
Resilience
Resolve
Emotional Regulation
Mindfulness

CO-CREATION DOMAIN COMPETENCIES

The core of learning is the human knowledge skills such as thinking, problem solving, empathy etc. how you achieve this can be done in many ways with many tools - 'technology' being one - you have to show how the usage of your technology will enhance these objectives ie it is a effective and optimal learing tool. As long as you are clear of this learning strategy the usage of technology in this fast changing world can be 'overlayed'.

Dr. Mohamed Yunus Yasin, the president and founder of the Association of Science, Technology and Innovation (ASTI), an education NGO in Malaysia.

Key Areas of Focus

- **AI Driving:** Concentrates on the development of comprehensive skills in AI technology, encompassing understanding AI principles, applying AI in diverse scenarios, analyzing its effectiveness, and creating innovative AI-driven solutions.
- **Design Thinking:** Fosters an understanding of innovative design processes, applying user-centered and reflective practices, analyzing design effectiveness, and creating empathetic and ethical design solutions.
- **Ethical Judgement and Complexity Handling:** Involves applying ethical frameworks to evaluate and make decisions in various scenarios, analyzing outcomes for moral implications, and creating strategies to address complex ethical dilemmas.
- **Interdisciplinary Knowledge:** Develops the ability to integrate knowledge and methods from different disciplines, applying a holistic approach to problem-solving and innovation, and understanding the importance of cross-disciplinary collaboration.
- **Resilience and Resolve:** Cultivates skills in understanding and managing adversity, applying emotional regulation, analyzing personal perseverance, and creating strategies for sustained commitment and resilience.

Learning Outcomes at Different Proficiency Levels

- **Introductory:** Involves understanding key technology concepts, basic principles of AI and ML, blockchain technology, and Web3, and recognizing fundamental concepts in mathematics, science, and critical thinking.
- **Intermediate:** Focuses on applying technical tools in practical tasks, utilizing AI and ML techniques in scenarios, applying mathematical and scientific knowledge to technical problems, and assessing the credibility of information and arguments with critical thinking.
- **Advanced:** Concentrates on creating innovative applications or modifications of technical tools, developing advanced AI/ML models, creating advanced system integration strategies, and formulating sophisticated strategies using analytical reasoning for complex problem-solving.

Real-World Applications

- Using design thinking to create user-friendly products and services, enhancing customer satisfaction.
- Leading AI-driven projects, transforming industries with innovative applications.
- Addressing complex problems in areas like environmental policy, healthcare, and urban development through interdisciplinary approaches.
- Applying emotional intelligence and ethical judgment in leadership roles, promoting a positive and ethical workplace culture.
- Exhibiting resilience and resolve in entrepreneurial ventures or high-stress professions, driving innovation despite challenges.

The competency areas within the Pythaverse COCREATE Framework are meticulously crafted to furnish learners with an education that is comprehensive, pertinent, and versatile, aligning seamlessly with real-world demands. These areas encompass a broad spectrum of skills and knowledge, from ethical and human values to cutting-edge technological proficiency and innovative co-creation abilities.

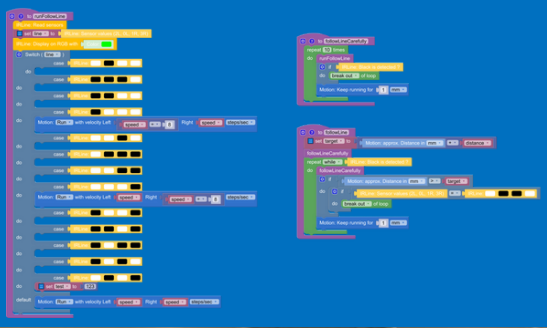
The framework is not just focused on knowledge acquisition but is deeply committed to cultivating the necessary skills and mindsets. This holistic approach ensures learners are well-equipped to apply their knowledge effectively across diverse contexts, whether it be in ethical decision-making in technology, leading with emotional intelligence and cultural awareness in global settings, or innovating with AI and design thinking.

In essence, the framework prepares learners not only for academic excellence but also for practical application, leadership, and innovation in an ever-evolving global landscape.

IMPLEMENTATION STRATEGY

The implementation of the Pythaverse COCREATE Framework involves a strategic approach and specific guidelines to ensure its effective integration into educational institutions.

This strategy is aimed at seamlessly incorporating the framework into existing curriculums, supported by adequate training and resources.



Approach

- **Engage: Engage Early and Make It Easy**
  - Fostering early engagement by providing user-friendly tools and resources that simplify the integration of the framework.
  - Utilizing digital platforms and interactive tools to make the learning experience more accessible and engaging for students and educators.
- **Learn: Immersive Learning and Learning by Doing**
  - Emphasizing immersive learning experiences through Learning Management Systems (LMS) and blended learning approaches.
  - Encouraging hands-on learning and practical application of knowledge, aligning with the framework's focus on real-world skills.
- **Resolve: A Practical Assessment Approach for Real-World Problem-Solving**
  - Introducing a new assessment framework that evaluates students' abilities to tackle global issues and challenges.
  - Organizing competitions and tournaments focused on resolving global issues, enhancing problem-solving skills and global awareness.
- **Grow: Open Up Digital Resources**
  - Providing open access to a variety of digital resources, including educational materials, technology tools, and collaborative platforms.
  - Creating opportunities for students and educators to showcase their work and achievements within the framework.

Guidelines for Educational Institutions

- **Curriculum Assessment and Alignment:** Conducting an audit of the existing curriculum to identify areas where the Pythaverse COCREATE Framework can be integrated or enhance current offerings.

- **Customization and Flexibility:** Adapting the framework to fit the specific needs and context of the institution, considering factors like student demographics, resource availability, and educational goals.

- **Phased Integration:** Implementing the framework in phases, starting with foundational elements and gradually introducing more advanced components.

Integration into Existing Curriculums

- **Interdisciplinary Approach:** Integrating framework concepts across various subjects to demonstrate real-world applications and promote cross-disciplinary learning.

- **Project-Based Learning:** Utilizing project-based learning methods to allow students to apply concepts from the framework in practical, hands-on projects.

- **Continuous Learning and Update:** Regularly updating the curriculum to include the latest developments in technology and education, ensuring ongoing relevance and effectiveness.

Training and Resources Required

- **Professional Development for Educators:** Providing comprehensive training for educators on the framework's principles, technologies, and teaching methodologies.

- **Resource Allocation:** Ensuring that adequate resources, including technology tools, software, and learning materials, are available for effective implementation.

- **Community and Industry Partnerships:** Establishing partnerships with technology companies, higher education institutions, and community organizations for resources, expertise, and real-world project opportunities.

Continuous Evaluation and Feedback

- Implementing systems for continuous feedback and iterative improvement of the integration strategies, involving educators, students, and possibly external reviewers.

By following this implementation strategy, educational institutions can effectively incorporate the Pythaverse COCREATE Framework into their educational offerings. This strategy ensures that the framework is not just an addition to the curriculum but becomes an integral part of the learning experience, enhancing the overall educational outcomes and preparing students for the future.

ASSESSMENT AND EVALUATION

The assessment and evaluation component of the Pythaverse COCREATE Framework is crucial in measuring learning outcomes and ensuring continuous improvement. This component is designed to be dynamic, encompassing various methods that align with the framework's innovative approach.

Measuring Learning Outcomes

- **Rubrics and Benchmarks:** Developing clear, specific rubrics and benchmarks for each competency to objectively assess students' progress and mastery of skills.

- **Portfolio Assessments:** Encouraging students to maintain portfolios of their work, showcasing their learning journey and the practical application of skills in various projects.

- **Formative and Summative Assessments:** Utilizing both formative (ongoing) and summative (end-of-term) assessments to gauge students' understanding and skill development over time.

- **Collaborative Wall of Fame:** Implement a 'Wall of Fame' system where students' collaborative efforts and achievements are recognized. This could include monthly highlights of top performers in areas like attendance, engagement, and collaboration. This approach shifts the focus from individual accomplishments to celebrating collective achievements and encourages a healthy competitive spirit.

- **Peer Review of Collaborative Projects:** After completion of collaborative projects, especially in the digital twin world, students can conduct peer reviews. This method allows students to assess and provide feedback on their peers' contributions, teamwork, and collaborative skills.

- **Structured Peer Collaboration Assessments:** Develop structured assessments where students evaluate the collaborative process and outcomes. This can include factors like communication, problem-solving, and joint effort. Such assessments can help students reflect on their teamwork abilities and understand the dynamics of effective collaboration.

- **Digital Twin Collaboration Metrics:** Introduce specific metrics within the digital twin world to assess collaboration. These metrics could track aspects like joint project contributions, communication frequency, and collaborative problem-solving. Leveraging digital tools can provide a quantifiable measure of collaboration, adding a data-driven aspect to peer assessments.

- **Interactive Feedback Sessions:** Organize regular feedback sessions where students can discuss their collaborative experiences, share insights, and learn from each other. These sessions could be facilitated by educators to ensure constructive and guided discussions.

Continuous Improvement and Feedback Mechanisms

- **Regular Feedback Loops:** Establishing regular feedback loops involving students, teachers, and parents to assess and improve the learning experience continuously.

- **Data-Driven Decision Making:** Using data from assessments to inform decisions about curriculum adjustments, teaching methods, and resource allocation.

- **Professional Development for Educators:** Offering ongoing professional development opportunities for educators based on assessment outcomes, ensuring effective implementation and adaptation of teaching strategies.

- **Adaptive Learning Technologies:** Implementing adaptive learning technologies that provide real-time feedback and personalized learning experiences for students.

Success Stories and Feedback

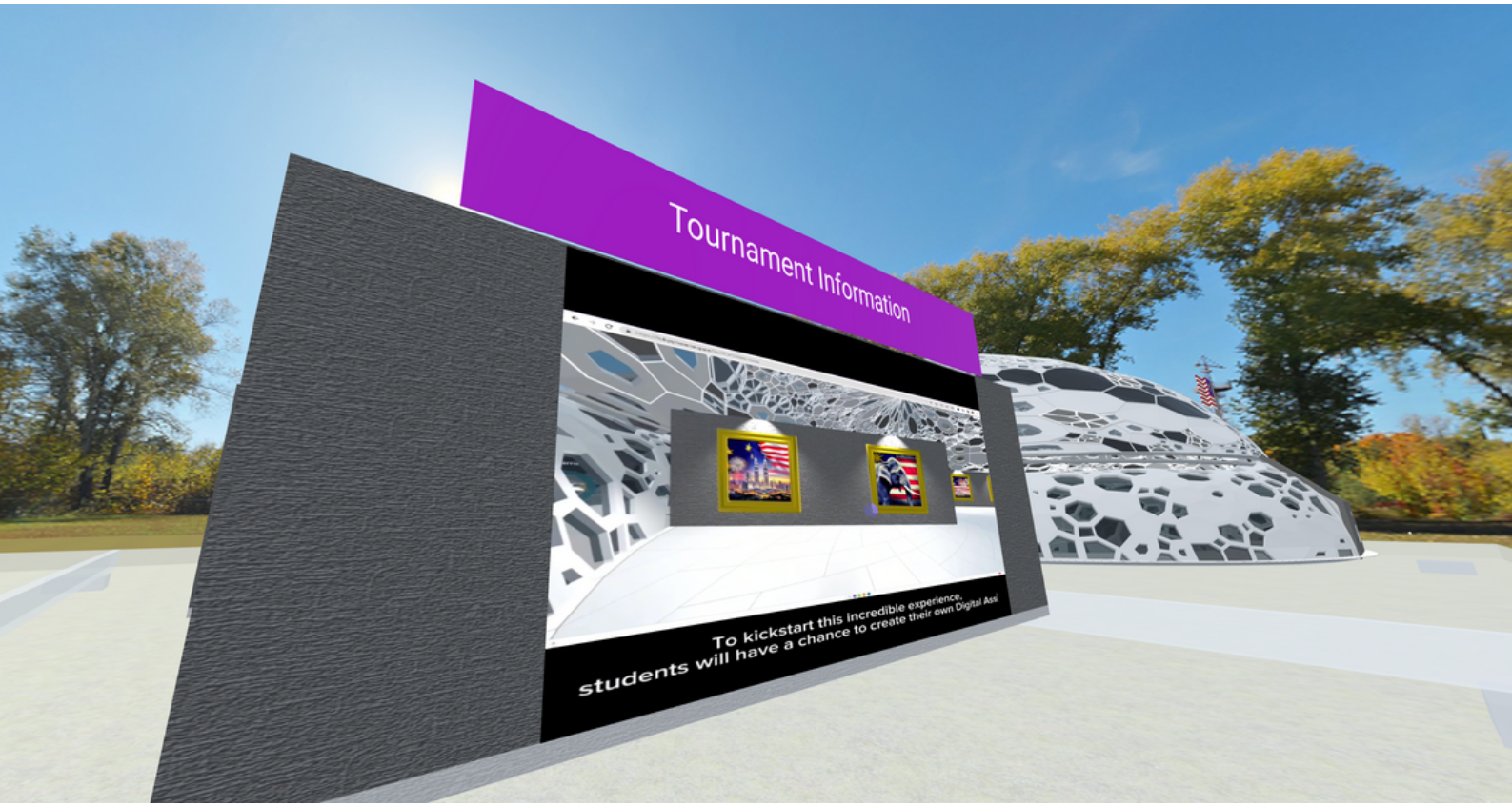
- **Showcase of Student Projects:** Regularly showcasing student projects and achievements to highlight the practical application of skills learned and the success of the framework.

- **Case Studies of Implementation:** Documenting and sharing case studies from various schools implementing the framework, highlighting challenges, successes, and lessons learned.

Community and Parental Involvement

- Engaging the wider school community and parents in understanding and supporting the framework, sharing success stories to build a supportive learning environment.

By employing these assessment and evaluation strategies, the Pythaverse COCREATE Framework aims to create a comprehensive and responsive educational experience. This approach not only measures academic proficiency but also emphasizes the development of practical skills, creativity, and ethical understanding, aligning with the framework's holistic educational goals.



TECHNOLOGY INTEGRATION

The Pythaverse COCREATE Framework serves as the foundational blueprint for educational experiences, dictating the approach and objectives of learning. It is within this framework that the integration of advanced technologies, such as AI, IoT, Robotics, and the Metaverse, occurs. This integration is not merely additive but is fundamental to the framework's design—it conditions and shapes the curriculum, pedagogy, and learning outcomes. Technology acts as both a medium and an enhancer of the educational process, directly influencing how students engage with content, develop skills, and apply their knowledge to real-world scenarios. In essence, while the Pythaverse COCREATE Framework establishes the educational vision and goals, it is the strategic incorporation of these technologies that enables the realization of this vision, providing students with the necessary competencies for success in the digital age.

The integration of technology, specifically AI, IoT, Robotics, and the Metaverse, is a pivotal aspect of the Pythaverse COCREATE Framework. This integration is designed to enhance the learning experience and equip students with the skills necessary for the digital age.

Utilizing AI, IoT, Robotics, and the Metaverse

- **Artificial Intelligence (AI):** AI can be used to personalize learning experiences, provide adaptive learning paths, and offer intelligent tutoring systems. AI-driven analytics can also help in assessing student performance and providing insights for improvement.

- **Internet of Things (IoT):** IoT devices can be integrated into classroom activities for real-time data collection and analysis, enabling hands-on learning experiences that mirror real-world applications.

- **Robotics:** Robotics can be used to teach programming, engineering concepts, and problem-solving skills. Robotics projects can foster teamwork and creativity among students.

- **The Metaverse:** The Metaverse offers immersive virtual environments for experiential learning. It can be utilized for simulations, virtual field trips, and interactive learning modules that bring complex concepts to life.

Practical Tips and Best Practices

- **Curriculum Integration:** Technology should be integrated into the curriculum in a way that complements and enhances traditional teaching methods, rather than replacing them.

- **Teacher Training:** Teachers should receive comprehensive training to effectively use these technologies in the classroom. This includes not only technical training but also pedagogical training to integrate technology into teaching strategies.

- **Student-Centered Approach:** Use technology to support a student-centered approach, catering to individual learning styles and paces. This includes utilizing technology for project-based learning and collaborative activities.

- **Safety and Ethics:** Teach students about the safe and ethical use of these technologies, especially in digital spaces. This includes understanding data privacy, cybersecurity, and the ethical implications of AI and robotics.

- **Resource Allocation:** Ensure that schools have the necessary technology infrastructure, including hardware, software, and internet connectivity.

- **Community and Industry Partnerships:** Establish partnerships with technology companies and educational technology firms to access resources, expertise, and the latest developments in the field.

- **Future Trends and Ongoing Development:** Stay abreast of emerging technologies and evolving best practices in educational technology. This includes exploring new tools and methodologies that could further enhance learning.

By integrating these technologies into the learning process, the Pythaverse COCREATE Framework not only enhances the educational experience but also equips students with critical skills for success in the digital age.

The approach is to leverage technology in a balanced manner that supports and enriches traditional educational methods while preparing students for a future in which digital literacy and technological proficiency are paramount.

RESOURCES AND SUPPORT

> ***"The current curriculum (Kurikulum Merdeka) provides opportunities to be integrated in the program, such as through the subject matter or Project based learning of P5 (Proyek Penguatan Profil Pelajar Pancasila). There are 7 topics of P5 which are: Sustainability, Cultural practices/indigenous knowledge, Unity in diversity, Democracy, Healthiness, Entrepreneurship, STEM (Engineering Technology). Example by Pythaverse cocreate activities such as for students develop the city, dancing through code, can be integrated to the current curricula."***
>
> Dr. Teguh Trianung Djoko Susanto, Universitas Negeri Jakarta, Indonesia.

The Pythaverse COCREATE Framework offers a rich array of resources and support mechanisms to enhance the learning experience. These resources are designed to make the framework accessible and engaging for students, educators, and institutions. This section showcases a selection of offerings from the Pythaverse Learning Platform, illustrating the practicality and applicability of the framework in various learning environments.

Digital Twin Robotics STREAM (Science, Technology, Reading, Engineering, Arts, Mathematics)

- **Courses and Content:**
  - **Digital Twin Robotics:** Integration of Robotics with Digital Twin technology, providing a hands-on approach to STEM learning.
  - **SWRP (STREAM With Robotics Pythaverse):** Comprehensive K-12 curriculum aligned with global standards, focusing on inspiring youth with STEM through digital twin robotics.

SWRP

Courseware	STREAM With Robotics Pythaverse
• Suitable for Schools • Structured learning • Holistic curriculum • Structured Learning Path • STREAM Focused • Real-World Skills Development • Global Perspective Program	STREAM WITH ROBOTICS PYTHAVERSE Level 1 **Exploring the Miniature World with PMinetest** STREAM WITH ROBOTICS PYTHAVERSE Level 2 **Mastering the Minetest World: Building, Exploring, and Creating** STREAM WITH ROBOTICS PYTHAVERSE Level 3 **Exploring LEANBOT Adventures: Coding, Creativity, and Automation** STREAM WITH ROBOTICS PYTHAVERSE Level 4 **Investigating the Technological Frontiers: LEANBOT, PSim, and Digital Twins** STREAM WITH ROBOTICS PYTHAVERSE Level 5 **Robotics and Programming Applications: Unleashing Creativity with LEANBOT** STREAM WITH ROBOTICS PYTHAVERSE Level 6 **Robotics in the Future: Igniting Innovation with LEANBOT** STREAM WITH ROBOTICS PYTHAVERSE Level 7 **Intelligent Robotics: Expanding Horizons with LEANBOT** STREAM WITH ROBOTICS PYTHAVERSE Level 8 **Advance LEANBOT Applications for Sustainable World** STREAM WITH ROBOTICS PYTHAVERSE Level 9 **LEANBOT Programming Applications with IoT** STREAM WITH ROBOTICS PYTHAVERSE Level 10 **Advanced Robotics and Data Analytics: Empowering Innovation with LEANBOT** STREAM WITH ROBOTICS PYTHAVERSE Level 11 **Exploring IoT and AI with LEANBOT Intermediate** STREAM WITH ROBOTICS PYTHAVERSE Level 12 **Advanced Robotics and AI: Innovations for Tomorrow** * Teacher Certification Program with Technical & Pedagogical Training provided

- **After School Program:** Intensive workshops and programs for primary and secondary schools, emphasizing hands-on learning in robotics and programming with tools like Blockly and C++.

ASP

Courseware	After School Program
Level / Title	ELEMENTARY Beginner **Introduction to Robotics: Avatar & Robot Fundamentals** ELEMENTARY Intermediate **Robotics Skills Lab: Sensors and Interactive Design** SECONDARY Beginner **Robotics Foundations: Intermediate Coding and Interactive Mechanics** ELEMENTARY Intermediate **Advanced Robotics: Integration and Complex Systems** * Teacher Certification Program with Technical & Pedagogical Training provided

After School Program

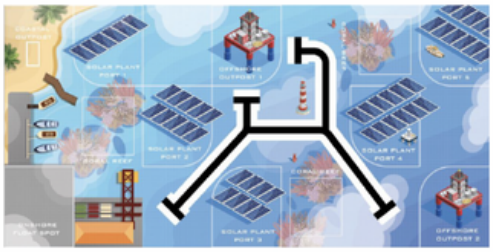
- Suitable for Clubs, Co-curriculum, Center-based learning
- Holistic curriculum
- Structured Learning Path
- More technical-driven
- Real-World Skills Development
- Global Perspective Program
- Mastering STREAM Concepts to elevate potentia
- Innovate with confidence
- Hands-on experience
- Compete Globally
- Shapers of Tomorrow

Intensive Workshop

Prepare for the tournament or short-term classes **introducing students to robotics**.

This workshop is tailored for **primary and secondary** schools, emphasizing **hands-on learning**, covering Blockly and C++ programming with Leanbot.

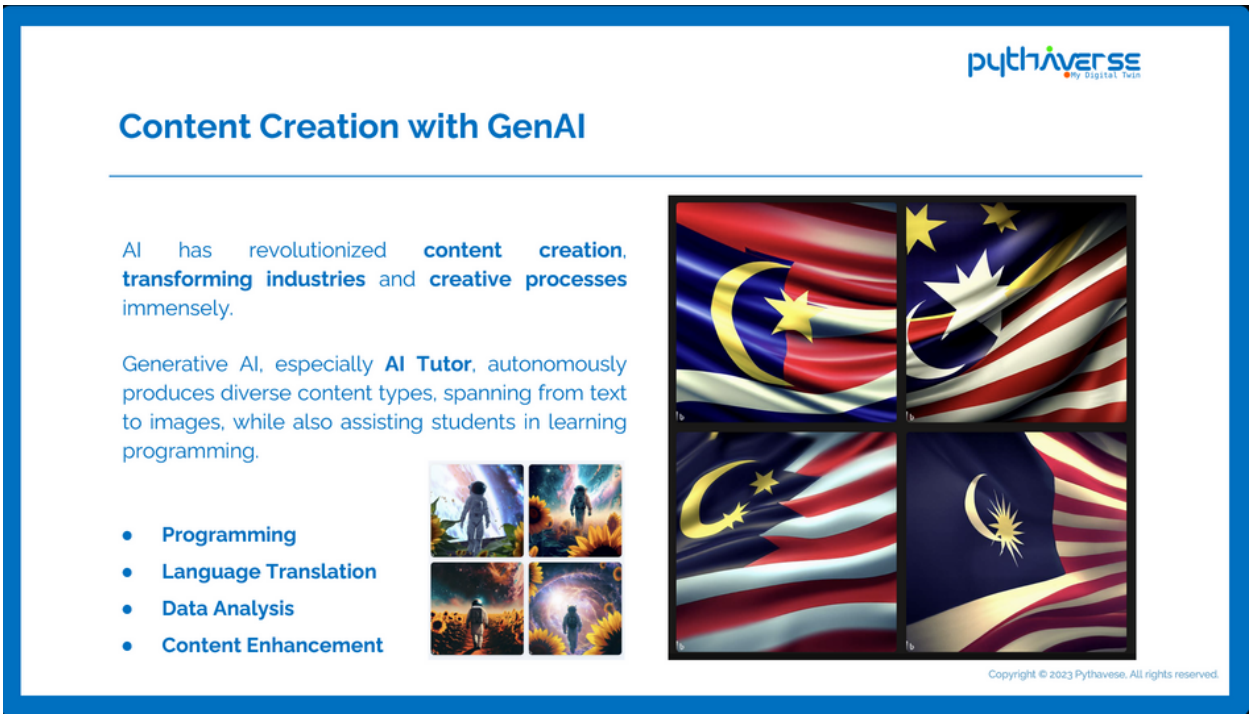
Students explore **Digital Twin**, **IoT** modules with **AI Tutor**, and beyond to build their environments.



- **Supplementary Materials and Resources**
  - **Curriculum Focused on Global Competencies and SDGs:** Aligning learning with the UN's Sustainable Development Goals, nurturing responsibility and empathy towards global challenges.

  - **Robothon & National Robotics Competition (NROC):** Platforms for interclass and international tournaments, focusing on real-world challenges and creative solutions.

- **Online Platforms and Tools**
  - **AI Tutor:** Assisting in programming, language translation, data analysis, and content enhancement, leveraging AI technology.

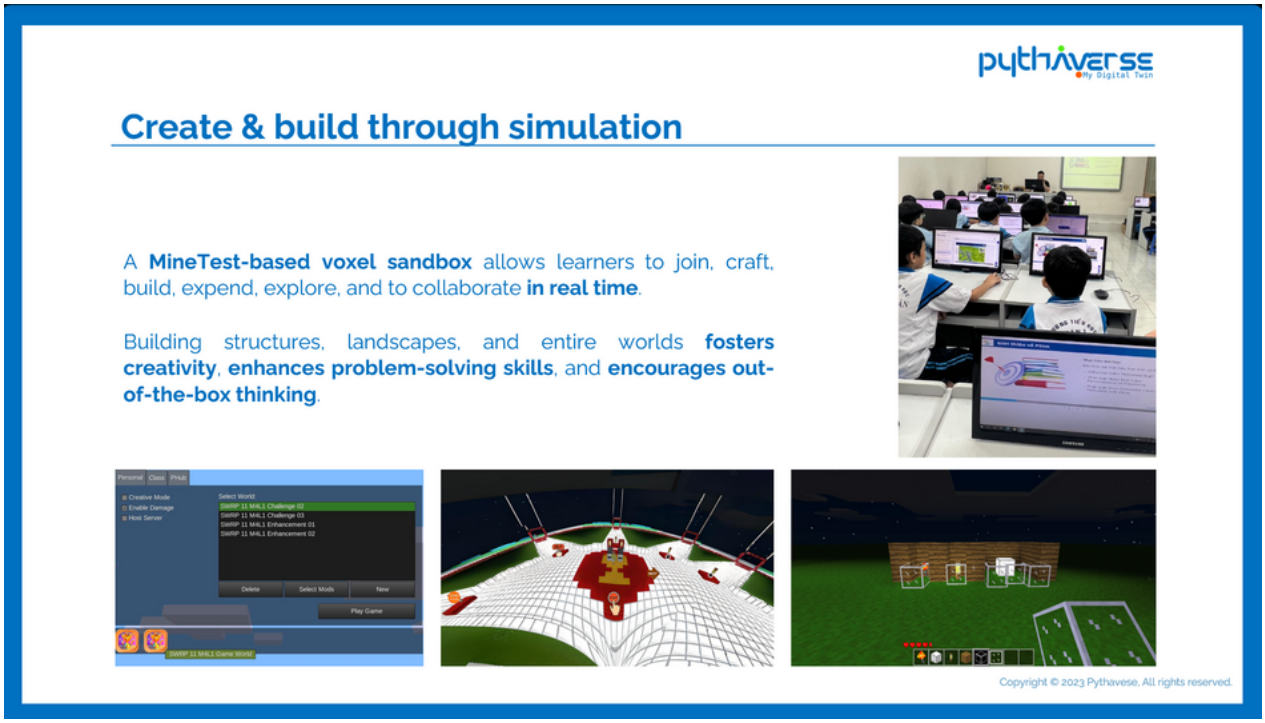


- **Community and Networking Opportunities**
  - **Competitions and Tournaments:** Engaging students in challenges like Robothon, fostering a competitive spirit and enhancing problem-solving skills.

- **LEANBOT in the Pythaverse**
  - **LEANBOT:** A versatile educational robot designed for interactive STEM learning, equipped with diverse sensors and programming tools, fostering hands-on experience in digital twin and AI-driven projects.

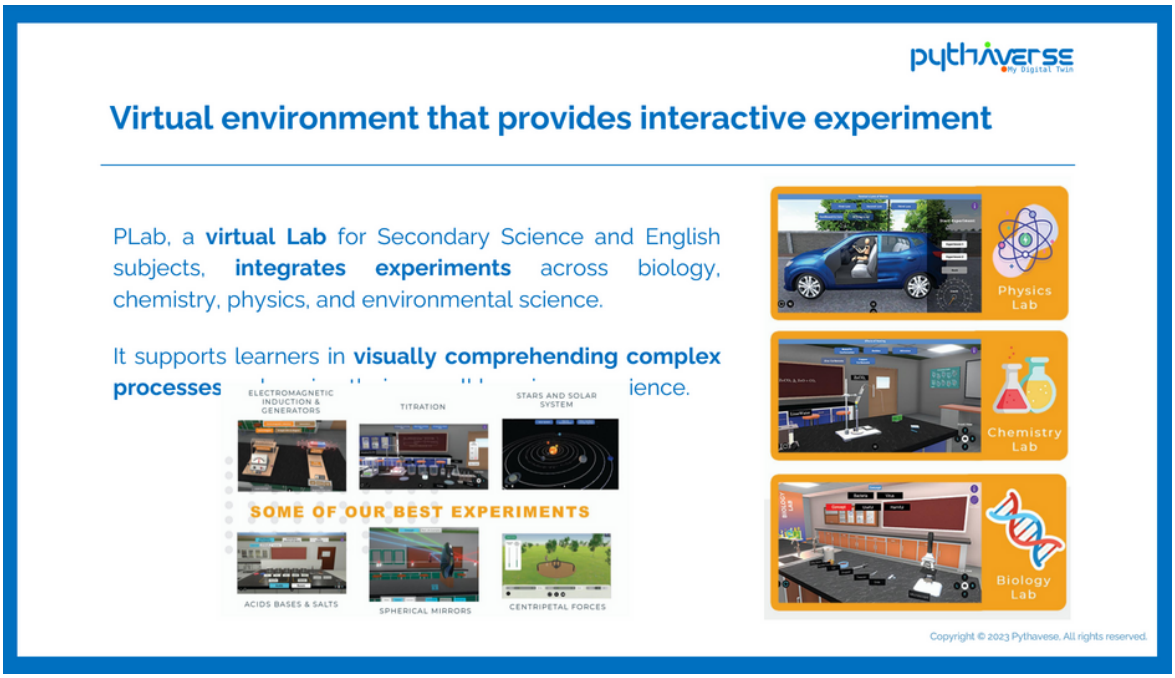
Immersive STREAM (Science, Technology, Reading, Engineering, Arts, Mathematics)

- **Courses and Content:**
  - **Immersive Learning:** Utilizing immersive technologies for a deeper understanding and engagement in educational content.



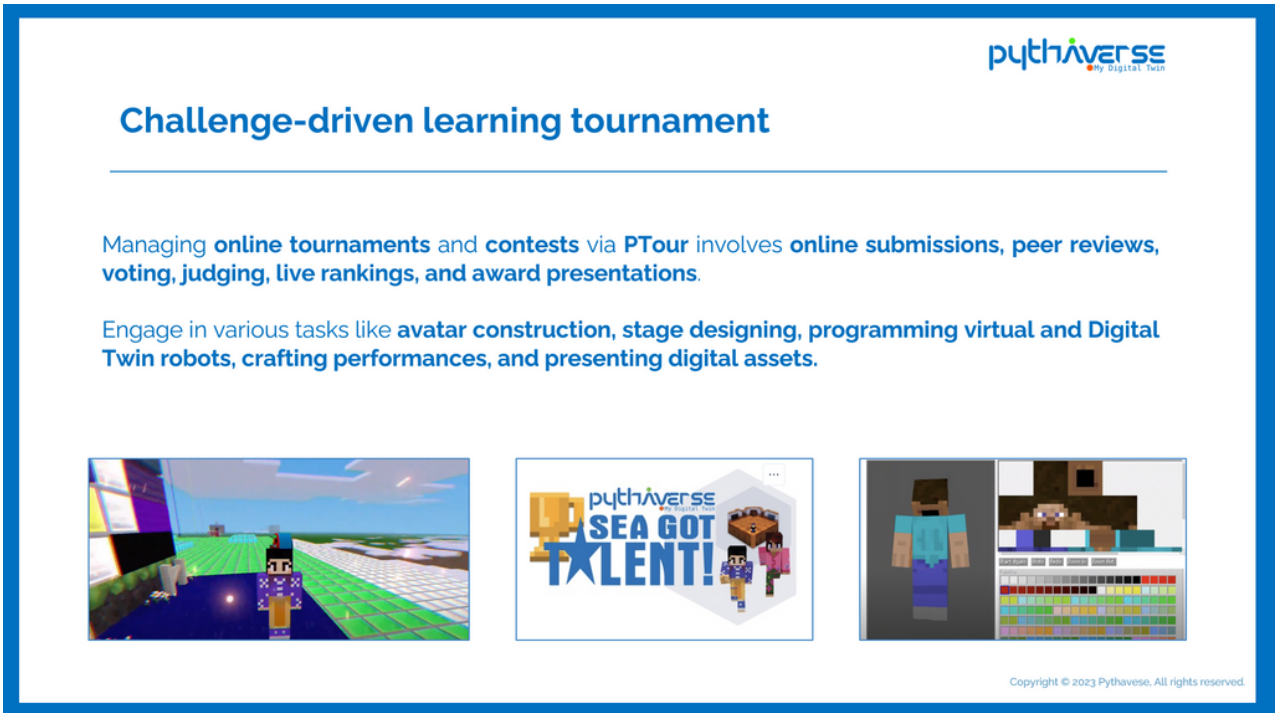
  - **PSim:** A MineTest-based voxel sandbox allowing learners to join, craft, build, and explore in a simulated environment.

- **Supplementary Materials and Resources**
  - **Virtual Experiments with PLab:** A virtual lab for science subjects, enhancing understanding of complex processes through interactive experiments.



- **Online Platforms and Tools**
  - **PHub:** Offers immersive, collaborative activities through browser-based multi-user experiences or VR devices, featuring avatars and spatial audio.

- **Community and Networking Opportunities**
  - **WeCreate:** Manages online tournaments and contests, engaging students in various tasks like building sustainable solutions through co-creation with Coding or AI.



These resources support the two distinct tracks in the Pythaverse COCREATE Framework, offering a diverse range of educational experiences that leverage the latest in digital technology and immersive learning.

CONCLUSION

The Pythaverse COCREATE Framework represents a groundbreaking approach to K-12 education. Integrating technologies such as AI, IoT, Robotics, and the Metaverse, it aims to provide a holistic learning experience that encompasses technical proficiency, responsible citizenship, and co-creation competencies. The framework advances through various levels, ensuring a comprehensive learning journey. It emphasizes immersive experiences, equipping students with technical skills, creativity, critical thinking, and adaptability, preparing them for the challenges and opportunities of the digital age.

> ***The real world problems are rather complex and require multidiscipline knowledge. The Pythaverse COCREATE framework not only provides the comprehensive learning approach that suits present day challenges but also equips students with the future readiness. The holistic approach and the continuous feedback system create an excel learning environment for students and educators.***
>
> Dr. Sarum Boonmee, School of Metallurgical Engineering, Suranaree University of Technology, Thailand

Vision for the Future of Learning

The vision of the Pythaverse COCREATE Framework is to transform the educational landscape, aligning it closely with rapid technological advancements and evolving global workforce demands. It envisions education as a means to develop a deep understanding of technology's role in society, fostering innovation, and nurturing responsible digital citizens. The framework aspires to create a learning environment where students are empowered to explore, create, and innovate, preparing them for careers that may not yet exist and contributing positively to a technology-driven world.

Call to Action for Educators and Institutions

Educators and educational institutions are encouraged to embrace this transformative approach to learning. They are urged to integrate the Pythaverse COCREATE Framework into their curricula, fostering an environment conducive to explorative and experiential learning. The success of this framework relies on widespread adoption and the commitment of educators and institutions to prepare a new generation of learners for a future intertwined with technology and innovation. Schools and teachers should leverage provided resources and continuous professional development opportunities to effectively implement the framework. Collaboration among educators, industry experts, and the broader community is essential to maximize the benefits of this innovative approach.

ACKNOWLEDGEMENTS

We extend our profound appreciation to the distinguished panel of reviewers whose diverse expertise has greatly enriched the Pythaverse framework. We are particularly grateful to:

- Dr. Ton Quang Cuong, Head of the Department of Educational Technology - University of Education, Vietnam National University, Hanoi, Vietnam, whose expertise in educational technology and his systemtic review has been instrumental.
- Father Gerardo Ma. de Villa, O.S.B. Rector/President, San Beda College Alabang, The Philippines, whose guidance in human core values over technology has been invaluable.
- Dr. Mohamed Yunus Yasin, the president and founder of the Association of Science, Technology and Innovation (ASTI), an education NGO in Malaysia, for his expertise in teacher training and educational practices.
- Dr. Teguh Trianung Djoko Susanto, Universitas Negeri Jakarta, Indonesia for his valuable perspectives on implementing technology & STEM in education.
- Dr. Sarum Boonmee, School of Metallurgical Engineering, Suranaree University of Technology for his review of student future readiness in technology era.

Their collective wisdom and support have been pivotal in shaping our framework into a comprehensive and globally relevant educational solution. We are deeply indebted to their contributions and ongoing commitment to educational excellence.

APPENDICES

Glossary

The Pythaverse COCREATE Framework includes a comprehensive glossary as part of its appendices and references. This glossary provides clear definitions of key terms and concepts that are crucial for understanding the technical and educational aspects of the framework. Here are some highlighted terms and their definitions:

- **Artificial Intelligence (AI):** A branch of computer science dealing with the creation of machines capable of performing tasks that typically require human intelligence. AI encompasses machine learning, natural language processing, and robotics.
- **Internet of Things (IoT):** A network of physical objects ('things') embedded with sensors, software, and other technologies, aimed at connecting and exchanging data with other devices and systems over the internet.
- **Robotics:** The branch of technology that deals with the design, construction, operation, and application of robots, often incorporating computer systems for their control, sensory feedback, and information processing.
- **Metaverse:** A collective virtual shared space, created by the convergence of virtually enhanced physical reality, augmented reality (AR), and internet technology. It's a space where users interact with a computer-generated environment and other users.

- **Pedagogical Methods:** The art or science of teaching and instructional methods. This includes various approaches and techniques used in education, such as inquiry-based learning, collaborative learning, and adaptive learning.
- **Digital Twin:** A virtual representation of a physical object or system across its lifecycle, using real-time data to enable understanding, learning, and reasoning. It is often used for simulation, analysis, and control.
- **STEM (Science, Technology, Engineering, and Mathematics):** An interdisciplinary approach to learning where academic concepts are coupled with real-world lessons, encouraging students to think critically and solve complex problems.
- **Design Thinking:** A non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems, and create innovative solutions to prototype and test.
- **Computational Thinking:** A problem-solving process that includes a number of characteristics and dispositions, such as logically ordering and analyzing data and creating solutions using a series of ordered steps (or algorithms).
- **Sustainable Development Goals (SDGs):** A collection of 17 global goals set by the United Nations General Assembly, intended to be a "blueprint to achieve a better and more sustainable future for all."

Detailed Competencies Maps and Guides

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(RC) Responsible Citizen Competencies: Promote Human Values in Technology Era	(RC.CLTW) Collaboration and Teamwork: Develops essential skills for working effectively in team environments. It involves learning and applying techniques for successful collaboration, understanding how to communicate effectively in a team, and coming up with innovative solutions to enhance teamwork.	(RC.CLTW.CL.01) At introductory level, students learn to identify and understand the basic principles of working together effectively. They recognize different roles and responsibilities within a team, laying the foundation for effective teamwork.	(RC.CLTW.CL.02) At intermediate level, students apply their collaborative skills in diverse team settings. They learn to analyze how teams interact and work on improving these interactions for better cooperation.	(RC.CLTW.CL.03) At advanced level, students are capable of creating and implementing new strategies to enhance collaboration. They evaluate these strategies to see their impact on improving overall team productivity and unity.
		(RC.CLTW.CM.01) At introductory level, students learn to recognize various forms of communication. They start to understand the basic principles behind effective information exchange, setting the stage for better communication skills.	(RC.CLTW.CM.02) At intermediate level, students actively apply effective communication techniques in different team settings. They analyze the results of using various communication styles and methods, gaining insights into what works best in different scenarios.	(RC.CLTW.CM.03) At advanced level, students are capable of creating specialized communication strategies that are tailored to specific team scenarios. They evaluate how these strategies impact overall team understanding and collaboration.
		(RC.CLTW.CR.01) At introductory level, students learn to identify and describe different types of conflicts and their causes. They gain an understanding of the basic methods used in conflict resolution, laying the groundwork for effective dispute management.	(RC.CLTW.CR.02) At intermediate level, students apply conflict resolution strategies within team environments. They analyze conflicts to understand their nature and determine the most effective approaches for resolution.	(RC.CLTW.CR.03) At advanced level, students are equipped to innovate and implement advanced techniques for conflict resolution. They evaluate the effectiveness of these methods in resolving complex disputes within teams.
		(RC.CLTW.GM.01) At introductory level, students learn to identify and understand a variety of cultural values and practices. They start recognizing the importance of being sensitive to different cultures, especially in team settings.	(RC.CLTW.GM.02) At intermediate level, students apply their knowledge of cultural diversity in team projects. They analyze how different cultural backgrounds influence team dynamics and the outcomes of collaborative efforts.	(RC.CLTW.GM.03) At advanced level, students are capable of creating and implementing strategies to improve global collaboration. They evaluate these strategies to ensure they effectively promote inclusive and productive team environments.
		(RC.CLTW.IPS.01) At introductory level, students learn to recognize and define the basics of interpersonal communication and behavior. They identify what constitutes effective interactions within team settings.	(RC.CLTW.IPS.02) At intermediate level, students apply their interpersonal skills in team activities. They analyze the dynamics of relationships and interactions in collaborative environments to better understand team functioning.	(RC.CLTW.IPS.03) At advanced level, students create and implement strategies to enhance interpersonal relationships within teams. They evaluate the effectiveness of these strategies in diverse team scenarios.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(RC) Responsible Citizen Competencies: Promote Human Values in Technology Era	(RC.CLTW) Collaboration and Teamwork	(RC.CLTW.LDS.01) At introductory level, students learn to identify and understand the fundamental concepts of leadership. They describe what it means to be a leader and recall examples of successful social influence in team environments.	(RC.CLTW.LDS.02) At intermediate level, students apply leadership principles in team activities. They study how various leadership styles impact team interactions and evaluate how effectively they can influence teams in collaborative settings.	(RC.CLTW.LDS.03) At advanced level, students design new leadership strategies for complex team projects. They critically examine how leadership shapes team culture and outcomes, and they develop sophisticated methods to positively influence teams and enhance collaboration.
	(RC.CCT) Creative and Critical Thinking: Nurtures the ability to think reflectively and independently. It encourages innovation and creative problem-solving across various fields, ensuring students can effectively adapt and contribute in diverse contexts.	(RC.CCT.CT.01) At introductory level, students learn to recognize the fundamentals of logical reasoning and understand the basics of critical analysis. This foundation is crucial for developing higher-order thinking skills.	(RC.CCT.CT.02) At intermediate level, students actively apply critical thinking skills. They evaluate various arguments and information, analyzing the strength and credibility of different sources to form well-informed opinions and conclusions.	(RC.CCT.CT.03) At advanced level, students are capable of creating well-reasoned arguments and devising innovative solutions for complex problems. They also evaluate the effectiveness of these solutions based on logical criteria, ensuring their reasoning is sound and their solutions are practical and effective.
		(RC.CCT.CI.01) At introductory level, students learn to recognize the importance of curiosity in driving the learning process. They begin to understand the principles of inquisitive thinking, setting the stage for a lifelong journey of exploration and discovery.	(RC.CCT.CI.02) At intermediate level, students apply their sense of curiosity and inquisitiveness in various learning and research scenarios. They analyze information more deeply, aiming to uncover new insights and expand their understanding.	(RC.CCT.CI.03) At advanced level, students create environments and situations that actively foster curiosity and inquisitive exploration. They evaluate the impact of these environments on enhancing the process of learning and discovery.
		(RC.CCT.IDT.01) At introductory level, students learn to identify and understand the basic principles of innovation and design thinking. They grasp why these concepts are vital in solving problems effectively.	(RC.CCT.IDT.02) At intermediate level, students apply techniques of innovation and design thinking to real-world problem-solving scenarios. They analyze the effectiveness of these techniques in generating practical solutions.	(RC.CCT.IDT.03) At advanced level, students are capable of creating and innovating new design thinking methodologies. They evaluate the impact of these methodologies on solving complex challenges and enhancing overall creativity.
		(RC.CCT.ST.01) At introductory level, students learn to recognize and understand the basic principles of systems thinking. This includes grasping the interconnectedness of various components within a system.	(RC.CCT.ST.02) At intermediate level, students apply systems thinking to dissect complex problems. They analyze how different actions might impact the system as a whole, considering potential outcomes of these actions.	(RC.CCT.ST.03) At advanced level, students create innovative strategies based on systems thinking. They use this approach to tackle complex challenges and evaluate the effectiveness of their solutions in terms of the entire system.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(RC) Responsible Citizen Competencies: Promote Human Values in Technology Era	(RC.EHV) Ethics - Human Values: Develops an understanding of ethical principles and human values, applying these in various situations, analyzing their impact on society, and devising ethical solutions to challenges.	(RC.EHV.ADPF.01) At introductory level, students learn to recognize the importance of adaptability and flexibility. They understand how these traits contribute to effective problem-solving and resilience in various contexts.	(RC.EHV.ADPF.02) At intermediate level, students apply adaptability and flexibility in diverse situations. They analyze how effectively these traits help in overcoming challenges and adapting to change.	(RC.EHV.ADPF.03) At advanced level, students develop strategies to cultivate adaptability and flexibility in both themselves and others. They evaluate the impact of these strategies in managing and leading change effectively.
		(RC.EHV.CULC.01) At introductory level, students learn to identify different cultural norms and values. They understand the significance of these cultural aspects in shaping both student and collective behaviors.	(RC.EHV.CULC.02) At intermediate level, students apply cultural competency skills in various social and professional settings. They analyze the impact of cultural diversity on interpersonal relationships and the dynamics within communities.	(RC.EHV.CULC.03) At advanced level, students create strategies and initiatives to promote cultural awareness and inclusivity. They evaluate the effectiveness of these strategies in fostering mutual understanding and respect across different cultural environments.
		(RC.EHV.DC.01) At introductory level, students learn to recognize the basics of safe and ethical online behavior. They understand the fundamental principles of digital citizenship, laying the groundwork for responsible online conduct.	(RC.EHV.DC.02) At intermediate level, students apply the principles of digital citizenship in various online settings. They analyze their digital footprints, considering the implications and consequences of their online actions.	(RC.EHV.DC.03) At advanced level, students develop and implement strategies for promoting responsible digital citizenship. They evaluate the effectiveness of these strategies in creating ethical online communities.
		(RC.EHV.IP.01) At introductory level, students learn to identify and understand the basic concepts of intellectual property rights. They grasp the significance of these rights in the realm of creative and intellectual work.	(RC.EHV.IP.02) At intermediate level, students apply ethical guidelines in the use of intellectual property. They analyze various scenarios involving intellectual property rights and potential infringements, understanding the complexities involved.	(RC.EHV.IP.03) At advanced level, students create strategies for protecting and ethically managing intellectual property. They evaluate the effectiveness of these strategies in different contexts, ensuring a balanced and responsible approach to intellectual property management.
		(RC.EHV.SDL.01) At introductory level, students begin to identify and understand the basics of self-directed learning. They learn about the skills and attitudes necessary for learning autonomously, laying the groundwork for effective independent learning.	(RC.EHV.SDL.02) At intermediate level, students apply self-directed learning techniques to their personal and academic pursuits. They analyze their learning styles and preferences, fine-tuning their approaches for more effective self-education.	(RC.EHV.SDL.03) At advanced level, students create personalized learning strategies and plans. They evaluate the effectiveness of these strategies in achieving their learning goals and fostering continuous self-improvement.
		(RC.EHV.SUS.01) At introductory level, students begin to recognize the basic principles of environmental and social sustainability. They understand the global significance of these concepts, setting the stage for responsible living.	(RC.EHV.SUS.02) At intermediate level, students apply sustainable practices in their personal lives and within their communities. They analyze the effects of these practices on environmental and social well-being, gaining insight into the impact of their actions.	(RC.EHV.SUS.03) At advanced level, students create and implement innovative solutions to complex sustainability challenges. They evaluate the long-term impact of these solutions on environmental and social systems, ensuring that their initiatives contribute positively to sustainability.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(DTT) Digital Twin Technology Competencies: Foundational and Future Technology Readiness	(DTT.CTS) Core Technological Skills: Develops essential technological competencies, which include understanding critical tech concepts, applying practical tools, analyzing the impacts of technology, and creating innovative technological solutions.	(DTT.CTS.CODP.01) At introductory level, students learn to recognize the fundamental concepts of programming. They start to understand the syntax and structure of at least one programming language, laying the groundwork for further development in software creation.	(DTT.CTS.CODP.02) At intermediate level, students apply their coding skills to develop simple software applications. They analyze their code for errors and efficiency, honing their ability to create functional and effective software.	(DTT.CTS.CODP.03) At advanced level, students are capable of creating complex and innovative software solutions. They evaluate the effectiveness and efficiency of these solutions, ensuring they meet high standards of functionality and innovation.
		(DTT.CTS.CSF.01) At introductory level, students learn to identify and understand the fundamental concepts of cybersecurity. This includes becoming familiar with common digital threats and the measures used to protect against them.	(DTT.CTS.CSF.02) At intermediate level, students apply basic cybersecurity practices to secure digital systems. They analyze potential vulnerabilities and threats, enhancing their ability to protect digital infrastructure.	(DTT.CTS.CSF.03) At advanced level, students are capable of creating and implementing comprehensive cybersecurity strategies. They evaluate the effectiveness of these strategies in defending against sophisticated digital threats, ensuring robust and resilient digital security.
		(DTT.CTS.DTA.01) At introductory level, students learn to recognize the basic concepts of data analysis. They start to understand fundamental statistical methods, laying the groundwork for more complex data interpretation and analysis.	(DTT.CTS.DTA.02) At intermediate level, students apply data analysis techniques to examine and interpret various data sets. They analyze this data to identify significant patterns and trends, enhancing their ability to draw meaningful conclusions.	(DTT.CTS.DTA.03) At advanced level, students are adept at creating advanced data analysis models and strategies. They evaluate the effectiveness of these models and strategies in generating actionable insights, ensuring their data analysis skills lead to valuable and practical outcomes.
		(DTT.CTS.CT.01) At introductory level, students learn to identify the principles of computational thinking. They understand how these principles can be applied in problem-solving, providing a foundational insight into the computational approach to challenges.	(DTT.CTS.CT.02) At intermediate level, students apply computational thinking methods, such as algorithmic thinking and pattern recognition, to address moderately complex problems. This level enhances their ability to deconstruct problems and find effective solutions.	(DTT.CTS.CT.03) At advanced level, students are capable of creating innovative computational models. They evaluate the efficiency and effectiveness of these models in solving complex problems, ensuring their solutions are both practical and innovative.
		(DTT.CTS.DGL.01) At introductory level, students learn to identify basic digital tools and understand their functionalities. They gain insights into how these tools can be applied in various contexts, setting the foundation for effective digital literacy.	(DTT.CTS.DGL.02) At intermediate level, students apply digital tools for various purposes, such as communication, research, and problem-solving. They analyze digital content to assess its validity and usefulness, enhancing their ability to discern quality digital information.	(DTT.CTS.DGL.03) At advanced level, students create innovative digital content or solutions. They evaluate the effectiveness of these creations in addressing specific needs or challenges, ensuring their digital competencies lead to practical and impactful outcomes.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(DTT) Digital Twin Technology Competencies: Foundational and Future Technology Readiness	(DTT.CTS) Core Technological Skills	(DTT.CTS.TTP.01) At introductory level, students learn to identify and understand the basic functions of various technical tools. They become familiar with the potential applications of these tools, setting the stage for effective utilization.	(DTT.CTS.TTP.02) At intermediate level, students apply technical tools to practical tasks or projects. They analyze the performance of these tools, assessing their suitability and effectiveness for specific tasks, thereby enhancing their practical problem-solving skills.	(DTT.CTS.TTP.03) At advanced level, students are capable of creating innovative applications or modifications of technical tools. They evaluate the effectiveness of these innovations in boosting productivity and resolving complex problems, showcasing their advanced technical proficiency.
	(DTT.ET) Emerging Technologies: Cultivates an understanding of advanced technologies and their applications. This subcategory encourages applying innovative solutions, analyzing the impacts of these technologies, and creating cutting-edge advancements in areas like Artificial Intelligence (AI), Machine Learning (ML), Blockchain, Internet of Things (IoT), Quantum Computing, and Robotics.	(DTT.ET.AIML.01) At introductory level, students learn to identify the fundamental concepts of AI and ML. They understand the basic applications of these technologies, laying the groundwork for further exploration and development in the field.	(DTT.ET.AIML.02) At intermediate level, students apply AI and ML techniques in practical scenarios. They analyze the performance and outcomes of these applications, enhancing their understanding of the technologies' capabilities and limitations.	(DTT.ET.AIML.03) At advanced level, students are capable of creating advanced AI/ML models. They evaluate these models not just for their innovation and effectiveness but also for their ethical implications, ensuring responsible development and use of AI and ML.
		(DTT.ET.BCWEB3.01) At introductory level, students learn to identify the basic principles of blockchain technology and Web3. They begin to understand the potential applications of these technologies, setting the foundation for further exploration and development.	(DTT.ET.BCWEB3.02) At intermediate level, students apply blockchain and Web3 concepts to develop decentralized solutions. They analyze the advantages and challenges of these technologies in various contexts, gaining a deeper understanding of their potential and limitations.	(DTT.ET.BCWEB3.03) At advanced level, students create cutting-edge applications using blockchain and Web3 technologies. They evaluate the impact of these applications on digital transactions and the development of a decentralized internet, ensuring that their solutions are innovative and effective.
		(DTT.ET.IOT.01) At introductory level, students learn to identify the basic components and principles of IoT systems. They understand the functionalities and potential applications of these systems, laying the groundwork for further exploration in IoT.	(DTT.ET.IOT.02) At intermediate level, students apply IoT technology in creating connected devices or systems. They analyze the operational efficiency and security challenges of these systems, gaining a deeper insight into the practical aspects of IoT implementation.	(DTT.ET.IOT.03) At advanced level, students create advanced and integrated IoT solutions. They evaluate the effectiveness of these solutions in enhancing connectivity and smart functionality, ensuring that their innovations contribute significantly to the realm of IoT.
		(DTT.ET.QC.01) At introductory level, students learn to identify and understand the basics of quantum mechanics and the principles underlying quantum computing. This foundational knowledge is crucial for delving deeper into the field.	(DTT.ET.QC.02) At intermediate level, students apply quantum computing concepts to solve simpler problems. They analyze the performance and practicality of quantum algorithms, enhancing their understanding of the technology's capabilities.	(DTT.ET.QC.03) At advanced level, students create innovative solutions using quantum computing technology. They evaluate the effectiveness of these solutions in tackling complex computational challenges, demonstrating their mastery in the cutting-edge field of quantum computation.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(DTT) Digital Twin Technology Competencies: Foundational and Future Technology Readiness	(DTT.ET) Emerging Technologies	(DTT.ET.ROB.01) At introductory level, students begin to identify the fundamental principles of robotics. They learn about the components and functions of robotic systems, setting the foundation for more advanced exploration in the field.	(DTT.ET.ROB.02) At intermediate level, students apply their skills in designing, building, and programming robots for specific tasks. They analyze the performance and adaptability of these robotic systems, enhancing their understanding of practical robotics applications.	(DTT.ET.ROB.03) At advanced level, students are capable of creating advanced and innovative robotic systems. They evaluate the effectiveness of these systems in performing complex tasks and contributing to the field of automation, showcasing their advanced expertise in robotics.
	(DTT.TP) Technical Proficiency: Develops skills in understanding technical concepts, applying specialized techniques, analyzing technical systems, and creating innovative solutions across various areas like System Integration, Scientific Inquiry, and Engineering Design.	(DTT.TP.ABSR.01) At introductory level, students learn to identify and understand basic abstract concepts and patterns. This foundational knowledge is essential for developing higher-order thinking skills and problem-solving abilities.	(DTT.TP.ABSR.02) At intermediate level, students apply abstract reasoning to solve moderately complex problems. They analyze abstract scenarios, enhancing their ability to think critically and solve problems effectively.	(DTT.TP.ABSR.03) At advanced level, students are capable of creating innovative solutions by applying advanced abstract reasoning skills. They evaluate the effectiveness of these solutions in complex scenarios, showcasing their proficiency in handling intricate and abstract concepts.
		(DTT.TP.ANAR.01) At introductory level, students learn to identify the basic principles of analytical reasoning. They understand how these principles can be applied to simple problem-solving scenarios, providing a base for more complex analytical tasks.	(DTT.TP.ANAR.02) At intermediate level, students apply their analytical reasoning skills to evaluate data and arguments. They analyze various scenarios, using their skills to form logical and well-reasoned conclusions.	(DTT.TP.ANAR.03) At advanced level, students are skilled in creating sophisticated strategies using analytical reasoning. They apply these strategies to complex problem-solving situations and evaluate their effectiveness in various contexts, demonstrating a high level of proficiency in analytical reasoning.
		(DTT.TP.AMS.01) At introductory level, students learn to identify and understand fundamental concepts in mathematics and science. They gain insights into how these principles can be practically applied, laying the groundwork for more advanced applications.	(DTT.TP.AMS.02) At intermediate level, students apply their knowledge of mathematics and science to practical and technical problems. They analyze the outcomes of these applications for effectiveness and accuracy, enhancing their ability to solve real-world challenges.	(DTT.TP.AMS.03) At advanced level, students are capable of creating innovative solutions to complex problems using advanced applied mathematics and science. They evaluate the practicality and efficiency of these solutions, ensuring their applicability and effectiveness in solving complex technical challenges.
		(DTT.TP.CT.01) At introductory level, students learn to identify the fundamentals of critical thinking. They understand its importance in evaluating information and arguments, setting a foundation for more advanced reasoning skills.	(DTT.TP.CT.02) At intermediate level, students apply critical thinking techniques to assess the credibility of information and arguments. They analyze issues from multiple perspectives, enhancing their ability to discern and evaluate various viewpoints.	(DTT.TP.CT.03) At advanced level, students create complex, reasoned arguments and solutions. They evaluate the effectiveness of these arguments and solutions in addressing challenging problems, demonstrating their mastery in critical thinking.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(DTT) Digital Twin Technology Competencies: Foundational and Future Technology Readiness	(DTT.TP) Technical Proficiency	(DTT.TP.ED.01) At introductory level, students learn to identify and understand the basic concepts and methodologies in engineering design. They gain an introductory understanding of how engineering principles are applied in the design process.	(DTT.TP.ED.02) At intermediate level, students apply engineering design principles to create prototypes and models. They analyze the effectiveness and feasibility of these models, enhancing their practical understanding of the engineering design process.	(DTT.TP.ED.03) At advanced level, students create innovative engineering solutions. They consider factors such as functionality, sustainability, and efficiency in their designs and evaluate the overall effectiveness of these solutions in solving real-world problems.
		(DTT.TP.EXD.01) At introductory level, students learn to identify the basic principles of experimental design. They understand the process of planning and conducting scientific experiments, setting the stage for more advanced research techniques.	(DTT.TP.EXD.02) At intermediate level, students apply experimental design techniques to conduct research and gather data. They analyze the results of their experiments, focusing on their validity and significance, thereby enhancing their research skills.	(DTT.TP.EXD.03) At advanced level, students create innovative experimental designs for complex research projects. They evaluate the effectiveness of these designs in generating reliable and significant findings, demonstrating their advanced expertise in experimental research.
		(DTT.TP.PS.01) At introductory level, students learn to identify basic problem-solving strategies. They understand how to apply these strategies in straightforward situations, providing a foundation for tackling more complex problems.	(DTT.TP.PS.02) At intermediate level, students apply problem-solving techniques to address more complex challenges. They analyze the outcomes of these methods for effectiveness and efficiency, enhancing their practical problem-solving skills.	(DTT.TP.PS.03) At advanced level, students create advanced problem-solving strategies. They evaluate the effectiveness of these strategies in resolving sophisticated and multifaceted issues, showcasing their advanced capability in problem-solving.
		(DTT.TP.PM.01) At introductory level, students learn to identify basic project management concepts. They understand the foundational process of planning and organizing projects, setting the groundwork for effective project execution.	(DTT.TP.PM.02) At intermediate level, students apply project management tools and techniques to efficiently execute projects. They analyze the progress and outcomes of these projects, enhancing their ability to manage and adjust project plans effectively.	(DTT.TP.PM.03) At advanced level, students create sophisticated project management strategies. They evaluate the effectiveness of these strategies in delivering successful project outcomes, demonstrating their advanced skills in managing complex projects.
		(DTT.TP.QA.01) At introductory level, students learn to identify the basic principles of quality assurance. They understand the importance of these principles in maintaining the standards of various projects and processes.	(DTT.TP.QA.02) At intermediate level, students apply quality assurance methods to monitor and maintain the standards of products or services. They analyze the effectiveness of these methods, enhancing their ability to ensure and improve quality.	(DTT.TP.QA.03) At advanced level, students create advanced quality assurance strategies. They evaluate the impact of these strategies on improving and maintaining high standards in project outcomes and processes, showcasing their expertise in quality assurance.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(DTT) Digital Twin Technology Competencies: Foundational and Future Technology Readiness	(DTT.TP) Technical Proficiency	(DTT.TP.SCI.01) At introductory level, students learn to identify the basic principles of scientific inquiry. They understand how these principles are applied in conducting research, laying the groundwork for further exploration in scientific studies.	(DTT.TP.SCI.02) At intermediate level, students apply scientific inquiry methods to conduct research studies. They analyze the results of their research, focusing on scientific validity and relevance, thereby enhancing their research skills.	(DTT.TP.SCI.03) At advanced level, students create innovative research methodologies. They evaluate the effectiveness of these methodologies in contributing to scientific knowledge and understanding, showcasing their expertise in scientific inquiry.
		(DTT.TP.SIN.01) At introductory level, students learn to identify the basic concepts of system integration. They understand the importance of interoperability among different technological systems, setting a foundation for more advanced integration skills.	(DTT.TP.SIN.02) At intermediate level, students apply system integration techniques to combine multiple technological components into cohesive systems. They analyze the functionality and efficiency of these integrated systems, enhancing their understanding of effective system interconnection.	(DTT.TP.SIN.03) At advanced level, students create sophisticated system integration strategies. They evaluate the effectiveness of these strategies in achieving seamless interoperability and improved system performance, demonstrating their advanced competency in system integration.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(COC) Co-Creation Competencies: Equip new machine and AI empowered creativity	(COC.AID) AI Driving: Develops comprehensive skills in AI technology, including understanding its principles, applying AI in various scenarios, analyzing its effectiveness, and creating innovative AI-driven solutions.	(COC.AID.CR.01) At introductory level, students learn to identify the basic principles of causal reasoning. They understand how these principles can be applied in AI contexts, providing a foundation for more complex causal analyses..	(COC.AID.CR.02) At intermediate level, students apply causal reasoning to analyze AI data and model cause-and-effect relationships. They analyze the outcomes of these models for validity, enhancing their understanding of the nuances of causal analysis in AI.	(COC.AID.CR.03) At advanced level, students create AI models or solutions utilizing advanced causal reasoning. They evaluate the effectiveness of these models or solutions in complex scenarios, demonstrating their expertise in integrating causal reasoning with AI technologies.
		(COC.AID.INAP.01) At introductory level, students learn to recognize the potential of AI for innovative applications. They understand the basics of implementing AI solutions, setting the groundwork for more advanced applications.	(COC.AID.INAP.02) At intermediate level, students apply AI technology creatively to solve practical problems. They analyze the outcomes and effectiveness of these AI solutions, enhancing their ability to assess and improve AI applications.	(COC.AID.INAP.03) At advanced level, students are capable of creating cutting-edge AI-driven solutions or applications. They evaluate the innovation and impact of these solutions in addressing complex challenges, showcasing their advanced skills in leveraging AI for creative and innovative purposes.
		(COC.AID.PE.01) At introductory level, students learn to identify the basics of prompt engineering. They understand its significance in guiding AI behavior, setting a foundation for more effective AI interactions.	(COC.AID.PE.02) At intermediate level, students apply the principles of prompt engineering to create effective prompts for AI systems. They analyze the AI's responses to ensure alignment with the desired outcomes, enhancing their ability to guide AI behavior effectively.	(COC.AID.PE.03) At advanced level, students create sophisticated and nuanced prompts for complex AI interactions. They evaluate the precision and effectiveness of these prompts in achieving specific objectives, demonstrating their mastery in the nuanced art of prompt engineering.
		(COC.AID.UAIAP.01) At introductory level, students learn to identify basic AI concepts and understand their practical applications across different industries. This foundational knowledge sets the stage for further exploration and application of AI technologies.	(COC.AID.UAIAP.02) At intermediate level, students apply AI solutions to specific problems and analyze the outcomes. They assess the effectiveness and suitability of these AI applications, enhancing their understanding of how AI can be utilized in real-world scenarios.	(COC.AID.UAIAP.03) At advanced level, students create innovative strategies for the application of AI in complex scenarios. They evaluate the impact and efficacy of these strategies in solving advanced problems, demonstrating their expertise in leveraging AI for innovative and effective solutions.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(COC) Co-Creation Competencies: Equip new machine and AI empowered creativity	(COC.DT) Design Thinking: Fosters an understanding of innovative design processes. It emphasizes applying user-centered and reflective practices, analyzing the effectiveness of design solutions, and creating empathetic and ethical solutions.	(COC.DT.CPS.01) At introductory level, students learn to identify and understand the nature of complex problems. They grasp basic problem-solving methodologies, setting the stage for tackling more intricate challenges.	(COC.DT.CPS.02) At intermediate level, students apply structured approaches to solve complex problems. They analyze the effectiveness of these solutions, enhancing their ability to devise practical and impactful resolutions.	(COC.DT.CPS.03) At advanced level, students create innovative and effective strategies for complex problem-solving. They evaluate the impact and feasibility of these strategies, demonstrating their proficiency in navigating and resolving multifaceted challenges.
		(COC.DT.UCD.01) At introductory level, students learn to identify the basics of user-centered design. They understand its importance in creating effective and satisfying user experiences, laying the groundwork for more advanced design applications.	(COC.DT.UCD.02) At intermediate level, students apply user-centered design principles to develop products or services. They analyze their usability and effectiveness from the user's perspective, enhancing their ability to create designs that resonate with users.	(COC.DT.UCD.03) At advanced level, students create advanced design solutions that innovatively meet user needs. They evaluate the impact of these solutions on enhancing user experience and satisfaction, showcasing their expertise in user-centered design.
		(COC.DT.SR.01) At introductory level, students learn to identify the role of self-reflection in the design process. They understand its importance in ethical decision-making, setting a foundation for more introspective design practices.	(COC.DT.SR.02) At intermediate level, students apply self-reflection to assess their personal design choices and biases. They analyze how these personal perspectives influence design outcomes, enhancing their awareness of the ethical dimensions of design.	(COC.DT.SR.03) At advanced level, students create design methodologies that integrate self-reflection. They enhance ethical and user-centric design practices and evaluate their impact on the overall design process. This advanced approach ensures that designs are not only effective but also ethically and empathetically informed.
	(COC.EHCH) Ethical Judgement and Complexity Handling: Cultivates an understanding of ethics in complex problem-solving, applying principled decision-making, analyzing multifaceted scenarios, and creating ethical and strategic solutions.	(COC.EHCH.ER.01) At introductory level, students learn to identify fundamental ethical concepts. They understand the relevance of these concepts in decision-making processes, laying the groundwork for ethical evaluation and decision-making.	(COC.EHCH.ER.02) At intermediate level, students apply ethical frameworks to evaluate and make decisions in various scenarios. They analyze the outcomes of these decisions for their moral implications, enhancing their capacity to make ethically informed choices.	(COC.EHCH.ER.03) At advanced level, students create and implement strategies to address complex ethical dilemmas. They evaluate the effectiveness of these strategies in upholding ethical standards, demonstrating their advanced skills in ethical reasoning and decision-making.
		(COC.EHCH.MC.01) At introductory level, students learn to identify the basic elements of complex situations. They understand the interconnected nature of these elements, which is essential for beginning to manage complexity.	(COC.EHCH.MC.02) At intermediate level, students apply strategic thinking and problem-solving methods to manage complex scenarios. They analyze the outcomes of their strategies for effectiveness, enhancing their ability to tackle complex challenges.	(COC.EHCH.MC.03) At advanced level, students create sophisticated strategies for handling high levels of complexity in various contexts. They evaluate the effectiveness of these strategies in resolving intricate challenges, showcasing their expertise in managing complex scenarios.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(COC) Co-Creation Competencies: Equip new machine and AI empowered creativity	(COC.IDK) Interdisciplinary Knowledge: Develops the ability to merge knowledge and methods from different disciplines. This approach is crucial for applying a holistic perspective to problem-solving and innovation, ensuring solutions are well-rounded and effective.	(COC.IDK.CDS.01) At introductory level, students learn to identify the principles of cross-disciplinary collaboration. They understand its importance in achieving comprehensive and effective problem-solving, laying the groundwork for more advanced interdisciplinary applications.	(COC.IDK.CDS.02) At intermediate level, students apply cross-disciplinary knowledge to develop solutions for complex problems. They analyze the outcomes of these solutions for their effectiveness and innovation, enhancing their ability to integrate diverse perspectives.	(COC.IDK.CDS.03) At advanced level, students create innovative approaches and solutions by integrating multiple disciplinary perspectives. They evaluate the impact of these integrated solutions on solving multifaceted challenges, demonstrating their expertise in cross-disciplinary problem-solving.
	(COC.RR) Resilience and Resolve: Fosters skills in understanding and managing adversity. A key aspect of this is emotional regulation, which is significantly enhanced through the practice of mindfulness. This proficiency involves understanding and applying mindfulness techniques to improve focus, emotional regulation, and stress management.	(COC.RR.RS.01) At introductory level, students learn to identify the key aspects of resilience. They understand the importance of resilience in overcoming adversity, setting the stage for developing effective coping strategies.	(COC.RR.RS.02) At intermediate level, students apply resilience strategies to manage and adapt to challenging situations effectively. They analyze the effectiveness of these strategies in contributing to personal growth and recovery, enhancing their ability to bounce back from adversity.	(COC.RR.RS.03) At advanced level, students create approaches or initiatives to enhance resilience in themselves and others. They evaluate the impact of these strategies in promoting enduring strength and adaptability, demonstrating their proficiency in fostering resilience in various contexts.
		(COC.RR.RSLV.01) At introductory level, students learn to identify and understand the concept of resolve. They comprehend its crucial role in achieving personal and professional goals, laying the foundation for developing a strong sense of purpose and determination.	(COC.RR.RSLV.02) At intermediate level, students apply resolve in diverse situations to overcome challenges and persist towards their objectives. They analyze how resolve impacts goal attainment, enhancing their understanding of the dynamics of perseverance and commitment.	(COC.RR.RSLV.03) At advanced level, students create methods to cultivate and maintain strong resolve in themselves and others. They evaluate the effectiveness of these methods in ensuring sustained commitment and success, showcasing their ability to foster determination and steadfastness in various contexts.

Domain Category	Sub Category	Introductory Proficiency	Intermediate Proficiency	Advanced Proficiency
(COC) Co-Creation Competencies: Equip new machine and AI empowered creativity	(COC.RR) Resilience and Resolve	(COC.RR.EMR.01) At introductory level, students learn to identify basic emotional regulation techniques. They understand the importance of these techniques in maintaining emotional balance in both personal and professional contexts.	(COC.RR.EMR.02) At intermediate level, students apply emotional regulation strategies to maintain composure and effectiveness in challenging situations. They analyze the impact of these strategies on personal well-being and interpersonal relations, enhancing their emotional intelligence.	(COC.RR.EMR.03) At advanced level, students create comprehensive approaches for enhancing emotional regulation skills in themselves and others. They evaluate the effectiveness of these approaches in fostering resilience and resolve, demonstrating their expertise in managing emotions in complex and demanding scenarios.
		(COC.RR.MF.01) At introductory level, students identify and remember the core principles of mindfulness. They begin to understand the role of mindfulness in improving focus, emotional regulation, and stress reduction. This foundational knowledge sets the stage for deeper exploration and application of mindfulness techniques.	(COC.RR.MF.02) At intermediate level, students apply mindfulness techniques, such as deep breathing or meditation, in their daily routines. They analyze the impact of these practices on their personal well-being and emotional state. This stage is crucial for experiencing the benefits of mindfulness firsthand and understanding how it contributes to emotional balance.	(COC.RR.MF.03) At advanced level, students create personalized mindfulness routines or programs. These routines integrate various mindfulness practices tailored to individual needs. Individuals then evaluate and assess the effectiveness of these routines in enhancing resilience, focus, and emotional balance. This level demonstrates a deep understanding of mindfulness and its application in enhancing personal growth and resilience.

REFERENCES

Bovill, C. (2020). Co-creation in learning and teaching: The case for a whole-class approach in higher education. *Higher education, 79*(6), 1023-1037.

Council of Europe. Education Department (Ed.). (2018). Reference framework of competences for democratic culture. *Council of Europe*.

Drigas, A. S., & Papoutsi, C. (2018). A new layered model on emotional intelligence. *Behavioral sciences, 8*(5), 45.

Fisher, D. (2021). Educational leadership and the impact of societal culture on effective practices. *Journal of Research in International Education, 20*(2), 134-153.

Fortuin, K. P. J., Gulikers, J. T., Post Uiterweer, N. C., Oonk, C., & Tho, C. W. (2023). Developing a boundary crossing learning trajectory: supporting engineering students to collaborate and co-create across disciplinary, cultural and professional practices. *European Journal of Engineering Education, 1*-24.

Fuentes-Moreno, C., Sabariego-Puig, M., & Ambros-Pallarés, A. (2020). Developing social and civic competence in secondary education through the implementation and evaluation of teaching units and educational environments. *Humanities and Social Sciences Communications, 7*(1), 1-12.

Gama, F., & Magistretti, S. (2023). Artificial intelligence in innovation management: A review of innovation capabilities and a taxonomy of AI applications. *Journal of Product Innovation Management*.

Gimbert, B. G., Miller, D., Herman, E., Breedlove, M., & Molina, C. E. (2023). Social emotional learning in schools: The importance of educator competence. *Journal of Research on Leadership Education, 18*(1), 3-39.

Hartwig, A., Clarke, S., Johnson, S., & Willis, S. (2020). Workplace team resilience: A systematic review and conceptual development. *Organizational Psychology Review, 10*(3-4), 169-200.

Heitzmann, N., Opitz, A., Stadler, M., Sommerhoff, D., Fink, M. C., Obersteiner, A., ... & Fischer, F. (2021). Cross-Disciplinary Research on Learning and Instruction–Coming to Terms. *Frontiers in Psychology, 12*, 562658.

Hemberg, J., & Hemberg, H. (2020). Ethical competence in a profession: Healthcare professionals' views. *Nursing Open, 7*(4), 1249-1259.

Hemdan, E. E. D., El-Shafai, W., & Sayed, A. (2023). Integrating Digital Twins with IoT-Based Blockchain: Concept, Architecture, Challenges, and Future Scope. Wireless Personal Communications, 1-24.

Herberg, M., & Torgersen, G. E. (2021). Resilience competence face framework for the unforeseen: Relations, emotions and cognition. A qualitative study. Frontiers in psychology, 12, 669904.

Holopainen, M., Saunila, M., Rantala, T., & Ukko, J. (2022). Digital twins' implications for innovation. Technology Analysis & Strategic Management, 1-13.

Huang, Z., Shen, Y., Li, J., Fey, M., & Brecher, C. (2021). A survey on AI-driven digital twins in industry 4.0: Smart manufacturing and advanced robotics. Sensors, 21(19), 6340.

Jones, D., Snider, C., Nassehi, A., Yon, J., & Hicks, B. (2020). Characterising the Digital Twin: A systematic literature review. CIRP journal of manufacturing science and technology, 29, 36-52.

Lopez, J. S., Snyder, C. R., & Maddux, J. E. (2009). Self-Efficacy: The Power of Believing You Can.'.

Ma, Y., Pang, C., Chen, H., Chi, N., & Li, Y. (2014). Interdisciplinary cooperation and knowledge creation quality: A perspective of recombinatory search. Systems Research and Behavioral Science, 31(1), 115-126.

Moirano, R., Sánchez, M. A., & Štěpánek, L. (2020). Creative interdisciplinary collaboration: A systematic literature review. Thinking Skills and Creativity, 35, 100626.

Morales-Sánchez, R., & Cabello-Medina, C. (2013). The role of four universal moral competencies in ethical decision-making. Journal of business ethics, 116, 717-734.

Pennington, D. D. (2011). Collaborative, cross-disciplinary learning and co-emergent innovation in eScience teams. Earth Science Informatics, 4, 55-68.

Quílez-Robres, A., Usán, P., Lozano-Blasco, R., & Salavera, C. (2023). Emotional Intelligence and Academic Performance: A Systematic Review and Meta-Analysis. Thinking Skills and Creativity, 101355.

Selenko, E., Bankins, S., Shoss, M., Warburton, J., & Restubog, S. L. D. (2022). Artificial intelligence and the future of work: A functional-identity perspective. Current Directions in Psychological Science, 31(3), 272-279.

Sharma, A., Kosasih, E., Zhang, J., Brintrup, A., & Calinescu, A. (2022). Digital twins: State of the art theory and practice, challenges, and open research questions. Journal of Industrial Information Integration, 100383.

Skywark, E. R., Chen, E., & Jagannathan, V. (2022). Using the Design Thinking Process to Co-create a New, Interdisciplinary Design Thinking Course to Train 21st Century Graduate Students. Frontiers in Public Health, 9, 777869.

Vardakosta, E., Priniotakis, G., Papoutsidakis, M., Sigala, M., Tsikritsis, A., & Nikolopoulos, D. (2023). Design Thinking as a Co-Creation Methodology in Higher Education. A Perspective on the Development of Teamwork and Skill Cultivation. European Journal of Educational Research, 12(2).

Victorino-Soriano, C. (2016). Community-based Lifelong Learning and Adult Education: Adult skills and competencies for lifelong learning.

Yang, S., & Wang, W. (2022). The Role of Academic Resilience, Motivational Intensity and Their Relationship in EFL Learners' Academic Achievement. Frontiers in Psychology, 12, 823537.

AUTHORS

Co-Authors

TRUNG The Nguyen
CEO & Founder, Pythaverse

WILLIAM Law
Content Director, Pythaverse

Contribution from Pythaverse Team Members

LIM Soon Seong
TRINH To Bach
ARTHUR Liew
LINH Nguyen
Wendy LAU
GIANG Duong
QUANG Dinh
CHINH Duc Nguyen
TALHA Khan
NURFAIZZIN
ONG Poh Swan
MARCO Miranda
LINH Dang
VIRNA Pomendia
JOAN Tranquillo
LANG Hui Xian

This report is co-created with various AI tools including ChatGPT4, Google Bard, Stable Diffusion

