



# Ohio

## Information Technology

CAREER FIELD TECHNICAL CONTENT STANDARDS

2013

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# Foreword

The Career Field Technical Content Standards serve as the curricular framework for Ohio's career-technical education pathway programs as outlined in Ohio Administrative Code 3301-61-03 (Criteria for Secondary Workforce Development Programs).

Career Field Technical Content Standards outline the knowledge and skills needed for success in careers across multiple pathways. Validated by Ohio business and industry representatives in conjunction with Ohio educators, these standards form the basis for developing educational programming in Ohio secondary schools. The standards also serve as the framework for developing strong career pathways that connect secondary education with postsecondary education systems and the workplace.

This version of Career Field Technical Content Standards is intended to support the ongoing evolution of career technical education pathway programs. The standards tend to be somewhat broader than previous versions and are not repeated for individual pathways or occupational areas. The broader and non-duplicated statements are intended to capture the knowledge and skills that can be applied across any number of occupations in a pathway rather than focusing on the requirement of a single occupation. After all, the intent of a pathway program is to prepare a student for a range of educational and career opportunities following high school.

Pathway programs prepare students to combine broad knowledge, insight and understanding of business processes, academic attainment and workplace readiness with depth of knowledge and expertise in a technical area. Knowing that many careers will require some level of postsecondary education, the content standards also delineate the knowledge and skills necessary to seamlessly transition to postsecondary educational programs.

This document seeks to provide the basis for educational programming that will provide the employee with fundamental skill-sets that employers demand. This ensures that Ohio's workforce of tomorrow is competitive in a global environment. An environment that requires knowledge and skills can be applied in a broader context, aimed at innovation to support new products and services in an ever-changing economy.

In addition to the extensive engagement of secondary and postsecondary educators and business/industry professionals, development of these standards represents a collaborative effort of the following professional partners: the Ohio Department of Education's Office of Career-Technical Education; the Ohio Board of Regents Secondary Career-Technical Alignment Initiative; and CETE, known as the Center on Education and Training for Employment, at The Ohio State University.

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# Acknowledgements

A number of individuals contributed their time and expertise to this development. Special thanks go to all the business representatives and educators named in this document.

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Those listed above provided vision and implementation support for the Information Technology Career Field Technical Content Standards and Ohio's Information Technology educational programs.

# Philosophy and Principles for Implementation

## Ohio Career Field Initiative

The overarching framework for Ohio career-technical education is outlined in the Ohio Revised Code and subsequent administrative rules, which specify career-technical programming based on 16 career fields. To view the full text of Administrative Rule 3301-61-03 (Criteria for Secondary Workforce Development Programs), go to: <http://education.ohio.gov/Topics/Career-Tech/Career-Development-OCIS/CTE-Administrative-Rules-Update>. These 16 fields provide the framework for an Ohio career field initiative that seeks to foster the educational shift necessary to respond to the needs of a rapidly changing global environment.

A career field is a “group of occupations and broad industries based on common characteristics” (see [www.careertech.org](http://www.careertech.org)). Career fields are the basis for developing both broad and specialized technical content standards that serve as a framework for curriculum, instruction, assessment and program design, addressing the needs of an entire industry and business sector. Ohio’s 16 career fields align with national efforts to broaden career-technical education, integrate career-technical with academic study and reflect the workforce needs of today and tomorrow. For today’s students to be adequately prepared for tomorrow’s workforce, they must have an education that:

- **Incorporates a broad, long-term conception of work in combination with the depth of specialization skills;**  
Employees need a comprehensive understanding beyond a single occupational area. Career-technical programming needs to be provided in a larger context, so students can generalize learning, make connections between education and work and adapt to changes in their careers. Workplace knowledge and skills are needed to prepare employees for collaborating and problem solving while contributing to the broader business process.
- **Emphasizes the acquisition of strong academic knowledge and skills; and**  
Academic skills provide the foundation for career success. The integration of academic content standards with career field technical content standards helps to contextualize learning for students, making English language arts, mathematics, social studies and science relevant to students as a means to an important end—success at work and in life.
- **Facilitates high-school-to-postsecondary transitions.**  
A lifetime of change means a lifetime of learning, including postsecondary education. Students need knowledge and skills for success in a variety of postsecondary options, including apprenticeships, industry credentialing through adult education, two- and four-year college degree programs and graduate school.

## Career Pathways

A key component of the Ohio Career Field Initiative is a career pathway, which is a coherent, articulated sequence of rigorous academic and career-technical coursework commencing in the ninth grade and leading to an associate degree, baccalaureate degree and beyond—an industry-recognized certificate and/or licensure. Pathways facilitate a seamless transition from high school to postsecondary education (including apprenticeships, adult education, two- and four-year colleges and graduate school) and from postsecondary education to the workplace. The career pathway is developed, implemented and maintained in partnership among secondary and postsecondary education, business and employers. Career pathways are available to all students, including adult learners and lead to rewarding careers.

To effectively facilitate the transition from secondary to postsecondary education and a career, high school career pathways should encompass:

1. Challenging technical coursework in a chosen career field based on career field technical content standards;
2. Rigorous academics that meet Ohio’s academic content standards and grade-level expectations;
3. Electives that relate to career objectives;
4. Instructional enhancements such as experiential and authentic learning opportunities (e.g., work-based learning, mentorships, internships) and career-technical student organization participation;
5. Opportunities (when appropriate) for program and student certification and licensure;
6. Preparation for transition to further study that includes college readiness and opportunities to earn college credit while in high school;
7. Preparation for transition to employment with advancement opportunities;
8. Performance targets that include high school academic and technical testing/exit and postsecondary entry/placement requirements;
9. Various sector(s) within an industry or encompass a function that crosses industry sectors;
10. The scope of opportunities in the related industry and available college programs;
11. Opportunities to prepare for a range of careers, including
  - a. multiple employment opportunities after high school and
  - b. opportunities for students to enter and succeed in postsecondary and continuing education programs;
12. Transferable skills required for employment in the range of occupations aligned to the pathway; and
13. Opportunities to learn skills across the pathway as well as in specialized areas.

For additional information on the Career Field Initiative, including Ohio Career Field Technical Content Standards and Career Pathways, go to <http://education.ohio.gov/Topics/Career-Tech/Career-Fields>.

# Structure and Format

The Career Field Technical Content Standards document is composed of a series of strands comprised of outcomes that each contain a set of competencies.

- A strand is a large content area under which multiple outcomes are organized, regardless of the pathway. It includes a title and a concise description with statements that capture multiple, broad areas of learner knowledge and skills expected across all outcomes in the strand. There are approximately six strands of content per career field. Strand 1, Business Operations/21<sup>st</sup> Century Skills (employability skills, leadership and communications, business ethics and law, knowledge management and information technology, global environment, business literacy, entrepreneurship/entrepreneurs, operations management, financial management, sales and marketing and principles of business economics), is the same for all career-technical education career fields.
- An outcome is an overarching statement that summarizes the knowledge and skills described in a set of individual competencies to be learned by the end of the 12<sup>th</sup> grade. There are usually 5–15 outcomes within a strand, depending on the breadth of content to be addressed.
- A competency is a specific statement of essential knowledge or skill to be learned in the pathway program. There are usually 5–12 competencies under an outcome.

Each set of outcomes and competencies is included in one or more pathways in the career field. Outcomes and competencies form the basis for developing secondary courses, programs, instruction and assessment, facilitating transition from one educational level to the next and to the workplace. This supports career readiness and long-term career success by:

- Providing the basis for effective collaboration, teamwork and communication across pathways;
- Laying the groundwork for successful transfer of knowledge and skills across pathways, thereby facilitating horizontal and vertical career success and
- Equipping students and workers with the skills needed to transition to new and emerging careers throughout a working lifetime.

All outcomes and competencies in the Career Field Technical Content Standards have been verified as essential by business and labor representatives within the pathway or pathways specified.

These essential outcomes and competencies specify industry-based knowledge or hands-on skills that CTE students need by the end of the 12<sup>th</sup> grade to be successful in their selected career pathway and on-going learning (such as college, apprenticeships and military opportunities).

# Development of Information Technology Career Field Technical Content Standards

The process for the development of the Information Technology Career Field Technical Content Standards began in February 2012 and culminated in June 2013. Over the course of 2012–2013, numerous business and industry representatives as well as secondary and postsecondary educators from across the state of Ohio took part in the formal development process. The following summarizes the various stages of the development process.

## Research and Development

The involvement of subject matter experts, including educators, was critical to the completion of the draft revision of the document. Development was also informed by consulting the following sources of information:

- National Association of State Directors of Career Technical Education Consortium (NASDCTEC); Common Career Technical Core (CCTC) standards and Programs of Study;
- Industry-based certifications/standards;
  - CompTIA curriculum for A+ Certification, Network +, Security + and Server +;
  - CISCO curriculum for Cisco Certified Networking Associate, Cisco Academy and Cisco IT Essentials;
  - Adobe curriculum for Photoshop and Dreamweaver;
  - Microsoft certification standards;
- Department of Education, Office of Career-Technical Education in Oklahoma, Illinois and New Jersey;
- itWORKS.OHIO;
- SkillsUSA;
- Business Professionals of America (BPA);
- Partnership for 21<sup>st</sup> Century Skills;
- Career-Technical Transfer Assurance Guides (CTAGs);
- University System of Ohio Academic Program Guide; and
- Ohio Industry Employment Projections Report, 2008-18.

## Futuring Panel

On May 23, 2012, the Information Technology futuring panel brought together key business and industry representatives from across the state to advise the Ohio Department of Education on trends impacting the Information Technology career field. The participants were asked to share their perceptions on changes in the workplace, employment trends, changes in technical skill requirements, needed workplace readiness skills and available industry-recognized standards and credentials. This feedback was used to develop and streamline the standards document into what is most demanded by the labor market.

## **Validation Panel**

On December 11, 2012, and January 23, 2013, a diverse group of Ohio business and industry representatives participated in panels to validate and rate the importance of the work-related competencies in the draft standards document. Drawn from various sectors and regions of the state, the panels identified what employees should know and be able to do in the four Information Technology pathways. Secondary and postsecondary education representatives participated on the panels to gain an understanding of the standards development process as well as to provide their perspective to the business representatives, when needed.

## **Postsecondary Alignment**

The goal of the Secondary Career-Technical Alignment Initiative (SCTAI) was to develop new statewide Career-Technical Assurance Guides (CTAGs) for secondary career-technical institutions using the combined process of the Ohio Board of Regents' CTAG development process with the Ohio Department of Education's Career Field Technical Content Standards development process. The result of this collaboration was a tighter alignment between secondary career-technical and postsecondary content and the development of pathways that encourage college-going and increase statewide postsecondary options for career technical students. For more information on CTAGs and opportunities for statewide postsecondary articulated transfer credit, visit <https://student-transfer.ohiohighered.org>.

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# Career Pathways Definitions

The Information Technology Career Field prepares students for careers in Information Support and Services (ISS), Interactive Media (IM), Network Systems (NS) and Programming and Software Development (PSD).

## Information Support and Services

Information Support and Services program areas will prepare students for careers dealing with information technology (i.e., operations, support, deployment/integration). Students will gain the necessary technical and academic skills to implement computer systems and software, provide technical assistance and manage information systems.

### Careers for which this pathway prepares students include:

Application Support Specialist  
Computer Support Specialist  
Help Desk Technician  
Product Support Engineer

### Postsecondary majors for which this pathway prepares students include:

Computer and Information Sciences and Support Services  
Computer Science  
Computer Software and Media Applications  
Information Services

## Interactive Media

Interactive Media program areas will prepare students for careers using multimedia technology to develop online products for business, training, entertainment, communications and marketing. Students will gain the necessary technical and academic skills to create, design and produce interactive media products and services.

### Careers for which this pathway prepares students include:

Desktop Publisher  
Multimedia Specialist  
Webmaster  
Website Developer

### Postsecondary majors for which this pathway prepares students include:

Digital Communication and Media/Multimedia  
Digital/Multimedia and Information Resources Design  
Prepress/Desktop Publishing and Digital Imaging Design  
Web/Multimedia Management and Webmaster

## **Network Systems**

Network Systems program areas will prepare students for careers dealing with network systems analysis, planning and implementation. Students will gain the necessary technical and academic skills to design, install, maintain and manage network systems.

**Careers for which this pathway prepares students include:**

Cyber Security Specialist  
Network Technician  
Operations Technician  
Systems Integration Advisor

**Postsecondary majors for which this pathway prepares students include:**

Computer Engineering  
Integrated Media and Technology  
Project Management  
Telecommunications

## **Programming and Software Development**

Programming and Software Development program areas will prepare students for careers using technical and academic skills to design, develop, test, document, implement and maintain computer software and database systems.

**Careers for which this pathway prepares students include:**

Application Developer  
Application Support Specialist  
Database Administrator  
Database Designer

**Postsecondary majors for which this pathway prepares students include:**

Computer Science  
Information Science/Studies  
Software Engineering  
Video Game Development

# Strand/Outcome Pathway Chart

An “X” indicates that the pathway applies to the outcome.

Strand/Outcome	Pathway			
	Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
<b>Strand 1: Business Operations/21st Century Skills</b> page 2				
Outcome 1.1: Employability Skills	X	X	X	X
Outcome 1.2: Leadership and Communications	X	X	X	X
Outcome 1.3: Business Ethics and Law	X	X	X	X
Outcome 1.4: Knowledge Management and Information Technology	X	X	X	X
Outcome 1.5: Global Environment	X	X	X	X
Outcome 1.6: Business Literacy	X	X	X	X
Outcome 1.7: Entrepreneurship/Entrepreneurs	X	X	X	X
Outcome 1.8: Operations Management	X	X	X	X
Outcome 1.9: Financial Management	X	X	X	X
Outcome 1.10: Sales and Marketing	X	X	X	X
Outcome 1.11: Principles of Business Economics	X	X	X	X
<b>Strand 2: IT Fundamentals</b> page 12				
Outcome 2.1: Security, Risks, and Safeguards	X	X	X	X
Outcome 2.2: Networking Fundamentals	X	X	X	X
Outcome 2.3: Data Encoding	X	X	X	X
Outcome 2.4: Emerging Technologies	X	X	X	X
Outcome 2.5: Operating Systems	X	X	X	X
Outcome 2.6: Installation and Configuration	X	X	X	X
Outcome 2.7: Web Architecture	X	X	X	X
Outcome 2.8: Databases	X	X	X	X
Outcome 2.9: Project Concept Proposal	X	X	X	X
Outcome 2.10: Equipment	X	X	X	X
Outcome 2.11: Troubleshooting	X	X	X	X
Outcome 2.12: Performance Tests and Acceptance Plans	X	X	X	X
Outcome 2.13: Rollout and Handoff	X	X	X	X

Strand/Outcome	Pathway			
	Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
<b>Strand 3: Information Security</b> page 19				
Outcome 3.1: Components of Information Security	X	X	X	X
Outcome 3.2: General Security Compliance	X	X	X	X
Outcome 3.3: Network Security	X		X	
Outcome 3.4: Multilayer Defense Structure	X		X	
Outcome 3.5: Wireless Security	X		X	
<b>Strand 4: Infrastructure Systems</b> page 22				
Outcome 4.1: Network Infrastructure	X		X	
Outcome 4.2: Open Systems Interconnection	X		X	
Outcome 4.3: Network Media	X		X	
Outcome 4.4: Wireless Communications	X		X	
Outcome 4.5: Wireless Network Solutions	X		X	
Outcome 4.6: Network Protocols	X		X	
Outcome 4.7: Transmission Control Protocol/Internet Protocol (TCP/IP)			X	
Outcome 4.8: Network Architecture			X	
Outcome 4.9: Network Operating Systems			X	
Outcome 4.10: Network Administration			X	
Outcome 4.11: Cloud Computing			X	
Outcome 4.12: Wide Area Network			X	
Outcome 4.13: Disaster Recovery	X		X	
<b>Strand 5: Programming and Software Systems</b> page 30				
Outcome 5.1: Programming Concepts	X	X	X	X
Outcome 5.2: Computational and String Operations	X			X
Outcome 5.3: Logical Operations and Control Structures				X
Outcome 5.4: Integrated Development Environment				X
Outcome 5.5: Programming Conventions				X
Outcome 5.6: Software Development Lifecycle				X
Outcome 5.7: Configuration Management				X
<b>Strand 6: Web Development</b> page 34				
Outcome 6.1: Web pages	X	X	X	X

Strand/Outcome	Pathway			
	Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
Outcome 6.2: Links and Multimedia	X	X		X
Outcome 6.3: Scripting		X		X
Outcome 6.4: Web Forms		X		X
Outcome 6.5: Websites		X		X
<b>Strand 7: Digital Media</b> page 37				
Outcome 7.1: Interactive Media	X	X	X	X
Outcome 7.2: Multimedia Tools		X		
Outcome 7.3: Production		X		
Outcome 7.4: Graphics		X		
Outcome 7.5: Typography		X		
Outcome 7.6: Animation		X		
Outcome 7.7: Video		X		
Outcome 7.8: Audio		X		
Outcome 7.9: Photographs		X		
<b>Strand 8: Databases</b> page 42				
Outcome 8.1: Data Modeling				X
Outcome 8.2: Design and Creation				X
Outcome 8.3: Data Entry and Access				X
Outcome 8.4: Database Management				X
<b>Total Outcomes by Pathway:</b>	41	41	45	43
<b>Total Outcomes:</b>	67			

# **INFORMATION TECHNOLOGY**

## **CAREER FIELD TECHNICAL CONTENT STANDARDS**

### **STRANDS 1-8**

## Strand 1. Business Operations/21st Century Skills

Learners apply principles of economics, business management, marketing, and employability in an entrepreneur, manager, and employee role to the leadership, planning, developing, and analyzing of business enterprises related to the career field.

### Outcome 1.1. Employability Skills

Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 1.1.1. Identify the knowledge, skills, and abilities necessary to succeed in careers.
- 1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure, and experience.
- 1.1.3. Develop a career plan that reflects career interests, pathways, and secondary and postsecondary options.
- 1.1.4. Describe the role and function of professional organizations, industry associations, and organized labor and use networking techniques to develop and maintain professional relationships.
- 1.1.5. Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development).
- 1.1.6. Explain the importance of work ethic, accountability, and responsibility and demonstrate associated behaviors in fulfilling personal, community, and workplace roles.
- 1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.
- 1.1.8. Identify the correlation between emotions, behavior, and appearance and manage those to establish and maintain professionalism.
- 1.1.9. Give and receive constructive feedback to improve work habits.
- 1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.
- 1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.
- 1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits, and abusive behavior.

## **Outcome 1.2. Leadership and Communications**

Process, maintain, evaluate, and disseminate information in a business. Develop leadership and team building to promote collaboration.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X	X	X	X

### **Competencies**

- 1.2.1. Extract relevant, valid information from materials and cite sources of information.
- 1.2.2. Deliver formal and informal presentations.
- 1.2.3. Identify and use verbal, nonverbal, and active listening skills to communicate effectively.
- 1.2.4. Use negotiation and conflict-resolution skills to reach solutions.
- 1.2.5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.
- 1.2.6. Use proper grammar and expression in all aspects of communication.
- 1.2.7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.
- 1.2.8. Identify the strengths, weaknesses, and characteristics of leadership styles that influence internal and external workplace relationships.
- 1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).
- 1.2.10. Use interpersonal skills to provide group leadership, promote collaboration, and work in a team.
- 1.2.11. Write professional correspondence, documents, job applications, and resumés.
- 1.2.12. Use technical writing skills to complete forms and create reports.
- 1.2.13. Identify stakeholders and solicit their opinions.
- 1.2.14. Use motivational strategies to accomplish goals.

**Outcome 1.3. Business Ethics and Law**

Analyze how professional, ethical, and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

**Competencies**

- 1.3.1. Analyze how regulatory compliance affects business operations and organizational performance.
- 1.3.2. Follow protocols and practices necessary to maintain a clean, safe, and healthy work environment.
- 1.3.3. Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice).
- 1.3.4. Identify how federal and state consumer protection laws affect products and services.
- 1.3.5. Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.
- 1.3.6. Identify deceptive practices (e.g., bait and switch, identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance.
- 1.3.7. Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g., harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission [EEOC]).
- 1.3.8. Verify compliance with computer and intellectual property laws and regulations.
- 1.3.9. Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal, organizational, and professional ethical standards.

#### **Outcome 1.4. Knowledge Management and Information Technology**

Demonstrate current and emerging strategies and technologies used to collect, analyze, record, and share information in business operations.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X	X	X	X

#### **Competencies**

- 1.4.1. Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems).
- 1.4.2. Select and use software applications to locate, record, analyze, and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines).
- 1.4.3. Verify compliance with security rules, regulations, and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway.
- 1.4.4. Use system hardware to support software applications.
- 1.4.5. Use information technology tools to maintain, secure, and monitor business records.
- 1.4.6. Use an electronic database to access and create business and technical information.
- 1.4.7. Use personal information management and productivity applications to optimize assigned tasks (e.g., lists, calendars, address books).
- 1.4.8. Use electronic media to communicate and follow network etiquette guidelines.

#### **Outcome 1.5. Global Environment**

Evaluate how beliefs, values, attitudes, and behaviors influence organizational strategies and goals.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X	X	X	X

#### **Competencies**

- 1.5.1. Describe how cultural understanding, cultural intelligence skills, and continual awareness are interdependent.
- 1.5.2. Describe how cultural intelligence skills influence the overall success and survival of an organization.
- 1.5.3. Use cultural intelligence to interact with individuals from diverse cultural settings.
- 1.5.4. Recognize barriers in cross-cultural relationships and implement behavioral adjustments.
- 1.5.5. Recognize the ways in which bias and discrimination may influence productivity and profitability.
- 1.5.6. Analyze work tasks for understanding and interpretation from a different cultural perspective.
- 1.5.7. Use intercultural communication skills to exchange ideas and create meaning.
- 1.5.8. Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities.

**Outcome 1.6. Business Literacy**

Develop foundational skills and knowledge in entrepreneurship, financial literacy, and business operations.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

**Competencies**

- 1.6.1. Identify business opportunities.
- 1.6.2. Assess the reality of becoming an entrepreneur, including advantages and disadvantages (e.g., risk versus reward, reasons for success and failure).
- 1.6.3. Explain the importance of planning your business.
- 1.6.4. Identify types of businesses, ownership, and entities (i.e., individual proprietorships, partnerships, corporations, cooperatives, public, private, profit, not-for-profit).
- 1.6.5. Describe organizational structure, chain of command, the roles and responsibilities of the organizational departments, and interdepartmental interactions.
- 1.6.6. Identify the target market served by the organization, the niche that the organization fills, and an outlook of the industry.
- 1.6.7. Identify the effect of supply and demand on products and services.
- 1.6.8. Identify the features and benefits that make an organization’s product or service competitive.
- 1.6.9. Explain how the performance of an employee, a department, and an organization is assessed.
- 1.6.10. Describe the impact of globalization on an enterprise or organization.
- 1.6.11. Describe how all business activities of an organization work within the parameters of a budget.
- 1.6.12. Describe classifications of employee benefits, rights, deductions, and compensations.

### **Outcome 1.7. Entrepreneurship/Entrepreneurs**

Analyze the environment in which a business operates and the economic factors and opportunities associated with self-employment.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X	X	X	X

#### **Competencies**

- 1.7.1. Compare and contrast the four types of business ownership (i.e., individual proprietorships, partnerships, corporations, cooperatives).
- 1.7.2. Explain the role of profit as the incentive to entrepreneurs in a market economy.
- 1.7.3. Identify the factors that contribute to the success and failure of entrepreneurial ventures.
- 1.7.4. Assess the roles of nonprofit and for-profit businesses.
- 1.7.5. Develop a business plan.
- 1.7.6. Describe life cycles of an entrepreneurial business and an entrepreneur.
- 1.7.7. Create a list of personal strengths, weaknesses, skills, and abilities needed to be successful as an entrepreneur.
- 1.7.8. Explain pathways used to become an entrepreneur.
- 1.7.9. Conduct a self-assessment to determine entrepreneurial potential.
- 1.7.10. Describe techniques for obtaining experience (e.g., apprenticeship, co-operative [co-op] education, work placement, internship, job shadowing) related to an entrepreneurial objective.
- 1.7.11. Identify initial steps in establishing a business (e.g., limited liability company [LLC], tax ID, permits, insurance, licensing).
- 1.7.12. Identify resources available to entrepreneurs (e.g., Small Business Administration, mentors, information resources, educational opportunities).
- 1.7.13. Protect intellectual property and knowledge (e.g., copyright, patent, trademark, trade secrets, processes).

## Outcome 1.8. Operations Management

Plan, organize, and monitor an organization or department to maximize contribution to organizational goals and objectives.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 1.8.1. Forecast future resources and budgetary needs using financial documents (e.g., balance sheet, demand forecasting, financial ratios).
- 1.8.2. Select and organize resources to develop a product or a service.
- 1.8.3. Analyze the performance of organizational activities and reallocate resources to achieve established goals.
- 1.8.4. Identify alternative actions to take when goals are not met (e.g., changing goals, changing strategies, efficiencies).
- 1.8.5. Use inventory and control systems to purchase materials, supplies, and equipment (e.g., Last In, First Out [LIFO]; First In, First Out [FIFO]; Just in Time [JIT]; LEAN).
- 1.8.6. Identify the advantages and disadvantages of carrying cost and Just-in-Time (JIT) production systems and the effects of maintaining inventory (e.g., perishable, shrinkage, insurance) on profitability.
- 1.8.7. Collect information and feedback to help assess the organization’s strategic planning and policymaking processes.
- 1.8.8. Identify routine activities for maintaining business facilities and equipment.
- 1.8.9. Develop a budget that reflects the strategies and goals of the organization.
- 1.8.10. Analyze how business management and environmental management systems (e.g., health, safety) contribute to continuous improvement and sustainability.

## **Outcome 1.9. Financial Management**

Use financial tools, strategies, and systems to develop, monitor, and control the use of financial resources to ensure personal and business financial well-being.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X	X	X	X

### **Competencies**

- 1.9.1. Create, analyze, and interpret financial documents (e.g., budgets, income statements).
- 1.9.2. Identify tax obligations.
- 1.9.3. Review and summarize savings, investment strategies, and purchasing options (e.g., cash, lease, finance, stocks, bonds).
- 1.9.4. Identify credit types and their uses in order to establish credit.
- 1.9.5. Identify ways to avoid or correct debt problems.
- 1.9.6. Explain how credit ratings and the criteria lenders use to evaluate repayment capacity affect access to loans.
- 1.9.7. Review and summarize categories (types) of insurance and identify how insurances can reduce financial risk.
- 1.9.8. Identify income sources and expenditures.
- 1.9.9. Compare and contrast different banking services available through financial institutions.
- 1.9.10. Identify the role of depreciation in tax planning and liability.

**Outcome 1.10. Sales and Marketing**

Manage pricing, place, promotion, packaging, positioning, and public relations to improve quality customer service.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

**Competencies**

- 1.10.1. Identify how the roles of sales, advertising, and public relations contribute to a company’s brand.
- 1.10.2. Determine the customer's needs and identify solutions.
- 1.10.3. Communicate features, benefits, and warranties of a product or service to the customer.
- 1.10.4. Identify the company policies and procedures for initiating product and service improvements.
- 1.10.5. Monitor customer expectations and determine product/service satisfaction by using measurement tools.
- 1.10.6. Discuss the importance of correct pricing to support a product’s or service’s positioning in the marketing mix.
- 1.10.7. Describe the importance and diversity of distribution channels (i.e., direct, indirect) to sell a product.
- 1.10.8. Use promotional techniques to maximize sales revenues (e.g., advertising, sales promotions, publicity, public relations).
- 1.10.9. Describe how product mix (e.g., product line, product items, bundling) maximizes sales revenues, market, share, and profit margin.
- 1.10.10. Demonstrate sales techniques.

**Outcome 1.11. Principles of Business Economics**

Examine and employ economic principles, concepts, and policies to accomplish organizational goals and objectives.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

**Competencies**

- 1.11.1. Identify the economic principles that guide geographic location of an industry's facilities (e.g., relative scarcity, price, quantity of products and services).
- 1.11.2. Identify the difference between monetary and nonmonetary incentives and explain how changes in incentives cause changes in behavior.
- 1.11.3. Use economic indicators to identify economic trends and conditions (e.g., inflation, interest rate fluctuations, unemployment rates).
- 1.11.4. Determine how the quality, quantity, and pricing of goods and services are affected by domestic and international competition in a market economy.
- 1.11.5. Analyze factors that affect currency and exchange rates.
- 1.11.6. Explain how financial markets and government policies influence interest rates (credit ratings/debt ceiling), trade deficits, and unemployment.
- 1.11.7. Describe how economic performance and culture are interdependent.
- 1.11.8. Identify the relationships between economy, society, and environment that lead to sustainability.
- 1.11.9. Describe how laws and regulations influence domestic and international trade.

## Strand 2. IT Fundamentals

Learners apply fundamental principles of IT, including the history of IT and its impact on society, common industry terms, systems theory, information storage and retrieval, database management, and computer hardware, software, and peripheral device configuration and installation. This base of knowledge and skills may be applied across the career field.

### Outcome 2.1. Security, Risks, and Safeguards

Describe the need for security and explain security risks and security safeguards.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 2.1.1. Explain the need for confidentiality, integrity, and availability (CIA) of information.
- 2.1.2. Describe authentication, authorization, and auditing.
- 2.1.3. Describe multilevel security.
- 2.1.4. Identify security risks and describe associated safeguards and methodologies (e.g., auditing).
- 2.1.5. Describe major threats to computer systems (e.g., internal threats, viruses, worms, spyware, malware, ransomware, spoofing, hacking).
- 2.1.6. Describe the components of the physical environment (e.g., wiring closets, server rooms) and physical security systems.
- 2.1.7. Describe the need for security in networking.
- 2.1.8. Describe the need for security in application development.
- 2.1.9. Track and catalogue physical assets.
- 2.1.10. Describe computer forensics, its importance in information security and cybersecurity, and its relevance to law enforcement.
- 2.1.11. Identify the need for personal security in digital information and describe how personal information can be safeguarded.
- 2.1.12. Practice information security per job requirements.
- 2.1.13. Describe privacy security compliance on systems (e.g., Health Insurance Portability and Accountability Act [HIPAA], Payment Card Industry [PCI], Sarbanes-Oxley Act [SOX], Americans with Disabilities Act [ADA]).

## Outcome 2.2. Networking Fundamentals

Apply networking fundamentals to infrastructure systems.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 2.2.1. Differentiate between Local Area Networks (LANs), Wide Area Networks (WANs), Wireless Local Area Networks (WLANs), and Near Field Communication (NFC).
- 2.2.2. Select the basic point-to-point (PTP) and point-to-multipoint (PTMP) network topologies (e.g., star, ring, tree, network, mesh, irregular) and broadband and baseband transmission methods.
- 2.2.3. Select network storage techniques (e.g., fiber channel, Internet Small Computer System Interface [iSCSI], Internet Protocol [IP], Fiber Channel over Ethernet [FCoE], Serial Attached SCSI [SAS], Network File Systems [NFS], Network Attached Storage/Server Message Blocks [NAS/SMB], Redundant Array of Inexpensive Disks [RAID]).
- 2.2.4. Differentiate between the Internet, intranets, and extranets.
- 2.2.5. Identify and apply Transmission Control Protocol and Internet Protocol (TCP/IP), Internet Protocol Version 4 (IPv4), Internet Protocol Version 6 (IPv6) applications and services (e.g., rlogin, Simple Mail Transfer Protocol [SMTP], Telecommunications Network [Telnet], File Transfer Protocol [FTP], Domain Name System [DNS], Network File System [NFS], Voice over Internet Protocol [VoIP], Internet Control Message Protocol [ICMP]).
- 2.2.6. Differentiate between cable types (e.g., fiber optic, twisted pair, coaxial) and interfaces.
- 2.2.7. Identify the top-level domains (e.g., .gov, .com, .edu).
- 2.2.8. Describe the characteristics and uses of networks, network devices, and components (e.g., hubs, switches, routers, firewalls).

## Outcome 2.3. Data Encoding

Explain and describe data encoding basics.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 2.3.1. Identify and explain coding information and representation of characters (e.g., American Standard Code for Information Interchange [ASCII], Extended Binary Coded Decimal Interchange Code [EBCDIC], Unicode).
- 2.3.2. Convert between numbering systems (e.g., binary, hexadecimal, decimal).

## Outcome 2.4. Emerging Technologies

Identify trending technologies, their fundamental architecture, and their value in the marketplace.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 2.4.1. Investigate the scope and the impact of mobile computing environments on society.
- 2.4.2. Describe the differences, advantages, and limitations of cloud computing (e.g., public cloud, private cloud, hybrid cloud) and on-premises computing.
- 2.4.3. Utilize cloud computing applications (e.g., services, applications, virtual environments).

## Outcome 2.5. Operating Systems

Maintain operating systems (OSs).

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 2.5.1. Compare and contrast OSs for computer hardware (e.g., personal computers, servers, mainframes, and mobile devices).
- 2.5.2. Describe virtual machines and why they are used.
- 2.5.3. Identify the properties of open and proprietary systems.
- 2.5.4. Maintain file structures in an OS.
- 2.5.5. Use system utilities to maintain an OS.
- 2.5.6. Describe OS interfaces (e.g., command line, Graphic User Interface [GUI]).
- 2.5.7. Install and test updates and patches to OSs.

## **Outcome 2.6. Installation and Configuration**

Install and configure hardware and software.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X	X	X	X

### **Competencies**

- 2.6.1. Comply with license agreements for software and hardware and describe the consequences of noncompliance.
- 2.6.2. Identify hardware requirements for software applications.
- 2.6.3. Verify software compatibility and troubleshoot any software incompatibility.
- 2.6.4. Install and test new software and software upgrades on stand-alone, mobile, and networked systems.
- 2.6.5. Preserve, convert, or migrate existing data files to a new format.
- 2.6.6. Determine compatibility of software and hardware and resolve any conflicts.
- 2.6.7. Install and test hardware peripherals.
- 2.6.8. Document the installation and configuration of hardware and software.

## **Outcome 2.7. Web Architecture**

Explain the fundamentals of delivering information and applications using web architecture.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X	X	X	X

### **Competencies**

- 2.7.1. Describe methods of securely transmitting data.
- 2.7.2. Describe ways to present data (e.g., mobile applications, desktop applications, web applications).
- 2.7.3. Differentiate between a client and a server.
- 2.7.4. Identify how the use of different browsers and devices affects the look of a webpage.
- 2.7.5. Explain the relationship between data transmission volumes, bandwidth, and latency.
- 2.7.6. Describe the characteristics and use of browser plug-ins.
- 2.7.7. Compare the advantages and disadvantages of running an in-house server or using a service provider.
- 2.7.8. Describe the difference between static and dynamic sites and the reasons for using each.

## Outcome 2.8. Databases

Describe the fundamentals of databases.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 2.8.1. Identify emerging database technology (e.g., Not only Structured Query Language [NoSQL], New Structured Query Language [NewSQL], graph databases).
- 2.8.2. Identify the purpose and uses of a database.
- 2.8.3. Compare and contrast databases (e.g., flat file, hierarchical, relational).
- 2.8.4. Describe the elements of a database (e.g., table, record/row, field, relationships, transactions).
- 2.8.5. Describe the elements of a database user interface (e.g., form, queries, filters, reports).
- 2.8.6. Describe the uses of a Database Management System (DBMS).
- 2.8.7. Describe how data can be stored in and extracted from a database.
- 2.8.8. Explain the importance of data integrity and security.
- 2.8.9. Differentiate between a front-end interface and a back-end database.

## Outcome 2.9. Project Concept Proposal

Develop a project concept proposal.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 2.9.1. Identify and incorporate branding strategies.
- 2.9.2. Determine the scope and purpose of the project.
- 2.9.3. Determine the target audience, client needs, expected outcomes, objectives, and budget.
- 2.9.4. Develop a conceptual model and design brief for the project.
- 2.9.5. Develop a timeline, a communication plan, a task breakdown, costs (e.g., equipment, labor), deliverables, and responsibilities for completion.
- 2.9.6. Develop and present a comprehensive proposal to stakeholders.

**Outcome 2.10. Equipment**

Select, operate, and maintain equipment.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

**Competencies**

- 2.10.1. Identify hardware platforms, configurations, and support models.
- 2.10.2. Identify processor, memory, and storage requirements.
- 2.10.3. Identify architecture requirements.
- 2.10.4. Identify software application requirements.
- 2.10.5. Prepare and operate equipment per project design specifications.
- 2.10.6. Monitor equipment operation and troubleshoot issues and problems.
- 2.10.7. Backup, archive, and manage data.
- 2.10.8. Prepare equipment for storage or decommissioning.
- 2.10.9. Perform routine maintenance per manufacturer specifications.

**Outcome 2.11. Troubleshooting**

Select and apply troubleshooting methodologies for problem solving.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

**Competencies**

- 2.11.1. Identify the problem.
- 2.11.2. Select troubleshooting methodology (e.g., top down, bottom up, follow the path, spot the differences).
- 2.11.3. Investigate symptoms based on the selected methodology.
- 2.11.4. Gather and analyze data about the problem.
- 2.11.5. Design a solution.
- 2.11.6. Test a solution.
- 2.11.7. Implement a solution.
- 2.11.8. Document the problem and the verified solution.

## **Outcome 2.12. Performance Tests and Acceptance Plans**

Develop performance tests and acceptance plans.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X	X	X	X

### **Competencies**

- 2.12.1. Create a written procedure agreed by the stakeholders and project team for determining the acceptability of the project deliverables.
- 2.12.2. Develop a test system that accurately mimics external interfaces.
- 2.12.3. Develop test cases that are realistic, compare with expected performance, and include targeted platforms and device types.
- 2.12.4. Develop, perform, and document usability and testing integration.
- 2.12.5. Make corrections indicated by test results.
- 2.12.6. Seek stakeholder acceptance upon successful completion of the test plan.

## **Outcome 2.13. Rollout and Handoff**

Plan rollout and facilitate handoff to customer.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X	X	X	X

### **Competencies**

- 2.13.1. Include overall project goals and timelines in the rollout plan.
- 2.13.2. Communicate rollout plans to key stakeholders in a timely manner.
- 2.13.3. Conduct final review and approvals according to company standards.
- 2.13.4. Identify support staff, training needs, and contingency plans in the rollout plan.
- 2.13.5. Test delivered application to assure that it is fully functional for the customer or user and meets all requirements.
- 2.13.6. Deliver support and training materials.

### Strand 3. Information Security

Learners apply principles of information security to implement and maintain security compliance and network security. Learners select components and mechanisms required for a multilayer defense structure and evaluate and minimize security risks to wired and wireless networks and devices.

#### Outcome 3.1. Components of Information Security

Describe the components associated with information security systems.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

#### Competencies

- 3.1.1. Differentiate between authentication and authorization.
- 3.1.2. Compare and contrast authentication techniques (e.g., single factor, multifactor, passwords, biometrics, certificates, Radio Frequency Identification [RFID] cards).
- 3.1.3. Compare and contrast methods of achieving information assurance and integrity and confidentiality (e.g., digital signatures, digital certifications, hashing algorithms, encryption).
- 3.1.4. Describe Virtual Private Networks (VPNs) using tunneling protocols (e.g., Layer 2 Tunneling Protocol [L2TP], Secure Socket Tunneling Protocol [SSTP], Point-to-Point Tunneling Protocol [PPTP]) and encrypting techniques).
- 3.1.5. Discuss the role of certificate authorities (CAs) and Public Key Infrastructure (PKI).

#### Outcome 3.2. General Security Compliance

Implement and maintain general security compliance.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

#### Competencies

- 3.2.1. Identify and implement data and application security.
- 3.2.2. Implement backup and verification procedures (e.g., tape, disk, cloud).
- 3.2.3. Describe and assign permissions (e.g., read-only, read-write).
- 3.2.4. Provide user authentication (e.g., assign and reset user accounts and passwords).
- 3.2.5. Install, test, implement, and update virus and malware detection and protection software.
- 3.2.6. Identify sources of virus and malware infection and remove viruses and malware.
- 3.2.7. Provide documentation, training, and support to users on established security procedures.
- 3.2.8. Identify the need for disaster recovery policies and procedures.

### Outcome 3.3. Network Security

Implement and maintain network security.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X		X	

#### Competencies

- 3.3.1. Describe network security policies (e.g., acceptable use policy).
- 3.3.2. Identify security appliances and describe the role of each in a networked environment.
- 3.3.3. Devise account administration functions to support network security.
- 3.3.4. Describe Access Control Lists (ACLs) and explain why they are used.
- 3.3.5. Assess risks based on vulnerability of the organization, likelihood of risk, and impact on the organization.
- 3.3.6. Describe patch management and its purposes.
- 3.3.7. Train users in network security procedures.

### Outcome 3.4. Multilayer Defense Structure

Explain information technology mechanisms as they apply to a multilayer defense structure.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X		X	

#### Competencies

- 3.4.1. Describe available systems for intrusion prevention, detection, and mitigation.
- 3.4.2. Review system log files to identify security risks.
- 3.4.3. Compare and contrast network analysis software (e.g., network analyzer) and hardware tools to identify security risks and vulnerabilities.
- 3.4.4. Identify the components of human security (e.g., social engineering) and techniques to mitigate human security threats (e.g., policies, procedures, training).

**Outcome 3.5. Wireless Security**

Implement secure wireless networks.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X		X	

**Competencies**

- 3.5.1. Describe wireless security risks (e.g., unauthorized access) and how to mitigate them.
- 3.5.2. Compare and contrast methods of increasing the security of wireless networks and devices (e.g., Media Access Control [MAC] address filtering, Wired Equivalent Privacy [WEP], Wi-Fi Protected Access [WPA], 802.1x, Remote Authentication Dial In User Service [RADIUS]).
- 3.5.3. Identify security enhancements provided by Institute of Electrical and Electronics Engineers (IEEE) 802.11(x).
- 3.5.4. Describe practices and policies for preventing and detecting installation of rogue networks.
- 3.5.5. Describe security practices and policies for personal devices.
- 3.5.6. Implement and test the security of a wireless network.

## Strand 4. Infrastructure Systems

Learners apply principles of networking and infrastructure related to the installation, administration, and maintenance of computer networks and components. Knowledge and skills may be applied to network connectivity, cabling, protocols, architecture, classification, topologies, operating systems, Open Systems Interconnection (OSI) standards, data encoding, Quality of Service (QoS), Internet Protocol (IP) addressing, and wide area network (WAN) design.

### Outcome 4.1. Network Infrastructure

Build a multinode network.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X		X	

### Competencies

- 4.1.1. Determine the basic point-to-point (PTP) and point-to-multipoint (PTMP) network topologies (e.g., star, ring, tree, mesh, hybrid) and identify broadband and baseband (e.g., Ethernet) transmission methods and standards.
- 4.1.2. Explain packet-switching techniques.
- 4.1.3. Compare the characteristics of connection-oriented and connectionless protocols and select protocols based on given criteria.
- 4.1.4. Identify standard and emerging network technologies (e.g., broadband, satellite nets, optic nets, Integrated Services Digital Network [ISDN], Switched Multimegabit Data Service [SMDS], Asynchronous Transfer Mode [ATM], T1, T3, Synchronous Optical Network [SONET], interplanetary Internet, Long-Term Evolution [LTE], High Speed Packet Access [HSPA]).
- 4.1.5. Describe how Unified Communication (UC) integrates voice, data, and video communications.
- 4.1.6. Configure and build a network.

## Outcome 4.2. Open Systems Interconnection

Describe the Open Systems Interconnection (OSI) standard (International Organization for Standardization [ISO] Standard 7498).

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X		X	

### Competencies

- 4.2.1. Identify the benefits of using a layered network model.
- 4.2.2. Compare OSI stack positions and their relationships to one another.
- 4.2.3. Compare the seven layers of the OSI stack to the four layers of the Transmission Control Protocol/Internet Protocol (TCP/IP) stack.
- 4.2.4. Compare the basics of TCP/IP layers, components, and functions.
- 4.2.5. Describe actions to be performed at each of the OSI physical layers.
- 4.2.6. Explain how the OSI layers relate to the elements of network communication.

## Outcome 4.3. Network Media

Select, assemble, terminate, and test media.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X		X	

### Competencies

- 4.3.1. Identify the criteria used in selecting media (e.g., physical properties, transmission technologies, transmission span, bandwidth, topology, security, noise immunity, installation considerations, cost).
- 4.3.2. Differentiate between media types (e.g., coaxial, twisted pair, fiber optic) and interfaces.
- 4.3.3. Compare and contrast media categories (e.g., single mode, multimode, CAT5, CAT5E, CAT6+).
- 4.3.4. Describe types of media connectors (e.g., Bayonet Neill-Concelman [BNC], Registered Jack [RJ]-45, LC, ST) and grounding techniques.
- 4.3.5. Identify media standards (e.g., American National Standards Institute [ANSI], Electronic Industries Alliance/Telecommunications Industry Association [EIA/TIA]-568, EIA/TIA-568A and 568B).
- 4.3.6. Identify the advantages and disadvantages of cabling systems.
- 4.3.7. Describe typical problems associated with cable installation.
- 4.3.8. Assemble and test Ethernet cable (e.g., straight-through, crossover, loopback).

#### **Outcome 4.4. Wireless Communications**

Explain wireless communications.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X		X	

#### **Competencies**

- 4.4.1. Compare and contrast wireless standards in common use (e.g., Institute of Electrical and Electronics Engineers [IEEE] 802.11, Bluetooth, Worldwide Interoperability for Microwave Access [WiMAX], Radio Frequency Identification [RFID], Near Field Communication [NFC]).
- 4.4.2. Compare and contrast characteristics of wireless signals (e.g., reflection, diffraction, scattering, fading).
- 4.4.3. Differentiate media access methods used by wireless.
- 4.4.4. Describe appropriate applications of wireless technologies to specific communication scenarios.

#### **Outcome 4.5. Wireless Network Solutions**

Design and implement wireless network solutions.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
X		X	

#### **Competencies**

- 4.5.1. Compare and contrast secure wireless solutions operating in ad-hoc mode and infrastructure mode.
- 4.5.2. Describe the frequency ranges and associated rules in the wireless spectrum as managed by the Federal Communication Commission (FCC).
- 4.5.3. Describe the Service Set Identifier (SSID) as used in wireless communications.
- 4.5.4. Select and install access points, wireless Network Interface Cards (NICs), antennas, and other hardware and software components to provide a wireless networking solution as determined by a site and customer survey.
- 4.5.5. Troubleshoot Wireless Local Area Networks (WLANs) using system logs, vendor-provided utilities, and diagnostic tools.
- 4.5.6. Secure the wireless network.

## Outcome 4.6. Network Protocols

Compare and contrast network protocols.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X		X	

### Competencies

- 4.6.1. Explain network protocols (e.g., Transmission Control Protocol/Internet Protocol [TCP/IP], User Datagram Protocol [UDP], Internet Protocol Version 4 [IPv4], Internet Protocol Version 6 [IPv6]).
- 4.6.2. Identify the advantages and disadvantages of well-known protocols (e.g., Domain Name System [DNS], File Transfer Protocol [FTP], Secure Hypertext Transfer Protocol [HTTPS], Telecommunications Network [Telnet], Dynamic Host Configuration Protocol [DHCP], Remote Desktop Protocol [RDP]) and associated port numbers.
- 4.6.3. Explain the purposes of encapsulation and decapsulation and their relationship to the Open Systems Interconnection (OSI) model.
- 4.6.4. Explain the difference between User Datagram Protocol (UDP) and TCP.
- 4.6.5. Identify TCP and UDP conventional ports (e.g., Simple Mail Transfer Protocol [SMTP], Telnet, Hypertext Transfer Protocol [HTTP], FTP).
- 4.6.6. Explain TCP/IP protocol details (e.g., Internet addresses, Address Resolution Protocol [ARP], Reverse Address Resolution Protocol [RARP], IP datagram format, routing IP datagrams, TCP segment format, IPv4, IPv6).
- 4.6.7. Describe a Virtual Private Network (VPN) and identify associated protocols (e.g., Layer 2 Tunneling Protocol [L2TP], Point-to-Point Tunneling Protocol [PPTP]).
- 4.6.8. Capture and analyze data packets.

### **Outcome 4.7. Transmission Control Protocol/Internet Protocol (TCP/IP)**

Describe IP addressing schemes and create subnet masks.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
		X	

#### **Competencies**

- 4.7.1. Explain Fully Qualified Domain Names (FQDNs) and how they are used.
- 4.7.2. Explain the IP addressing scheme and how it is used.
- 4.7.3. Identify Class A, B, and C reserved (i.e., private) address ranges and why they are used.
- 4.7.4. Identify the class of network to which a given address belongs.
- 4.7.5. Differentiate between default subnet masks and custom subnet masks.
- 4.7.6. Explain the relationship between an IP address and its associated subnet mask.
- 4.7.7. Identify the differences between classful and classless addressing schemes.
- 4.7.8. Identify multicasting addresses and explain why they are used.
- 4.7.9. Create custom subnet masks to meet network design requirements.
- 4.7.10. Compare and contrast Internet Protocol Version 4 (IPv4) and Internet Protocol Version 6 (IPv6).

### **Outcome 4.8. Network Architecture**

Describe network architecture.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
		X	

#### **Competencies**

- 4.8.1. Describe media-access protocols (e.g., Carrier Sense Multiple Access with Collision Detection [CSMA/CD], Carrier Sense Multiple Access with Collision Avoidance [CSMA/CA]).
- 4.8.2. Identify the components of and relationships within the Institute of Electrical and Electronics Engineers (IEEE) 802 standards.
- 4.8.3. Identify Local Area Network (LAN) performance factors (e.g., signal attenuation, signal propagation delay).

### Outcome 4.9. Network Operating Systems

Describe and install network operating systems (OSs).

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
		X	

#### Competencies

- 4.9.1. Explain how the components of a network OS (i.e., server platform, network services software, network redirection software, communications software) and all support network operations.
- 4.9.2. Identify licensing requirements.
- 4.9.3. Describe the characteristics of the tiered model (e.g., peer-to-peer, thin client, thick client, cloud).
- 4.9.4. Analyze the advantages and disadvantages of the client/server model.
- 4.9.5. Select network and desktop OSs (e.g., Windows®, Linux, MacOS®, iOS®, Android™).
- 4.9.6. Install, test, and patch network OSs manually and using automation.
- 4.9.7. Log in to a network device (e.g., router, Secure File Transfer Protocol [SFTP] server, directory server).
- 4.9.8. Evaluate the performance of the network OS.

### Outcome 4.10. Network Administration

Administer network operating systems and services.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
		X	

#### Competencies

- 4.10.1. Select physical and logical topology.
- 4.10.2. Connect devices to network systems.
- 4.10.3. Create domain trusts.
- 4.10.4. Maintain domain controllers.
- 4.10.5. Create user accounts, groups, and login scripts.
- 4.10.6. Establish shared network resources.
- 4.10.7. Define and set access controls on files, folders, shares, and directories.
- 4.10.8. Configure network domain accounts and profiles.
- 4.10.9. Create roaming user profiles and use Group Policy Objects (GPO) to manage the user environment.
- 4.10.10. Troubleshoot network performance connectivity (e.g., performance monitor, command line utilities).
- 4.10.11. Explain the fundamentals of Quality of Service (QoS).
- 4.10.12. Securely delegate standard management tasks.

### Outcome 4.11. Cloud Computing

Implement a hypervisor.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
		X	

#### Competencies

- 4.11.1. Differentiate between public, private, and hybrid clouds and describe the fundamental cloud components (e.g., shared or dedicated processing, storage, memory, networking, hypervisor).
- 4.11.2. Provision cloud services (e.g., Software as a Service [SaaS], Platform as a Service [PaaS], Infrastructure as a Service [IaaS], Security as a Service).

### Outcome 4.12. Wide Area Network

Design a wide area network (WAN).

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
		X	

#### Competencies

- 4.12.1. Select WAN connections (e.g., satellite, Synchronous Optical Network [SONET], T1, T3, E1, E3, Digital Subscriber Line [DSL], cable, Worldwide Interoperability for Microwave Access [WiMAX], Multiprotocol Label Switching [MPLS], frame relay).
- 4.12.2. Describe point-to-point (PTP) and point-to-multipoint (PTMP) interconnection.
- 4.12.3. Evaluate and select basic telecommunications services (e.g., satellite, circuit switching, wireless, packet switching) and carriers for WAN requirements.
- 4.12.4. Identify the role of telecommunications tariffs.
- 4.12.5. Determine availability from Local Area Network (LAN) to meet WAN requirements.
- 4.12.6. Determine the speed needed between sites to access applications.
- 4.12.7. Determine the subnets needed on the WAN (e.g., Variable Length Subnet Masking [VLSM]).
- 4.12.8. Evaluate and select transmission options.
- 4.12.9. Evaluate and select routing protocols (e.g., Border Gateway Routing Protocol [BGRP], Open Shortest Path First [OSPF], Routing Information Protocol Version 2 [RIPv2]).

**Outcome 4.13. Disaster Recovery**

Recommend disaster recovery and business continuity plans.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X		X	

**Competencies**

- 4.13.1. Differentiate between disaster recovery and business continuity.
- 4.13.2. Identify common backup devices.
- 4.13.3. Identify the criteria for selecting a backup system.
- 4.13.4. Establish a process for archiving files.
- 4.13.5. Develop a disaster recovery plan.

## Strand 5. Programming and Software Systems

Learners apply principles of computer programming and software development to develop code; build, test, and debug programs; create finished products; and plan, analyze, design, develop, implement, and support software applications.

### Outcome 5.1. Programming Concepts

Describe programming concepts.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

#### Competencies

- 5.1.1. Describe how computer programs and scripts can be used to solve problems (e.g., desktop, mobile, enterprise).
- 5.1.2. Explain how algorithms and data structures are used in information processing.
- 5.1.3. Model the solution using both graphic tools (e.g., flowcharts) and pseudocode techniques.
- 5.1.4. Describe, compare, and contrast the basics of procedural, structured, object-oriented (OO), and event-driven programming.
- 5.1.5. Describe the concepts of data management through programming languages.
- 5.1.6. Analyze the strengths and weaknesses of different languages for solving a specific problem.
- 5.1.7. Compare and contrast the functions and operations of compilers and interpreters.
- 5.1.8. Describe version control and the relevance of documentation.

### Outcome 5.2. Computational and String Operations

Develop code that performs computational and string operations.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X			X

#### Competencies

- 5.2.1. Compare and contrast primitive types of numeric and nonnumeric data (e.g., integers, floats, Boolean, strings).
- 5.2.2. Identify the scope of data (e.g., global versus local, variables, constants, arrays).
- 5.2.3. Write code that uses arithmetic operations.
- 5.2.4. Write code that uses subtotals and final totals.
- 5.2.5. Write code that applies string operations (e.g., concatenation, pattern matching, substring).

### Outcome 5.3. Logical Operations and Control Structures

Develop code that uses logical operations and control structures.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
			X

#### Competencies

- 5.3.1. Explain Boolean logic.
- 5.3.2. Solve a truth table.
- 5.3.3. Write code that uses logical operators (e.g., and, or, not).
- 5.3.4. Write code that uses relational operators and compound conditions.
- 5.3.5. Write code that uses conditional control structures (e.g., if, if-then-else).
- 5.3.6. Write code that uses repetition control structures (e.g., while, for).
- 5.3.7. Write code that uses selection control structures (e.g., case, switch).
- 5.3.8. Write code that uses nested structures and recursion.
- 5.3.9. Write code that creates and calls functions.
- 5.3.10. Code error-handling techniques.
- 5.3.11. Write code to access data repositories.
- 5.3.12. Write code to create classes, objects, and methods.

### Outcome 5.4. Integrated Development Environment

Build and test a program using an integrated development environment (IDE).

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
			X

#### Competencies

- 5.4.1. Configure options, preferences, and tools.
- 5.4.2. Write and edit code in the IDE.
- 5.4.3. Compile or interpret a working program.
- 5.4.4. Define test cases.
- 5.4.5. Test the program using defined test cases.
- 5.4.6. Correct syntax and runtime errors.
- 5.4.7. Debug logic errors.

**Outcome 5.5. Programming Conventions**

Develop programs using applications security best practices according to information security policies (e.g., cross-site scripting, Structured Query Language [SQL] injection attack, bounds-checking).

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
			X

**Competencies**

- 5.5.1. Develop programs using data validation techniques.
- 5.5.2. Develop programs that use reuse libraries.
- 5.5.3. Develop programs using operating system calls.
- 5.5.4. Develop programs that call other programs.
- 5.5.5. Use appropriate naming conventions and apply comments.
- 5.5.6. Format output (e.g., desktop, mobile, enterprise, reports, data files).

## Outcome 5.6. Software Development Lifecycle

Apply the software development lifecycle (SDLC).

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
			X

### Competencies

- 5.6.1. Determine requirements specification documentation.
- 5.6.2. Identify constraints and system processing requirements.
- 5.6.3. Develop and adhere to timelines.
- 5.6.4. Identify a programming language, framework, and an integrated development environment (IDE).
- 5.6.5. Identify input and output (I/O) requirements.
- 5.6.6. Design system inputs, outputs, and processes.
- 5.6.7. Document a design using the appropriate tools (e.g., program flowchart, dataflow diagrams, Unified Modeling Language [UML]).
- 5.6.8. Create documentation (e.g., implementation plan, contingency plan, data dictionary, user help).
- 5.6.9. Review the design (e.g., peer walkthrough).
- 5.6.10. Present the system design to stakeholders.
- 5.6.11. Develop the application.
- 5.6.12. Compare and contrast software methodologies (e.g., agile, waterfall).
- 5.6.13. Perform code reviews (e.g., peer walkthrough, static analysis).
- 5.6.14. Ensure code quality by testing and debugging the application (e.g., system testing, user acceptance testing).
- 5.6.15. Train stakeholders.
- 5.6.16. Deploy the application.
- 5.6.17. Collect application feedback and maintain the application.

## Outcome 5.7. Configuration Management

Describe configuration management activities.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
			X

### Competencies

- 5.7.1. Explain version management and interface control.
- 5.7.2. Explain baseline and software lifecycle phases.
- 5.7.3. Analyze the impact of changes.

## Strand 6. Web Development

Learners apply principles of design and technology, including programming standards and protocols, to create, test, host, and maintain web pages and websites with text, graphics, multimedia, scripting, linking, and data integration in a structure that is easy to navigate and accessible for all users via a variety of hardware and software platforms.

### Outcome 6.1. Web pages

Create basic web pages.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

#### Competencies

- 6.1.1. Describe the basic principles of Hypertext Markup Language (HTML) and its functional relationship with web browsers.
- 6.1.2. Plan a web page considering subject, devices, audience, layout, color, links, graphics, and Americans with Disabilities Act (ADA) requirements.
- 6.1.3. Format the text of a web page in a WYSIWYG (What You See Is What You Get) editor and in a text editor using HTML formatting tags (e.g., hyperlink, e-mail, table formatting, graphic attributes).
- 6.1.4. Use writing process techniques (i.e., drafting, revising, editing, proofreading) to check the web page for format and text accuracy.
- 6.1.5. Create and format ordered and unordered lists on a web page using HTML list formatting tags.
- 6.1.6. Create and format a table in a web page using HTML table formatting tags and attributes.
- 6.1.7. Integrate styles (e.g., inline or external Cascading Style Sheets [CSS]).

### Outcome 6.2. Links and Multimedia

Add links to a web page and insert multimedia files.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X		X

#### Competencies

- 6.2.1. Create absolute links and relative links.
- 6.2.2. Write a Hypertext Markup Language (HTML) anchor that links to another section of the same web page.
- 6.2.3. Create hyperlinks that send e-mail messages and download files.
- 6.2.4. Insert image and wrap text around the image using Cascading Style Sheets (CSS).
- 6.2.5. Resize a graphic image in a web page using CSS.
- 6.2.6. Insert audio and video files into a web page using HTML tags.
- 6.2.7. Build a hover or mouseover effect to change the style of a link.

### **Outcome 6.3. Scripting**

Integrate scripting into a web page.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
	X		X

#### **Competencies**

- 6.3.1. Select and apply scripting languages used in web development.
- 6.3.2. Insert client-side script into a web page.
- 6.3.3. Insert comments into client-side scripts.

### **Outcome 6.4. Web Forms**

Integrate forms into a web page.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
	X		X

#### **Competencies**

- 6.4.1. Design a data entry form from specifications that will accept a variety of user inputs, (e.g., radio buttons, text entry fields, check boxes, drop-down menus).
- 6.4.2. Write the Hypertext Markup Language (HTML) code to add a form to a web page.
- 6.4.3. Write the HTML code to add text entry fields, radio buttons, check boxes, drop-down menus, and other user inputs to a form.
- 6.4.4. Explain the concept of a form action.
- 6.4.5. Write the HTML code to add a working button (e.g., submit, reset) to a form.
- 6.4.6. Format a completed form using HTML and Cascading Style Sheets (CSS) (e.g., fieldset, tabindex).
- 6.4.7. Code scripting to interact with data sources (e.g., database, web services).

## Outcome 6.5. Websites

Create and update a website.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
	X		X

### Competencies

- 6.5.1. Implement web programming standards and protocols (e.g., World Wide Web Consortium [W3C], Hypertext Markup Language [HTML] 5).
- 6.5.2. Plan a website’s structure for navigation and usability.
- 6.5.3. Utilize standard web programming languages (e.g., markup, scripting languages) in website development.
- 6.5.4. Install and configure a content management system (CMS).
- 6.5.5. Select an integrated development environment (IDE).
- 6.5.6. Create and edit a web page template.
- 6.5.7. Create and attach Cascading Style Sheets (CSS).
- 6.5.8. Format website layout (e.g., targeted platforms, text formatting, background color, text, tables, lists, iframes).
- 6.5.9. Incorporate audio and video, forms, and links on a website.
- 6.5.10. Develop and execute usability tests on a completed website, checking for information accessibility, ease of use, and navigation.
- 6.5.11. Code a website for cross-platform and cross-browser compatibility and validation.
- 6.5.12. Publish the completed website to a web server.

## Strand 7. Digital Media

Learners apply principles of digital media to produce interactive media; develop and produce multimedia applications; integrate typography into media; create 3D models and 2D and 3D animation; and create digital video, audio, and photographs.

### Outcome 7.1. Interactive Media

Describe and explain interactive media and interactive media production.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
X	X	X	X

### Competencies

- 7.1.1. Identify the types and uses of interactive media environments (e.g., web-based, kiosks, games, mobile devices, video, print).
- 7.1.2. Describe the components of interactive media.
- 7.1.3. Identify the major characteristics of interactive media presentations.
- 7.1.4. Identify important historical developments and future trends in interactive media.
- 7.1.5. Identify the major interactive media genres.
- 7.1.6. Perform critical review of interactive media products in different genres.
- 7.1.7. Identify the intellectual property rights, responsibilities, and controls related to interactive media.
- 7.1.8. Analyze the social and cultural implications of interactive media.
- 7.1.9. Identify major applications for interactive media (e.g., sales and marketing, interactive advertising, education, corporate training, corporate communications, distance learning, news, entertainment).
- 7.1.10. Identify specific uses for interactive media in each potential market.

## Outcome 7.2. Multimedia Tools

Develop navigational structures, scripts, storyboards, and flowcharts for multimedia applications.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
	X		

### Competencies

- 7.2.1. Choose a navigational menu structure (e.g., rollovers, drop-downs, disjointed).
- 7.2.2. Construct and place navigational units.
- 7.2.3. Build in interactive elements.
- 7.2.4. Determine uses and needs for site maps, multimedia scripts, storyboards, and flowcharts.
- 7.2.5. Make preliminary sketches showing placement of images and text on screen.
- 7.2.6. Show placement of buttons and navigational graphics.
- 7.2.7. Provide information on color schemes.
- 7.2.8. Describe music, video, and special effects to be used.
- 7.2.9. Provide a sample layout to stakeholders for review.
- 7.2.10. Select and create visual design elements appropriate for the intended audience and use.
- 7.2.11. Develop characters and narrative to support intended outcomes.

## Outcome 7.3. Production

Produce interactive media.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
	X		X

### Competencies

- 7.3.1. Select the media elements to be used (e.g., sound, video, graphics, text, animation).
- 7.3.2. Generate text for multi-image presentations (e.g., title graphics, charts, graphs).
- 7.3.3. Incorporate graphics (e.g., digital, hand-drawn, photographic).
- 7.3.4. Incorporate computer animation.
- 7.3.5. Prepare and integrate photographic images and special effects with graphic images.
- 7.3.6. Incorporate video footage.
- 7.3.7. Edit video footage.
- 7.3.8. Record and/or acquire sound tracks (e.g., narrative, voiceover, sound effects, music).
- 7.3.9. Integrate sound with visuals.
- 7.3.10. Produce, test, debug, and archive a final product.

### **Outcome 7.4. Graphics**

Construct and manipulate digital graphics.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
	X		

#### **Competencies**

- 7.4.1. Identify the purpose and intended audience of graphics.
- 7.4.2. Select color, shape, size, and texture of objects.
- 7.4.3. Create or acquire graphics.
- 7.4.4. Manipulate and layer objects.
- 7.4.5. Differentiate between vector and raster images.
- 7.4.6. Select an appropriate graphic file format and resolution.
- 7.4.7. Optimize and export graphics files for intended use.
- 7.4.8. Select graphic software applications.
- 7.4.9. Manipulate graphic objects.
- 7.4.10. Compress and decompress graphic files.
- 7.4.11. Describe and select color profiles (e.g., Red Green Blue [RGB], Cyan Magenta Yellow Key [CMYK], Pantone).

### **Outcome 7.5. Typography**

Integrate typography in media.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
	X		

#### **Competencies**

- 7.5.1. Identify typographic measurements (e.g., picas, points, pixels, em’s).
- 7.5.2. Mix families of type within a project.
- 7.5.3. Select appropriate kerning, leading, tracking, and other related formatting.
- 7.5.4. Identify appropriate typefaces (e.g., serif, sans serif, Web Safe, screen, print).
- 7.5.5. Prepare a type style guide.

**Outcome 7.6. Animation**

Create 2D and 3D animation.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
	X		

**Competencies**

- 7.6.1. Develop a plan and storyboard for an animation.
- 7.6.2. Import 2D or 3D assets.
- 7.6.3. Create key frames and apply tweens and paths.
- 7.6.4. Create special effects and virtual navigation.
- 7.6.5. Create 2D or 3D environments.
- 7.6.6. Render and export animations.

**Outcome 7.7. Video**

Create a video production.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
	X		

**Competencies**

- 7.7.1. Identify equipment and other production needs.
- 7.7.2. Analyze the script and storyboard to develop a production schedule.
- 7.7.3. Set up audio, lighting, and scenery for the shoot.
- 7.7.4. Select a video recording format and shoot the video.
- 7.7.5. Select a linear or nonlinear editing system and edit the video.
- 7.7.6. Add transitions (e.g., dissolves, wipes, cuts), titles, special effects, and digital effects.
- 7.7.7. Add a sound track, narration, and/or voiceover.
- 7.7.8. Export video to the desired medium.

**Outcome 7.8. Audio**

Create an audio production.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
	X		

**Competencies**

- 7.8.1. Evaluate performance needs and technical resources.
- 7.8.2. Identify sound requirements based on script analysis.
- 7.8.3. Design score appropriate to production and post-production needs.
- 7.8.4. Determine microphone and speaker placement.
- 7.8.5. Select and incorporate Foley mechanical and electrical sound effects.
- 7.8.6. Set up and operate audio-for-video recording devices.
- 7.8.7. Set up and operate a time code system for audio-video synchronization.
- 7.8.8. Perform audio mixing.

**Outcome 7.9. Photographs**

Create photographs.

An “X” indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
	X		

**Competencies**

- 7.9.1. Select and set up lighting needed (e.g., electronic flash units, reflectors, bounce, spot, daylight).
- 7.9.2. Select a digital file format or film format and camera.
- 7.9.3. Select and attach lenses (e.g., wide-angle, telephoto, zoom) and filters (e.g., color-compensating, polarizing, special effects).
- 7.9.4. Determine composition, formal qualities, scale, and use of space.
- 7.9.5. Shoot photographs.
- 7.9.6. Edit photographs (e.g., color corrections, cropping, enhancements).

## Strand 8. Databases

Learners apply principles of designing, creating, and maintaining databases, including data storage, retrieval, modeling, manipulation, and formatting; database access, management, and administration; and database hardware and software issues.

### Outcome 8.1. Data Modeling

Develop a data model to describe an application's data.

An "X" indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
			X

#### Competencies

- 8.1.1. Develop specifications for a database in consultation with the client.
- 8.1.2. Identify the real-world entities (e.g., customers, purchases) to put in a table and the attributes of the entities (e.g., customer names and addresses, purchase dates and amounts).
- 8.1.3. Identify the relationships between database entities.
- 8.1.4. Determine the data types (e.g., text, numbers) and domains (e.g., number greater than zero, text string of two letters) of attributes.
- 8.1.5. Determine whether attributes allow for a null value.
- 8.1.6. Determine unique identifiers (i.e., keys) of entities.
- 8.1.7. Normalize the data model as appropriate for the application.
- 8.1.8. Generate data modeling documentation (e.g., entity-relationship, workflow, Unified Modeling Language [UML]).
- 8.1.9. Verify that the data model matches specifications.

### Outcome 8.2. Design and Creation

Design and create databases.

An "X" indicates that the pathway applies to the outcome.

Information Support and Services	Interactive Media	Network Systems	Programming and Software Development
			X

#### Competencies

- 8.2.1. Design and create database tables and relationships.
- 8.2.2. Create database columns and specify properties (e.g., name, type, domain).
- 8.2.3. Name tables and fields in conformance with naming conventions.
- 8.2.4. Define indexes as appropriate for the application.

### **Outcome 8.3. Data Entry and Access**

Enter and access data in databases.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
			X

#### **Competencies**

- 8.3.1. Create, edit, and delete records.
- 8.3.2. Enter and bulk import data into databases and transfer data between databases.
- 8.3.3. Write Structured Query Language (SQL) scripts and stored procedures.
- 8.3.4. Retrieve, filter, sort, and parse data.
- 8.3.5. Commit and roll back transactions.
- 8.3.6. Generate and print forms, reports, and results of queries (e.g., calculated fields, functions).

### **Outcome 8.4. Database Management**

Manage databases.

An “X” indicates that the pathway applies to the outcome.

<b>Information Support and Services</b>	<b>Interactive Media</b>	<b>Network Systems</b>	<b>Programming and Software Development</b>
			X

#### **Competencies**

- 8.4.1. House database files in an environment appropriate to anticipated user demand.
- 8.4.2. Control user access to data.
- 8.4.3. Log access to the database by user and type of transaction.
- 8.4.4. Backup, verify, and recover data.