



# Professional Skill Standards for Interactive Application & Video Game Creation



## OVERVIEW

The Professional Skill Standards for Interactive Application and Video Game Creation were developed to identify and document the fundamental skills and abilities required for entry level employment in the industry, or for individuals preparing to launch an independent career. In the academic space, developing curriculum and assessments based on validated, professional skill standards can improve relevance and outcomes, while still accommodating a wide variety of course objectives and instructional delivery models. Unity has also provided a clear link to academic standards for science, technology, engineering, art and math (STEAM) by providing a crosswalk between these professional skills and academic standards like the Common Core. As a result, Unity seeks to maximize the value of this resource for independent learners and academic students, faculty and staff.

Professional skill standards focus on the foundational competencies and skills required for a particular discipline, and specifically in this case, for cross-functional teams creating interactive applications and video games. The ability to understand programming concepts, write scripts, and apply fundamental math and science knowledge are essential skills for all project team members to be successful. However, project engineers will need significantly deeper computer programming skill than say, project artists or interface designers. Thus, these standards encompass skills across a variety of jobs and individuals in what is a broad, team based, cross-functional, creative discipline.

Unity identifies three primary purposes for the *Professional Standards for Interactive Application & Video Game Creation* document:

- To provide a common set of expectations for what learners should achieve on their own, or in any instructional program for interactive application and video game creation.
- To provide a foundation for developing relevant, engaging and articulated curriculum at secondary and post-secondary levels at state, local and provincial levels.
- To provide a clear linkage to other essential skill standards including STEAM (Science, Technology, Engineering, Art and Math) standards and academic core standards.

Furthermore, because these professional skill standards aim only to describe, define and organize what the instructional content should be, they are not to be confused with curriculum. Standards provide a framework for developing curriculum and instructional content. Curriculum provides the specific details on how instruction is to be organized, balanced, integrated, and the various methods of instruction that can be employed to address the material and engage the learners. Curriculum developers and instructors can use professional skills standards as guides for developing, applying or supplementing curricula, but such standards do not specify what should occur in the classroom.

Overall, the Professional Skill Standards for Interactive Application and Video Game Creation describe what learners should know and be able to do to become proficient team members on related projects. They describe only outcomes for studies in this discipline.



## INTERACTIVE APPLICATIONS AND VIDEO GAMES

The first step for understanding these Professional Skill Standards is to define what interactive applications and video games are and to define their core components.

- Interactive Applications: Applications, or computer applications, are software programs that cause the host computer to perform useful tasks. The host computer with its hardware and operating system is sometimes called the platform. Applications can be deployed on various platforms including super computers, personal computers, kiosks, mobile devices, and dedicated game consoles. The word “Interactive” specifies that the application takes input from the user and responds. Interactive responses can include visual, audial, and tactile feedback, depending on the application design and the capabilities of the host platform. Interactive applications can serve a wide variety of purposes including education, training and familiarization; technical and scientific communications; even sales and marketing.
- Video Games are a specific type of interactive computer application intended for entertainment purposes. Games are typically played for fun with diversion or amusement as their primary task. Games have goals and/or objectives to achieve; as well as obstacles and/or challenges to overcome. Games also have implicit or explicit rules that dictate game play including the human-computer interactions (also called the user interface or simply UI) and the progression of the game. Some people play for the thrill of it, some play for the social aspects, some play to explore virtual worlds, while others play for the competition within themselves or other players by maximizing achievement in the game.

Within the category of interactive applications and video games, there are many different genre. These standards broadly address such interactive computer applications across a variety of platforms and purposes. They can consist of simple scenes to complex simulations, but all involve media, logic, data manipulation and rapid, real-time feedback systems.

## REQUIRED SKILLSETS AND ABILITIES

The Professional Skill Standards focus on the specific knowledge, skills and abilities required to successfully create interactive applications and video games. Team members must also possess other skills and abilities that are fundamental and requisite as exemplified below:

- Written & Verbal Communications
- Information Processing
- Operational Analysis
- Deductive Reasoning
- Inductive Reasoning
- Critical Thinking
- Creative Problem Solving

# ORGANIZATIONAL STRUCTURE

## Concept Domains for game creation

The Profession Skill Standards are organized around three Domains and twenty-one Competencies which include specific standard statements. These competencies establish and clarify the clear context, specific knowledge, skills and abilities required to be a proficient game developer. The standards are first broken down by the following domains:

### **Domain I: Design**

Design: This Domain places focus upon preplanning, design, and development of prerequisite knowledge required to be a proficient interactive application and video game creator. This cluster of standards contextualizes the development process and assures that the learner fully understands all aspects of the design process.

### **Domain II: Development**

Development: This Domain provides a framework for the development of solid game building, versioning, debugging and optimization. These standards define the core knowledge base and core competencies that a game developer must possess to be a proficient gamer.

### **Domain III: Deployment**

Deployment: This Domain provides a focus on releasing completed games to include multi-platform game design requirements and best practice for game deployment platforms.

These broad Domains define the process of creating a new interactive digital game from beginning or planning stage though building the game to deploying and sharing the game with end users or players. The Domains provide a context for each of the Core Competencies and the skill standard areas specific to proficient game development.

## Competencies

The next level under each domain are the specific foundational competencies that delineate the categories of content that a proficient creators must know in order to design, develop and deploy interactive applications and video games.

**Note:** These Professional Skill Standards assume general employability skills. Since these topics have been covered in depth elsewhere, we shall not cover them explicitly here, but they should be incorporated by reference as pre-requisites.





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# Professional Standards for Interactive Application & Video Game Creation

<b>1. INTERACTIVE APPLICATION AND VIDEO GAME DESIGN</b>		
<b>1.1. OVERVIEW OF KEY ASPECTS IN THE DESIGN PROCESS</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
1.1.1.	Identify the primary steps in the design process (i.e. conceptualize, prototype, test, analyze)	T21C2, T21C3, CWS2, T8,T11, SCC01, SCC10
1.1.3.	Explain the role of iteration in the design process	CWS2, T8, T11
1.1.4.	Explain the difference between game mechanics and gameplay	T21C8, T21C10, CRS2, CWS2, NGSS3, NGSS8, SCC01
1.1.6.	Assess and describe the basic gameplay from an existing game	T21C12, NGSS3, NGSS8
1.1.7.	Analyze and evaluate the user experience of several game mechanics used in an existing game	T21C12, CWS1, SCC02.01
1.1.8.	Investigate the concept of "Interactive Narrative" and explain how/when it could pertain to game design	T21C12, CRS2, CWS2, CRI10
1.1.9.	Explain the relevance of ambiance and environment in game design	T21C10, CRS2, CWS2, SCC02.01
1.1.10.	Determine the relevance of character development, backstory and attributes (power, speed, intelligence, empathy, etc.) in game design	CRS2, NGSS8, T21C2, T21C8
1.1.11.	Differentiate basic game player types and objectives with examples (Thrill seekers, Socializers, Explorers, Achievers)	T21C12, SCC02.01
1.1.12.	Evaluate and describe various 2D & 3D, single & multi-user genre	CRS2, NGSS3
1.1.13.	Explain the role of psychology and sociology on interactive design	T21C10, CRS2, CWS2, SCC02.01
1.1.13.2.	Explain the use of beta testing and pre-release feedback	T21C10, CWS2, SCC02.01
1.1.13.3.	Explain the use of testing methods for sensory and emotional responses	T21C10, CWS2, SCC02.01
1.1.13.4.	Explain various uses of in-app user analytics	T21C10, CWS2, SCC02.01
1.1.14.	Explain the relevance of platform capabilities and constraints (CPU, GPU, Memory, Storage, etc.) to design	T21C10, T21C13, CWS2, SCC01, SCC10
1.1.15.	Describe common hardware interface devices and their usage (keyboards, controllers, etc.)	T21C10, T21C13, SCC10
1.1.16.	Describe available target platforms, their capabilities and constraints	T21C13, SCC01, SCC10
1.1.17.	Describe profiling techniques for performance & resource monitoring	CRS2
1.1.17.1.	Describe measurements for frame rates and draw calls and explain their usage	CWS2

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<b>1.1. OVERVIEW OF KEY ASPECTS IN THE DESIGN PROCESS</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
1.1.18.	Explain how profiling can indicate different areas for optimization	T21C10, CWS2, SCC02.01
1.1.19.	Explain why performance optimization on target platforms should begin at the design stage, continuing through development & deployment	T21C10, CRS2, CWS1, T8, SCC02.01
1.1.19.1.	Detail practical methods for optimizing artwork and	T21C10
1.1.19.2.	Detail practical methods for optimizing gameplay	
1.1.20.	Examine an existing game and critique its design with respect to functionality and usability	T21C12, CWS1, NGSS8
1.1.21.	Examine an existing game and critique its design with respect to artistic impression and emotional response	T21C12, CWS1, NGSS8
1.1.22.	Examine an existing game and attempt to determine the developer's target demographics and its appeal for basic player types & objectives	T21C12, NGSS8

<b>1.2. PROBLEM-SOLVING AND CRITICAL THINKING SKILLS</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
1.2.1.	In the discovery phase, research and document project requirements and deliverables	T21C12, CWS2, T11, SCC01, SCC10
1.2.2.	Develop problem statements and design briefs	T21C4, CWS2, T10, NGSS1, SCC01, SCC10
1.2.3.	Describe problem-solving processes and their application	T21C4, T21C3, T10, NGSS1, SCC03
1.2.4.	Develop specifications (criteria and constraints) to optimize solutions	T21C11, CWS2, NGSS1, SCC03 SCC10
1.2.5.	Describe methods for establishing priorities	T21C11, NGSS1, NGSS3, SCC03
1.2.6.	Explain the concept of "tradeoffs" in the design process	T21C11, CWS2, T8, SCC02.01
1.2.7.	Explain how the "optimum solution" is not always the "best"	T21C3, T21C8, CWS2, T10, SCC02.01, SCC03
1.2.8.	Describe the difference between goals and objectives	CWS2
1.2.9.	Analyze a complex set of objectives and prioritize them	T21C11, CSL1b, T10, SCC03
1.2.10.	Analyze potential solutions to discern which is optimum	T21C10, T10, SCC03
1.2.11.	Translate solutions into discreet objectives and tasks	T21C11, CSL1b
1.2.12.	Sequence objectives and tasks logically	T21C2, CSL1b
1.2.13.	Explain and demonstrate project management techniques	T21C3, CWS2, SCC03

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1.3. ARTISTIC AND TECHNICAL COMMUNICATIONS		
Topic	Description	Competencies
1.3.1.	Use effective, accurate terminology when communicating about artistic concepts and technology	T21C8, CRS4, CWS2, CWS4 T17, NGSS8, SCC01, SCC02.01
1.3.2.	Write effectively in styles that produces clear, correct, & coherent prose adapted to purpose and audience	T21C8, CWS2, CRS4, NGSS8, SCC01, SCC02.01
1.3.3.	Identify and use different types of sketching and technical drawings techniques	T21C4, T21C3 T10 NGSS1 SCC03
1.3.4.	Explain and demonstrate graphic design rules (composition, white space, typographic, legibility, readability)	T21C10, CSL5, CWS2, T8
1.3.5.	Develop, analyze and communicate design ideas using annotated sketches, technical drawings, graphical, mathematical and/or physical models	T21C8, T21C10 T11 NGSS8 SCC01 SCC02.01, SCC10
1.3.6.	Use design layout/presentation software effectively	T21C4, CSL5, T8, T11, SCC10
1.3.7.	Communicate and exchange artistic and technical ideas	T21C8, CSL5, CWS2, CWS4, NGSS8, SCC02.01, SCC10
1.3.8.	Use brainstorming techniques to creatively generate a multitude of possible solutions to a stated problem	T21C4, T21C5, T10, NGSS1, SCC03
1.3.9.	Actively participate in critical analysis of self and others' ideas in a design team review session	T21C6, CSL1, SCC03
1.3.10.	Record your observations and critique the effectiveness of a brainstorming and design review session	CSL1, CWS1, T8
1.3.11	Research, describe and implement revision control procedures for design ideas	T21C11, CRS2, T8
1.3.12.	Collate feedback into an iterative design process	CRS2, T11
1.3.13.	Assemble sketches & annotations into storyboards and presentations for both print and web	T21C11, SCC10
1.3.14.	Create a narrative & storyboard for a new interactive app / video game	CWS4, CWS7, SCC10

  

1.4. APPLICATION OF MATHEMATICS FOR DESIGN		
Topic	Description	Competencies
1.4.1.	Explain the use of mathematics as it pertains to interactive apps and video games	T21C10, NGSS5, SCC02.01
1.4.2.	Use algebraic, geometric, and trigonometric relationships to define game object characteristics and properties	NGSS5
1.4.3.	Demonstrate functions of linear algebra and vector mathematics (dot product, cross product, etc.)	NGSS5
1.4.4.	Explain how quaternion calculations could be used in video game development.	CWS2, NGSS5, SCC02.01
1.4.5.	Apply mathematical concepts to interactive application and video game design	NGSS5

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1.5. APPLICATION OF PHYSICS FOR DESIGN		
Topic	Description	Competencies
1.5.1.	Understand and apply Newtonian physics to static & dynamic systems	T21C10, NGSS5, SCC02.01
1.5.1.1.	Define Mass	CRS4
1.5.1.2.	Define and calculate Velocity	CRS4, NGSS5
1.5.1.3.	Define and calculate Force	CRS4, NGSS5
1.5.1.4.	Define and calculate Torque	CRS4, NGSS5
1.5.1.5	Define and calculate Acceleration	CRS4, NGSS5
1.5.2.	Use physics to create realistic motions with objects and characters	NGSS5, SCC10
1.5.3.	Explain the use of collision geometry for physics-based interactions and as programming triggers.	T21C10, CWS2, NGSS5, SCC02.01
1.5.4	Apply and manage the use of Colliders	SCC10
1.5.5.	Apply and manage the use of Rigidbodies	SCC10
1.5.6.	Explain four types of forces that can act on Rigidbodies	T21C10, CWS2, SCC02.01
1.5.7.	Explain the concept of Rigidbody 'sleeping'.	T21C10 ,CWS2, SCC02.01
1.5.8.	Apply, and manage the use of Physic Materials, Joints and Raycasting	SCC10
1.5.9.	Demonstrate the ability to handle object collisions and physics simulations in a realistic manner	
1.6. LEVEL DESIGN AND SCENES		
Topic	Description	Competencies
1.6.1.	Explain principles of user navigation and level progression	T21C10, CRS2 CWS2 NGSS8 SCC02.01
1.6.2.	Demonstrate understanding and ability to use game mechanics to improve gameplay	T21C10
1.6.3.	Demonstrate knowledge and understanding of balancing layouts	T21C2
1.6.4.	Demonstrate an understanding of pathways, choke points, control points, spawn points and methods for creating balance, timing, pacing and flow	T21C11, SCC10
1.6.5.	Develop level designs with planning maps and use research and references to sketch characters and environments	T21C10, SCC10

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<b>1.6. LEVEL DESIGN AND SCENES</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
1.6.6.	Analyze and describe level features & progression from a level in an existing title	T21C10
1.6.7.	Explain how game levels relate to or support an interactive narrative	T21C10, CWS2, SCC02.01
1.6.8.	Design and develop intuitive levels in 2D & 3D	T21C10, SCC10
1.6.9.	Define “cut scenes” and explain how they can be used as a game mechanic to improve gameplay	T21C10, SCC02.01
1.6.10.	Develop examples of how cut scenes can be used to improve gameplay, further the storyline or enhance the interactive narrative	T21C10, T21C13, CWS4, SCC10

  

<b>1.7. TOOLS AND TECHNOLOGY</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
1.7.1.	Understand technology tools and processes for producing deliverables that meet requirements and quality standards	T21C14, T1, SCC01, SCC10
1.7.2.	Demonstrate a working knowledge 2D digital bitmap art tools	T21C14, SCC01
1.7.3.	Demonstrate a working knowledge of 2D digital vector art tools	T21C14, SCC01
1.7.4.	Demonstrate a working knowledge 3D modeling & animation tools	T21C14, SCC01
1.7.5.	Demonstrate a working knowledge technical design & modeling tools	T21C14, SCC01
1.7.6.	Demonstrate a working knowledge of audio capture & editing tools	T21C14, SCC01
1.7.7.	Demonstrate a working knowledge of video capture, editing & post-processing tools	T21C14, SCC01
1.7.8.	Demonstrate a working knowledge of digital 2D animation tools	SCC01
1.7.9.	Demonstrate a working knowledge of game development tools	SCC01
1.7.10.	Explain “lossy vs. lossless” file compression for images, video and audio files	CRS4, CWS2, SCC02.01
1.7.10.1.	Define “Codec” and describe their use	CRS4
1.7.11.	Describe graphic file color spaces and attributes (gamma, bit depth, color gamut, output medium)	T21C10
1.7.12.	Explain the usage of graphic files formats and file interoperability	T21C10, CWS2, SCC02.01
1.7.13.	Explain the usage of video files formats and file interoperability	T21C10, CWS2, SCC02.01
1.7.14.	Explain the usage of audio file formats and file interoperability	T21C10, CWS2, SCC02.01
1.7.15.	Describe the basic logic, concepts and key structures behind computer programming languages	T21C10, T21C2, T2

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<b>1.7. TOOLS AND TECHNOLOGY</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
1.7.16.	Explain pros & cons of various programming & scripting languages	T21C10, CWS1, T2
1.7.17.	Determine appropriate programming and scripting languages to create desired game mechanics, control the environment, UI and gameplay	T21C10, T2, SCC10
1.7.18.	Create a hypothetical technology pipeline for an interactive application or video game project.	T21C10
1.7.18.1	Determine necessary technical capabilities	SCC10
1.7.18.2.	Select software tools with those capabilities	T21C14, SCC10
1.7.18.3.	Specify computers and hardware to effectively run the necessary tools	T21C14, SCC10
<b>1.8. DESIGN PROJECT DOCUMENTATION</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
1.8.1.	Explain the purpose, content and format of various design documents	T21C12, CWS2, T11, SCC01, SCC02.01, SCC03.01
1.8.2.	Create a formal pitch based on a narrative, storyboards and initial design documentation for a new title	T21C25, CWS4, CWS, SCC01
1.8.3.	Define game design documentation (GDD), its purpose & components	T21C23, T9, T10, CWS4
1.8.3.1.	Character listing and descriptions if applicable	T21C3
1.8.4.	Create, iterate and maintain a full set of game design documentation	CWS2, CWS10, SCC01, SCC10
1.8.5.	Prepare a plan of work based on an approved GDD including deliverables, tasks, resources, and schedule	T21C3, CRS3, SCC01, SCC03.01, SCC10
1.8.6.	Label and package documents with all supporting materials	SCC10

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<b>2. INTERACTIVE APPLICATION AND VIDEO GAME DEVELOPMENT</b>		
<b>2.1. INTERACTIVE / REAL-TIME EDITING</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.1.1.	Explain and demonstrate the use of Cartesian coordinate systems	T21C2, NGSS5, SCC02.01
2.1.2.	Convert between local and world coordinate systems	T21C2, NGSS5, SCC10
2.1.3.	Demonstrate successful navigation of 2D and 3D scenes using pan, zoom, orbit, walk-thru modes, etc.	SCC10
2.1.4.	Define objects, assets, components and properties and describe their relationships	
2.1.5.	Explain and demonstrate asset importing procedures for images, models, audio and video	SCC02.01
2.1.6.	Explain the importance of “scale” as it relates to importing models for objects and environments	CWS2, NGSS5
2.1.7.	Demonstrate the use of object preferences and inspector tools	T21C10
2.1.8.	Accurately transform objects with respect to coordinate systems (translate, rotate and scale)	NGSS5
2.1.9.	Describe and change the active status of objects	T21C2
2.1.10.	Describe and change the status of components	
2.1.11.	Create or import extensions to enhance component functionality	
<b>2.2. ASSET MANAGEMENT AND RESOURCES</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.2.1.	Organize assets and components	T21C2, T12, SCC01
2.2.2.	Understand and use hierarchical organization structures	T21C2
2.2.3.	Create an effective naming convention for objects and assets	
2.2.4.	Apply descriptive tags, labels, and use layers for asset management	
2.2.5.	Use object instantiation, nesting and linking to facilitate development and optimize performance	
2.2.6.	Create and use prefabs to save and reuse setups	SCC10

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2.3. OBJECTS & CHARACTERS		
Topic	Description	Competencies
2.3.1.	Import assets from appropriate file formats	
2.3.2.	Describe basic aspects of digital 3D geometry (points, vertices, edges, tri-, quad- and polygon meshes, scale, units)	
2.3.3.	Define and evaluate the pro's and con's of various 3D geometry creation techniques	CWS1
2.3.3.1.	Describe and evaluate mesh subdivision modeling	T21C10, CRS4
2.3.3.2.	Describe and evaluate Polygon modelling	T21C10, CRS4
2.3.3.3.	Describe and evaluate Mesh Object Hierarchies	T21C10, CRS4
2.3.3.4.	Describe and evaluate Digital Sculpting	T21C10, CRS4
2.3.3.5.	Describe and evaluate Procedural modelling	T21C10, CRS4
2.3.3.6.	Describe and evaluate Image based modeling & 3D scanning	T21C10, CRS4
2.3.4.	Explain the performance impact of polygon counts and describe polygon optimization techniques	T21C10, CWS2, SCC02.01
2.3.4.1.	Define and describe High to Low Polygon Baking	T21C10, CRS4
2.3.4.2.	Define and describe threshold approximating optimizers with examples	T21C10, CRS4
2.3.5	Create and manipulate 2D bitmapped images for textures and sprites	
2.3.6.	Explain the performance impact of using sprite sheets, texture atlases and individual bitmaps	T21C10, CWS2, SCC02.01
2.3.7.	Pack bitmaps into sheets and use elements as textures and sprites	
2.3.8.	Create / modify materials and manage material libraries	
2.3.9.	Transform, manipulate and apply materials to 3D geometry (UV texture, normal and bump maps)	
2.3.10.	Explain the difference between characters and other game objects	CWS2, SCC02.01
2.3.11.	Demonstrate the use of humanoid character bone structures, rigging techniques and kinematics	
2.3.11.1.	Define and demonstrate rig constraint editing	T21C10, CRS4
2.3.11.2.	Define and demonstrate Forward Kinematics (FK)	T21C10, CRS4
2.3.11.3.	Define and demonstrate Inverse Kinematics (IK)	T21C10, CRS4

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# Professional Standards for Interactive Application & Video Game Creation

<b>2.4. ENVIRONMENT CREATION AND REAL WORLD CONSTRAINTS</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.4.1.	Implement environmental designs into 2D & 3D levels	T21C3
2.4.2.	Select appropriate models and materials for creating environments	
2.4.3.	Understand and use terrain generation and manipulation tools	
2.4.4.	Create, edit and enhance environments to optimize quality	
2.4.5.	Create and modify procedural effects like skyboxes, fog and lens flare	T21C1

  

<b>2.5. LIGHTS, CAMERAS AND RENDERING</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.5.1.	Explain the role of cameras and lighting with respect to ambiance	T21C10, CWS2, SCC02.01
2.5.2.	Demonstrate and describe various lighting types and techniques to properly light indoor and outdoor scenes with the desired ambiance	SCC10
2.5.2.1.	Create, transform and modify area lights	SCC10
2.5.2.2.	Create, transform and modify Pixel lights vs Vertex lights	SCC10
2.5.2.3.	Create, transform and modify Directional lights	SCC10
2.5.2.4.	Create, transform and modify Point and Spotlights	SCC10
2.5.2.5.	Define and demonstrate lightmapping techniques	T21C10, SCC10
2.5.3.	Demonstrate the creation, transformation, modification and use of cameras	SCC10
2.5.4.	Explain the use of cameras to create alternative views of gameplay (1st, 2nd and 3rd person perspectives)	T21C10 ,CWS2, SCC02.01
2.5.5.	Effectively use framing & camera views to create visual cues for users	T21C1, SCC10
2.5.6.	Use cameras and lightening to create specific emotional experiences such as tension, fear, excitement, bliss, calm, etc.	T21C1, SCC10
2.5.7.	Demonstrate the ability to balance Lightmaps, Light Probes and Dynamic Lights	SCC10
2.5.8.	Demonstrate the effective use of Shaders	SCC10
2.5.9.	Explain various rendering techniques, their relevance, pro's & con's	T21C10, CWS1, SCC02.01, SCC10

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# Professional Standards for Interactive Application & Video Game Creation

## 2.5. LIGHTS, CAMERAS AND RENDERING

Topic	Description	Competencies
2.5.9.1.	Find, show examples and explain raytracing	CRS4
2.5.9.2.	Find, show examples and explain Rasterization	CRS4
2.5.9.3.	Find, show examples and explain Direct3D	CRS4
2.5.9.4.	Find, show examples and explain OpenGL	CRS4
2.5.9.5.	Find, show examples and explain OpenGL ES	CRS4
2.5.9.6.	Find, show examples and explain WebGL	CRS4
2.5.10.	Describe Level of Detail usage for distance-based optimization	T21C10
2.5.11.	Set up models and parameters for Level of Detail (LOD) substitution	SCC10
2.5.12.	Demonstrate use of procedural mesh generation and UV manipulation	SCC10
2.5.13.	Explain the function of and demonstrate the use of clipping planes	SCC02.01
2.5.14.	Use environments, cameras, lights and real-time rendering techniques to create photo-realistic scenes	T21C1, SCC10

## 2.6. ANIMATION

Topic	Description	Competencies
2.6.1.	Use various techniques for effectively animating objects & component properties	T21C1, SCC10
2.6.1.1.	Explain and demonstrate Stop Motion animation	T21C10, CRS4, SCC02.01
2.6.1.2.	Explain and demonstrate Keyframing	T21C10, CRS4, SCC02.01
2.6.1.3.	Explain and demonstrate Tweening animation between keyframes	T21C10, CRS4, SCC02.01
2.6.1.4.	Explain and demonstrate Dopesheet usage	T21C10, CRS4, SCC02.01
2.6.1.5.	Explain and demonstrate the use of Animation Curves, including Euler, quaternion and TCB functions	T21C10, CRS4, SCC02.01
2.6.1.6.	Explain and demonstrate Physics-based animation	T21C10, CRS4, SCC02.01
2.6.1.7.	Explain and demonstrate Softbody animation	T21C10, CRS4, SCC02.01
2.6.1.8.	Explain and demonstrate Fluid Dynamics simulation	T21C10, CRS4, SCC02.01
2.6.2.	Describe and employ procedural animation & artificial intelligence (AI)	T21C10, T21C1 SCC10

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<b>2.6. ANIMATION</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.6.2.1.	Create navigation agents	SCC10
2.6.2.2.	Specify navigation geometry	
2.6.2.3.	Explain the difference between path finding algorithms (A*, Dijkstra, Bi-directional)	T21C10, CWS2, SCC02.01
2.6.2.4.	Explain the use of navigation meshes and waypoints	T21C10, CWS2, SCC02.01
2.6.2.5.	Define waypoints and demonstrate their use for controlling navigation agents	T21C10 CRS4
2.6.2.6.	Define and demonstrate navigation agent destination intelligence	CRS4
2.6.2.7.	Employ flocking algorithms to create group behaviors among navigation agents	SCC10
2.6.2.8.	Define and demonstrate the use particle systems	CRS4
2.6.2.9.	Explain and demonstrate various effects you can create using particle systems	CWS2, SCC02.01
2.6.3.	Demonstrate various character animation techniques	
2.6.3.1.	Define and demonstrate rig-based animation	CRS4
2.6.3.2.	Define and demonstrate IK, FK and using constraints with character rigs	CRS4
2.6.3.3.	Import and use Motion Capture (Mocap) data to drive character animation	SCC10
2.6.4.	Retarget motion data and animation setups between character rigs	SCC10
<b>2.7. SCRIPTING AND PROGRAMMING</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.7.1.	Demonstrate an understanding of the mathematical concepts, logic and syntax of programming languages	T21C14
2.7.2.	Demonstrate an understanding of "if" and "switch" statements	
2.7.3.	Demonstrate an understanding of loops to manage recurring events	
2.7.4.	Demonstrate an understanding of co-routines	
2.7.5.	Declare and update Fields and Properties with varied access modifiers	
2.7.6.	Demonstrate an understanding of Functions, Constants and Variables	

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<b>2.7. SCRIPTING AND PROGRAMMING</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.7.7.	Demonstrate an understanding of Scope for Variables and Functions	
2.7.8.	Demonstrate the usage of Initialization Functions for reference assignment	
2.7.9.	Demonstrate an understanding of proper use of Classes and Functions	
2.7.10.	Demonstrate an understanding of Object Oriented Programming	T21C10
2.7.10.1.	Explain and show examples of Abstraction	T21C10, CRS4, SCC02.01
2.7.10.2.	Explain and show examples of Encapsulation	T21C10, CRS4, SCC02.01
2.7.10.3	Explain and show examples of Composition	T21C10, CRS4, SCC02.01
2.7.10.4.	Explain and show examples of Inheritance	T21C10, CRS4, SCC02.01
2.7.10.5	Explain and show examples of Polymorphism	T21C10, CRS4, SCC02.01
2.7.11.	Demonstrate an understanding of Namespaces for organization	
2.7.12.	Demonstrate the use of real-time data for interaction detection	SCC04.02
2.7.13.	Demonstrate an understanding of various programming interfaces	
2.7.14.	Demonstrate an understanding of Object Switching and Pooling	
2.7.15.	Demonstrate an understanding of memory management techniques	
2.7.16.	Demonstrate an understanding of the appropriate use of Collections, Arrays, Lists and Dictionaries	
2.7.17.	Use scripting/coding to create and control games objects and events	T21C14, T21C2, SCC04.02, SCC10
2.7.18.	Demonstrate an understanding of debugging techniques, break points and stepping through code	T21C4, T21C2, CRS3
2.7.19.	Programmatically solve issues with object interactions and events	T21C4
<b>2.8. HUMAN COMPUTER INTERFACE/GRAFICAL USER INTERFACE</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.8.1.	Explain and demonstrate principles of visual communication	CWS2, T17, SCC02.01
2.8.2.	Explain how Cascading Information Theory can be used as a game mechanic	T21C10, CWS2, SCC02.01
2.8.3.	Using examples, describe key principles behind graphical user interfaces (UIs)	T8, T17

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<b>2.8. HUMAN COMPUTER INTERFACE/GRAFICAL USER INTERFACE</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.8.4.	Define usability as an objective for user interfaces (UIs)	T21C10
2.8.5.	Differentiate between diegetic and non-diegetic user interface elements	T21C10
2.8.6.	Explain how specific UI characteristics can affect usability	T21C10, CWS2, SCC02.01
2.8.7.	Determine the UI functionality required by a specific project to improve outcomes and meet the needs of users	T21C10
2.8.8.	Explain how target platform capabilities and constraints affect the choice of user interfaces	T21C10, CWS2, T1, T2, SCC02.01
2.8.9.	Apply structured methods to user interface development	T11, SCC10
2.8.10.	Implement a new user interface system, test and evaluate its usability	
2.8.11.		

  

<b>2.9. DATA STORAGE AND MANAGING USER DATA</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
2.9.1.	Explain the concept of checkpoints with respect to gameplay	T21C10, SCC02.01
2.9.2.	Employ platform appropriate techniques for saving user data & passing data between levels	SCC10
2.9.2.1.	Explain methods for saving data locally	T21C10, CWS2, SCC02.01
2.9.2.2.	Explain methods for saving data to a server	T21C10, SCC02.01
2.9.2.3.	Explain methods for Integrating third party networking solutions for saving user data	T21C10, SCC02.01
2.9.2.4.	Explain methods for using XML serialization for saving player data	T21C10, SCC02.01
2.9.3.	Compare data storage capabilities and constraints on various platforms	T21C10, SCC04.02
2.9.4.	Compare various methods for storing player data on specific target platforms	T21C10, SCC04.02
2.9.5.	Formulate methods for sharing and storing user data and game progress on various target platforms	T21C10, SCC04.02

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# Professional Standards for Interactive Application & Video Game Creation

<b>3. INTERACTIVE APPLICATION AND VIDEO GAME DEPLOYMENT</b>		
<b>3.1. TARGETING ONE OR MORE PLATFORMS</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
3.1.1.	Create a comparison chart detailing the differences in capabilities and constraints for several target platforms from at least three different categories (super computers, personal computers, mobile devices, web browsers and game consoles)	CWS2, T3, T13, SCC01
3.1.2.	Demonstrate an understanding of cross- & multi-platform considerations	T1, T2, T13, SCC01
3.1.2.1.	Demonstrate and explain considerations for user Interface design	CWS2, T8, SCC01
3.2.2.2.	Demonstrate and explain deployment considerations for target display resolution and aspect ratios	CWS2, SCC01
3.1.2.3.	Demonstrate and explain considerations for storage and executable size	CWS2, SCC01
3.1.2.4.	Demonstrate and explain the use of detail level compression	CWS2
3.1.3.	Using coding techniques for multi-platform decision trees	
3.1.4.	Develop a plan for deploying a title to multiple target platforms, including differences between deployments	SCC03.01
<b>3.2. SOFTWARE VERSIONING AND REVISION CONTROL</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
3.2.1.	Explain the stages of game deployment (Pre-Alpha, Alpha, Beta stages, Release Candidate, "going gold", etc.)	T21C10, T21C11, CRS4, CWS2, T13, SCC01, SCC02.01
3.2.2.	Explain how software versioning is used and why	CWS2, T12, SCC01
3.2.3.	Compare revision control software options and discuss pros and cons from several specific examples	CSL1, CWS1
3.2.4.	Deploy, use and demonstrate a revision control system for a new or existing project	T21C2, T21C11, CRS3, T12
<b>3.3. TESTING, DEBUGGING, PROFILING AND OPTIMIZING</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
3.3.1.	Graphically describe a multi-step testing methodology	T10, NGSS1, SCC03
3.3.2.	Use general troubleshooting strategies to identify and resolve application problems	CRS3, T10, NGSS1, SCC03
3.3.3.	Use performance profiling and optimization techniques to deploy an existing title on a new target platform	

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# Professional Standards for Interactive Application & Video Game Creation

<b>3.3. TESTING, DEBUGGING, PROFILING AND OPTIMIZING</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
3.3.3.1.	Explain and demonstrate performance profiling techniques for determining appropriate optimization methods	T21C10, CWS2, SCC02.01
3.3.3.2.	Explain and demonstrate techniques for CPU and GPU optimizations	T21C10, CWS2, SCC02.01
3.3.3.3.	Explain and demonstrate techniques for rendering optimizations	T21C10, CWS2, SCC02.01
3.3.3.4.	Explain and demonstrate techniques for scripting and programming optimizations	T21C11, T21C23, CWS2, SCC02.01
3.3.4.	Develop a troubleshooting log	T10, NGSS1, SCC03
3.3.5.	Discuss the benefits of using bug tracking software	CSL1, T10, SCC02.01
3.3.6.	Research and compare the pro's and con's of several specific bug tracking software solutions	SCC02.01
3.3.7.	Demonstrate the use of a debugger to inspect code at runtime	T21C4, CRS3
3.3.8.	Demonstrate the use of exceptions to determine the location of coding errors	T21C4, NGSS1
3.3.9.	Create a cause and effect diagram to account for possible causes of a particular problem	T21C4, CRS3, NGSS1
3.3.10.	Redeploy, test, debug, profile and optimize an existing project to a new SP, PC, web or mobile platform	
<b>3.4. MAINTANENCE AND UPDATES</b>		
<b>Topic</b>	<b>Description</b>	<b>Competencies</b>
3.4.1.	Describe how software maintenance is related to software evolution	
3.4.2.	Explain adaptive, perfective, corrective and preventative maintenance	T21C10, CWS2, SCC02.01
3.4.3.	Assess the quality and effectiveness of a service level agreement	T21C10, T21C6
3.4.4.	Create a practical plan for lifecycle maintenance and updates	T21C2, CRS3, SCC01, SCC03

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## Appendix A: Common Core Standards

### ENGLISH LANGUAGE ARTS STANDARDS: READING STANDARDS FOR INFORMATIONAL TEXT

#### Key Ideas and Details:

##### ♦ CCSS.ELA-Literacy.RI.11-12.1

- Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

##### ♦ CCSS.ELA-Literacy.RI.11-12.2

- Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

##### ♦ CCSS.ELA-Literacy.RI.11-12.3

- Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

#### Craft and Structure:

##### ♦ CCSS.ELA-Literacy.RI.11-12.4

- Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

##### ♦ CCSS.ELA-Literacy.RI.11-12.5

- Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.

#### Integration of Knowledge and Ideas:

##### ♦ CCSS.ELA-Literacy.RI.11-12.7

- Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

#### Range of Reading and Level of Text Complexity:

##### ♦ CCSS.ELA-Literacy.RI.11-12.10

- By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
- By the end of grade 12, read and comprehend literary nonfiction at the high end of the grades 11-CCR text complexity band independently and proficiently.

## ENGLISH LANGUAGE ARTS STANDARDS: WRITING STANDARDS

### Text Types and Purposes:

#### ◆ *CCSS.ELA-Literacy.W.11-12.1*

- Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

#### ◆ *CCSS.ELA-Literacy.W.11-12.1.a*

- Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

#### ◆ *CCSS.ELA-Literacy.W.11-12.1.b*

- Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

#### ◆ *CCSS.ELA-Literacy.W.11-12.1.c*

- Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

#### ◆ *CCSS.ELA-Literacy.W.11-12.1.d*

- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

#### ◆ *CCSS.ELA-Literacy.W.11-12.1.e*

- Provide a concluding statement or section that follows from and supports the argument presented.

#### ◆ *CCSS.ELA-Literacy.W.11-12.2*

- Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

#### ◆ *CCSS.ELA-Literacy.W.11-12.2.a*

- Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

#### ◆ *CCSS.ELA-Literacy.W.11-12.2.b*

- Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

#### ◆ *CCSS.ELA-Literacy.W.11-12.2.c*

- Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

#### ◆ *CCSS.ELA-Literacy.W.11-12.2.d*

- Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

#### ◆ *CCSS.ELA-Literacy.W.11-12.2.e*

- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

#### ◆ *CCSS.ELA-Literacy.W.11-12.2.f*

- Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

#### ◆ *CCSS.ELA-Literacy.W.11-12.3*

- Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

#### ◆ *CCSS.ELA-Literacy.W.11-12.3.a*

- Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.



## Text Types and Purposes:(continued)

### ♦ CCSS.ELA-Literacy.W.11-12.3.b

- Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.

### ♦ CCSS.ELA-Literacy.W.11-12.3.c

- Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).

### ♦ CCSS.ELA-Literacy.W.11-12.3.d

- Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.

### ♦ CCSS.ELA-Literacy.W.11-12.3.e

- Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

## Production and Distribution of Writing:

### ♦ CCSS.ELA-Literacy.W.11-12.4

- Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)

### ♦ CCSS.ELA-Literacy.W.11-12.5

- Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grades 11-12 here.)

### ♦ CCSS.ELA-Literacy.W.11-12.6

- Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

## Research to Build and Present Knowledge:

### ♦ CCSS.ELA-Literacy.W.11-12.7

- Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

### ♦ CCSS.ELA-Literacy.W.11-12.8

- Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

### ♦ CCSS.ELA-Literacy.W.11-12.9

- Draw evidence from literary or informational texts to support analysis, reflection, and research.

### ♦ CCSS.ELA-Literacy.W.11-12.9.a

- Apply grades 11-12 Reading standards to literature (e.g., “Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics”).

### ♦ CCSS.ELA-Literacy.W.11-12.9.b

- Apply grades 11-12 Reading standards to literary nonfiction (e.g., “Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court Case majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses)”).

## Range of Writing:

### ♦ CCSS.ELA-Literacy.W.11-12.10

- Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

## ENGLISH LANGUAGE ARTS STANDARDS » SCIENCE & TECHNICAL SUBJECTS

### Key Ideas and Details:

#### ◆ CCSS.ELA-Literacy.RST.11-12.1

- Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

#### ◆ CCSS.ELA-Literacy.RST.11-12.2

- Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

#### ◆ CCSS.ELA-Literacy.RST.11-12.3

- Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

### Craft and Structure:

#### ◆ CCSS.ELA-Literacy.RST.11-12.4

- Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

#### ◆ CCSS.ELA-Literacy.RST.11-12.5

- Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

#### ◆ CCSS.ELA-Literacy.RST.11-12.6

- Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

### Integration of Knowledge and Ideas:

#### ◆ CCSS.ELA-Literacy.RST.11-12.7

- Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

#### ◆ CCSS.ELA-Literacy.RST.11-12.8

- Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

#### ◆ CCSS.ELA-Literacy.RST.11-12.9

- Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

### Range of Reading and Level of Text Complexity:

#### ◆ CCSS.ELA-Literacy.RST.11-12.10

- By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

ENGLISH LANGUAGE ARTS STANDARDS »  
WRITING SCIENCE & TECHNICAL SUBJECTS

**Text Types and Purposes:**

◆ **CCSS.ELA-Literacy.WHST.11-12.1**

- Write arguments focused on discipline-specific content.

◆ **CCSS.ELA-Literacy.WHST.11-12.1.a**

- Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

◆ **CCSS.ELA-Literacy.WHST.11-12.1.b**

- Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

◆ **CCSS.ELA-Literacy.WHST.11-12.1.c**

- Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

◆ **CCSS.ELA-Literacy.WHST.11-12.1.d**

- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

◆ **CCSS.ELA-Literacy.WHST.11-12.1.e**

- Provide a concluding statement or section that follows from or supports the argument presented.

◆ **CCSS.ELA-Literacy.WHST.11-12.2**

- Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

◆ **CCSS.ELA-Literacy.WHST.11-12.2.a**

- Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

◆ **CCSS.ELA-Literacy.WHST.11-12.2.b**

- Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

◆ **CCSS.ELA-Literacy.WHST.11-12.2.c**

- Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

◆ **CCSS.ELA-Literacy.WHST.11-12.2.d**

- Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

◆ **CCSS.ELA-Literacy.WHST.11-12.2.e**

- Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

◆ **CCSS.ELA-Literacy.WHST.11-12.3**

(Not applicable as a separate requirement)

## Production and Distribution of Writing:

### ◆ CCSS.ELA-Literacy.WHST.11-12.4

- Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

### ◆ CCSS.ELA-Literacy.WHST.11-12.5

- Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

### ◆ CCSS.ELA-Literacy.WHST.11-12.6

- Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

## Research to Build and Present Knowledge:

### ◆ CCSS.ELA-Literacy.WHST.11-12.7

- Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

### ◆ CCSS.ELA-Literacy.WHST.11-12.8

- Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

### ◆ CCSS.ELA-Literacy.WHST.11-12.9

- Draw evidence from informational texts to support analysis, reflection, and research.

## Range of Writing:

### ◆ CCSS.ELA-Literacy.WHST.11-12.10

- Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

## ENGLISH LANGUAGE ARTS STANDARDS » SPEAKING & LISTENING

## Comprehension and Collaboration:

### ◆ CCSS.ELA-Literacy.SL.11-12.1

- Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

### ◆ CCSS.ELA-Literacy.SL.11-12.1.a

- Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

### ◆ CCSS.ELA-Literacy.SL.11-12.1.b

- Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

### ◆ CCSS.ELA-Literacy.SL.11-12.1.c

- Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

### ◆ CCSS.ELA-Literacy.SL.11-12.1.d

- Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

## Comprehension and Collaboration (Continued):

### ◆ CCSS.ELA-Literacy.SL.11-12.2

- Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

### ◆ CCSS.ELA-Literacy.SL.11-12.3

- Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

## Presentation of Knowledge and Ideas:

### ◆ CCSS.ELA-Literacy.SL.11-12.4

- Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

### ◆ CCSS.ELA-Literacy.SL.11-12.5

- Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

### ◆ CCSS.ELA-Literacy.SL.11-12.6

- Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11-12 Language standards 1 and 3 here for specific expectations.)

## MATHEMATICS STANDARDS

### Represent and model with vector quantities.

#### ◆ CCSS.Math.Content.HSN.VM.A.1

- (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g.,  $v$ ,  $|v|$ ,  $\|\mathbf{v}\|$ ,  $v$ ).

#### ◆ CCSS.Math.Content.HSN.VM.A.2

- (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

#### ◆ CCSS.Math.Content.HSN.VM.A.3

- (+) Solve problems involving velocity and other quantities that can be represented by vectors.
- Perform operations on vectors.

#### ◆ CCSS.Math.Content.HSN.VM.B.4

- (+) Add and subtract vectors.

#### ◆ CCSS.Math.Content.HSN.VM.B.4.a

- Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

#### ◆ CCSS.Math.Content.HSN.VM.B.4.b

- Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

#### ◆ CCSS.Math.Content.HSN.VM.B.4.c

- Understand vector subtraction  $v - w$  as  $v + (-w)$ , where  $-w$  is the additive inverse of  $w$ , with the same magnitude as  $w$  and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

#### ◆ CCSS.Math.Content.HSN.VM.B.5

- (+) Multiply a vector by a scalar.

#### ◆ CCSS.Math.Content.HSN.VM.B.5.a

- Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as  $c(vx, vy) = (cvx, cvy)$ .

#### ◆ CCSS.Math.Content.HSN.VM.B.5.b

- Compute the magnitude of a scalar multiple  $cv$  using  $\|cv\| = |c|\|v\|$ . Compute the direction of  $cv$  knowing that when  $|c|v \neq 0$ , the direction of  $cv$  is either along  $v$  (for  $c > 0$ ) or against  $v$  (for  $c < 0$ ).

## Appendix B: ITEA Standards for Technological Literacy

### The Nature of Technology

- ◆ **T1.**
  - Students will develop an understanding of the characteristics and scope of technology.
- ◆ **T2.**
  - Students will develop an understanding of the core concepts of technology.
- ◆ **T3.**
  - Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

### Technology and Society

- ◆ **T4.**
  - Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- ◆ **T5.**
  - Students will develop an understanding of the effects of technology on the environment.
- ◆ **T6.**
  - Students will develop an understanding of the role of society in the development and use of technology.
- ◆ **T7.**
  - Students will develop an understanding of the influence of technology on history.

### Design

- ◆ **T8.**
  - Students will develop an understanding of the attributes of design.
- ◆ **T9.**
  - Students will develop an understanding of engineering design.
- ◆ **T10.**
  - Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

### Abilities for a Technological World

- ◆ **T11.**
  - Students will develop abilities to apply the design process.
- ◆ **T12.**
  - Students will develop abilities to use and maintain technological products and systems.
- ◆ **T13.**
  - Students will develop abilities to assess the impact of products and systems.



## The Designed World

### ◆ T14.

- Students will develop an understanding of and be able to select and use medical technologies.

### ◆ T15.

- Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.

### ◆ T16.

- Students will develop an understanding of and be able to select and use energy and power technologies.

### ◆ T17.

- Students will develop an understanding of and be able to select and use information and communication technologies.

### ◆ T18.

- Students will develop an understanding of and be able to select and use transportation technologies.

### ◆ T19.

- Students will develop an understanding of and be able to select and use manufacturing technologies.

### ◆ T20.

- Students will develop an understanding of and be able to select and use construction technologies.

# Appendix C: 21st Century Skills

**Note:** <sup>t</sup>indicates standards are addressed in the Unity Curriculum Framework.

## LEARNING AND INNOVATION SKILLS

### Critical thinking and problem solving

#### ◆ T21C1 <sup>t</sup>Reason Effectively

- Use various types of reasoning (e.g., inductive, deductive, etc.) as appropriate to the situation

#### ◆ T21C2 <sup>t</sup>Use Systems Thinking

- Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems

#### ◆ T21C3 <sup>t</sup>Make Judgments and Decisions

- Effectively analyze and evaluate evidence, arguments, claims and beliefs
- Analyze and evaluate major alternative points of view
- Synthesize and make connections between information and arguments
- Interpret information and draw conclusions based on the best analysis
- Reflect critically on learning experiences and processes

#### ◆ T21C4 <sup>t</sup>Solve Problems

- Solve different kinds of non-familiar problems in both conventional and innovative ways
- Identify and ask significant questions that clarify various points of view and lead to better solutions

### Creativity and innovation

#### ◆ T21C5 <sup>t</sup>Think Creatively

- Use a wide range of idea creation techniques (such as brainstorming)
- Create new and worthwhile ideas (both incremental and radical concepts)
- Elaborate, refine, analyze, and evaluate ideas in order to improve and maximize creative efforts
- Demonstrate imagination and curiosity

#### ◆ T21C6 <sup>t</sup>Work Creatively with Others

- Develop, implement, and communicate new ideas to others effectively
- Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
- Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas
- View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes

#### ◆ T21C7 <sup>t</sup>Implement Innovations

- Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur

### Communication and Collaboration

#### ◆ T21C8 <sup>t</sup>Communicate Clearly

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade) and in diverse environments (including multi-lingual)
- Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact

#### ◆ T21C9 <sup>t</sup>Collaborate with Others

- Demonstrate ability to work effectively and respectfully with diverse teams
- Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
- Assume shared responsibility for collaborative work, and value the individual contributions made by each team member

## INFORMATION, MEDIA AND TECHNOLOGY SKILLS

### Information literacy

#### ◆ *T21C10<sup>t</sup> Access and Evaluate Information*

- Access information efficiently (time) and effectively (sources)
- Evaluate information critically and competently

#### ◆ *T21C11<sup>t</sup> Use and Manage Information*

- Use information accurately and creatively for the issue or problem at hand
- Manage the flow of information from a wide variety of sources
- Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information

### Media literacy

#### ◆ *T21C12<sup>t</sup> Analyze Media*

- Understand both how and why media messages are constructed and for what purposes
- Examine how individuals interpret messages differently, how values and points of view are included or excluded, and how media can influence beliefs and behaviors
- Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of media

#### ◆ *T21C13<sup>t</sup> Create Media Products*

- Understand and utilize the most appropriate media creation tools, characteristics, and conventions
- Understand and effectively utilize the most appropriate expressions and interpretations in diverse, multi-cultural environments

### ICT (information, communications and technology) literacy

#### ◆ *T21C14<sup>t</sup> Apply Technology Effectively*

- Use technology as a tool to research, organize, evaluate, and communicate information
- Use digital technologies (e.g., computers, PDAs, media players, GPS, etc.), communication/networking tools, and social networks appropriately to access, manage, integrate, evaluate, and create information to successfully function in a knowledge economy
- Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information technologies

## LIFE AND CAREER SKILLS

### Flexibility and adaptability

#### ◆ *T21C16<sup>t</sup> Adapt to Change*

- Adapt to varied roles, job responsibilities, schedules, and contexts
- Work effectively in a climate of ambiguity and changing priorities

#### ◆ *T21C17<sup>t</sup> Be Flexible*

- Incorporate feedback effectively
- Deal positively with praise, setbacks, and criticism
- Understand, negotiate, and balance diverse views and beliefs to reach workable solutions, particularly in multi-cultural environments

### Initiative and self-direction

#### ◆ *T21C18<sup>t</sup> Manage Goals and Time*

- Set goals with tangible and intangible success criteria
- Balance tactical (short-term) and strategic (long-term) goals
- Utilize time and manage workload efficiently

#### ◆ *T21C19<sup>t</sup> Work Independently*

- Monitor, define, prioritize, and complete tasks without direct oversight

#### ◆ *T21C20<sup>t</sup> Be Self-directed Learners*

- Go beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise
- Demonstrate initiative to advance skill levels towards a professional level
- Demonstrate commitment to learning as a lifelong process
- Reflect critically on past experiences in order to inform future progress

## Social and cross-cultural skills

### ◆ T21C21 <sup>t</sup>Interact Effectively with Others

- Know when it is appropriate to listen and when to speak
- Conduct oneself in a respectable, professional manner

### ◆ T21C22 <sup>t</sup>Work Effectively in Diverse Teams

- Respect cultural differences and work effectively with people from a range of social and cultural backgrounds
- Respond open-mindedly to different ideas and values
- Leverage social and cultural differences to create new ideas and increase both innovation and quality of work

## Productivity and accountability

### ◆ T21C23 <sup>t</sup>Manage Projects

- Set and meet goals, even in the face of obstacles and competing pressures
- Prioritize, plan, and manage work to achieve the intended result

### ◆ T21C24 <sup>t</sup>Produce Results

- Demonstrate additional attributes associated with producing high quality products including the abilities to:
- Work positively and ethically
- Manage time and projects effectively
- Multi-task
- Participate actively, as well as be reliable and punctual
- Present oneself professionally and with proper etiquette
- Collaborate and cooperate effectively with teams
- Respect and appreciate team diversity
- Be accountable for results

## Leadership and responsibility

### ◆ T21C25 <sup>t</sup>Guide and Lead Others

- Use interpersonal and problem-solving skills to influence and guide others toward a goal
- Leverage strengths of others to accomplish a common goal
- Inspire others to reach their very best via example and selflessness
- Demonstrate integrity and ethical behavior in using influence and power

### ◆ T21C26 <sup>t</sup>Be Responsible to Others

- Act responsibly with the interests of the larger community in mind

## Appendix D: STEM Clusters

### ◆ **SCC01 <sup>†</sup>Academic foundations:**

- Achieve additional academic knowledge and skills required to pursue the full range of career and postsecondary education opportunities within a career cluster.

### ◆ **SCC02 <sup>†</sup>Communications:**

- Use oral and written communication skills in creating, expressing and interpreting information and ideas including technical terminology and information.

➢ **SCC02.01** Prepare STEM material in oral, written, or visual formats that provide information to an intended audience to fulfill specific communication need of an audience.

➢ **SCC02.02** Apply active listening skills to obtain or clarify information pertaining to plans, processes, projects, or designs.

### ◆ **SCC03 <sup>†</sup>Problem-solving and critical thinking:**

- Solve problems using critical thinking skills (analyze, synthesize, and evaluate) independently and in teams. Solve problems using creativity and innovation.

➢ **SCC03.01** Effectively develop and apply the skills inherent in systems engineering where requirements, configuration, integration, project management, quality assurance, and process applications are necessary.

### ◆ **SCC04 <sup>†</sup>Information technology applications:**

- Use information technology tools specific to the career cluster to access, manage, integrate, and create information.

➢ **SCC04.01** Effectively use information technology to gather, store, and communicate data in appropriate formats.

➢ **SCC04.02** Evaluate and use skills relating to the differing technological tools used to manipulate, report, or operate with data acquisition.

### ◆ **SCC05 <sup>†</sup>Systems:**

- Understand roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment. Identify how key organizational systems affect organizational performance and the quality of products and services. Understand global context of industries and careers.

### ◆ **SCC06 Safety, health and environmental:**

- Understand the importance of health, safety, and environmental management systems in organizations and their importance to organizational performance and regulatory compliance. Follow organizational policies and procedures and contribute to continuous improvement in performance and compliance.

➢ **SCC06.01** Apply safety practices in the environment where science, technology, engineering, and/or mathematical principles are appropriate to ensure a safe workplace.

➢ **SCC06.02** Develop an awareness of safety, health, and environmental hazards inherent in the STEM arenas when solving problems, developing plans, processes, or completing projects to be proactive in promoting safety.

### ◆ **SCC07 <sup>†</sup>Leadership and teamwork:**

- Use leadership and teamwork skills in collaborating with others to accomplish organizational goals and objectives.

### ◆ **SCC08 Ethics and legal responsibilities:**

- Know and understand the importance of professional ethics and legal responsibilities.

➢ **SCC08.01** Develop the knowledge and abilities to comprehend ethical and legal standards as they apply to STEM where plans, processes, and projects will be dependent upon them.

### ◆ **SCC09 <sup>†</sup>Employability and career development:**

- Know and understand the importance of employability skills. Explore, plan, and effectively manage careers. Know and understand the importance of entrepreneurship skills.

➢ **SCC09.01** Develop the skills and abilities to research career pathways in

### ◆ **SCC10 Technical skills:**

- Use the technical knowledge and skills required to pursue the targeted careers for all pathways in the career cluster, including knowledge of design, operation, and maintenance of technological systems critical to the career cluster.

## Appendix E: Next Generation Science Standards

### Eight practices of science and engineering

- ◆ NGSS1 <sup>†</sup>Asking questions (for science) and defining problems (for engineering)
- ◆ NGSS2 <sup>†</sup>Developing and using models
- ◆ NGSS3 Planning and carrying out investigations
- ◆ NGSS4 Analyzing and interpreting data
- ◆ NGSS5 <sup>†</sup>Using mathematics and computational thinking
- ◆ NGSS6 <sup>†</sup>Constructing explanations (for science) and designing solutions (for engineering)
- ◆ NGSS7 <sup>†</sup>Engaging in argument from evidence
- ◆ NGSS8 <sup>†</sup>Obtaining, evaluating, and communicating information

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