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STEM in TVET Curriculum Guide

An Initiative of the ILO Women in STEM Workforce
Readiness and Development Programme

Supported by

J.P.Morgan

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I. Introduction

STEM in TVET is important for securing skills for the digital economy. Globally, economic agenda have pushed for the delivery of STEM skills for accelerating economic growth and for staying resilient amidst different crises. A workforce that is steeped in STEM competencies is a strong backbone that can withstand economic pressures because the skills of critical thinking, problem solving, and innovation have become deeply ingrained.

The International Labour Organization (ILO) Women in STEM for Workforce Readiness and Development Programme echoes the same determination that is aligned with the Fourth Industrial Revolution (4IR) Framework of the Technical Education and Skills Development Authority (TESDA). Previously, it has developed the STEM in TVET Learning Design Framework. The framework has synthesized salient international perspectives and strategies on STEM in TVET to generate one that is relevant to the Philippine context. It identifies priority STEM competencies and pedagogical approaches suitable for TVET. Moreover, it explains the role of teacher professional development, innovation and intelligence, resources, ecosystem, the education continuum, and cultural context as critical levers in making STEM in TVET a success. The next logical step for a learning design framework is a curriculum guide that translates the framework into usable information for curriculum planners and trainers, hence, the development of this STEM in TVET Curriculum Guide.

This curriculum guide maps the STEM competencies in the STEM in TVET Learning Design Framework to the existing basic, common, and core competencies of TESDA qualifications. It aims to demonstrate the extent to which STEM competencies are already embedded in TVET programs. More importantly, the curriculum guide expands the current curriculum design by offering comprehensive reference documents for the STEM competencies. The reference documents outline relevant knowledge and specific indicators of STEM competencies as well as instructional activities that can translate them into practice. Moreover, this curriculum guide provides templates for learning activities that foster thinking skills and literacies. It also has a section on assessing STEM-oriented outputs.

Overall, the goal of this STEM in TVET curriculum guide is to reinforce existing STEM competencies in TESDA qualifications through STEM-oriented learning activities and assessments.

II. STEM in TVET: Learning Design Framework

The STEM in TVET Learning Design Framework is derived from the different perspectives and salient features of STEM frameworks in the United States, European Union, Germany, United Kingdom, Australia, Singapore, and the Philippines. It presents the goals of STEM in TVET and the STEM competencies that should be prioritized in relation to the future of work. In light of the emerging trends in the delivery of TVET programs across the world, effective STEM pedagogies are described as well as the learning theories that foreground said pedagogies. Moreover, the framework highlights critical levers that can facilitate the success of STEMifying TVET.

Goals of STEM in TVET

The goals of STEM in TVET are employability, proactive citizenship, and human flourishing. Employability means being equipped with knowledge, skills, and attitudes that enable an individual to be able to secure a job. On the other hand, proactive citizenship means contributing to nation-building as well as being a responsible global and digital citizen. Although not explicitly stated in any of the frameworks, the third goal “human flourishing” can be something akin to lifelong learning but on a much higher level. Human flourishing is the highest form of self-actualization. It means that an individual can flourish and prosper not only for himself/herself but also for others, regardless whether circumstances are favorable or not.

STEM Competencies

STEM competencies that support Technical and Vocational Education and Training (TVET) have four major domains, namely, STEM knowledge, thinking skills, multiliteracies, and socio-emotional intelligence.

1. STEM knowledge that is disciplinary and also transdisciplinary is important in TVET.

Disciplinary knowledge means subject-specific understanding of concepts, theories, principles, laws, and contexts of Science, Technology, Engineering, and Mathematics.

On the other hand, transdisciplinary knowledge refers to the integrative understanding of the useful and most relevant content and techniques from the STEM disciplines to be able to solve work-related and other real-world problems.

2. Thinking skills involve skills for sense-making to be able to solve problems, understand connections, make informed decisions, or innovate for the improvement of personal, community, workplace, and regional/national contexts. Thinking skills include:

a. **Creative/Inventive Thinking**

Combine or connect ideas and information in unique and novel ways to generate new ideas, applications, products, processes, or services

b. **Critical Thinking**

Apply logic and reasoning to make sense of data or information by posing questions, putting forward arguments, exploring counterexamples, searching evidence, identifying relationships, recognizing patterns and trends, evaluating pros and cons, and synthesizing information

- c. **Systems Thinking**
Understand the bigger context of a system, its emergent properties, and behavior over time by knowing the connections, interrelationships, and dynamics of its constituent parts
- d. **Problem Solving**
Identify feasible and efficient solutions to solve problems and to create new opportunities
- e. **Transdisciplinary Thinking**
Put together relevant concepts and processes from multiple disciplines to generate solutions and new applications
- f. **Decision-making**
Make a logical choice of action by looking at evidence, exploring alternatives, considering likely impact, evaluating options and providing justifications
- g. **Computational Thinking¹**
Develop or apply computational models, tools and techniques to interpret and understand data, solve problems, and guide decision-making
- h. **Ethical Thinking**
Use value system as guide for making choices that adhere to acceptable standards and protocols.

3. Multiliteracies are various forms of literacy that bridge STEM knowledge, skills, attitudes, dispositions, and values. The literacies can be applied singly or in combination with other forms depending on the context of learning. The multiliteracies that are relevant to STEM in TVET are the following:

- a. **Numeracy**
Apply mathematical ideas in personal, occupational, societal, and scientific contexts by reasoning, creating representations, or using measuring instruments or calculating tools
- b. **Digital Literacy**
Search, evaluate, create, and share digital information using ICT device, equipment, tools, platforms, and applications for communication, collaboration, or problem solving
- c. **Civic Literacy**
Contribute to the broader goals of the community by participating proactively in community affairs and observing social responsibility
- d. **Cultural Literacy**
Be sensitive and respectful of the culture where an individual is immersed in

¹ Definition of computational thinking adopted from SkillsFuture Critical Core Skills. SkillsFuture SG. Critical Core Skills for Training and Adult Education (formerly Generic Skills and Competencies). <https://www.skillsfuture.sg/-/media/SkillsFuture/Initiatives/Files/SF-for-Infocomm-Technology/SF-GSC.PDF?la=en>

- e. Occupational Health Literacy
Understand and apply occupational safety standards and protocols as well as take care of one's health and well-being to maintain productivity
 - f. Entrepreneurial Literacy²
Detect an opportunity and make it grow in a sustainable way applying relevant knowledge, skills, and attitudes
 - h. Organizational Literacy
Negotiate way within an organization by understanding its structure, dynamics of its members, communication channels, and appropriate procedures
4. **Socio-Emotional Intelligence** refers to *“the ability to integrate feeling, intuition, and cognition to acknowledge, understand, manage, apply, and express an individual's emotions and social interactions at the right time, for the right purpose, in the right context, and with the right person or group.”* (Devis-Rozenthal, 2017)³

For STEM in TVET, the applicable components of socio-emotional intelligence are:

- a. Communication
Convey and exchange thoughts, ideas and information effectively through various mediums and approaches⁴
- b. Collaboration
Work effectively in a team to achieve shared goals either through face-to-face or virtual interaction
- c. Empathy
Sense, share and respond positively to the feelings of another
- d. Agency
Manage own behavior and emotions to act professionally and independently, make choices freely, and pursue goals persistently
- e. Lifelong/ Lifewide Learning
Find opportunities to enhance one's knowledge and skills for continual learning; Maintain curiosity, passion, and growth mindset; Connect learning to a purpose and real-world context
- i. Resilience
Thrive or prosper despite difficult circumstances; Be adaptable and flexible

² Perez-Bustamante, G. (2014). Developing Entrepreneurial Literacy at University: A Hands-on Approach. *International Journal of Multidisciplinary Comparative Studies*, 1(2), pp. 57-75.

³ Devis-Rozental, C. (2017). Developing socio-emotional intelligence in early years scholars (Doctoral dissertation, Bournemouth University).

⁴ Definition of communication adopted from SkillsFuture Critical Core Skills. SkillsFuture SG. Critical Core Skills for Training and Adult Education (formerly Generic Skills and Competencies). <https://www.skillsfuture.sg/-/media/SkillsFuture/Initiatives/Files/SF-for-Infocomm-Technology/SF-GSC.PDF?la=en>

- j. Leadership
Lead others to attain shared goals by managing relationships, respecting diversity, recognizing talent, and empowering people
- k. Service Orientation
Support a culture of service excellence within the organization by producing products or providing services that exceed the expectations of the customers
- l. Project Management
Use resources (human, material, and time) wisely to deliver work-related tasks or projects
- m. Glocal Mindset
Be adaptive to global standards but remain responsive to local needs

STEM Pedagogies

Based on the STEM pedagogies that are applied in TVET programs in the United States, European Union, Germany, United Kingdom, Australia, and Singapore, Table 1 shows pedagogical approaches, their corresponding descriptions and examples of activities and tools.

Table 1. STEM Pedagogies, Example Activities, and Tools for TVET from International TVET Programs

Pedagogical Approach	Description	Example Activities and Tools
Experiential learning	Immersing trainees in tools, activities, actual work settings of the relevant trade	Apprenticeship Industry-led competitions/projects Immersion or short-term engagements (industry, research facility, innovation spaces, colleges/universities)
Contextual learning	Using examples that are familiar and relevant to the situation of the trainees, which may also include indigenous resources such as artefacts and tools	Practical tasks Work process matrix Four-step method (explanation-demonstration-imitation-practice) Guiding texts Photo association Task analysis Training portfolio Home-based projects/experiments Mentoring Brown bag sessions with practitioners
Problem-centered learning	Providing opportunities for students to address authentic, open-ended, ill-structured, real-world problems for meaningful learning	Case study Industry-led competitions/projects Experiments Internet rally Technical specifications Project plans Data visualization

Project-based Learning	Giving short-term challenges or tasks with relatively shorter period of time to complete	<ul style="list-style-type: none"> Projects Case study Simulation game Role play Experiments Internet rally Data visualization
Inquiry-based learning	Designing an investigation to enable students to discover new concepts or explore scientific phenomenon by asking questions, gathering evidence, offering explanation from evidence, connecting evidence to scientific knowledge, as well as, providing justification based on patterns derived from evidence	<ul style="list-style-type: none"> Experiments Technical specifications Research projects Baseline assessments Needs analysis Data analysis, visualization Research meetings Colloquia
Design-based learning	Posing an open-ended, hands-on design challenge that allows students to go through the engineering design or design thinking processes in generating innovative solutions such as new products, optimized processes or services	<ul style="list-style-type: none"> Design challenges Agile project management (e.g. Kanban, Scrum) Persona maps Ideation techniques Brainstorming Invention algorithms Storyboards Design briefs Technical specifications Project plans Prototyping Innovation pitch Concept testing Usability testing Mock campaigns
Collaborative learning	Allowing trainees to work in teams, exercise interpersonal and communication skills	<ul style="list-style-type: none"> Projects Design challenges Virtual meetings Jigsaw technique Agile project management (e.g. Kanban, Scrum) Persona maps Ideation techniques Brainstorming Invention algorithms Storyboards Design briefs Technical specifications Project plans Prototyping Innovation pitch Concept testing Usability testing Mock campaigns Critical reading and writing

<p>Technology-supported learning</p>	<p>Using ICT tools, platforms, software, device, or equipment for training delivery or assessment</p>	<p>Internet rally Mobile applications Virtual meetings Online forum Webinar Wiki Blog/vlog Online quizzes Surveys Digital interactive boards Infographics Interactive media AR/VR Chatbots Predictive/learning analytics</p>
<p>Phenomenon-based learning</p>	<p>Using phenomena or observable occurrences as anchors for investigations, as well as, launch pads for problem finding or problem solving</p>	<p>Integration of disaster risk reduction and management (DRRM) concepts Projects Design challenges Agile project management (e.g. Kanban, Scrum) Persona maps Ideation techniques Brainstorming Invention algorithms Storyboards Design briefs Technical specifications Project plans Prototyping Innovation pitch Concept testing Usability testing Mock campaigns Critical reading and writing</p>
<p>Place-based learning</p>	<p>Addressing local or community needs by applying relevant STEM knowledge and skills</p>	<p>Case study Experiments Projects Community Science Design challenges Agile project management (e.g. Kanban, Scrum) Persona maps Ideation techniques Brainstorming Invention algorithms Storyboards Design briefs Technical specifications Project plans Prototyping Innovation pitch Concept testing Usability testing</p>

		Mock campaigns Critical reading and writing
Education for Sustainable Development	Using Sustainable Development Goals (SDGs) as platforms for connecting learning to global needs for greater societal impact	Case study Industry-led competitions/projects Experiments Projects Design challenges Agile project management (e.g. Kanban, Scrum) Persona maps Ideation techniques Brainstorming Invention algorithms Storyboards Design briefs Technical specifications Project plans Prototyping Innovation pitch Concept testing Usability testing Mock campaigns Critical reading and writing
Reflective learning	Engaging in the analysis of individual or team thoughts, actions, and outputs to enable improvement	Task analysis Mind mapping Flowchart Critical reading and writing Personal growth plan Training portfolio

Learning Theories

The learning theories that foreground the abovementioned pedagogies, tools, and activities are the following (Figure 1) :

- a. Constructivist Theory (Jerome Bruner, 1960s)⁵
Learners learn effectively when: (a) their prior experiences and context are applied to understanding a new concept or completing a new task; (b) the content to be learned is structured optimally, i.e., from simplest to most complex; and (c) when learners perform hands-on explorations/inquiries that facilitate discovery of concepts and construction of new knowledge.
- b. Social Development Theory (Lev Vygotsky, 1978)⁶
Social interaction plays a crucial role in developing thinking skills. Compared to learning in isolation, higher level of skills can be attained from expert guidance or peer collaboration.

⁵ Bruner, J. (1966). Theory of instruction. http://www.ascd.org/ASCD/pdf/journals/ed_lead/el_196305_bruner.pdf

⁶ Lev Vygotsky, <https://pdfs.semanticscholar.org/96ba/471b2677b7ca0b62e778dee40fa1078d5c03.pdf>

- c. **Andragogy (Malcom Knowles, 1980s)⁷**
Learning activities should be task-oriented/problem-centered, relevant, more experiential, and should optimize the use of learners' prior knowledge.
- d. **Neuroplasticity (Michael Merzenich, 1993)⁸**
The brain is plastic. It can continuously change and learn, even in adulthood, through challenging tasks and complex problem solving activities.
- e. **Connectivism (George Siemens, 2004)⁹**
Learning is attained by recognizing patterns or seeing connections between fields, ideas, and concepts. It is not limited to individuals alone but may also take place within interactions in organizations and databases.
- f. **Scaffolding Theory of Aging and Cognition (STAC) (Denise Park and Patricia Reuter-Lorenz, 2009)¹⁰**
The brain builds protective “scaffolds” to adapt to the natural neural decline brought about by aging. To enhance the scaffolds, individuals should maintain high levels of engagement in novel activities including learning new things, engaging in exercise, or possibly participating in cognitive training.

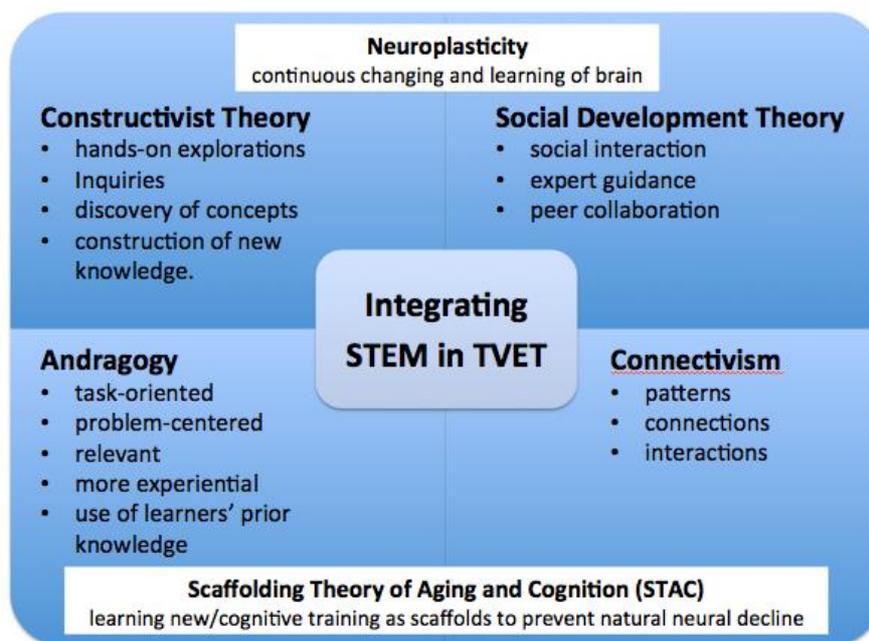


Figure 1. Learning Theories Supporting STEM in TVET

⁷ Adult learning theories, https://lincs.ed.gov/sites/default/files/11_%20TEAL_Adult_Learning_Theory.pdf

⁸ Guglielman, E. (2012). The Ageing brain: Neuroplasticity and lifelong learning. eLearning Papers.

⁹ Siemens, G. (2004). Connectivism: A Learning theory for the digital age. http://www.itdl.org/journal/jan_05/article01.htm.

¹⁰ Park, D. and Reuter-Lorenz, P. (2009). The Adaptive brain: Aging nad neurocognitive scaffolding. Annual Review of Psychology, (60), 173-196.

Critical Levers of STEM in TVET

Six (6) critical levers have emerged from the different frameworks that can ensure the success of STEMifying TVET. The concept of levers in this case is very apt because levers are able to multiply input force in order to lift a load, which in this case is the concept of STEM in TVET. The critical levers are the following:

1. **Education Continuum**
Alignment of education systems from basic education, higher education, and technical vocational education and training
2. **Teacher Professional Development**
Constant upgrading of trainers and teachers to enable innovative learning designs, practices, and assessments
3. **Intelligence and Innovation**
Research and innovation that can drive pedagogies and assessments that are aligned with industry needs
4. **Resources**
Tools, equipment, and technology that facilitate the delivery of high-quality training programs
5. **Ecosystem**
Partnerships and collaborations with private and public stakeholders to nurture an ecosystem for STEMifying TVET
6. **Cultural Context**
Sensitivity to diversity and inclusion, and empowerment of women-adult-youth (WAY)

Figure 2 shows the STEM in TVET Learning Design Framework combining the goals, relevant competencies, and critical levers for delivery. At the core of the framework are the goals of STEM for TVET which are: employability, proactive citizenship, and human flourishing. To reach the goals, critical levers that can elevate the delivery of STEM-oriented TVETs are the education continuum, teacher professional development, intelligence and innovation, resources, partnerships, and cultural context. STEM competencies are composed of four major domains: STEM knowledge, thinking skills, multiliteracies, and socio-emotional intelligence can be developed through effective STEM pedagogies.

Moreover, the model of STEM in TVET is similar to a “nut” that is used for securing or fastening a “bolt”, which can be considered as the digitization of TVET and skills systems. STEM in TVET is important for securing skills for the digital economy. The unique emphasis of STEM on critical thinking, creative/inventive thinking and problem solving can take the more generic stance of “digitized TVET” to the higher level of human capital development. Technology is important but more so is the ability to think how to wield technology purposely for impactful results.

However, to ensure the success of the STEM in TVET strategy, the education continuum from early years to adulthood have to be aligned; intelligence and innovation have to be sustained, and investments in teacher professional development and resources have to be prioritized. It is also essential that a diverse, inclusive, and empowering ecosystem is nurtured through partnerships and collaborations between private and public stakeholders. All things

considered, STEM in TVET can significantly contribute to national economic growth. It can develop a workforce that is not only defined by its employability but more importantly has the ability to flourish and be proactive despite challenging circumstances.

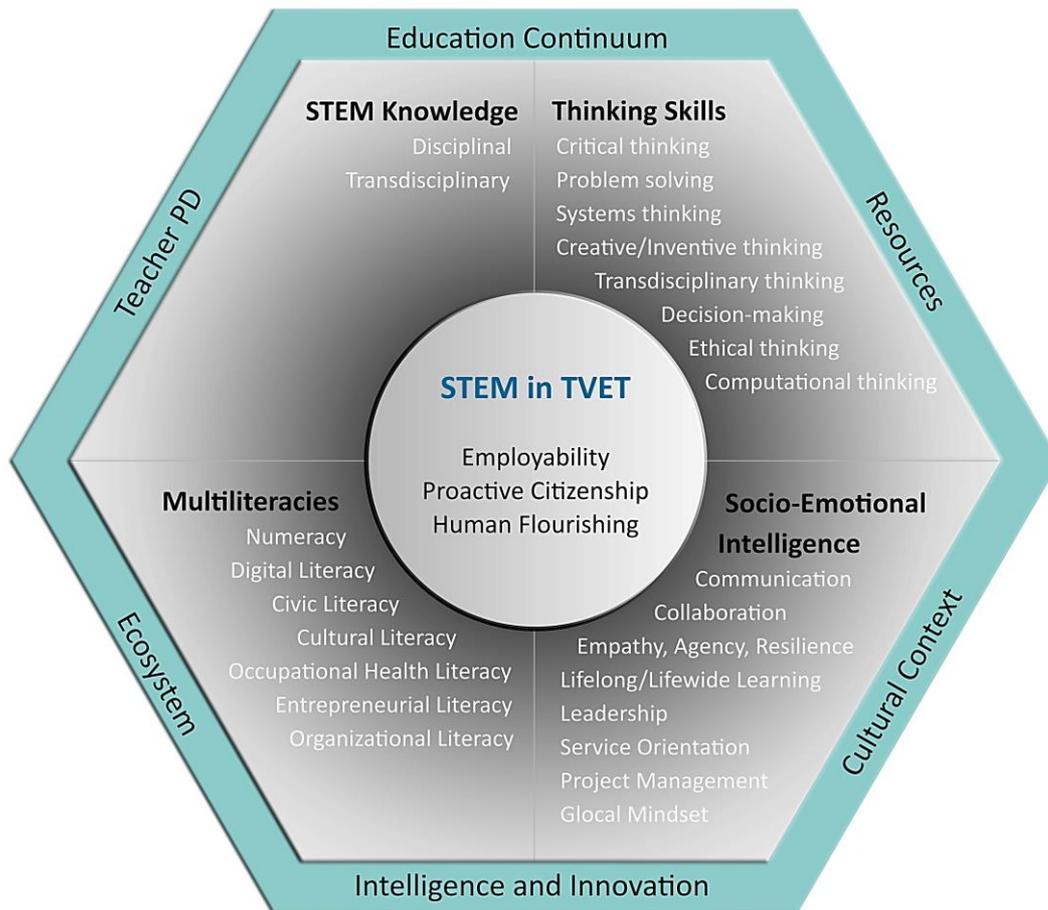


Figure 2. STEM in TVET Learning Design Framework

III. Mapping of TESDA Competencies against STEM Competencies

To determine whether existing training regulations (TRs) of TESDA are aligned with the proposed STEM in TVET Learning Design Framework, a mapping of existing units of competencies against STEM competencies is carried out. Table 2 shows the mapping of basic units of competencies that cut across different training programs and their corresponding NC level. The results of the mapping show that there are gaps in STEM competencies in the current basic units of competencies. Competencies such as systems thinking, transdisciplinary thinking, computational thinking, cultural literacy, empathy, resilience, and service orientation are not yet represented by the basic units of competencies. On the other hand, STEM competencies such as numeracy, organizational literacy, agency, lifelong/lifewide learning, and glocal mindset are represented yet narrowly covered. Moreover, there are opportunities to expand other competencies that are already STEM-oriented. For example, creative/inventive thinking, which already covers workplace innovation can be expanded to be able to cover the generation of new ideas, applications, products, processes, and services based on the needs of the occupational sector. It means that relevant knowledge, skills, learning activities, and methods of assessment can be added to make the competency more STEM-oriented.

Tables 3a and 3b provide a summary of STEM-oriented common units of competencies in various occupational sectors. The predominant STEM competencies that are reflected are numeracy, ICT literacy, occupational health literacy, and ethical thinking. Numeracy, for instance, is indicated by the use of measuring tools, computations/calculations, estimations, and costing. Although not true for all sectors, there are common competencies that express critical thinking, problem solving, transdisciplinary thinking, systems thinking, agency, and service orientation. At the level of common competencies across occupational sectors, the STEM competencies that are not represented are creative/inventive thinking, decision-making, computational thinking, civic literacy, cultural literacy, entrepreneurial literacy, collaboration, empathy, resilience, leadership, project management, and glocal mindset. It is understandable that not all STEM competencies are reflected at the level of basic or common units of competencies but are articulated in the core units of competencies.



IV. STEM Competencies and Existing Units of Competencies

Basic Competencies

Table 2. STEM Competencies and Basic Units of Competencies

Skills and Literacies	Definition	Basic Units of Competencies				
		NCI	NCII	NCIII	NCIV	NCV
Thinking Skills						
Creative/Inventive Thinking	Combine or connect ideas and information in unique and novel ways to generate new ideas, applications, products, processes, or services	Support Innovation	Contribute to workplace innovation	Propose methods of applying learning and innovation in the organization	Manage innovative work instructions	Incorporate innovation into work procedures
Critical Thinking	Apply logic and reasoning to make sense of data or information by posing questions, putting forward arguments, exploring counterexamples, searching evidence, identifying relationships, recognizing patterns and trends, evaluating pros and cons, and synthesizing information			Apply critical thinking and problem solving techniques in the workplace	Perform higher order thinking processes and apply techniques in the workplace	Evaluate higher order thinking skills and adjust problem solving techniques
Systems Thinking	Understand the bigger context of a system, its emergent properties, and behavior over time by knowing the connections, interrelationships, and dynamics of its constituent parts					

Problem Solving	Identify feasible and efficient solutions to solve problems and to create new opportunities	Solve/address routine problems	Solve/address general workplace problems	Apply critical thinking and problem solving techniques in the workplace	Perform higher order thinking processes and apply techniques in the workplace	Evaluate higher order thinking skills and adjust problem solving techniques
Transdisciplinary Thinking	Put together relevant concepts and processes from multiple disciplines to generate solutions and new applications					
Decision-making	Make a logical choice of action by looking at evidence, exploring alternatives, considering likely impact, evaluating options and providing justifications		Develop and practice negotiation skills		Perform higher order thinking processes and apply techniques in the workplace	Evaluate higher order thinking skills and adjust problem solving techniques
Computational Thinking	Develop or apply computational models, tools and techniques to interpret and understand data, solve problems, and guide decision-making					
Ethical Thinking	Use value system as guide for making choices that adhere to acceptable standards and protocols	Apply environmental work standards		Evaluate environmental work practices	Lead towards improvement of environmental work programs, policies and procedures	Manage implementation of environmental programs in the workplace
Multiliteracies Numeracy	Apply mathematical ideas in personal, occupational, societal,			Use mathematical concepts and techniques		

Digital Literacy	and scientific contexts by reasoning, creating representations, or using measuring instruments or calculating tools					
	Search, evaluate, create, and share digital information using ICT device, equipment, tools, platforms, and applications for communication, collaboration, or problem solving	Access and maintain information	Present relevant information	Use information systematically	Manage and evaluate usage of information	Develop systems in managing and maintaining information
Civic Literacy	Contribute to the broader goals of the community by participating proactively in community affairs and observing social responsibility			Use relevant technologies		
	Be sensitive and respectful of the culture where an individual is immersed in			Work in a diverse environment		Advocate strategic thinking for global citizenship
Cultural Literacy	Understand and apply occupational safety standards and protocols as well as take care of one's health and well-being to maintain productivity	Follow occupational safety and health policies and procedures	Practice occupational safety and health policies and procedures	Evaluate occupational safety and health work practices	Lead in improvement of Occupational Safety and Health Program, Policies and Procedures	Manage implementation of occupational safety and health programs in the workplace

Entrepreneurial Literacy	Detect an opportunity and make it grow in a sustainable way applying relevant knowledge, skills, and attitudes	Adopt entrepreneurial mindset in the workplace	Practice entrepreneurial skills in the workplace	Facilitate entrepreneurial skills for micro-small-medium enterprises (MSMEs)	Sustain entrepreneurial skills	Develop and sustain a high-performing enterprise
Organizational Literacy	Negotiate way within an organization by understanding its structure, dynamics of its members, communication channels, and appropriate procedures				Contribute to the practice of social justice in the workplace	
Socio-Emotional Intelligence						
Communication	Convey and exchange thoughts, ideas and information effectively through various mediums and approaches	Receive and respond to workplace communication	Participate in workplace communication	Lead workplace communication	Utilize specialized communication skill	Manage and sustain effective communication strategies
Collaboration	Work effectively in a team to achieve shared goals either through face-to-face or virtual interaction	Work with others	Work in team environment	Work in a diverse environment		
Empathy	Sense, share and respond positively to the feelings of another					
Agency	Manage own behavior and emotions to act professionally and independently, make choices freely, and pursue goals persistently	Enhance self-management skills				



Lifelong/Lifewide Learning	Find opportunities to enhance one’s knowledge and skills for continual learning; Maintain curiosity, passion, and growth mindset; Connect learning to a purpose and real-world context	Support Innovation	Contribute to workplace innovation	Propose methods of applying learning and innovation in the organization	Manage innovative work instructions	Incorporate innovation into work procedures
		Develop career and life decisions				
Resilience	Thrive or prosper despite difficult circumstances; Be adaptable and flexible					
Leadership	Lead others to attain shared goals by managing relationships, respecting diversity, recognizing talent, and empowering people			Lead small teams	Develop and lead teams	Manage and sustain high performing teams
Service Orientation	Support a culture of service excellence within the organization by producing products or providing services that exceed the expectations of the customers					
Project Management	Use resources (human, material, and time) wisely to deliver work-related tasks or projects		Exercise efficient and effective sustainable practices in the workplace	Plan and organize work		
Glocal Mindset	Be adaptive to global standards but remain responsive to local needs					Advocate strategic thinking for global citizenship

Common Competencies

Table 3a. STEM Competencies and Common Units of Competencies across Sectors (NC III)

Skills and Literacies	Definition	Common Units of Competencies across Sectors				
		ICT-BPM	Construction	Agriculture & Fishery	Automotive Manufacturing	Health
Thinking Skills						
Creative/Inventive Thinking	Combine or connect ideas and information in unique and novel ways to generate new ideas, applications, products, processes, or services					
Critical Thinking	Apply logic and reasoning to make sense of data or information by posing questions, putting forward arguments, exploring counterexamples, searching evidence, identifying relationships, recognizing patterns and trends, evaluating pros and cons, and synthesizing information	Apply critical thinking and thought organization		Conduct diagnosis		
Systems Thinking	Understand the bigger context of a system, its emergent properties, and behavior over time by knowing the connections, interrelationships, and dynamics of its constituent parts					
Problem Solving	Identify feasible and efficient solutions to solve problems and to create new opportunities					



Transdisciplinary Thinking	Put together relevant concepts and processes from multiple disciplines to generate solutions and new applications					
Decision-making	Make a logical choice of action by looking at evidence, exploring alternatives, considering likely impact, evaluating options and providing justifications					
Computational Thinking	Develop or apply computational models, tools and techniques to interpret and understand data, solve problems, and guide decision-making					
Ethical Thinking	Use value system as guide for making choices that adhere to acceptable standards and protocols	Apply quality standards		Comply with quality and ethical standards		Apply quality standards
Multiliteracies Numeracy	Apply mathematical ideas in personal, occupational, societal, and scientific contexts by reasoning, creating representations, or using measuring instruments or calculating tools		Perform mensuration and calculations	Perform estimation and calculation	Perform mensuration and calculation	
				Perform mensuration and calculations		

ICT Literacy	Search, evaluate, create, and share digital information using ICT device, equipment, tools, platforms, and applications for communication, collaboration, or problem solving	Perform computer operations	Prepare construction materials and tools	Use farm tools and equipment	Read and interpret engineering drawings	Perform computer operations
			Observe procedures, specifications and manuals of instructions	Observe, procedures, specifications and manuals of instruction	Read, interpret, and apply specifications and manuals	
			Interpret technical drawings and plans	Interpret technical drawings and plans	Perform shop maintenance	
			Maintain tools and equipment	Maintain tools and equipment Perform shop maintenance		
Civic Literacy	Contribute to the broader goals of the community by participating proactively in community affairs and observing social responsibility					
Cultural Literacy	Be sensitive and respectful of the culture where an individual is immersed in					
Occupational Health Literacy	Understand and apply occupational safety standards and protocols as well as take care of one's health and well-being to maintain productivity			Apply safety measures in farm operations		Maintain a safe, clean and efficient environment
				Process farm wastes		Provide emergency care (First Aid)



Entrepreneurial Literacy	Detect an opportunity and make it grow in a sustainable way applying relevant knowledge, skills, and attitudes					
Organizational Literacy	Negotiate way within an organization by understanding its structure, dynamics of its members, communication channels, and appropriate procedures			Maintain service records		
Socio-Emotional Intelligence						
Communication	Convey and exchange thoughts, ideas and information effectively through various mediums and approaches					
Collaboration	Work effectively in a team to achieve shared goals either through face-to-face or virtual interaction					
Empathy	Sense, share and respond positively to the feelings of another					
Agency	Manage own behavior and emotions to act professionally and independently, make choices freely, and pursue goals persistently					Manage own performance



Lifelong/Lifewide Learning	Find opportunities to enhance one's knowledge and skills for continual learning; Maintain curiosity, passion, and growth mindset; Connect learning to a purpose and real-world context					
Resilience	Thrive or prosper despite difficult circumstances; Be adaptable and flexible					
Leadership	Lead others to attain shared goals by managing relationships, respecting diversity, recognizing talent, and empowering people					
Service Orientation	Support a culture of service excellence within the organization by producing products or providing services that exceed the expectations of the customers			Provide quality customer service		Maintain an effective relationship with clients/customers
Project Management	Use resources (human, material, and time) wisely to deliver work-related tasks or projects					
Glocal Mindset	Be adaptive to global standards but remain responsive to local needs					

Table 3b. STEM Competencies and Common Units of Competencies across Sectors (NCIII)

Skills and Literacies	Definition	Common Units of Competencies across Sectors				
		Automotive	Metals and Engineering	Electrical and Electronics	Transport and Logistics	Tourism
Thinking Skills						
Creative/Inventive Thinking	Combine or connect ideas and information in unique and novel ways to generate new ideas, applications, products, processes, or services					
Critical Thinking	Apply logic and reasoning to make sense of data or information by posing questions, putting forward arguments, exploring counterexamples, searching evidence, identifying relationships, recognizing patterns and trends, evaluating pros and cons, and synthesizing information	Inspect technical quality of work		Test electronic components		
Systems Thinking	Understand the bigger context of a system, its emergent properties, and behavior over time by knowing the connections, interrelationships, and dynamics of its constituent parts		Contributes to quality system		Contribute to quality system	
Problem Solving	Identify feasible and efficient solutions to solve problems and to create new opportunities	Apply appropriate sealant/adhesive	Repair welds			
		Use and apply lubricant/coolant	Take immediate action upon			

Transdisciplinary Thinking			encountering an accident or other medical emergency			
	Put together relevant concepts and processes from multiple disciplines to generate solutions and new applications	Identify and select original automotive parts and products		Terminate and connect electrical wiring and electronic circuits		
Decision-making	Make a logical choice of action by looking at evidence, exploring alternatives, considering likely impact, evaluating options and providing justifications					
Computational Thinking	Develop or apply computational models, tools and techniques to interpret and understand data, solve problems, and guide decision-making					
Ethical Thinking	Use value system as guide for making choices that adhere to acceptable standards and protocols	Maintain quality systems	Comply with environmental protection procedures	Apply quality standards	Ensure security of stocks and cargo	
			Implement Good Manufacturing Practice procedures		Comply with workplace procedures in handling stocks	

Multiliteracies							
Numeracy	Apply mathematical ideas in personal, occupational, societal, and scientific contexts by reasoning, creating representations, or using measuring instruments or calculating tools	Perform mensuration and calculation	Perform industry calculations	Perform mensuration and calculation	Perform industry calculations in warehousing operations		
		Prepare job estimate/costing	Measure workpiece (Basic)				
			Measure workpiece using gages and comparators				
			Prepare cost estimates				
			Perform shop computations				
			Measure workpiece using angular measuring instruments				
			Carry out measurements and calculation				
			Use standard measuring devices/instruments				
Digital Literacy	Search, evaluate, create, and share digital information using ICT device, equipment, tools, platforms, and applications for communication,	Move and position vehicle	Interpret drawing and sketches	Use hand tools	Perform computer operations		
				Prepare and interpret technical drawing			

Civic Literacy	collaboration, or problem solving	Perform shop maintenance	Use hand tools	Perform computer operations		
		Read, interpret and apply specification and manuals	Prepare weld materials			
		Interpret/draw technical drawing	Set-up welding equipment			
			Fit up weld materials			
			Select and cut workshop materials			
			Perform preventive and corrective maintenance			
			Perform routine housekeeping			
			Operate a personal computer			
			Set-up and operate machines			
			Perform basic bench works			
			Perform basic electrical works			
	Use food processing tools, equipment and utensils					
Contribute to the broader goals of the community by participating proactively in						



Cultural Literacy	community affairs and observing social responsibility					
	Be sensitive and respectful of the culture where an individual is immersed in					
Occupational Health Literacy	Understand and apply occupational safety standards and protocols as well as take care of one's health and well-being to maintain productivity	Practice health safety and environment procedures	Apply safety practices		Perform workplace security and safety	
			Apply food safety and sanitation			
			Implement Good Manufacturing Practice procedures			
			Implement environmental policies and procedures			
			Comply with emergency procedures			
Entrepreneurial Literacy	Detect an opportunity and make it grow in a sustainable way applying relevant knowledge, skills, and attitudes					
Organizational Literacy	Negotiate way within an organization by understanding its structure, dynamics of its members, communication				Apply freight forwarding documentation services and	

	channels, and appropriate procedures				workplace procedures	
					Apply workplace procedures in warehousing operations	
					Maintain warehouse records	
Socio-Emotional Intelligence						
Communication	Convey and exchange thoughts, ideas and information effectively through various mediums and approaches	Provide work skill instructions				
Collaboration	Work effectively in a team to achieve shared goals either through face-to-face or virtual interaction					
Empathy	Sense, share and respond positively to the feelings of another					
Agency	Manage own behavior and emotions to act professionally and independently, make choices freely, and pursue goals persistently		Document work accomplished			
Lifelong/Lifewide Learning	Find opportunities to enhance one's knowledge and skills for continual learning; Maintain curiosity, passion, and growth					



Resilience	mindset; Connect learning to a purpose and real-world context					
	Thrive or prosper despite difficult circumstances; Be adaptable and flexible					
Leadership	Lead others to attain shared goals by managing relationships, respecting diversity, recognizing talent, and empowering people					
Service Orientation	Support a culture of service excellence within the organization by producing products or providing services that exceed the expectations of the customers				Provide effective customer service	
					Provide efficient customer service	
Project Management	Use resources (human, material, and time) wisely to deliver work-related tasks or projects					
Glocal Mindset	Be adaptive to global standards but remain responsive to local needs					

V. STEM-Oriented Core Competencies of ICT Sector

Tables 4a and 4b show the STEM-oriented core competencies of NCIII Web Development and NCIII Game Art Development. STEM competencies are better mapped out when elements of the core competencies are laid out as shown in the two sample TRs. For example, creative/inventive thinking applies to elements that require ideation or conceptualization and generation of new product be it a character, a prop, or game world such as in the case of game art development. On the other hand, numeracy can be identified for elements that employ scale, proportion, shapes, and space. Similarly, STEM knowledge is expressed when considering laws and principles involving motion, lighting, physique and structures. When STEM knowledge together with other forms of knowledge and skills are applied in specific contexts to produce new applications, transdisciplinary thinking is activated, which is evident in web and game art development. The mapping example for core competencies of two TRs demonstrates that STEM competencies are already embedded in TVET programs. They only need to be identified explicitly.

Table 4a. STEM-Oriented Core Competencies of NC III Web Development

Core Competencies	Element	Corresponding STEM Competencies
1. Utilize Software Methodologies	1.1. Identify project requirements and software methodology	Project Management Systems thinking
	1.2. Apply software methodologies	ICT literacy Computational thinking
	1.3. Utilize code versioning tools	Computational thinking ICT literacy
	1.4. Conduct testing	Critical thinking Problem solving Transdisciplinary thinking
2. Develop Responsive Web Design	2.1 Perform research and analytics	Critical thinking Problem solving ICT literacy Transdisciplinary thinking Numeracy
	2.2 Identify and prepare design requirements	Project management Systems thinking
	2.3 Design and develop user-friendly responsive Web interface	Empathy Creative/Inventive thinking Computational thinking ICT literacy Communication Service orientation Cultural literacy Glocal mindset
	2.4 Develop HTML/CSS website	Creative/Inventive thinking Computational thinking ICT literacy
	2.5 Use/Deploy website content management system (CMS)	Systems thinking ICT literacy Communication
	2.6 Perform search engine optimization (SEO)	Critical thinking Problem solving Decision-making ICT literacy

3. Create Interactive Websites (Using JavaScript)	3.1 Inspect and analyze HTML/CSS files	Critical thinking Problem solving ICT literacy
	3.2 Gather and review specifications and requirements	Critical thinking Systems thinking Project management
	3.3 Apply JavaScript to HTML/CSS	Computational thinking ICT literacy Transdisciplinary thinking
	3.4 Configure JavaScript Efficiency	Problem solving Decision-making Computational thinking
4. Develop Website Backend Systems	4.1 Develop a project plan	Project management Communication Collaboration Leadership Numeracy Ethical thinking ICT literacy
	4.2 Configure a web or cloud server	Problem solving Decision-making Computational thinking ICT literacy Ethical thinking
	4.3 Design databases	Creative/Inventive thinking Critical thinking Transdisciplinary thinking Computational thinking ICT literacy
	4.4 Develop server side scripts	Creative/Inventive thinking Transdisciplinary thinking Computational thinking ICT literacy
	4.5 Develop web application using MVC Frameworks	Creative/Inventive thinking Transdisciplinary thinking Computational thinking ICT literacy Communication Collaboration Project Management

Table 4b. STEM-Oriented Core Competencies of NC III Game Art Development

Core Competencies	Element	Corresponding STEM Competencies
1. Develop and Conceptualize Art Style	1.1. Develop “look and feel”	Creative/Inventive Thinking STEM Knowledge ICT Literacy
	1.2. Draw and compile characters	Creative/Inventive Thinking STEM Knowledge ICT Literacy Communication
	1.3. Draw the game world	Creative/Inventive Thinking STEM Knowledge Critical Thinking Systems Thinking ICT Literacy
	1.4. Draw and compile other assets	Creative/Inventive Thinking STEM Knowledge ICT Literacy Project Management
	1.5. Develop game interface	Creative/Inventive Thinking STEM Knowledge Numeracy Transdisciplinary Thinking ICT Literacy Project Management
2. Create storyboard and asset list	2.1. Develop storyboard panels and scripts	Communication Creative/Inventive Thinking Critical Thinking Systems Thinking Project Management
	2.2. Create Narrative devices	Communication Creative/Inventive Thinking Critical Thinking
	2.3. Create cut scenes	Creative/Inventive Thinking Critical Thinking ICT Literacy
3. Prepare art document	3.1. Prepare concept art for characters	Creative/Inventive Thinking Critical Thinking Decision-making
	3.2. Prepare concept art for props/objects	Creative/Inventive Thinking Critical Thinking Decision-making
	3.3. Prepare concept art for background layout	Creative/Inventive Thinking Critical Thinking Decision-making Systems Thinking
	3.4. Prepare concept art for special effects	Creative/Inventive Thinking Critical Thinking Decision-making

		STEM Knowledge Numeracy Transdisciplinary Thinking
	3.5. Prepare concept art for GUI	ICT Literacy Critical Thinking Decision-making Systems Thinking
4. Develop 3D model using 3D graphic application	4.1. Prepare 3D document	Numeracy STEM Knowledge Creative/Inventive Thinking ICT Literacy
	4.2. Prepare base mesh	ICT Literacy Decision-making
	4.3. Develop mesh	Numeracy STEM Knowledge Creative/Inventive Thinking ICT Literacy Project Management
	4.4. Finalize mesh	Decision-making Problem Solving Systems Thinking ICT Literacy Project Management
5. Develop 3D textures using graphic application	5.1. Prepare UV-Map	Systems Thinking STEM Knowledge Numeracy ICT Literacy
	5.2. Apply color to UV-Map	Systems Thinking Decision-making ICT Literacy
	5.3. Prepare final palette/color map sheet	Systems Thinking Decision-making Transdisciplinary Thinking ICT Literacy
	5.4. Export UV-Map	ICT Literacy
	5.5. Import UV-Texture	ICT Literacy
6. Apply rigged In-Game animation	6.1. Import textured model assets	ICT Literacy
	6.2. Create Bones/Joints	STEM Knowledge Numeracy Transdisciplinary Thinking Systems Thinking ICT Literacy
	6.3. Apply rig to textured model	STEM Knowledge Numeracy Transdisciplinary Thinking Systems Thinking ICT Literacy Critical Thinking Decision-making

	6.4. Apply basic animation	STEM Knowledge Numeracy Transdisciplinary Thinking Systems Thinking ICT Literacy Critical Thinking Decision-making
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VI. Reference Documents of STEM Competencies

This section presents the elaboration of the major domains of STEM competencies such as STEM knowledge, thinking skills, multiliteracies, and socio-emotional intelligence. Each table includes relevant knowledge, skills, learning activities, and methods of assessment. The purpose is to deepen the understanding of each competency and facilitate the reframing of existing TVET pedagogies and assessments to be more STEM-oriented. The succeeding reference documents are recommendations and not in any way prescriptive. TVET trainers and technical writers remain to be the experts in contextualizing the pedagogies and assessments in their respective sectors. A separate section on example dimensions and scales that can be used for assembling rubrics is also provided.

STEM KNOWLEDGE

Descriptor	<p>Disciplinary knowledge means subject-specific understanding of concepts, theories, principles, laws, and contexts of Science, Technology, Engineering, and Mathematics.</p> <p>Transdisciplinary knowledge refers to the integrative understanding of the useful and most relevant content and techniques from the STEM disciplines to be able to solve work-related and other real-world problems.</p>
Disciplinary Knowledge	<p>Biology - organisms (structures and processes), growth and development, ecosystems (interactions, energy, and dynamics), genetics, biodiversity</p> <p>Chemistry - structure and properties of matter, chemical reactions</p> <p>Earth Science -weather and climate, natural hazards, earth materials, climate change, sustainable development goals</p> <p>Physics - motion, forces, interaction, energy, electricity, magnetism, light, sound, waves, thermodynamics</p> <p>Mathematics - number operations, percentages, rates, measurements (length, area, volume and capacity, mass), scales, ratio, proportion, data representation and interpretation, statistics, geometry, compound interest, estimates</p>

Transdisciplinary Knowledge

Cross-cutting concepts bridge boundaries between disciplines or fields of specializations and present a coherent view of STEM that can facilitate integrative applications for solving real-world problems.*

Patterns

- repeated events and relationships; and symmetry in shape or structure

Cause and effect

- mechanism and explanation; argument and evidence

Scale, proportion, and quantity

- measures of size, amount, time, capacity, space

Systems and systems model

- natural and designed systems, parts and wholes

Energy and matter

- flows, cycles, conservation

Structure and function

- properties, characteristics, and functions

Stability and change

- balance, equilibrium, disorder, chaos

*US Next Generation Science Standards

THINKING SKILLS

Creative/Inventive Thinking

Descriptor	Combine or connect existing ideas and information in unique and novel ways to generate new ideas, applications, products, processes, or services
Knowledge	<ul style="list-style-type: none"> • Design thinking process • Tools or strategies for collecting information • Analytical techniques • Ideation techniques • Brainstorming techniques • Invention algorithms • Lateral thinking techniques • Decision-making techniques • Inquiry or experimentation techniques • Prototyping techniques • Impact measurement techniques • Pitching/communicating design concepts or solutions • Application of design thinking in programs and organizations

Skills

- Apply design thinking process in generating new ideas, applications, or solutions based on an identified need
- Collect information using a variety of tools and strategies to understand the problem context, thoughts, actions, and attitudes of people for whom the solution is intended
- Analyze root-cause of identified problem/s
- Employ ideation techniques to identify potential solutions
- Share inputs during brainstorming sessions to contribute to the generation of ideas
- Apply invention algorithms to generate new and innovative design concepts
- Utilize lateral thinking techniques to explore multiple and alternative ideas
- Employ decision-making techniques to select most viable solution
- Conduct an inquiry or experiment to test ideas
- Execute design concepts through prototypes
- Identify metrics to determine baseline and measure outcomes of design ideas and solutions
- Pitch or communicate design ideas and solutions
- Apply design thinking in generating innovations for the organization and its programs

**Learning
Activities**

- Design challenge
- Empathy mapping
- 5 Whys
- Remixing words
- Invitational stems
- Braindumping
- Blitzkrieg Ideation
- Visual metaphors
- SCAMPER invention algorithm
- TRIZ invention algorithm
- Idea bundling
- SWOT analysis
- Attractiveness mapping
- Creating agile dartboard focus
- Disney creative strategy
- Blue Ocean activity
- Storyboard
- Design brief
- Prototyping
- Concept testing
- Usability testing
- User feedback
- Innovator's reflection
- Innovation pitch
- Mock campaign

Critical Thinking

Unit Descriptor	Apply logic and reasoning to make sense of data or information by posing questions, putting forward arguments, exploring counterexamples, searching evidence, identifying relationships, recognizing patterns and trends, evaluating pros and cons, and synthesizing information
Knowledge	<ul style="list-style-type: none"> • Information gathering techniques • Information processing techniques • Information verification • Analytical techniques • Pattern recognition techniques • Logical thinking techniques • Sensemaking techniques • Synthesis and insight generation • Constructing arguments and questions • Reasoning using evidence • Making inferences, claims, assumptions • Skepticism • Evaluation techniques
Skills	<ul style="list-style-type: none"> • Gather information from credible sources • Pose questions • Assess validity and reliability of information • Detect patterns based on information or data • Determine relationships or interactions among components within a context • Evaluate underlying factors which may be political, economic, social, technological, legal, environmental, and cultural • Sequence ideas or processes into a logical flow • Break down components of a structure • Cite counterexamples • Provide an outline of a process or procedure • Identify properties, characteristics, and functions • Propose a framework or system of understanding based on a synthesis of information • Advance an argument based on facts • State an inference, claim, or assumption supported by reliable information • Detect gaps in knowledge and limitations in information • Articulate insights gained from observation and data • Identify implications or consequences of a course of action • Establish a conclusion
Learning Activities	<ul style="list-style-type: none"> • Task analysis • Photo association • Mind mapping • Point query

- Structural laying
- Work process matrix
- Entity Relationship Diagram
- PESTLE-C Analysis
- SWOT Analysis
- What? So What? Now What?
- CER (Claim, Evidence, Reasoning)
- Compass points for exploring propositions
- Justification Routine (What Makes You Say That)
- POE (Predict, Observe, Explain)
- PPCs (Parts, Purposes, Complexities)
- Functional decomposition diagram
- Venn Diagram Comparing/Contrasting

Systems Thinking

Descriptor	Understand the bigger context of a system, its emergent properties, and behavior over time by knowing the connections, interrelationships, and dynamics of its constituent parts
Knowledge	<ul style="list-style-type: none"> • Identification of systems and system archetypes • Components of a system • Fundamental concepts of systems thinking • Approaches for developing shared vision • Creative mental models • Lateral thinking strategies • Big picture thinking approaches • Strategic thinking techniques • Techniques for pattern recognition • Visualization techniques • Use of models, representations, and simulations • Scenario planning techniques and tools
Skills	<ul style="list-style-type: none"> • Differentiate a system from a collection • Compare and contrast system archetypes • Identify components of a system • Discuss fundamental concepts of systems thinking • Apply approaches in developing shared vision • Create mental models to represent systems • Utilize lateral thinking techniques to understand how different systems operate • Try out big thinking approaches for a holistic perspective of a system • Employ strategic thinking techniques to find solutions intended for a system • Use various techniques in determining patterns and structures given the information about the constituent parts of a system and their interconnections

Learning Activities

- Try out visualization techniques and tools to simplify understanding of a system and its dynamics
- Use models, simulations, and other forms to accurately represent a system and how it operates
- Apply scenario planning techniques to explore potential changes within a system given external influences
- Construct a network to represent the durations and interdependencies of activities that must be completed during the project
- Use forward and backward scanning to determine the earliest starting time (EST) and latest starting times (LST) for each activity in the project
- System vs Collection activity
- Creating Entity Relationship Diagram
- Metaphorical case study
- Big Picture thinking activity
- Seeing the forest for the trees model
- Diagramming
- Creating models
- Iceberg model
- Pace-Levers-Relationship Map
- Simulations
- Scenario Planning

Problem Solving

Descriptor	Identify feasible and efficient solutions to solve problems and to create new opportunities
Knowledge	<ul style="list-style-type: none"> • Problem identification techniques • Techniques for asking questions • Problem solving approaches, processes, strategies, and tools • Experimentation techniques • Strategies to manage experimentation processes • Root cause analysis techniques • Techniques for assessing impact • Decision evaluation and prioritization frameworks • Risk analysis techniques • Types of political, economic, social, technological, environmental, and cultural factors • Conflict resolution strategies • Risk management strategies • Strategies and metrics to evaluate solution effectiveness
Skills	<ul style="list-style-type: none"> • Carry out problem identification techniques to establish issues in the workplace • Pose questions to clarify issues and seek solutions • Diagnose root cause of a problem • Determine underlying causes of an issue or conflict

**Learning
Activities**

- Identify constraints and risks related to potential solutions
 - Analyze political, economic, social, technological, legal, environmental, and cultural factors influencing a problem
 - Try out diverse approaches, processes, strategies, and tools to solve problems
 - Conduct experiments or investigations to test potential solutions
 - Manage risks in testing potential solutions
 - Document experimentation process for future reference and replicability
 - Recommend most suitable solution based on evidence from experiments
 - Evaluate the effectiveness of the problem solving process
 - Assess the impact of a solution using various techniques
 - Create decision evaluation and prioritization framework
 - Detect opportunities for growth and expansion
-
- 5 Whys
 - Fishbone Diagram
 - Look, Mock, Analyze Activity
 - PESTLE-C Analysis
 - Risk Analysis
 - Circle of Truth
 - Scientific Inquiry
 - Experiment Documentation
 - DMAIC (Define, Measure, Analyze, Improve, and Control) Activity
 - Four-box Problem Solving
 - Z Model for Problem Solving
 - Plus Delta Solution Evaluation
 - Horizons of Growth

Transdisciplinary Thinking

Unit Descriptor	Put together relevant concepts and processes from multiple disciplines to generate solutions and new applications
Knowledge	<ul style="list-style-type: none"> • Disciplinal and transdisciplinary knowledge • Information gathering techniques and tools • Verbal and non-verbal communication techniques, channels, and tools • Collaborative approaches, processes, strategies, and platforms • Knowledge sharing methods and tools • Divergent and convergent techniques of knowledge co-creation • Pattern recognition techniques • Decision-making processes • Perspective-taking techniques • Context-framing strategies • Problem-solving approaches, strategies, and tools • Knowledge of political, economic, social, technological, legal, environmental, and cultural factors

Skills

- Self-knowledge (strengths and weaknesses)
 - Dimensions of diversity
 - Workplace and social etiquettes
 - Cultural sensitivity
 - Conflict resolution strategies
 - Synthesis and insight generation
 - Strategies for group regulation and reflection
- Gather information from multiple sources and diverse perspectives
 - Communicate ideas and perspectives with clarity using various means
 - Collaborate with people from diverse backgrounds
 - Share information to collaborators using appropriate channels and tools
 - Generate ideas using divergent and convergent techniques
 - Co-create knowledge products or new applications drawing from concepts and processes of multiple disciplines
 - Detect patterns based on information or data
 - Determine relationships or interactions among components within a context
 - Analyze political, economic, social, technological, legal, environmental, and cultural factors influencing a problem
 - Try out diverse approaches, processes, strategies, and tools to solve problems
 - Create decision evaluation and prioritization framework
 - Use strategies and tools to describe context foregrounding a problem
 - Assess own strengths and weaknesses
 - Be sensitive to cultural and social differences
 - Observe workplace and social etiquettes

**Learning
Activities**

- Persona Mapping
- PESTLE-C Analysis
- Context Mapping
- Dialogs
- Group Generation of Ideas
- SCAMPER invention algorithm
- TRIZ invention algorithm
- Idea bundling
- Learning from multiple disciplines
- 6 Thinking Hats
- “How Might We” activity
- Brainstorming metaphors (in front of us; beyond the trees; over the mountains)
- SWOT analysis
- Attractiveness mapping
- Creating agile dartboard focus
- Idea bundles or clusters
- Disney creative strategy
- Self-assessment (growth mindset, shift and persist)

- Decision evaluation and prioritization framework

Decision-making

Unit Descriptor	<p>Make a logical choice of action by looking at evidence, exploring alternatives, considering likely impact, evaluating options and providing justifications</p>
Knowledge	<ul style="list-style-type: none"> • Decision making criteria and strategies • Decision making pitfalls and errors • Ethical guidelines, standards and procedures • Protocols, regulatory frameworks, and policies • Decision making styles • Decision making tools • Decision evaluation and prioritization frameworks • Stakeholder analysis techniques • Risk analysis techniques • Impact measurement techniques • Group decision making methods
Skills	<ul style="list-style-type: none"> • Define criteria that will be used in making decisions • Gather relevant information to support decision-making • Evaluate contexts to identify crucial decision-making points • Follow decision-making process based on agreed upon policies, standards, and guidelines • Subscribe to protocols, ethical guidelines, and regulatory frameworks • Apply decision-making strategies • Use tools to aid decision-making • Facilitate decision-making processes within teams • Analyze risks associated with proposed solutions • Assess feasibility of solutions to provide recommendations • Review outcomes and impact of solutions • Iterate successful or effective solutions
Learning Activities	<ul style="list-style-type: none"> • Stakeholder analysis • 4Ps Reframing Matrix • PMI Chart (Plus-Minus-Implications/Interesting detail) • Force Field Analysis • SWOT Analysis • Decision trees • Attractiveness Map • Decision Trees • Agile Dartboard Focus • Idea Box • McKinsey's 7S Model • Decision Frame and Out-of-the-Box Thinking • Productive Thinking Model



- AIDA Decision Funnel
- Step Up Strategy

Computational Thinking

Unit Descriptor	Develop or apply computational models, tools and techniques to interpret and understand data, solve problems, and guide decision-making
Knowledge	<ul style="list-style-type: none"> • Data collection and management strategies • Techniques for breaking down data, processes, and problems into smaller, manageable parts • Approaches for extracting relevant information • Understanding automated systems • Data representation techniques and tools • Algorithm design • Data analysis methods • Modeling and simulation practices • Troubleshooting and debugging strategies
Skills	<ul style="list-style-type: none"> • Collect and manage data/data sets • Break down data, processes, and problems into smaller, manageable parts (decomposition) • Identify and extract relevant information to define main idea(s) (abstraction) • Identify automated systems • Depict and organize data in appropriate graphs, charts, words, or images (data representation/visualization) • Create a series of ordered instructions for doing a task or for solving similar problems (algorithm design) • Observe patterns, trends, and regularities in data (pattern recognition) • Provide insights from data analysis to inform decision-making (data analysis) • Simultaneously process smaller tasks from a larger task to more efficiently reach a goal (parallelization) • Create models and simulations to represent processes (modelling and simulation) • Develop codes and modular computational solutions • Determine effectiveness of a solution, generalize, and apply to a new problem (evaluation) • Apply troubleshooting and debugging strategies
Learning Activities	<ul style="list-style-type: none"> • Seeing Data in the Workplace • What's going on in this graph? • Matching visualizations and data • An Algorithm of a Common Task at Work • Patterns, Trends, and Decisions • Insights from data



- Making a model
- Writing a code/program

Ethical Thinking

Unit Descriptor	Use value system as guide for making choices that adhere to acceptable standards and protocols
Knowledge	<ul style="list-style-type: none"> • Applicable laws and requirements with regulatory authority dealing with data protection, security and Intellectual Property Rights (IPR) • Sources of open standards e.g. ISO, RFC • Risk identification and mitigation • Ethical implications of technology e.g. hijacking code, software licensing • Code of business conduct and non-compliance consequences • Moral and ethical considerations concerned with the growing dependence on technology • Techniques, prevention, and repercussions of social engineering attacks
Skills	<ul style="list-style-type: none"> • Follow pertinent laws, regulations, and territorial restrictions to protect intellectual property and information privacy • Comply with requirements set by open standards to ensure interoperability of products and services • Track identified risks and apply risk mitigation strategies • Plan security measures to address ethical dilemmas and policy issues • Act ethically and responsibly in a digital or physical community and recognize inappropriate conduct • Use technology to facilitate good actions that will improve overall well-being • Conduct security awareness training to prevent social engineering attacks
Learning Activities	<ul style="list-style-type: none"> • Case Study • Best practices for cybersecurity ethics • Cybersecurity disaster planning and crisis response • Design for privacy and security • Data analysis • Data visualization

MULTILITERACIES

Numeracy

Unit Descriptor	Apply mathematical ideas in personal, occupational, societal, and scientific contexts by reasoning, creating representations, or using measuring instruments or calculating tools
Knowledge	<ul style="list-style-type: none"> • Relevant data and numerical information in the workplace • Number operations • Percentages, rates, and compound interest • Measurements (length, area, volume and capacity, mass) • Scales, ratio, and proportion • Data representation and interpretation • Basic statistics • Geometry (2-D and 3-D) • Project costing • Work process optimization
Skills	<ul style="list-style-type: none"> • Compare and order quantities • Identify expressions of time, temperature, length, mass, capacity, area, and volume • Identify the appropriate units for different tasks at work • Solve practical problems requiring basic number operations • Use a calculator for multi-step calculations • Check results of calculations for accuracy • Apply approximation strategies for calculations • Calculate a percentage of a given amount • Apply percentage increases and decreases in various contexts; for example, mark-ups, discounts, and VAT • Identify common usage of rates • Convert units of rates occurring in practical situations to solve problems • Use rates to make comparisons • Use rates to determine costs • Use metric units of quantities, corresponding abbreviations, and applicable conversions • Convert between metric units and other measurement units • Calculate perimeters and areas of familiar shapes and their composites • Interpret information presented in graphs, tables, and other data visuals • Discuss and interpret data visuals found in the media and in factual texts • Compare the suitability of different methods of data presentation in real-world contexts • Relate fractions and ratio • Use ratio to describe simple scales • Use timetables and electronic technologies to improve efficiency of work processes • Determine optimal quantities or equipment settings commonly used in work • Interpret commonly used symbols and abbreviations in scale drawings

**Learning
Activities**

- Use coordinates to describe position
 - Find actual measurements from scale drawings
 - Estimate and compare quantities, materials, and costs using actual measurements from scale drawings
 - Apply drawing conventions of scale drawings
 - Interpret angle measurements to understand position and movement
 - Interpret diagrams of three-dimensional objects
 - Describe sources of error in numerical reports
 - Identify outliers in a data set
 - Calculate and interpret mean
 - Describe ways of expressing probabilities formally using fractions, decimals, ratios, and percentages
 - Calculate interest for different rates and periods
 - Compare prices and values using the unit cost method
 - Use currency exchange rates to determine the cost in Philippine peso given an equivalent amount in a foreign currency
 - Solve practical problems requiring the calculation of perimeters and areas of circles, sectors of circles, triangles, rectangles, parallelograms and composites
 - Construct a network to represent the durations and interdependencies of activities that must be completed during the project
 - Use forward and backward scanning to determine the earliest starting time (EST) and latest starting times (LST) for each activity in the project
 - Measure quantities using simple measuring instruments
 - Check settings and output of equipment
 - Develop and use formulae which describe relationships between variables in work-related contexts
 - Calculate output from particular machines/equipment
 - Calculate wages, taxes, and net and gross amounts
 - Prepare budget plans
-
- Unit-Quantity Matching
 - Quantity-Tool Matching
 - Largest to Smallest: A Game of Order
 - Numbers at work
 - Mark Ups and Discounts
 - Final Cost with VAT
 - Calculator Tricks
 - Commonly Used Rates at Work
 - Conversion Exercise
 - What's in the graph?
 - Understanding scales and maps
 - Coordinates and Position
 - Data outliers
 - Currency Exchange Problems
 - Comparing prices and values using unit cost

- Write a problem
- Projects and timetables
- Optimization game
- Trends, Patterns, and Insights
- Data story from news
- Retelling a data story

Civic Literacy

Unit Descriptor	Contribute to the broader goals of the community by participating proactively in community affairs and observing social responsibility
Knowledge	<ul style="list-style-type: none"> • Self and civic identity • Civic and democratic principles • Civic learning in the context of learning experiences • Civic identity and civic learning • Effective modes of civic participation • Civic actions or other engagement. • Civil discourse in community interactions
Skills	<ul style="list-style-type: none"> • Acknowledge that communities interpret civic and democratic principles differently • Employ knowledge from learning experiences to imagine meaningful change in civic life • Adapt participation to changes in community contexts and structures • Reflect on benefits of involvement to civic identity, civic learning, and continued engagement • Assess options, plan actions, and engage in civil discourse, considering previous approaches, varied perspectives, political viability, and potential consequences • Act, personally and collaboratively, in ways that are creative and ethical to contribute to sustainable improvement, and assess the impact of the action • Synthesize civic identity and civic learning to articulate intention to act
Learning Activities	<ul style="list-style-type: none"> • Forum • Lectures • Case Studies • Class Discourse • Experiential Exercises • In-class Discussion • Personal Reflection • Concept Testing • Mock Campaigns • Civic Action Plan • Civic Participation Program • Community Development Project

Digital Literacy

Unit Descriptor	Search, evaluate, create, and share digital information using ICT device, equipment, tools, platforms, and applications for communication, collaboration, or problem solving
Knowledge	<ul style="list-style-type: none"> • Forms and sources of digital content • Digital etiquettes • Digital tools for search and information collection • Digital technology tools, systems and software • Technology-enabled communication channels • Troubleshooting and back-up processes • Data and privacy policies • Copyright and licenses • Cybersecurity risks • Managing cybersecurity risks • Criteria for selecting suitable digital technology tools, systems and software • Visualization tools and techniques • Coding and programming • Processes for technology implementation • Decision-making and prioritization frameworks • Risk assessment techniques • Digital media marketing
Skills	<ul style="list-style-type: none"> • Browse, search and filter data, information and digital content • Evaluate data, information and digital content • Manage data, information and digital content • Critically select suitable digital tools, systems and software • Interact and share through digital technologies • Engage in citizenship through digital technologies • Collaborate through digital technologies • Observe digital etiquettes • Manage digital identity • Develop, integrate, and re-elaborate digital content • Protect copyright and licenses • Create algorithms, codes, or programs • Protect devices, personal data, and privacy • Carry out practices in protecting health and well-being while using digital technologies • Solve technical problems • Troubleshoot and employ back-up processes • Identify needs & technological responses • Design, create, and revise digital content using different digital technologies • Produce technical/mechanical/engineering drawings

Learning Activities

- Visualize data using different techniques and tools
 - Build and design models using a software
 - Setup and control digital functions of software, device, and equipment needed in the workplace
 - Identify digital competence gaps in the workplace
 - Evaluate process of technology implementation and decide on best practices that can be repeated
 - Assess risks involved in the use of digital technologies and identify risk management strategies
 - Use various platforms for digital media marketing when applicable
-
- Wikis
 - Screencast
 - Video annotation
 - Infographics
 - Curated content/ online bulletin board
 - Online quiz
 - Digital interactive notebook
 - Graphic organizers
 - Group chat/Discussion forum
 - Synchronous virtual meetings
 - Webinars
 - Simulations
 - Asynchronous tasks in LMS
 - Mock digital media marketing
 - Online project management

Cultural Literacy

Unit Descriptor

Be sensitive and respectful of the culture where an individual is immersed in

Knowledge

- Types of social, political, economic and cultural factors which impact cross-cultural collaborations
- Best practices for businesses operating in global and cross-cultural environments
- Conflict management strategies
- Effective communication styles
- Cross-cultural Communication and Developing Cultural Awareness
- Defining Human Communication and Culture
- Components of Human Communication
- Developing Cross-cultural Competence
- Developing Cross-cultural Communication Competence in Contexts
- The Concept of Inclusion
- Identity and Differences
- Contemporary Opportunities & Challenges
- Basic Research in Inclusion

Skills	<ul style="list-style-type: none"> • Organizational Strategies on Promoting Inclusion • Employee Development • Critical Considerations in Developing an Inclusive Workforce
	<ul style="list-style-type: none"> • Identify fundamental concepts, multiple perspectives, and theories about culture and communication, and relate their influence on interpersonal and business interactions. • Describe global trends on intercultural communication • Explain how culture shapes human perception, communication and conflict styles, behaviors, and ways of thinking • Apply practical communication skills in the workplace • Analyze intercultural communication scenarios • Identify benefits of and challenges to inclusion in the workplace • Discuss the concept of identity and the differences employees bring to the workplace • Propose strategies and approaches to make the work environment inclusive • Apply best practices for inclusion on a personal and organizational level • Develop a training manual and plan for a sustainable workplace inclusion program.
Learning Activities	<ul style="list-style-type: none"> • Forum • Interactive Lectures • Interactive Board Discussions • Case Studies • Experiential Exercises • In-class Discussion • Research and Presentation

Organizational Literacy

Unit Descriptor	Negotiate way within an organization by understanding its structure, dynamics of its members, communication channels, and appropriate procedures
Knowledge	<ul style="list-style-type: none"> • Individual Perspectives of Diversity (prejudice, stereotypes, discrimination, differences and conflict, organizational diversity) • Primary Dimensions of Diversity (Race, ethnicity, age, gender, sexual orientation, physical and mental challenges) • Secondary Dimensions of Diversity (Social class, religion, appearance/weight, language/communication) • Ethical, legal, media and marketing issues in managing diversity • Organizational Strategies for Managing Workforce Diversity
Skills	<ul style="list-style-type: none"> • Describe diversity in the workplace and identify strategies for navigating diverse components of the organization • Discuss impact of diversity in the workplace

Learning
Activities

- Assess challenges and opportunities when creating inclusive work culture
- Evaluate and critique the implications of prejudice, stereotyping, workplace discrimination, differences and conflicts, and organizational diversity
- Identify various strategies for building bridges between diverse groups within the workforce
- Apply concepts of communication and diversity in personal work environment
- Propose solutions to organizational problems
- Develop a training manual and plan for a sustainable workplace diversity program.

- Forum
- Lectures
- Case Studies
- In-class Discussion
- Diversity Audit Project
- Workplace Diversity Program Training Plan/Matrix

SOCIO-EMOTIONAL INTELLIGENCE

Empathy

Unit Descriptor	Sense, share and respond positively to the feelings of another
Knowledge	<ul style="list-style-type: none"> • Value and expressions of empathy • Cognitive processes and neural structures supporting empathy • Influences of identity, motivation, and contexts on empathy • Relationships between empathy, compassion, pro-sociality, and morality • Tools and techniques for assessing empathy • Techniques in incorporating reflective listening into daily communication • Empathic body language techniques • Strategies for connecting with customers, colleagues, and clients • Development of user-friendly solutions, products, and services informed by empathy mapping
Skills	<ul style="list-style-type: none"> • Identify and discuss own experiences of empathy in a variety of settings and among people with different backgrounds • Relate empathy to prosocial behaviors, compassion, morality, and world justice • Examine cases of recent world events to develop an appreciation for empathy • Articulate multiple perspectives on a variety of global issues • Examine evidence of the effects of empathy on day-to-day interactions • Discuss psychological mechanisms behind understanding others' minds and "catching" others' emotions • Use tools to assess empathy • Incorporate techniques to cultivate interpersonal sensitivity

**Learning
Activities**

- Collaborate effectively and respectfully with peers and community members
 - Communicate empathy in the workplace through verbal and non-verbal expressions
 - Articulate value of empathy in the workplace and designing user-friendly solutions and services
-
- Empathy mapping
 - Persona mapping
 - Shadowing
 - Scrum stories
 - Forum or discussion board
 - Case Studies
 - Personal Empathy Inventory
 - Writing prompts
 - Action Plan Sketching
 - Advocacy campaign
 - Problem-based Activity
 - Personal Reflection

Agency

**Unit
Descriptor**

Manage own behavior and emotions to act professionally and independently, make choices freely, and pursue goals persistently

Knowledge

- Fundamental concepts of self-awareness
- Dimensions of socio-emotional intelligence
- Motivational beliefs
- Techniques for regulating emotions and behavior
- Tools and methods for gathering feedback
- Strategies for establishing personal branding
- Strategies for ensuring personal well-being
- Forms of stress triggers
- Mechanisms for managing stress
- Tools and techniques for time management, prioritization, and productivity
- Tools for assessing personal strengths and motivations
- Workplace and social etiquettes
- Help-seeking and coaching techniques
- Productivity tools

Skills

- Identify and reflect on personal strengths and weaknesses
- Determine factors motivating own response and behaviors
- Apply techniques for regulating emotions and behaviors in diverse scenarios
- Gather feedback from co-workers and superiors to inform personal and professional growth plan

**Learning
Activities**

- Identify work goals and priorities across and plan work activities accordingly
 - Monitor progress against goals and priorities
 - Evaluate strengths, weaknesses, and motivations to define personal branding
 - Develop a personal and professional growth plan
 - Apply various strategies for ensuring personal well-being
 - Determine factors that trigger stress
 - Implement mechanisms for managing stress
 - Use tools and techniques to resolve time management, prioritization, and productivity issues
 - Practice workplace and social etiquette when interacting with co-workers and superiors
 - Determine appropriate timing and people to seek help
 - Offer professional guidance to co-workers or subordinates in need
 - Try out productivity tools to improve personal effectiveness
- SWOT analysis
 - 4L Retrospective Chart (Liked, Learned, Lacked, and Longed for)
 - Reflective journaling
 - Blog/Vlog
 - Life mission-vision
 - Mind mapping
 - Personal/Professional Growth Plan

Resilience

Unit Descriptor	Thrive or prosper despite difficult circumstances; Be adaptable and flexible
Knowledge	<ul style="list-style-type: none"> • Dimensions of resilience • Factors affecting resilience • Strategies for building resilience • Mechanisms for coping and bouncing back • Tools and Techniques for assessing resilience and other related constructs (grit, adaptability) • Adaptive learning strategies for personal and professional development • Techniques for overcoming barriers to learning • Mindfulness techniques
Skills	<ul style="list-style-type: none"> • Relate dimensions of resilience (belonging, coping, bouncing back, and adapting) to personal and professional contexts • Discuss the effects of optimism, altruism, moral compass, social support, sense of purpose, training, faith and spirituality, and humour on resilience • Apply strategies for building resilience and mechanisms for coping and bouncing back • Assess resilience and other related constructs (e.g. grit, adaptability) to understand personal capacities

**Learning
Activities**

- Apply adaptive learning strategies that facilitate personal and professional development within the organization
- Implement techniques for overcoming barriers to learning
- Practice mindfulness techniques to improve personal and professional circumstances
- Team problem solving
- 4L Retrospective Chart (Liked, Learned, Lacked, and Longed for)
- Personal and professional growth planning
- Goal-setting exercises
- Reflection
- Persona mapping
- Mindfulness exercises

Service Orientation

Unit Descriptor	Support a culture of service excellence within the organization by producing products or providing services that exceed the expectations of the customers
Knowledge	<ul style="list-style-type: none"> • Tools and techniques for customer needs analysis • Strategies for managing customer relationship • Customer feedback management systems • Corporate policies and procedures for service delivery • Customer behavioral patterns • Methods and tools for evaluating service delivery • Metrics for understanding customer experience
Skills	<ul style="list-style-type: none"> • Analyze customer needs or perspectives to identify appropriate responses or actions • Use multiple information sources to profile customer behavior • Analyze trends to anticipate customers' needs and expectations • Evaluate customer needs to prioritize responses or action based on urgency and criticality • Communicate with customers and gather feedback for product and service improvement • Utilize customer experience metrics to inform how services can be improved • Resolve conflicts or difficulties with customers before problems escalate
Learning Activities	<ul style="list-style-type: none"> • HEART User-centric Metric • Consumer Trend Canvas • Affinity Diagram • Field Study • Diary study • Customer journey map • User interview • Reach, Engagement, Activation, Nurture (REAN) Matrix • Card sorting • Concept testing

- Usability Testing
- Acceptance Testing
- Blueprinting
- User Persona Mapping
- Design Survey
- Scenario Planning

Project Management

Unit Descriptor	Use resources (human, material, and time) wisely to deliver work-related tasks or projects
Knowledge	<ul style="list-style-type: none"> • Elements of a project plan • Project planning requirements • Suitable methodologies and tools • Risk management • Stakeholder management
Skills	<ul style="list-style-type: none"> • Identify essential elements of a project that can be autonomously completed in less than six months within a regulated budget • Carry out the approved plans built upon the project scope and objectives • Apply suitable methods and tools to help evaluate project progress and timelines • Perform risk analysis to anticipate possible effects and to develop a mitigation plan • Communicate the needs of project stakeholders to properly address expectations and concerns
Learning Activities	<ul style="list-style-type: none"> • Work process matrix • Agile project management (e.g. Kanban, Scrum) • Waterfall • Six Sigma • Brainstorming • Design briefs • Suppliers (sources), Input, Process, Output, and Customers (SIPOC) Chart

Glocal Mindset

Unit Descriptor	Be adaptive to global standards but remain responsive to local needs
Knowledge	<ul style="list-style-type: none"> • Organization's vision, objectives, and operations • Global business strategies • Business performance metrics • Global and local business needs • Factors affecting global and local business landscape • Methods to analyze impacts of global trends • Types of networks • Stakeholder analysis techniques • Communication and collaboration styles and platforms • Best practices for businesses operating in global and cross-cultural environments • Strategies for designing solutions with global and local impact • Cross-cultural, social, and workplace etiquette
Skills	<ul style="list-style-type: none"> • Connect organization's vision, objectives, and operations to global and local business needs • Conduct research on global challenges and opportunities related to one's occupation • Identify global business strategies that can be contextualized to local setting • Analyze factors affecting global and local business landscape • Apply diverse methods in analyzing global trends • Utilize social networks to learn best practices in the trade • Analyze global and local perspectives when evaluating information and making decisions • Designing solutions aligned with the global sustainable development goals but with local responsiveness • Interact with global and local counterparts observing cross-cultural, social, and workplace etiquette
Learning Activities	<ul style="list-style-type: none"> • Global/Local PESTLE-C Analysis (Extended) • 4P Global and Local Analysis (Product, Place, Promotions, Price) • Circle of Viewpoints (Global-Local) • Connect-Extend-Challenge Activity • Same and Different Thinking Activity • 4Cs analysis (Concepts, Connections, Challenges, Changes)

VII. STEM Learning Activities

This section presents various templates and detailed plans to demonstrate the STEM-oriented learning activities that have been identified in the reference documents. Some of the templates can be used for fostering multiple thinking skills, literacies, and socio-emotional intelligence.

Templates

SCAMPER Invention Algorithm

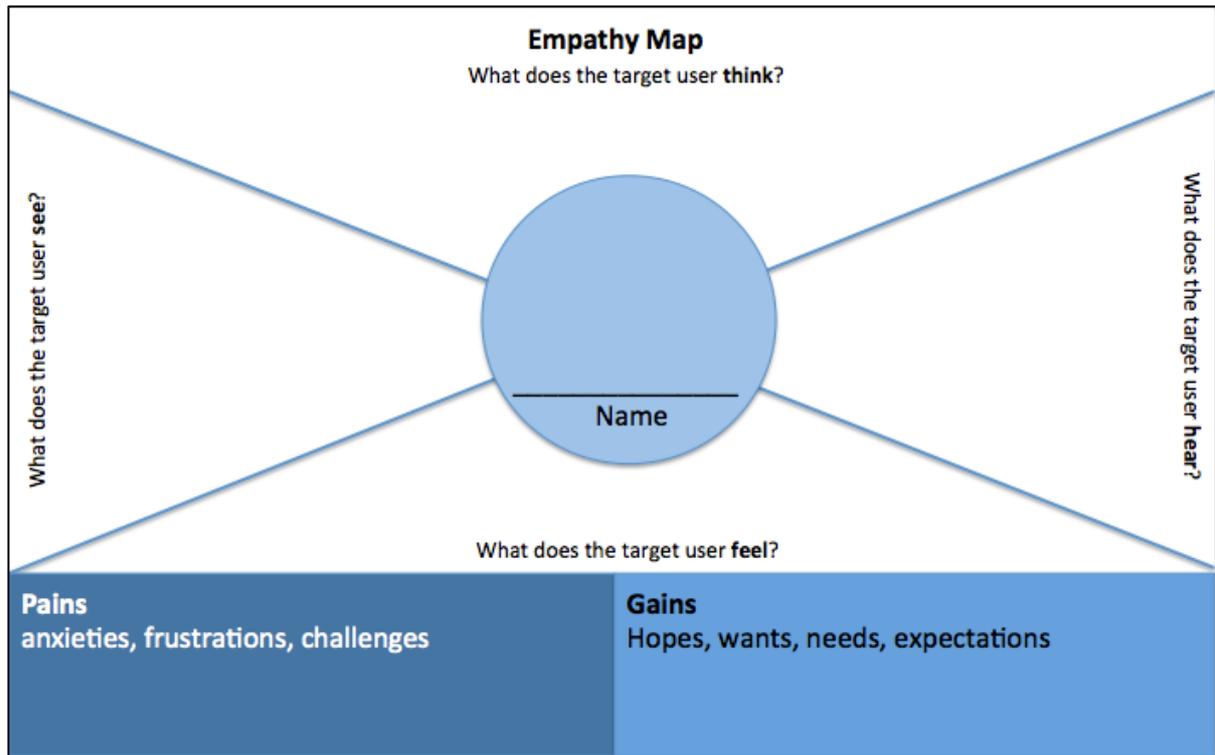
Instructions: Think of a product or a process within your program that needs radical change or innovation (e.g. *3D game arts or art style*). Use as design peg the product/process that you are currently using or that is available in the market. Using the SCAMPER ideation prompts below, conceptualize a new/innovative product or process. Think of a creative title for your idea.

Design Peg: (Existing product/process available in the market or currently in use)

	Ideation Prompts	Inventive Ideas <i>(creative title for new/innovative idea)</i>
Substitute	<ul style="list-style-type: none"> What materials or components can we substitute or swap to improve the product*? 	
Combine	<ul style="list-style-type: none"> What would happen if we combine this product with another, to create something new? 	
Adapt	<ul style="list-style-type: none"> How could we adapt or readjust this product to serve another purpose or use? 	
Modify	<ul style="list-style-type: none"> How could we change the shape, look, or feel of our product*? 	
Put to another use	<ul style="list-style-type: none"> Can we use this product* somewhere else, perhaps in another industry? 	
Eliminate	<ul style="list-style-type: none"> What features, parts, or rules could we eliminate? 	
Reverse	<ul style="list-style-type: none"> What if we try to do the exact opposite of what we are trying to do now? 	

Empathy Map

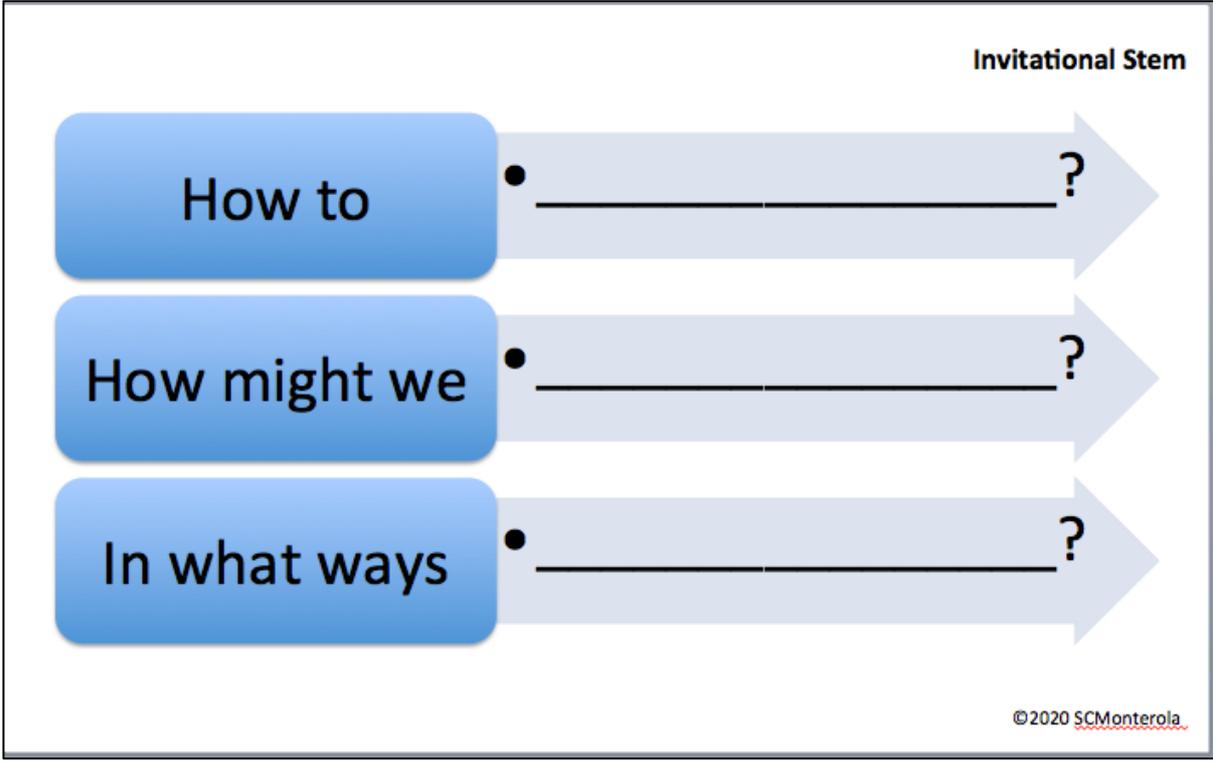
Instructions: Look for potential end-users of the product that you are designing and interview each of them. Create an individual empathy map by probing current experiences (what he/she feels, thinks, sees, and hears), pain points (anxieties, frustrations, and challenges), and gains (hopes, wants, needs, and expectations).



Invitational Stem

Instructions: Choose a topic or an area within your occupation for which you are expected to design or create an output. Use the invitational stems below to explore how the topic that you have chosen can be expanded by posing “How” questions related to “change”, “improvement”, “growth”, or “development”. Complete the invitational stems to turn them into complete questions.

Invitational Stem



How to _____ ?

How might we _____ ?

In what ways _____ ?

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SWOT Analysis

Instructions: Evaluate the proposal that you have on hand. Explore its strengths and weaknesses as well opportunities and threats that may affect the proposal. Strengths and weaknesses are considered as internal factors that stem out of the characteristics of the proposal. On the other hand, opportunities are external factors that can facilitate or hinder the proposal to reach its full potential. Use the guide questions below.

Internal Factors

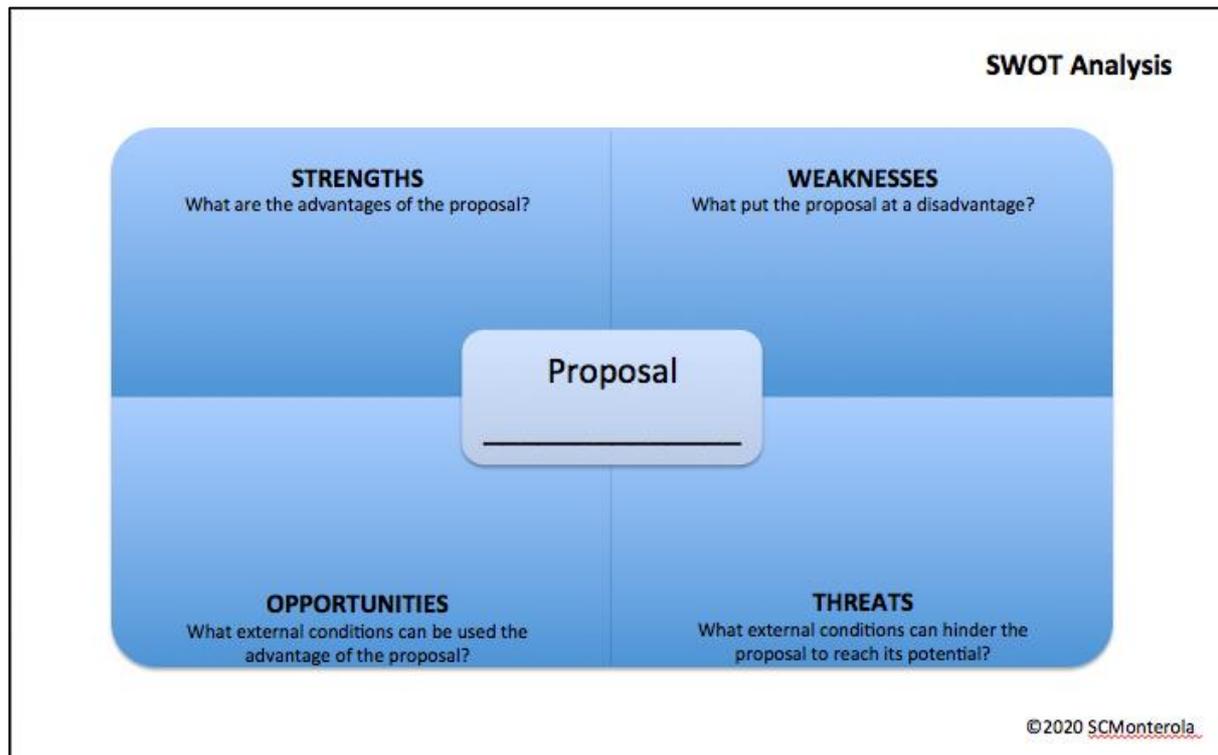
Strengths (*What are the advantages of the proposal?*)

Weaknesses (*What put the proposal at a disadvantage?*)

External Factors

Opportunities (*What external conditions can be used the advantage of the proposal?*)

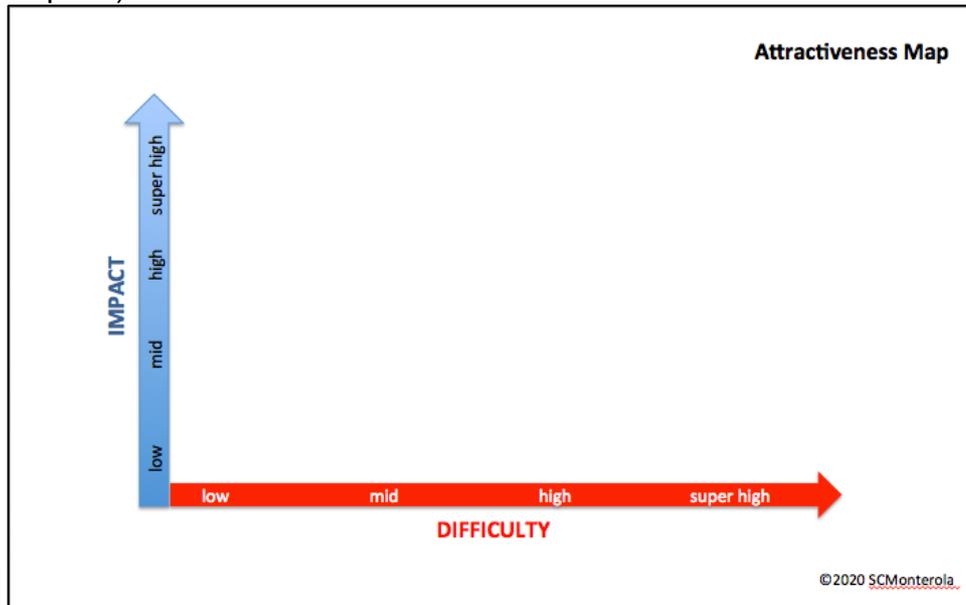
Threats (*What external conditions can hinder the proposal to reach its potential?*)



Attractiveness Mapping

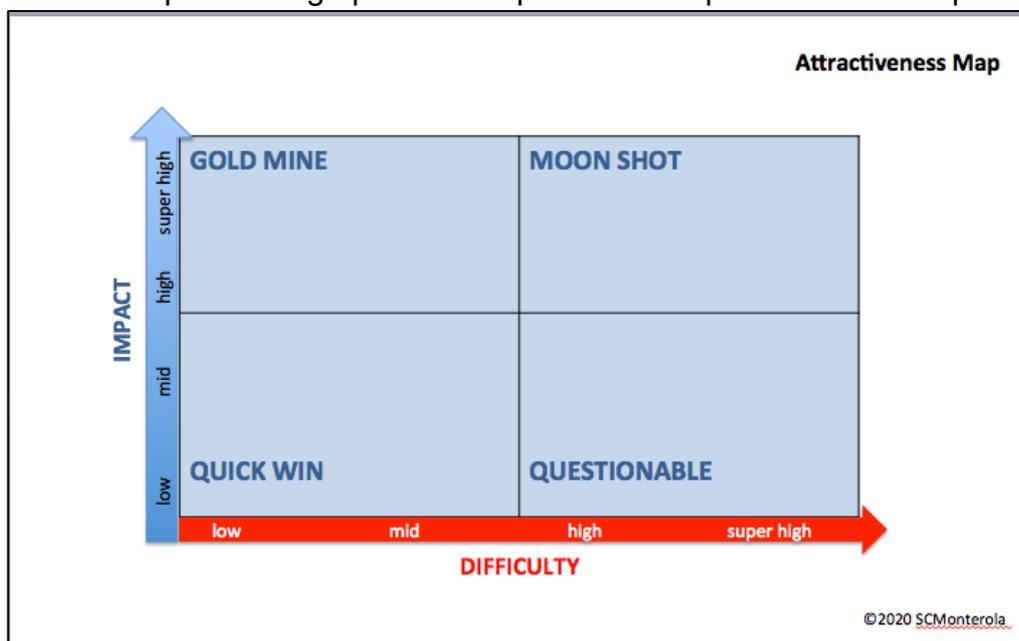
Instructions: To determine which ideas or proposals can be prioritized by a team, the attractiveness map can be used. This can be done virtually using an online bulletin board or a virtual whiteboard. On separate “sticky notes”, write each idea or major concept of a proposal. Ask the team members to place each sticky note on the difficulty-impact plane based on its level of difficulty and potential impact.

(Initial Template)



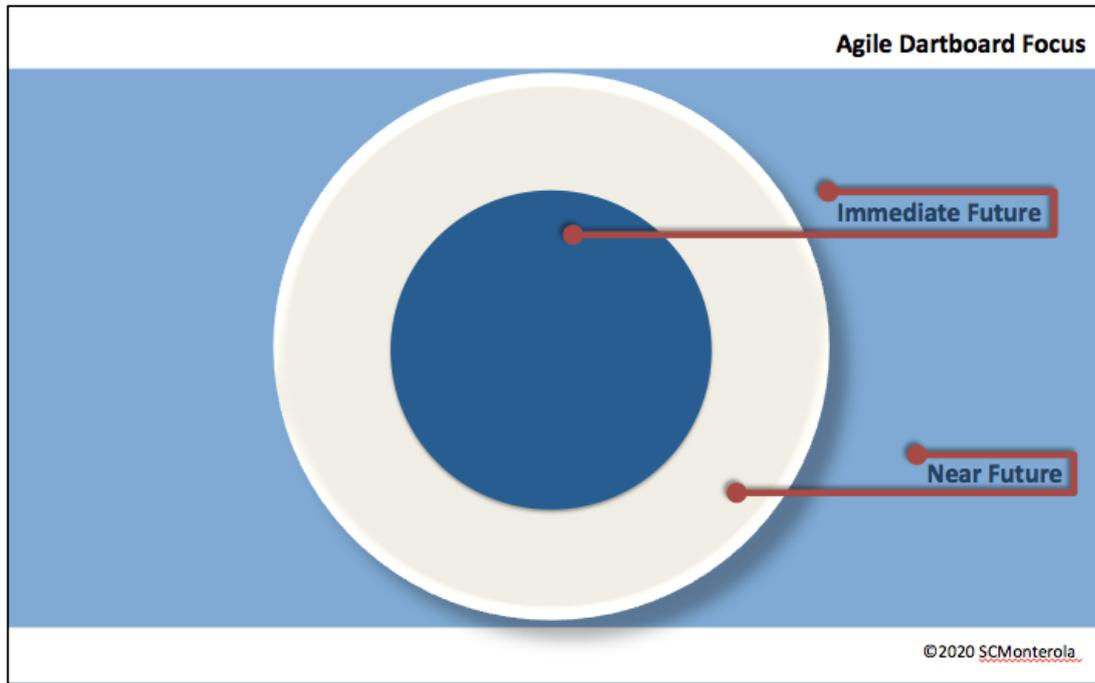
(Complete Template)

When the members are done, the four cells can be shown. “**Quick wins**” are considered low-hanging fruits. They are ideas/projects that are easy to do and have high potential impact. On the other hand, “**Gold Mines**” are ideas that are not too difficult to implement and have high potential impact. “**Questionables**” are those ideas that are too difficult to carry out but have low potential impact. “**Moon shots**” are concepts with high potential impact but are quite difficult to implement.



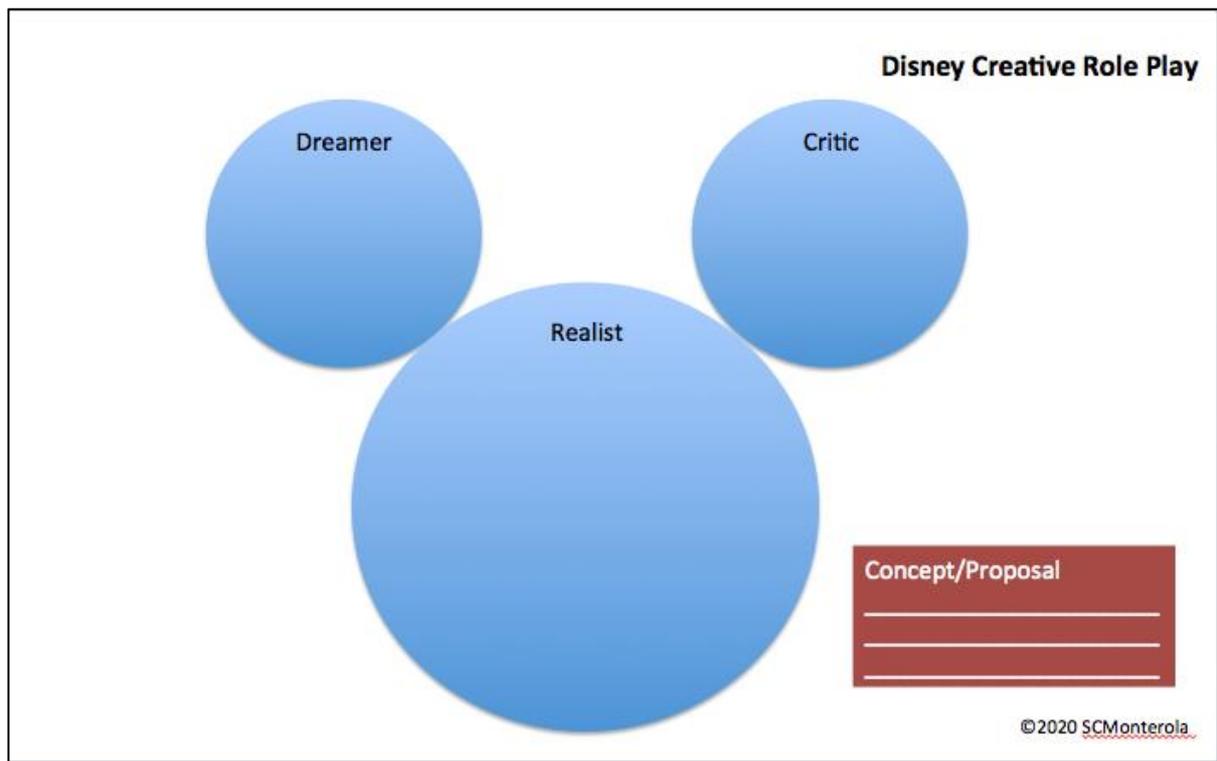
Agile Dartboard Focus

Instructions: The agile dartboard focus can be used to visualize which projects or ideas can anticipate immediate future needs as well as near future needs. An additional circle can be added to include far future needs. Those identified in the innermost circle are projects or ideas that need to be prioritized and carried out immediately because they are responsive to the immediate needs in the field.



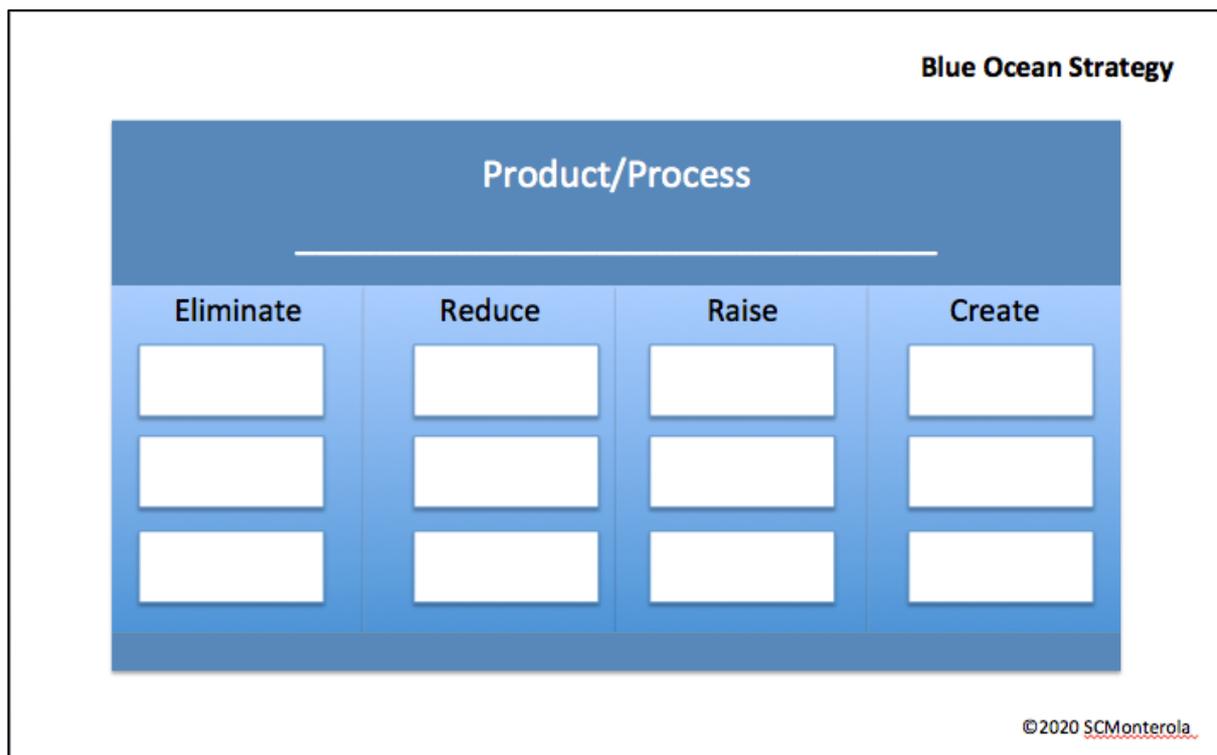
Disney Creative Role Play

Instructions: To review a proposal or concept, the members of the team can play different roles representing different perspectives. Those assigned to be “**Realists**” will give their comments and suggestions about the proposal based on facts, evidence, or information. On the other hand, members who play the “**Critics**” role will challenge the proposal by pointing out possible weak points or areas that need to be improved in order for the proposal to be approved. Lastly, the members who are “**Dreamers**” will propose ideas that can further push or elevate the proposal to its limits. This can be done in terms of materials or resources that proposal can use, people who can be involved, or novelty of overall look or feel of the desired output. After hearing the perspectives from different groups, the team will select suggestions or comments that can be combined to improve the viability of the concept or proposal.



Blue Ocean Strategy

Instructions: The Blue Ocean Strategy is used to explore innovative ideas based on available opportunities. It was developed by business professors but can also be used for brainstorming about improving an existing product or process within one's respective trade. The section "**Eliminate**" represents features or steps in the existing product or process that can be eliminated because they do not bring intended results. In contrast, the section "**Reduce**" includes features or steps that can be simplified or streamlined without compromising the intended results. The "**Raise**" section is concerned with the features of the existing product or steps in the current process that are above industry standards but are not yet addressed by the market. The last section "Create" covers features or steps that do not currently exist but will be valuable in the future. These ideas need to be anticipated and are considered features of next-generation products.



Reference: <https://miro.com/templates/four-actions-framework/>

Concept Testing

Instructions: Concept testing can be done to assess the initial response of target end-users to a product or prototype. It can be done in the form of a survey using metrics that can provide insight to the team for the improvement of the product or prototype. The sample template below shows the following metrics: appeal, credibility, innovativeness, quality, relevance, and value. Respondents are asked to indicate their degree of preference for the product based on each metric.

Concept Testing					
Metric	Product/Prototype: _____				
	Like it very much	Like it somewhat	Feel neutral about it	Dislike it somewhat	Dislike it very much
Appeal					
Credibility					
Innovativeness					
Quality					
Relevance					
Value					

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Usability Testing

Instructions: To determine the usability of a new product or prototype, initial usability testing can be done. Ask target end-users to participate in a survey. The survey consists of dimensions of usability that can help the team/designers understand better the product's ease of use, essential features or structure, level of confidence it elicits from the users, and whether the use of the product can be done independently or would always require external support. The template below shows sample items that can be revised depending on the nature of the product and scope of usability testing. Respondents are asked to indicate their degree of agreement to the usability statements in the survey.

Usability Testing					
Usability Dimension	Product/Prototype: _____				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I can use this product frequently.					
I find the product unnecessarily complex.					
I consider the product easy to use.					
I need support every time I use the product.					
I think other users can quickly learn how to use the product.					
I am not confident using the product.					

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Task Analysis

Instructions: Choose a performance task required in your training program. Ask the trainees to identify the steps involved in performing the task. They can add more boxes if necessary. For each step that has been identified, ask the trainees to indicate their level of confidence in performing it.

Task: (e.g. Dismantle accessible portion of a machine for cleaning and closer inspection of parts.)	Task Analysis	
Step 1	Confident	Not Confident
↓	<input type="checkbox"/>	<input type="checkbox"/>
Step 2	<input type="checkbox"/>	<input type="checkbox"/>
↓	<input type="checkbox"/>	<input type="checkbox"/>
Step 3	<input type="checkbox"/>	<input type="checkbox"/>

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Work Process Matrix

Instructions: Choose a work process required in your training program. Ask the trainees to outline its components such as the sequence of sub-tasks, methods involved, tools, and requirements. The trainees complete the said inputs prior to visiting an actual site and interviewing a skilled worker. A new set of inputs is added to the matrix when the trainees are able to visit an actual site and interview a skilled worker. After the visit, the trainees reflect on remaining questions that they have in mind regarding the sequence of sub-tasks, methods involved, tools, and requirements. The matrix can help both trainee and trainer to determine the components of the work process that the trainee find difficult to grasp.

Work Process: _____ (e.g. Dismount automatic transmission assembly)		Work Process Matrix	
Work Component	Trainee's Initial Outline (Prior to Direct Observation)	Trainee's Revised Outline (After Observing and Interviewing Skilled Worker)	Remaining Questions/Clarifications
Sequence			
Methods involved			
Tools			
Requirements			

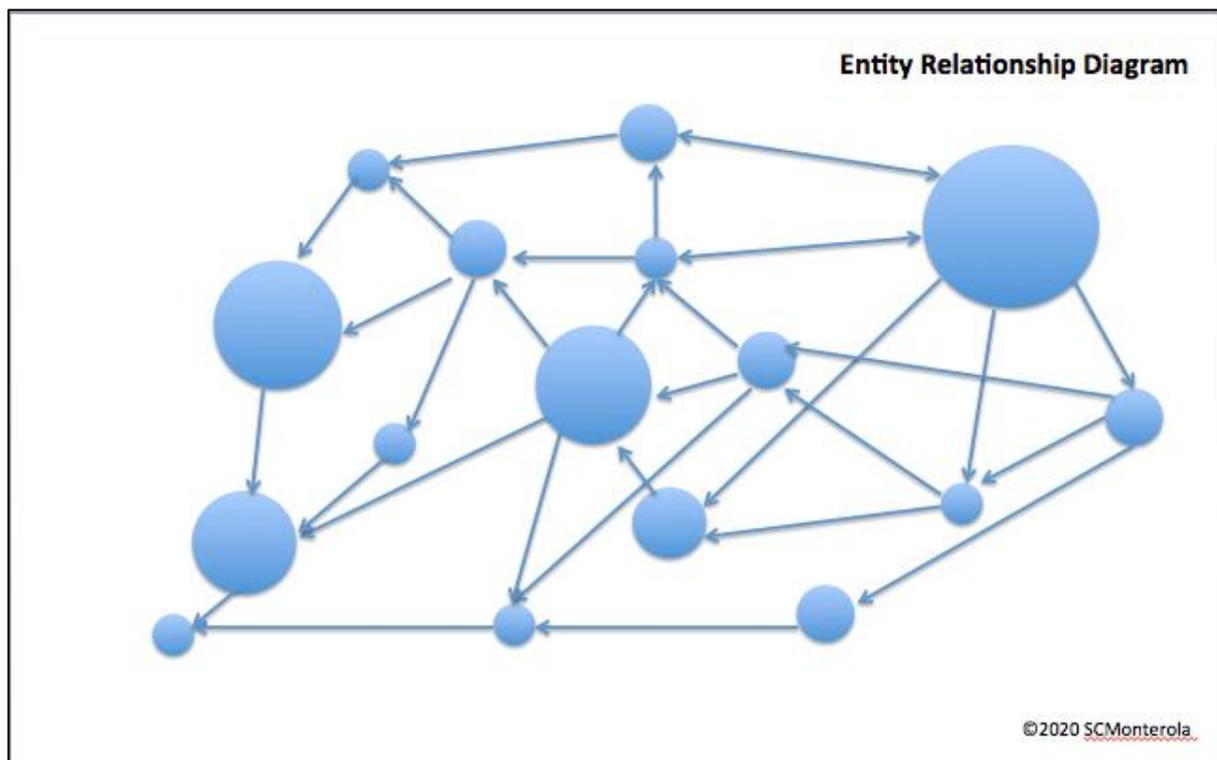
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Entity Relationship Diagram

Instructions: The Entity Relationship Diagram (ERD) aids in visualizing how entities of a system are interrelated. Create circles to represent the entities in a system. Use bigger circles for entities that can be connected to several other entities within the system. Label each circle using a term that can be understood by the users of the diagram. After completing the ERD, write down insights that can be drawn from it. A few of the questions below can be used to gather insights.

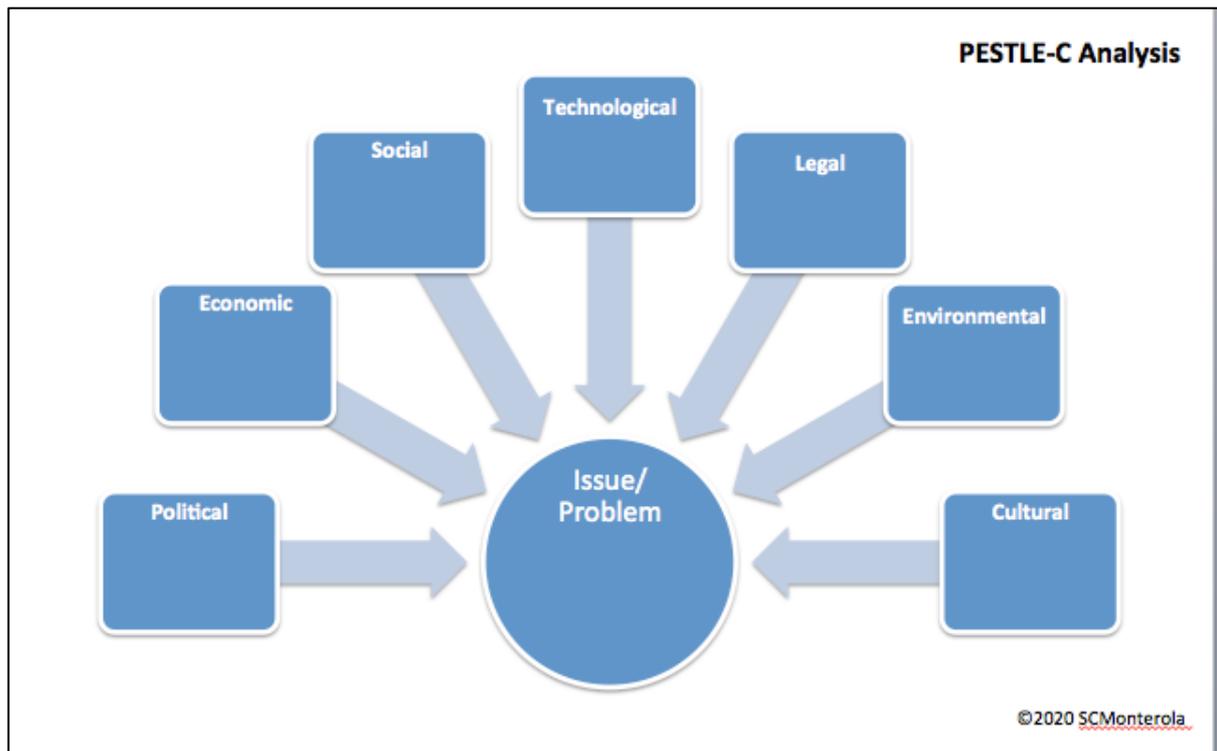
Prompts for gathering insights:

- What happens if one entity is cut off?
- Is it critical to the operation of the system?
- What are alternative paths that can be explored when connections are severed?
- Are there redundant entities in the system? Why?
- What can be done with overlapping entities?



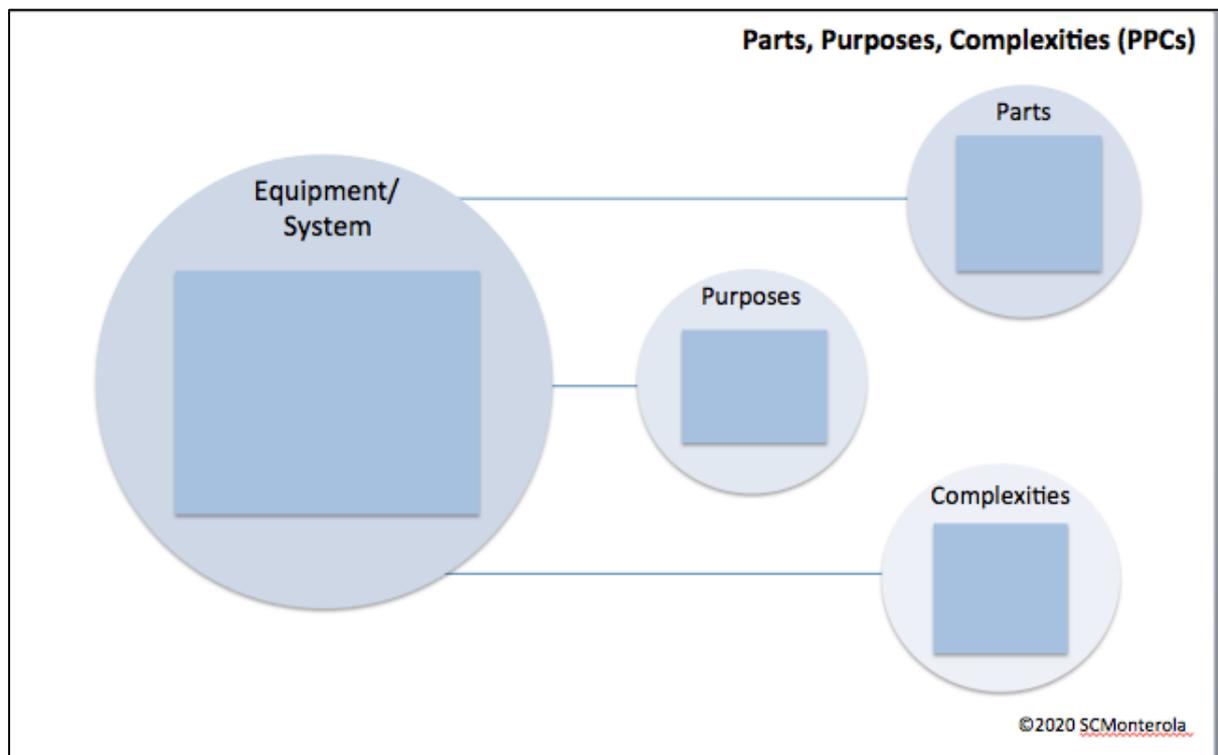
PESTLE-C Analysis

Instructions: The PESTLE-C Analysis can be used to analyze the factors that influence an issue or a problem. These factors can range from political, economic, social, technological, legal, environmental, and cultural. When given consideration in designing a solution, the output may become multi-sectoral and holistic.



Parts, Purposes, Complexities (PPCs)

Instructions: The PPCs activity can be used to break down a complex topic or concept into manageable chunks of information. It can be used to analyze an equipment or a system that is commonly used in a qualification or training program. “**Parts**” refer to the pieces or components that make up the equipment or system. “**Purposes**” refer to the corresponding function or use of each part. “**Complexities**” refer to the complications or difficulties that can be linked to the parts and purposes of the equipment or system.



Collections vs Systems

Instructions: Study the list of items below. Identify which item demonstrates a system and which one demonstrates a collection of parts. Write the word “System” or “Collection” in the second column of the table.

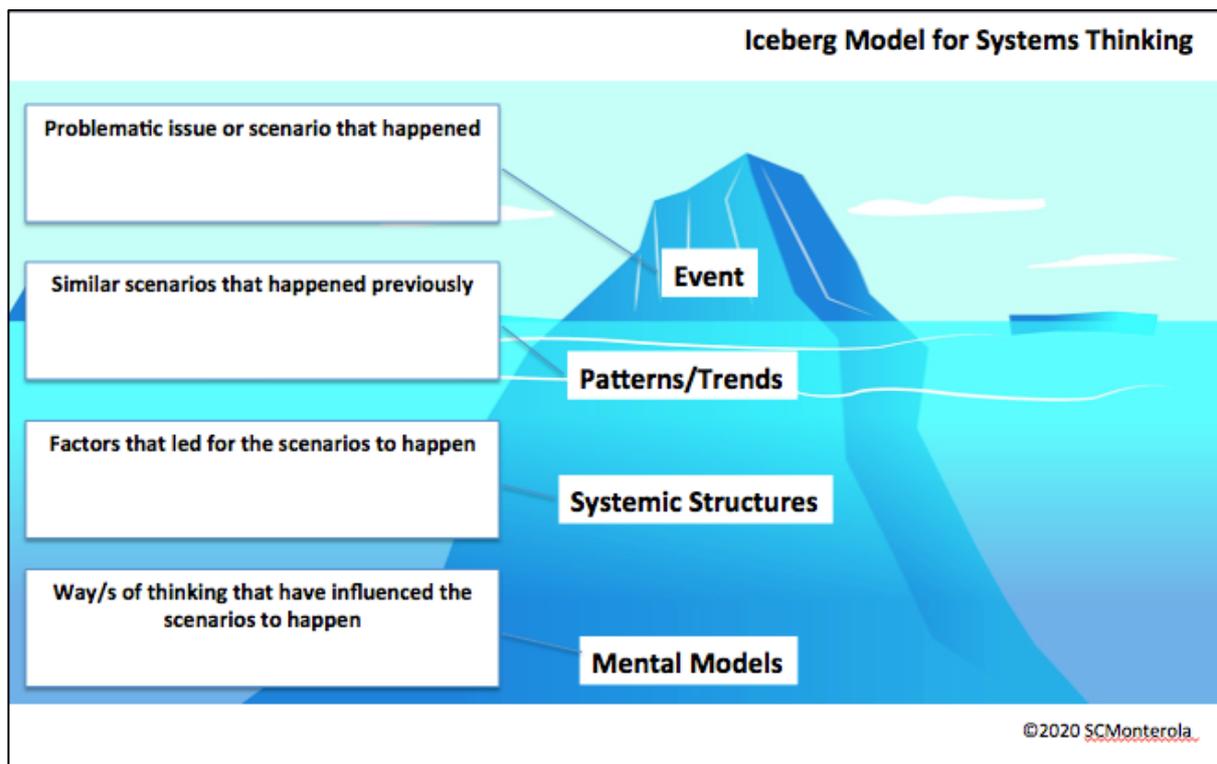
Item	System or Collection
1. Bowl of tropical fruits	
2. Basketball team	
3. Water pump	
4. Kitchen	
5. Assembly line	
6. Tools in a toolbox	
7. Database of customer names	
8. Catering crew	
9. Engine	
10. Fish pond	

A system is any group that is composed of parts that are interacting, interrelated, or interdependent. These parts form a complex, unified whole that has a specific purpose. The interdependencies of the parts distinguish a system from a collection of entities or parts.

Reference: Kim, D. (1999). *Introduction to Systems Thinking*. Pegasus Communications.
<https://thesystemsthinker.com/introduction-to-systems-thinking/>

Iceberg Model

Instructions: Choose a problematic issue or scenario in your qualification. Label it as the “Event”. Describe how it happened. Then recall whether similar scenarios happened before that ended up with the same result. Describe the said scenarios and label them as “Patterns”. Reflect on the factors that led to the scenarios. Write down these factors and label them as “Systemic Structures”. Lastly, reflect on your way/s of thinking that have influenced the problematic issue or scenario to happen. Identify the way/s of thinking as “Mental Models”



Reference: Peter Senge's Iceberg Model

The Customer's HEART

Instructions: The Customer's HEART can be used to evaluate a project based on the response of the customers, their satisfaction, interaction with the product or service, new users that have been attracted, patronage or continuous subscription of the customers, and overall success of the task. Each entry can be aligned to the goals of the projects, signals or indicators that have been observed, and metrics that have been used to capture customer response. Depending on the nature of a project, some columns of HEART framework need not be filled up.

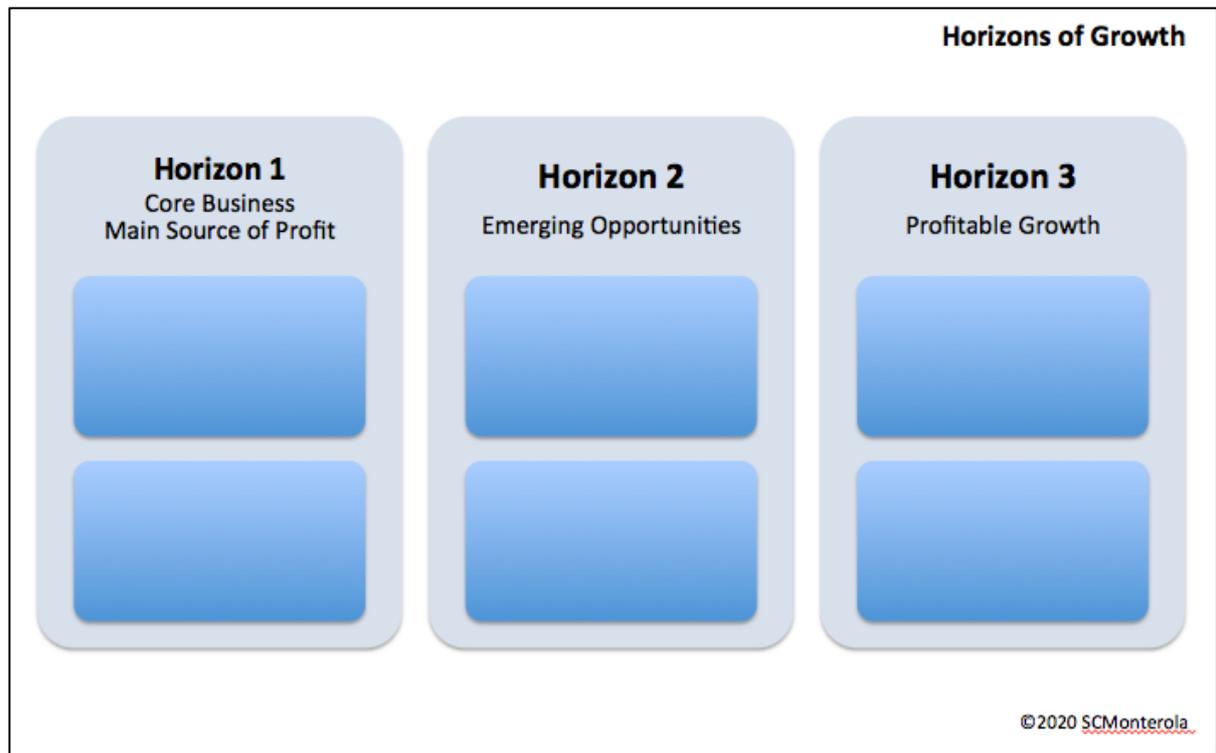
The Customer's HEART					
	Happiness	Engagement	Adoption	Retention	Task Success
Goals					
Signals					
Metrics					

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Reference: <https://miro.com/templates/insight-gathering/>

Horizons of Growth

Instructions: The Horizons of Growth Activity is used to foster entrepreneurial literacy and strategic thinking by identifying emerging opportunities and making projections for profitable growth. It also identifies the core of a business, its main source of profit. No matter how small or big an enterprise is, it will benefit from exploring horizons growth.



Reference: <https://miro.com/templates/strategy/>

Plus-Delta-Solution Evaluation

Instructions: The Plus-Delta-Solution Evaluation is a quick and simple way of evaluating a task or a project. “**Plus**” means the positive outcomes of the task or project. “**Delta**” means aspects of the task or project that need to be changed. On the other hand, “**Solution**” means new ideas or plans that can respond to the changes that are needed to improve the task or project.

Plus-Delta-Solution Evaluation

<p style="text-align: center;">Plus (+)</p> <p>What are the positive outcomes?</p>	
<p style="text-align: center;">Delta (Δ)</p> <p>What needs to be changed?</p>	
<p style="text-align: center;">Solution</p> <p>What are the solutions?</p>	

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Detailed Plans

ALL SYSTEMS GO

A Strategy for Project Management

What's the Goal?

This strategy encourages learners to maximize resources (human, material, and time) and to plan projects methodically.

What's the Connection?

This activity may be applied to all career clusters. The step-by-step completion of the project is well documented and communicated. It promotes ownership of responsibility for assigned tasks and areas of concern are immediately reported.

Table 1. Project Planning Checklist

Key Activities*	Assignee	Equipment	Location	Date Due
Define scope of project				
Identify stakeholders, decision-makers and escalation procedures				
Develop work breakdown structures				
Estimate time requirements				
Develop initial project management flow chart				
Identify required resources and budget				
Evaluate project requirements				
Identify and evaluate risks				
Prepare contingency plan				
Identify interdependencies				
Identify and track milestones				
Participate in project phase review				
Secure needed resources				
Manage the change control process				
Report project status				

* List of Key Activities taken from NCWET (US IT Skills and Standards 2003)

How to Get Started?

The strategy works best in groups. The key activities may be lessened depending on the complexity of the project. Allow learners to assign their project leader and give enough time for open discussion and task designation.

How is it Graded?

The following set of criteria may be used to evaluate the **Work Process Matrix**:

- **Planning** (*Is there evidence of communication and delegation?*)
- **Organization** (*Are all tasks labeled correctly and in chronological order?*)
- **Punctuality** (*Is the Work Process Matrix turned in on time?*)

ETHICS AS ALWAYS

A Strategy for Ethical Thinking

What's the Goal?

This strategy encourages learners to use value system as guide for making choices that adhere to acceptable standards and protocols.

What's the Connection?

This activity may be employed by World Wide Web users. The Web (and business in general) has many accepted professional standards of conduct that all Web developers should follow, called ethics. Ethics are a set of standards governing the conduct of members of a profession.

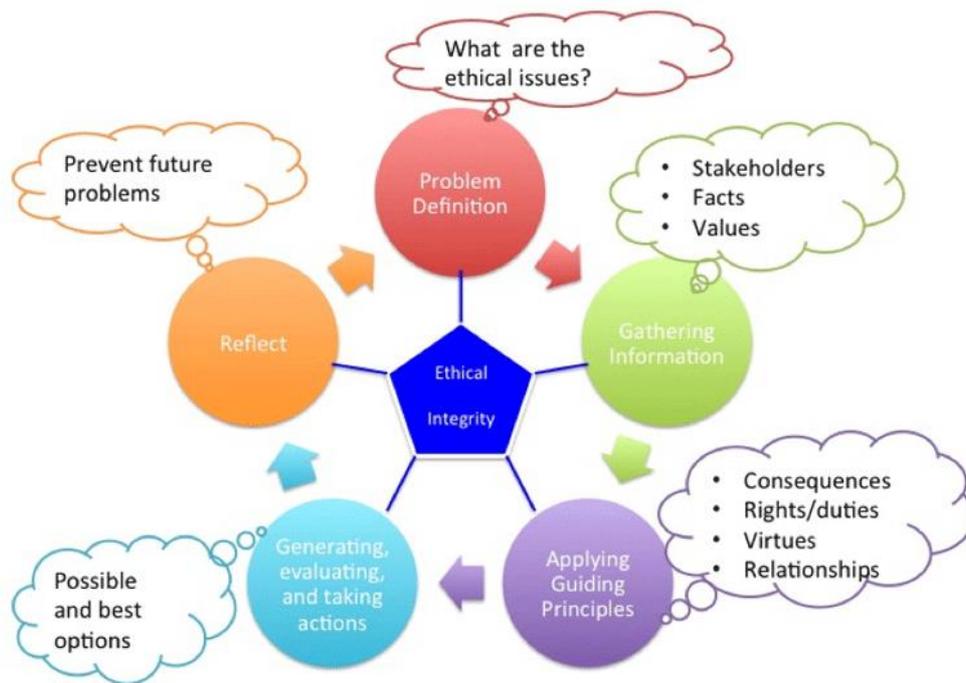


Source: leverageedu.com

How to Get Started?

OPTION 1: A flyer for an ethics campaign will be created. As trained professionals who provide services to customers, Web developers must be familiar with the ethical issues and laws that pertain to businesses operating on the Web. The generally agreed-upon ethical standards for Web professionals have developed from years of experience, and many have been inherited from other professions. Examples of ethical behavior for Web professionals include the following:

- Do not send unsolicited bulk e-mail, or spam.
- Do not buy domain names that you do not intend to use (a practice also known as domain squatting or cyber-squatting).
- Do not knowingly spread malicious program code such as viruses or worms.
- Do not pass along chain e-mail messages, especially those that imply threats.
- Be honest with your customers, and do not overcharge for technical services that they may not understand. (*okaloosaschools.com*)



Source: sites.psu.edu

OPTION 2: Ethical case analysis (**case study**) is a common exercise for identifying and reasoning about ethical challenges in complex situations. Analyzing ethical case studies with your mentors, colleagues, and peer students also provides opportunities for each participant to articulate her own ethical values and to seek ethical consensus within the group. The Rock Ethics Institute provides a 12-step approach for analyzing ethical case studies. (*Penn State Ethics of Data Management*)

This step-by-step framework includes:

1. State the nature of the ethical issue you've initially spotted
2. List the relevant facts
3. Identify stakeholders
4. Clarify the underlying values
5. Consider consequences
6. Identify relevant rights/duties
7. Reflect on which virtues apply
8. Consider relevant relationships
9. Develop a list of potential responses
10. Use moral imagination to consider each option based on the above considerations
11. Choose the best option
12. Consider what could be done in the future to prevent the problem

How is it Graded?

The following set of criteria may be used to evaluate the **ethics campaign flyer and case study**:

- **Accuracy** (Does it contain all ethical behaviors?)
- **Appeal** (Does it capture the attention of the audience?)
- **Organization** (Is it neat and properly sequenced?)

VISUALIZE YOUR DATA

A Strategy for Numeracy

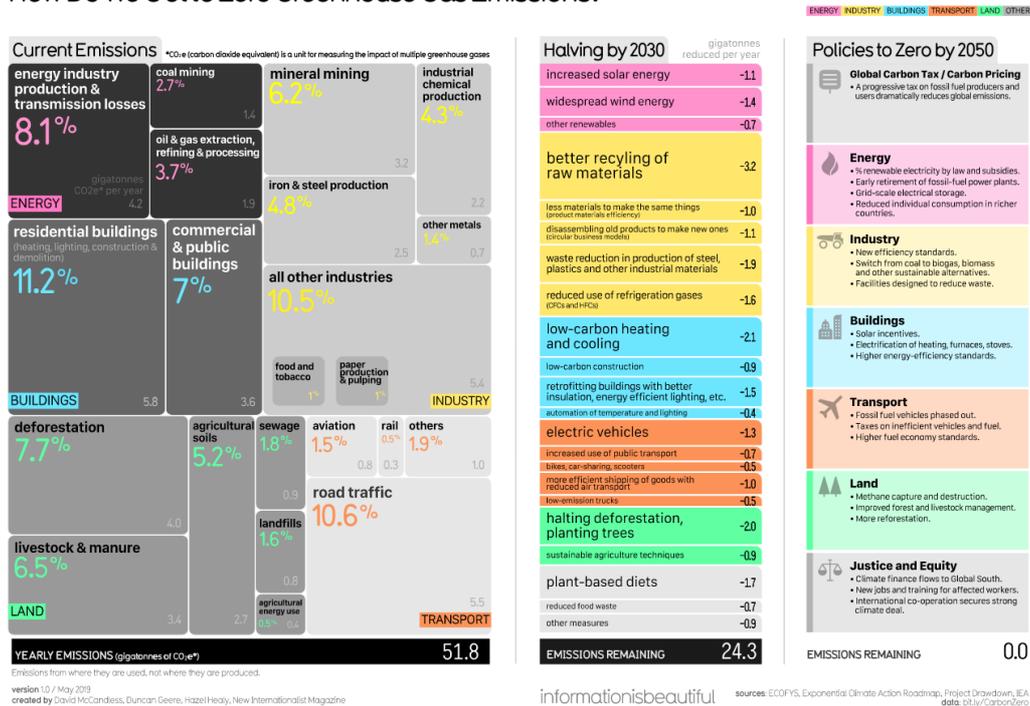
What's the Goal?

This strategy encourages learners to apply mathematical ideas in personal, occupational, societal, and scientific contexts by reasoning, creating representations, or using measuring instruments or calculating tools.

What's the Connection?

This activity may be applied to any field that requires understanding of the essentials of numeracy and statistics.

How Do We Get to Zero Greenhouse Gas Emissions?



Source: information is beautiful.net

How to Get Started?

A firm grasp of numerical concepts and statistics are needed for this activity. The world's data can be interpreted into creative and informative illustrations which make mathematics more appealing and easier to understand.

How is it Graded?

The following set of criteria may be used to evaluate the **infographic/data visualization**:

- **Accuracy** (Are the encoded physical quantities correct?)
- **Structure** (Is the graphical presentation appropriate?)
- **Creativity** (Is there novelty in terms of presentation?)

MATH and PHYSICS in ACTION

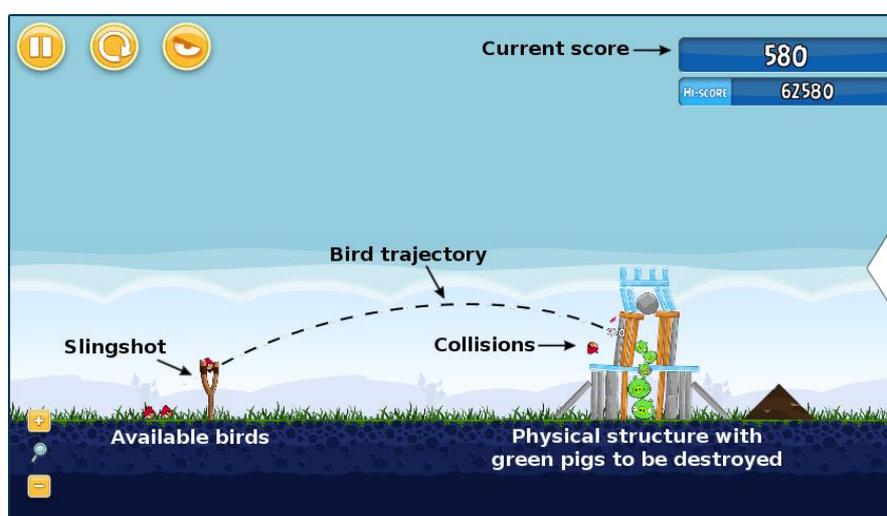
A Strategy for Transdisciplinary Thinking

What's the Goal?

This strategy encourages learners to put together relevant concepts and processes from multiple disciplines to generate solutions or new applications.

What's the Connection?

This activity may be applied to game development and animation. Computer animation physics or game physics involves the introduction of the laws of physics into a simulation or game engine, particularly in 3D computer graphics, for the purpose of making the effects appear more realistic to the observer.



Source: Angry Birds

How to Get Started?

Overall, physics is important for game development, since many formulas are needed depending on the nature of the game. But it seems that Mathematics is more important for game development. The branches of math used in games include trigonometry, matrices. There are also topics such as sine waves, vectors etc.

By far, the most important math skills needed for game design are related to 3-D graphics and animation, and these skills are based on matrix math and linear algebra, as well as logic and discrete math. These continuous math skills also apply to the physics needed to make animations look realistic. (www.onlinegamedesignschool.org)

How is it Graded?

The following set of criteria may be used to evaluate the **game/animation simulation**:

- **Accuracy** (*Are the laws of physics and math observed?*)
- **Realism** (*Do the animations appear life-like?*)
- **Creativity** (*Is there novelty in terms of presentation?*)

FOLLOW THE BRIEF

A Strategy for Service Orientation

What's the Goal?

This strategy encourages learners to support a culture of service excellence within the organization by producing products or providing services that exceed the expectation of customers.

What's the Connection?

This activity may be applied to game development, animation, or any design-related task. Game artists are graphic artists who imagine what items will look like, sketch out preliminary designs, develop sketches into forms that go with the game's desired feel, and turn the chosen sketches into 2 or 3D computer graphics.



Source: GameDesigning.org

How to Get Started?

Following the design brief promotes understanding between the customer and designer. It serves as a point of reference for both parties in terms of goal, target audience, connection, and designs. More importantly, the brief ensures that issues are considered before the designer begins the portfolio. (www.cleardesignuk.com)

How is it Graded?

The following set of criteria may be used to evaluate the **E-Portfolio**:

- **Appeal** (*Does it capture the attention of the audience?*)
- **Organization** (*Is it neat and properly sequenced?*)
- **Creativity** (*Is there novelty in terms of presentation?*)

TELL A STORY

A Strategy for Life wide Learning

What's the Goal?

This strategy encourages learners to find opportunities to enhance one's knowledge and skills for continual learning and to connect learning to a purpose and real-world context.

What's the Connection?

This activity may be applied to all career clusters. Storyboard refers to the planning process of a video. These are required to organize the video making process for professional purposes, demos, training and other aspects. It is a shot by shot, graphic representation of the video, showcasing how it is going to unfold. It has a number of illustrations in the form of squares in it. Each of these slots comes along with notes, referring to what is being said while the videos are played. It can be referred to a comic book-type representation of the script. **Creating storyboards for video** is an art and you need to master certain technologies as well when it comes to its digital realization.



Source: StoryboardThat.com

How to Get Started?

In the beginning, creating a storyboard can turn out to be a challenging task. However, it constitutes an integral part in making a video, conveying your ideas to your stakeholders. The first step involves creating blank slides which act as video frames. The scenes can be digitally sketched by hand, photographed or created by a computer. Then the script has to be incorporated just like a comic book followed by designs sketch for representing how it will look in the visual version. (mapsystems.com)

How is it Graded?

The following set of criteria may be used to evaluate the **digital storyboard**:

- **Consistency** (*Are the visual elements correlated and logical from start to finish?*)
- **Clarity** (*Does it ease up the process of conveying your idea?*)
- **Creativity** (*Is there novelty in terms of presentation?*)

BY THE NUMBER

A Strategy for Computational Thinking

What's the Goal?

This strategy encourages learners to develop or apply computational models, tools and techniques to interpret and understand data, solve problems, and guide decision-making.

What's the Connection?

This activity may be applied to career clusters that employ websites. The web designer's responsibility is to research, investigate, and determine the factors that would ensure widespread usability of the website.



Source: webfx.com

How to Get Started?

On-site data are the kind of information you obtain from website analytics software and monitoring user activity on your website. Most websites have some kind of visitor tracking mechanism installed, such as Google Analytics. Taking the time to understand how products like Google Analytics work and how to get a well-rounded overview and an intimate knowledge of your visitors gives you the best possible chance of hosting a great experience. (thinkbonfire.com)

How is it Graded?

The following set of criteria may be used to evaluate the **Google Analytics dashboard**:

- **Accuracy** (Are the relevant widgets selected to properly display your data?)
- **Organization** (Does the layout avoid dashboard clutter?)
- **Creativity** (Is there novelty in terms of presentation?)

BEST PRACTICES

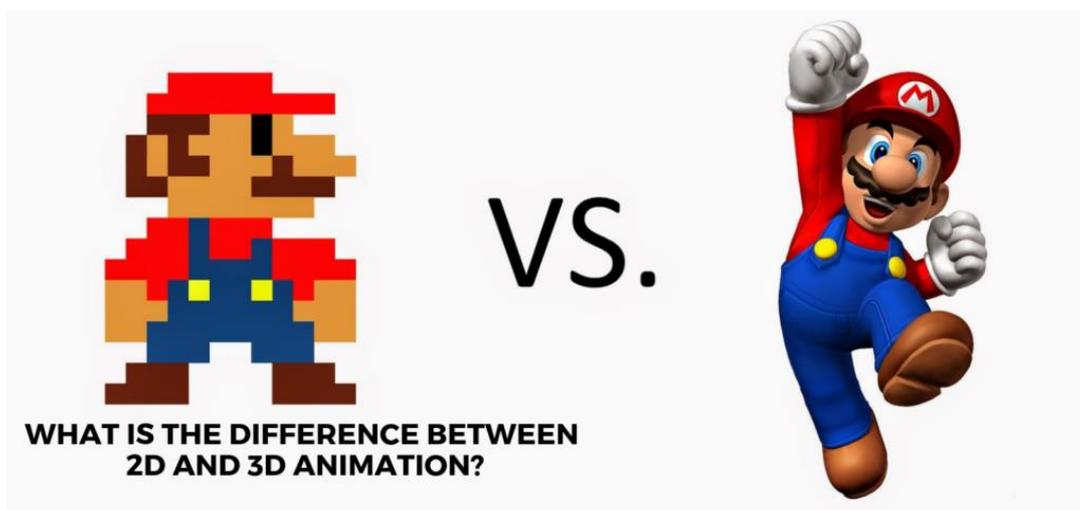
A Strategy for Glocal Mindset

What's the Goal?

This strategy encourages learners to be adaptive to global standards but remain responsive to local needs

What's the Connection?

This activity may be employed by animators. Animation is the capturing of sequential, static images—drawings or photos of inanimate objects—and playing them in rapid succession to mimic real world motion.



Source: Pixelloid Studios

How to Get Started?

Creating an **infographic** about the 12 Basic Principles of Animation by two top Disney animators, Frank Thomas and Ollie Johnson, will equip animators with a solid foundation for their craft, addressing areas like replicating real-world physics, emotional expression and character design. While this list of best practices was intended for traditional animation, most still hold up just as strong in the digital era. (99designs.com)

How is it Graded?

The following set of criteria may be used to evaluate the **infographics**:

- **Accuracy** (*Does it contain all principles?*)
- **Appeal** (*Does it capture the attention of the audience?*)
- **Creativity** (*Is there novelty in terms of presentation?*)

MOVE IT RIGHT!

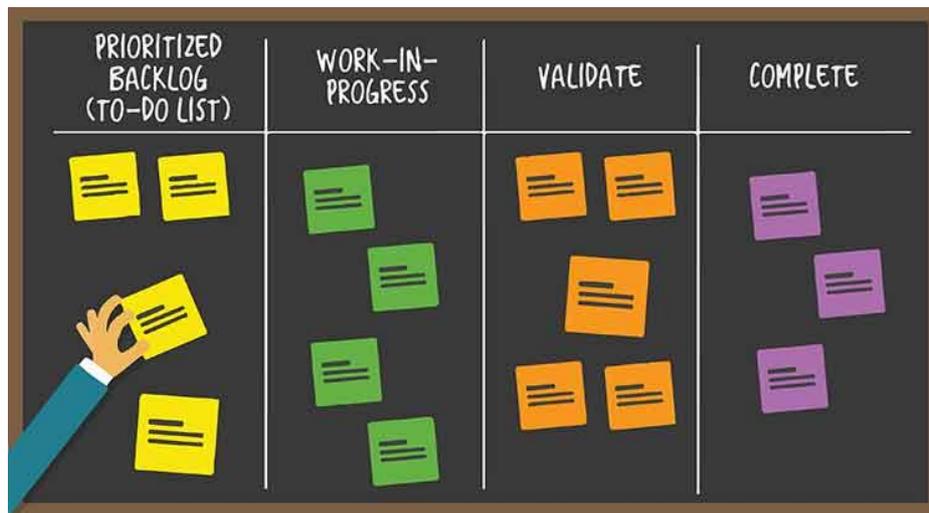
A Strategy for Organizational Literacy

What's the Goal?

This strategy encourages learners to work their way within an organization by understanding its structure, dynamics of its members, communication channels, and appropriate procedures.

What's the Connection?

This activity may be applied to manage work at a personal or organizational level. A **kanban board** is an agile project management tool designed to help visualize work, limit work-in-progress, and maximize efficiency.



Source: Systems Valley

How to Get Started?

Kanban boards use cards, columns, and continuous improvement to help technology and service teams commit to the right amount of work, and get it done! It visually depicts work at various stages of a process using cards to represent work items and columns to represent each stage of the process. Cards are moved from left to right to show progress and to help coordinate teams performing the work. (<https://www.atlassian.com/agile/kanban/boards>)

How is it Graded?

The following set of criteria may be used to evaluate the **kanban board**:

- **Progression** (Are the tasks stagnating or moving toward completion?)
- **Coordination** (Do teams communicate to clear backlogs?)
- **Timeliness** (Are the tasks ahead of or behind schedule?)

LET'S JAM!

A Strategy for Decision-making

What's the Goal?

This strategy encourages learners to make a logical choice of action by looking at evidence, exploring alternatives considering likely impact, evaluating options and providing justification.

What's the Connection?

This activity may be applied to any decision-making endeavor. **Google jamboard** offers a collaborative experience wherein contributors may list their ideas then brainstorm afterwards. A decision will not be made unless every member has listed two to three options.



Source: Google Jamboard

How to Get Started?

Remind the participants that there are no right or wrong ideas. In order to arrive at a good decision, every aspect has to be carefully considered. Words or images may be written or drawn on the board to be followed by a meaningful brainstorming session.

How is it Graded?

The following set of criteria may be used to evaluate the **Google jamboard**:

- **Diversity** (Do the options represent varied perspectives?)
- **Creativity** (Is there novelty in terms of presentation?)
- **Clarity** (Is there a decision made from the presented options?)

VIII. Assessing STEM-oriented Outputs

This section is divided into two parts. The first part presents dimensions and scales that can be used to assemble rubrics for assessing STEM-oriented outputs. The second part presents different scales or tools that can be used for self-assessment to facilitate better self-knowledge to the users, which is critical in developing socio-emotional intelligence.

Dimensions and Scales for Assembling Rubrics

The table below shows different dimensions and scales that can be used for assembling rubrics in assessing STEM-oriented outputs. Depending on the nature of the learning activity, a combination of dimensions can be put together. For example, an activity on ideation is dependent on the number of ideas being generated as well as the diversity, originality, and complexity of ideas being presented. Hence, for a rubric assessing and “Ideation” output, the dimensions that should be used are: quantity, variety, originality, and complexity. If the output is already a prototype or a model, the rubric that can be assembled to assess it may consist of the dimensions: attention to details, selection of materials, and quality of output.

Dimensions	4 Exceeds expectations	3 Meets expectations	2 Nearly meets expectations	1 Below expectations
Relevance <i>Has your proposed solution considered current conditions of the relevant environment (e.g. home/school/community/industry/university research)?</i>	Has thoroughly considered conditions of the relevant environment	Has considered conditions of the relevant environment	Has somehow considered conditions of the relevant environment	Has NOT considered conditions of the relevant environment
Quantity of Ideas <i>How many ideas/possible solutions have been generated?</i>	Many possible solutions have been generated.	Some possible solutions have been generated.	Few possible solutions have been generated.	Nearly no possible solutions have been generated.
Variety of Ideas <i>How diverse/varied are the ideas/identified possible solutions?</i>	A wide variety of solutions have been identified.	There is variety in the possible solutions that have been identified.	There is little variety in the possible solutions that have been identified.	There is no variety in the possible solutions that have been identified.
Originality of Ideas <i>How unique are the offered solutions?</i>	Solutions are very novel and unique.	Solutions are novel and unique.	Solutions are somehow novel and unique.	Solutions are not novel and unique.

Complexity of Ideas <i>How complex or detailed are the solutions proposed by the group?</i>	Details of proposed solutions are discussed thoroughly.	Details of proposed solutions are discussed.	Few details of proposed solutions are discussed.	Nearly no details of proposed solutions are discussed.
Attention to details <i>Is the list of materials/procedures provided in detail?</i>	All of the materials/procedures are provided in detail.	Most of the materials/procedures are provided in detail.	Only a few of the materials/procedures are provided in detail.	Almost all of the materials/procedures are NOT provided in detail.
Selection of Materials <i>Do materials or components fit the design requirements?</i>	Materials or components best fit the design requirements.	Materials or components fit the design requirements.	Materials or components somehow fit the design requirements.	Materials or components do NOT fit the design requirements.
Quality of Output <i>How well does the output meet expectations of quality?</i>	The output is constructed of exceptional quality.	The output is constructed of good quality.	The output is constructed of acceptable quality.	The output is constructed of poor quality.

Other dimensions that can be explored are the following:

- Accuracy of information
- Structure or Organization of ideas
- Appeal
- Clarity of purpose
- Appropriateness (material/approach/delivery)
- Depth
- Connections.

Assessment Tools for Strengthening Self-Knowledge

All the surveys came from the SPARQTools.org Measuring Mobility Toolkit. It is an initiative of the Stanford University that is available in the web. It offers practitioners a collection of instruments that the researchers link to the assessment of mobility from poverty. To know more about the complete toolkit, it can be accessed through <http://sparqtools.org/measuringmobility/>.

A. “Kind of Person” Implicit Theory Scale

Source: Stanford SPARQ Tools

<http://sparqtools.org/mobility-measure/kind-of-person-implicit-theory-scale/>

Age: Teen, Adult

Duration: < 3 minutes

Reading Level: 9th-12th grade

Number of Items: 8

Answer Format: 1 = strongly agree; 2 = agree; 3 = mostly agree; 4 = mostly disagree; 5 = disagree; 6 = strongly disagree.

Scoring

The fixed mindset subscale items are Q1, Q2, Q4, and Q6. The growth mindset subscale items Q3, Q5, Q7, and Q8, and should be reverse-scored. Reverse-scored items are worded in the opposite direction of what the scale is measuring. The formula for reverse-scoring an item is:

$$((\text{Number of scale points}) + 1) - (\text{Respondent's answer})$$

For example, Q3 is a 6-point scale. If a respondent answered 5 on Q3, you would re-code their answer as: $(6 + 1) - 5 = 2$.

In other words, you would enter a 2 for this respondents' answer to Q3.

To calculate subscale scores for each participant, take the average by adding respondents' answers to each subscale's items and dividing this sum by the number of items in the subscale (4).

You can either consider fixed and growth mindset subscale scores separately or generate a total growth mindset score by summing the two subscale averages and dividing by 2.

Sources

Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality, and development*. Philadelphia: Psychology Press.

Dweck, C. S., Chiu, C. Y., & Hong, Y. Y. (1995). Implicit theories and their role in judgments and reactions: A world from two perspectives. *Psychological Inquiry*, 6(4), 267-285.

“KIND OF PERSON” IMPLICIT THEORY SCALE

Instructions: Please circle how much you agree or disagree with each of the following statements.

1. The kind of person someone is, is something very basic about them and it can't be changed very much.

Strongly agree Agree Mostly agree Mostly disagree Disagree Strongly disagree

2. People can do things differently, but the important parts of who they are can't really be changed.

Strongly agree Agree Mostly agree Mostly disagree Disagree Strongly disagree

3. Everyone, no matter who they are, can significantly change their basic characteristics.

Strongly agree Agree Mostly agree Mostly disagree Disagree Strongly disagree

4. As much as I hate to admit it, you can't teach an old dog new tricks. People can't really change their deepest attributes.

Strongly agree Agree Mostly agree Mostly disagree Disagree Strongly disagree

5. People can always substantially change the kind of person they are.

Strongly agree Agree Mostly agree Mostly disagree Disagree Strongly disagree

6. Everyone is a certain kind of person, and there is not much that can be done to really change that.

Strongly agree Agree Mostly agree Mostly disagree Disagree Strongly disagree

7. No matter what kind of person someone is, they can always change very much.

Strongly agree Agree Mostly agree Mostly disagree Disagree Strongly disagree

8. All people can change even their most basic qualities.

Strongly agree Agree Mostly agree Mostly disagree Disagree Strongly disagree

Source: <http://sparqtools.org/mobility-measure/kind-of-person-implicit-theory-scale/>

B. Shift and Persist

Source: Stanford SPARQ Tools

<http://sparqtools.org/mobility-measure/shift-and-persist-teen-adult/>

Age: Teen, Adult

Duration: < 3 minutes

Reading Level: < 6th grade

Number of items: 14

Answer Format: 1 = not at all; 2 = a little; 3 = some; 4 = a lot.

Scoring:

Q6, Q7, Q9, Q10, Q12, and Q13 are filler questions and should not be used to calculate a final score.

Q4 should be reverse-scored. Reverse-scored items are worded in the opposite direction of what the scale is measuring. The formula for reverse-scoring an item is:

$((\text{Number of scale points}) + 1) - (\text{Respondent's answer})$

For example, Q4 is a 4-point scale. If a respondent answered 1 on Q4, you would re-code their answer as: $(4 + 1) - 1 = 4$.

In other words, you would enter a 4 for this respondent's answer to Q4.

To calculate the shift score, sum Q5, Q8, Q11, and Q14. To calculate the persist score, sum Q1-Q4 with Q4 reverse scored.

Sources: Chen, E., McLean, K. C., & Miller, G. E. (2015). Shift-and-Persist strategies: Associations With socioeconomic status and the regulation of inflammation among adolescents and their parents. *Psychosomatic Medicine*, 77(4), 371–382.



SHIFT AND PERSIST

Instructions: Please rate how well the following statements describe you:

1. I feel my life has a sense of purpose.

Not at all A little Some A lot

2. My life feels worthwhile.

Not at all A little Some A lot

3. I believe that there is a larger reason or purpose for my life.

Not at all A little Some A lot

4. I feel my life is going nowhere.

Not at all A little Some A lot

Instructions: Next you will see a list of things that people sometimes do, think, or feel when something stressful happens. Everybody deals with problems in their own way. Please rate how much you do each of the following things when something stressful happens in your life. When something stressful happens in my life...

5. I think about what I can learn from the situation.

Not at all A little Some A lot

6. I work to change or fix the problem.

Not at all A little Some A lot

7. I try not to think about it, to forget about it.

Not at all A little Some A lot



8. I think about the positive aspects, or the good that can come from the situation.

Not at all A little Some A lot

9. I start to act without thinking.

Not at all A little Some A lot

Instructions: In life, things don't always go the way that we want. Everyone has different preferences for how they deal with situations in which something doesn't turn out the way that they want, and they are not able to change it. Please rate how much you do each of the following.

When something doesn't turn out the way that I want...

10. Little things upset me easily.

Not at all A little Some A lot

11. I think about what good things could come from the situation.

Not at all A little Some A lot

12. I find it hard to stop thinking about what happened.

Not at all A little Some A lot



13. I start working on other new goals.

Not at all

A little

Some

A lot

14. I think about what I can learn from the situation.

Not at all

A little

Some

A lot

Source: <http://sparqtools.org/mobility-measure/shift-and-persist-teen-adult/>

C. Revised Life Orientation Test (LOT-R)

Source: Stanford SPARQ Tools

<http://sparqtools.org/mobility-measure/revised-life-orientation-test-lotr/>

Age: Adult

Duration: < 3 minutes

Reading Level: < 6th grade

Number of items: 10

Answer Format: 0 = strongly disagree; 1 = disagree; 2 = neutral; 3 = agree; 4 = strongly agree.

Scoring:

Q2, Q5, Q6, Q8 are filler questions and should not be used to calculate a final score.

Q3, Q7, and Q9 should be reverse-scored. Reverse-scored items are worded in the opposite direction of what the scale is measuring. The formula for reverse-scoring an item is:

$$((\text{Number of scale points}) + 1) - (\text{Respondent's answer})$$

For example, Q7 is a 5-point scale. If a respondent answered 3 on Q7, you would re-code their answer as: $(5 + 1) - 3 = 2$.

In other words, you would enter a 2 for this respondents' answer to Q7.

To calculate the total score for each participant, sum all responses, except the filler questions, for a score ranging from 0 to 24.

Sources:

Scheier, M. F., Carver, C. S., & Bridges, M. W. (1994). Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. *Journal of Personality and Social Psychology*, 67(6), 1063-1078.



REVISED LIFE ORIENTATION TEST (LOT-R)

Instructions: Please respond as accurately and honestly as you can. There are no right or wrong answers. Please circle your answer below.

1. In uncertain times, I usually expect the best.

Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

2. It's easy for me to relax.

Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

3. If something can go wrong for me, it will.

Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

4. I'm always optimistic about my future.

Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

5. I enjoy my friends a lot.

Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

6. It's important for me to keep busy.

Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

7. I hardly ever expect things to go my way.



Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

8. I don't get upset too easily.

Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

9. I rarely count on good things happening to me.

Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

10. Overall, I expect more good things to happen to me than bad.

Strongly
disagree

Disagree

Neutral

Agree

Strongly agree

Source: <http://sparqtools.org/mobility-measure/revised-life-orientation-test-lotr/>

D. Sense of Control

Source: Stanford SPARQ Tools

<http://sparqtools.org/mobility-measure/sense-of-control/>

Age: Adult

Duration: < 3 minutes

Reading Level: < 6th grade

Number of items: 12

Answer Format: 1 = strongly agree; 2 = somewhat agree; 3 = a little agree; 4 = neither agree or disagree; 5 = a little disagree; 6 = somewhat disagree; 7 = strongly disagree.

Scoring:

The Personal Mastery subscale items are Q1, Q2, Q3, and Q4. The Perceived Constraints subscale items are Q5, Q6, Q7, Q8, Q9, Q10, Q11, and Q12.

All items should be reverse-scored. Reverse-scored items are worded in the opposite direction of what the scale is measuring. The formula for reverse-scoring an item is:

$$((\text{Number of scale points}) + 1) - (\text{Respondent's answer})$$

For example, Q1 is a 7-point scale. If a respondent answered 2 on Q1, you would re-code their answer as: $(7 + 1) - 2 = 6$.

In other words, you would enter a 6 for this respondents' answer to Q1.

To calculate subscale scores for each participant, take the average by adding respondents' answers to each subscale's items and dividing this sum by the number of items in the subscale: 4 for the Personal Mastery subscale or 8 for the Perceived Constraints subscale.

Sources:

Lachman, M. E., & Weaver, S. L. (1998). The sense of control as a moderator of social class differences in health and well-being. *Journal of Personality and Social Psychology*, 74(3), 763-773.

SENSE OF CONTROL

Instructions: Please circle your answer below.

1. I can do just about anything I really set my mind to.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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2. When I really want to do something, I usually find a way to succeed at it.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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3. Whether or not I am able to get what I want is in my own hands.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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4. What happens to me in the future mostly depends on me.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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5. There is little I can do to change many of the important things in my life.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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6. I often feel helpless in dealing with the problems of life.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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7. Other people determine most of what I can and cannot do.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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8. What happens in my life is often beyond my control.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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9. There are many things that interfere with what I want to do.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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10. I have little control over the things that happen to me.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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11. There is really no way I can solve the problems I have.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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12. I sometimes feel I am being pushed around in my life.

Strongly agree	Somewhat agree	A little agree	Neither agree or disagree	A little disagree	Somewhat disagree	Strongly disagree
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Source: <http://sparqtools.org/mobility-measure/sense-of-control/>



IX. Template of STEM in TVET Curriculum Design

The template below is an expansion of the existing curriculum design template of TESDA. The main change is the addition of a column to reflect the STEM competencies. Moreover, the learning activities column are expected to integrate new STEM-oriented activities from the reference documents in the preceding sections.

Unit of Competency	Learning Outcomes	STEM Competencies	Learning Activities	Methodology	Assessment Approach	Nominal Duration



X. Conclusion

This curriculum guide is an elaboration of the STEM in TVET Learning Design Framework. It has mapped out STEM competencies to the existing basic, common, and core competencies of the Technical Education and Skills Development Authority (TESDA). Qualifications from priority sectors such as ICT, Agriculture, Construction, Automotive, Metals and Engineering, Health and Wellness, and Tourism have been revisited for better alignment of the proposed STEM-oriented learning activities. The reference documents of the STEM Competencies presented in this curriculum guide can be a good resource for curriculum planners, writers, and assessors. For each competency, relevant knowledge, specific indicators, and learning activities have been curated. Moreover, templates and detailed plans are provided to showcase how STEM competencies can be further developed with the right questions and activities. However, the sample activities are not in any way prescriptive. Technical writers and trainers are encouraged to contextualize the learning activities in their qualifications to ensure the relevance to their program.

