Acknowledgements

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EDC's Center for Education, Employment, and Community programs bring together people of diverse talents and backgrounds to create systems that help students learn to high standards, help workers advance in their careers, and help citizens participate in improving their communities. The Pathway Pipeline Model draws on the extensive knowledge base and experience of CEEC.

Our model is designed to help educators begin to bridge the gap between the technology skills they are helping students to develop and the long-term application of these skills to careers inside and outside of IT. As educators become more aware of the broad uses of these skills, existing and emerging partnerships with employers will ensure the continuous assessment of the IT skills relevant today and in the future.

We are grateful to many for their significant contributions:

Numerous individuals at EDC contributed to the success of this product. We would like to thank Vivian Guilfoy, vice president, for her guidance in forming the Techforce Collaborative and her conceptual leadership in developing the Nested System Model of IT for living, learning, and working. Rachel Kimboko and Carlin Llorente of the HUD Neighborhood Networks Project, in collaboration with Marsha Miller, New Hampshire's Southwest Regional School-to-Work coordinator and director of a Techforce Center of Excellence, helped us to refine the Pathway Pipeline Model Benchmarks chart describing what learners should be able to do as they progress in IT skill development. John Wong, senior project director, created the analysis of the ways that business and education can work together to ensure that the IT skills taught in school can be used in life and work. Additional input and assistance in refining and producing this document were provided by Judy Leff, senior project director; Tajah Holmes, office manager; Kimberly Sansoucy, project coordinator; Emily McLeod, administrative assistant; John Galvin, editor/writer; Siobhan Bredin, research associate; and Kay Baker, graphic designer.

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Finally, we acknowledge and thank the education and business communities with whom we have worked. Their sense of urgency about IT forced us to analyze standards and pathways and pipelines, to think through career development issues, to seek effective ways to connect technology skills learned in schools with information technology skill standards needed for success in life and work, and to present this information in useful ways for both communities.

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IT Pathway Pipeline Model: Rethinking Information Technology Learning in Schools

Executive Summary

This report describes the development of an Information Technology (IT) Pathway and Pipeline Model. This model supports the IT industry's need for a pipeline of talented workers and the education system's need for a pathway that provides learners with a foundation of IT knowledge and skills to use and build on in the future.

The need for an IT pathway goes beyond simple economics; everyone in today's complex society must acquire some degree of computer literacy to succeed, even to function, in today's IT-dominated world. Further, although many educators do not view their function as preparing students to enter the working world, they do want their students to be successful in work and life. The IT pathway must meet the needs of both the education and IT worlds. It must also overcome differences in methodologies and styles between these worlds to produce learners who meet the demands of the IT industry as well as their own personal goals.

While the student in the education system is taught IT skills in an orderly and sequential fashion, the IT professional must cope with learning multiple new technologies at a pace much more rapid than education has known in the past. The IT pathway and pipeline model, therefore, must provide learners with a pathway that will give them the foundation IT skills and career awareness that they need to succeed. The model must also provide IT employers with the required pool of talented IT workers.

National IT Issues

Issue 1: There is a severe IT skills gap and worker shortage, and a very unreliable job pipeline.
Goal 1: To create a reliable labor pool of skilled workers, with the required knowledge and skills in technical IT areas, foundations for success in IT (math, science, communications), and soft skills (problem solving, teaming) needed in the workforce.
Issue 2: IT education in the U.S. today is very fragmented; many students do not receive the career information and training they need when they need it to pursue IT careers.
Goal 2: To provide students and educators with the **information**, **career awareness**, **education and training** when and where they need it for an information age economy with IT at its core.

Challenges and Opportunities

One of the first challenges inherent in building an IT education to employment system is to reconcile educators' work in developing IT career pathways with industry's needs and expectations for skilled workers. Most educators view the IT pathway as a sequence of courses and work experiences that prepare learners for high skill, high wage IT jobs. The IT pathway can be found in a career major, a career magnet program, a vocational/technical program at a high school or community college, or a 4-year professional IT degree program.

Informed educators regard this pathway as a well paved, well lit road with on and off ramps, rotaries so that learners can change direction, exit and re-enter the pathway, and clearly marked travel lanes and exits leading to different places. This road is filled with different types of vehicles and with drivers of all ages. Some drivers know exactly where they want to go; they get in their cars and don't stop until they reach their destinations. Others stop at every scenic overlook and ocean view. The road has several well-marked lanes:

- One lane leads to life as an IT literate producer and consumer citizen—at one point or another everyone travels in this lane.
- Another leads to all jobs in which IT skills are used—a recent National Alliance of Business study tells us that 32 million people are traveling in this lane.
- Another lane leads to careers in technical fields with high IT use.
- Another lane leads to professional IT jobs.

For employers, the IT Pipeline is a multi-lane superhighway that ends in their parking lot. Part of their concern is to keep sufficient cars on the highway so that their parking lot always remains filled to capacity. The Techforce challenge in building IT employer participation in STW (School-To-Work) is to determine how IT employers can fully participate with educators in moving individuals into cars, providing them with maps, steering them to roads and, ultimately, into IT employers' parking lots.

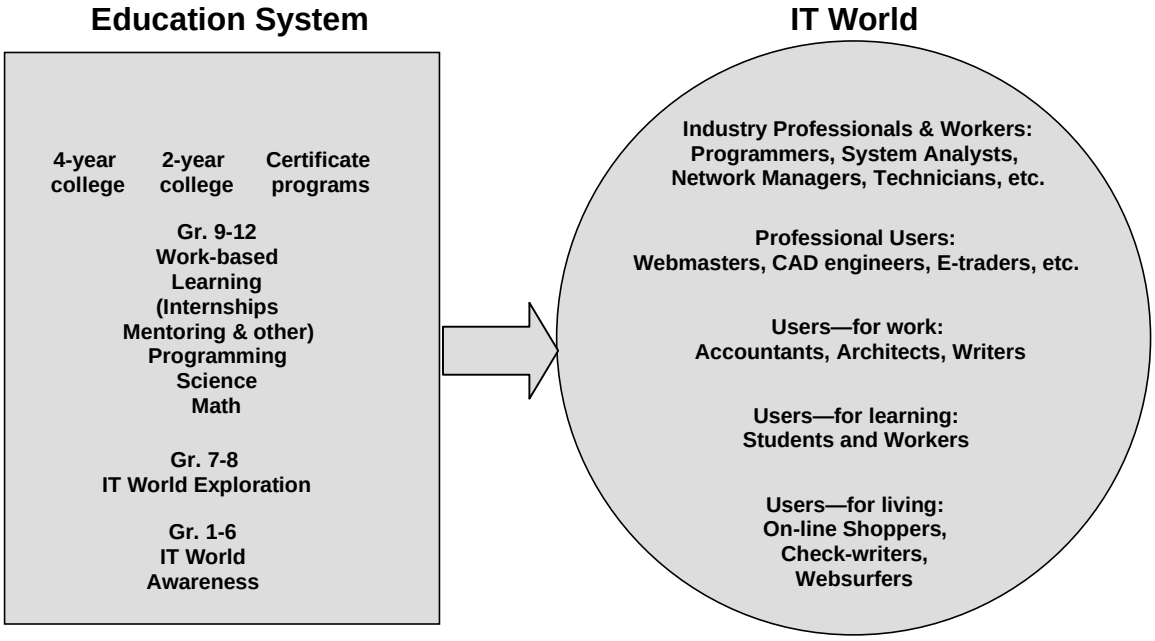
Technological change has raced ahead of attempts by local, state and national educators to design pathways and has cut deeply into every aspect of life and work. Our problem and challenge is that, as a nation, we have moved so quickly into the information age that the education system is still designing and constructing single-lane highways when superhighways are needed.

Our challenge is to examine both the education system and the IT world to create a model that best serves the needs and interests of both educators developing pathways to IT careers and employers seeking a larger pipeline into the IT industry. To maximize the learning and earning potential of all students, we must create IT pathways that reach broadly and deeply into our education system and connect IT foundation skills to learning standards throughout the K through 20 continuum.

Fitting a Square Peg into a Round Hole: Developing IT Skills in Schools vs. Using IT Skills in Life and Work

When we compare the current scope and sequence of IT learning in schools with the ways IT skills are used in the world around us, as illustrated in the graphic below, we see that the "fit" is not good. The primary difference between the education system and the IT industry concerns when and where IT learning takes place. In the traditional education system, IT learning takes place at specific times, within prescribed programs and courses, and at specific levels.

Although many learners develop sophisticated IT skills for learning at early ages, developing IT skills for work usually is relegated to secondary and post secondary vocational and workforce development programs. The IT World, however, is fast-paced and continually changing. To succeed in life and work, people continuously develop new ways of learning and working to keep current with the technologies and expectations for performance.



The Education System

Schools help students develop the academic and technical skills that they will need in all aspects of their lives, including as members of the workforce. School systems also help students develop an awareness of potential careers and help them explore career options. Schools are structured in a linear fashion. We can align IT career and skill development along the school system structure as follows:

IT World Awareness. In grades 1 through 6, students become aware of the IT world. Elementary school learners develop an awareness of themselves as individuals. Further, they develop an awareness of the world around them in ever broadening circles, learning about themselves and other children, groups, families, communities, states, countries and the world. At the same time, elementary children are beginning to develop an awareness of the world of work and careers. Children go to school; adults go to work.

IT World Exploration. In grades 7 and 8, students discover their own skills, interests and values. They begin to think about how their own skills and interests match potential careers. Middle school students form tentative career plans; some develop skills needed for all work, as well as for specialized careers in the IT industry. They develop high school plans that will lead them in their desired career directions. They also explore core IT skills

IT Career Preparation. In grades 9 through 12, students begin to prepare for higher education and some begin to prepare for their first jobs. School-to-Career initiatives provide school- and work-based learning activities that are connected to specific skills. Students participate in shadowships (following a worker throughout a day to discover what a career is all about), internships, apprenticeships, and community learning activities. They often get their first part-time jobs. High school students meet with their counselors to discuss their future careers, and identify and apply for further education and training opportunities. Some participate in mentoring programs.

IT Workforce Preparation. In grades 13 through 20+ students participate in 2- or 4-year college programs, in specialized training in certificate programs, and, perhaps, a graduate school or degree program. They further develop and refine their academic, technical and employability skills as they apply to the careers of their choice. Many students work while attending post secondary school. Upon graduation, they obtain work in their chosen fields.

Pathway Pipeline Model
Career Development for Information Technology

Stages of IT Career Development	IT World Awareness: Grades 1-6	IT World Exploration: Grades 7 & 8	IT Career Preparation: Grades 9-12	IT Workforce Preparation: Grades 13-20+
Progression Through Developmental Stages	**Students become aware of the IT world as they develop an awareness of:** ▪ Themselves as individuals ▪ The world around them ▪ The world of work and careers **Students begin to use computers in schools, at home, and in community centers as they:** ▪ Play video games or surf the Web ▪ Become aware of the many ways computers affect their lives as they see and use technology for living and learning ▪ Expand and deepen their IT skills in projects and use technology tools for both learning academic content and demonstrating academic performance	**Students discover their own skills, interests and values as they:** ▪ Begin to think about how their own skills and interests match potential careers ▪ Form tentative career plans ▪ In some cases, develop high school plans that will lead them in their desired career directions ▪ Explore core IT skills needed for all work, as well as for specialized careers, in the IT industry	**Students begin to prepare for higher education and some begin to prepare for their first jobs as they:** ▪ Participate in School-to-Career initiatives that provide school- and work-based learning activities ▪ Participate in shadowships (following a worker throughout a day to discover what a career is all about), internships, apprenticeships, and community learning activities ▪ Often get their first part-time jobs. ▪ Meet with their counselors to discuss their future careers, identify and apply for further education and training opportunities ▪ In some cases, participate in mentoring programs	**Students participate in higher education/training programs including:** ▪ 2- or 4-year college programs ▪ Specialized training in certificate programs ▪ Graduate school or degree programs **They:** ▪ Further develop and refine their academic, technical and employability skills as they apply to the careers of their choice ▪ In many cases, work while attending post secondary school ▪ Upon graduation, obtain work in their chosen fields
IT Career Competencies	Learners: ▪ Become aware of information technologies in the world around them ▪ Develop basic IT skills (learn to use computers) ▪ Develop basic keyboarding skills ▪ Integrate skills through projects	Learners: ▪ Explore careers in the IT industry, including visits to IT work sites and discussions with IT workers ▪ Identify the core IT skills needed by workers in all industries ▪ Develop advanced keyboarding skills ▪ Integrate technologies in projects to demonstrate academic performance	Learners: ▪ Select high school programs and courses that will lead them to their careers of interest ▪ Develop employability skills ▪ Develop core IT skills needed for all work and demonstrate proficiency in IT skills for preliminary career choices ▪ Demonstrate success and innovation in IT-based projects ▪ Participate in work-based learning or other on-site learning activity in which they further develop IT skills	Learners: ▪ Develop IT skills needed for technical and professional work ▪ Interview for IT jobs ▪ Become employed in the IT industry ▪ Demonstrate success in IT-based projects, efforts and services

IT World

The Information Technology World is fast paced and constantly changing. We can think about the IT world in terms of the different ways people interact with IT as they live and work. The chart on page 6 shows some examples of core IT skills that people apply to living, learning, all work, and to technical IT jobs.

IT Use—for Living. Whether hidden from view or directly in front of us, IT is all around us, in our homes, stores, train stations, medical facilities, restaurants and movie theaters. We use basic IT skills for living when we purchase a book over the Internet, withdraw funds from our ATMs, scan our train passes, surf the Web for better mortgage rates, or send an e-mail complaint to our landlord. As skilled consumers, we use IT tools and services for daily living. IT skills for living are learned by people of all ages at the same time. This learning is not linear. We learn these skills in our homes and communities. We refine them as needed, while using them.

IT Use—for Learning. Students in school develop the IT skills that they need for learning in their academic classrooms. Elementary school students make charts and graphs on computers to illustrate mathematics problems. They write and illustrate their own stories to develop language arts skills. In middle and high schools, students use the Internet to conduct research for term papers in English, Social Studies, and language classes. They use word processing programs to write their reports and format them with appropriate footnotes and bibliographic references. They use presentation software to give group reports on major projects.

IT Use—for All Work. As IT tools and processes permeate our world of work, almost all workers become users of technology and require a grounding in core IT skills. Accountants use spreadsheets and automated accounts billable/receivable programs; hotel desk clerks use automated reservations and billing programs; materials handlers in warehouses use automated inventory programs; physicians retrieve records from electronic databases and interpret images from highly sophisticated electronic medical equipment.

IT Use—for Professional Users. Some types of jobs are so heavily invested in IT equipment and processes that a more technical level of “user” has emerged. Architects and engineers use Computer-Aided-Design (CAD) software to create precision drawings or technical illustrations; graphic artists develop brochures and marketing materials with desktop publishing programs. This group of workers focuses the majority of their work on using IT tools and processes. This group includes jobs such as bioinfomatics specialist, CAD engineer, and E-trader.

IT Use—for IT Industry Professionals. People who design, build and maintain computer hardware and software, or support others using IT tools and resources comprise what most people consider to be the IT industry. These IT Professionals are the programmers, systems analysts, software developers, network managers, technicians, and Webmasters who create, build and maintain the IT products and systems used by everyone else. These people are usually employed by IT companies, and are the most readily visible IT workforce.

Core IT Skills Applied to Living, Learning, All Work and Technical Jobs

	IT for Living	IT for Learning	IT for All Work	IT for Tech Jobs
Internet	▪ Using Internet for finding mortgage rates ▪ Travel reservations ▪ Viewing information	▪ Conducting research for term papers and projects ▪ Conducting research for coursework	▪ Purchasing supplies ▪ Sales ▪ Contact with customers and vendors ▪ Scanning competitor activity	▪ Software upgrades ▪ Help desks
Word Processing	▪ Letter to Congressman ▪ Resume and job application letter ▪ Complaints to landlord	▪ Term papers ▪ Research notes ▪ Book reviews ▪ Notices and posters for club activities	▪ Correspondence ▪ Customer Service ▪ Meeting notes ▪ Sales reports	▪ Writing training manuals ▪ Writing procedures for operation or installation of software
Database	▪ Palm Pilot with holiday card lists ▪ Inventory of video tapes or CDs ▪ Inventory of household items for insurance purposes	▪ Developing and using data base to collect and analyze data for a research project ▪ School mailing lists ▪ Student Handbook	▪ Client List ▪ Mailing lists ▪ Inventory Control ▪ Orders for Purchasing ▪ Reorganizing, grouping and sorting data	▪ Developing relational data bases to draw on legacy data bases ▪ Customizing data bases to meet clients needs
Web	▪ Developing a personal Web page ▪ Communicating with relatives ▪ Participating in national sweepstakes	▪ Developing and maintaining Web pages for a class, grade or school ▪ Entering national contests	▪ Developing and maintaining a business Web site ▪ Conducting business via e-commerce (respond to and process orders via Web)	▪ Designing a search engine ▪ Developing guidelines and maintaining Web sites for clients

Differences Between IT and Education Systems

The primary difference between the education system and the IT industry concerns when and where IT learning takes place. In the traditional education system, IT learning takes place at specific times, within prescribed programs and courses, and at specific levels. For example, it is unlikely that many teachers in elementary schools would be teaching about IT jobs, the skills of IT workers, the working conditions, earning potential and training needed. It is also unlikely that many elementary teachers would be teaching highly technical IT skills in their classrooms, whether or not students are "ready" to learn those skills.

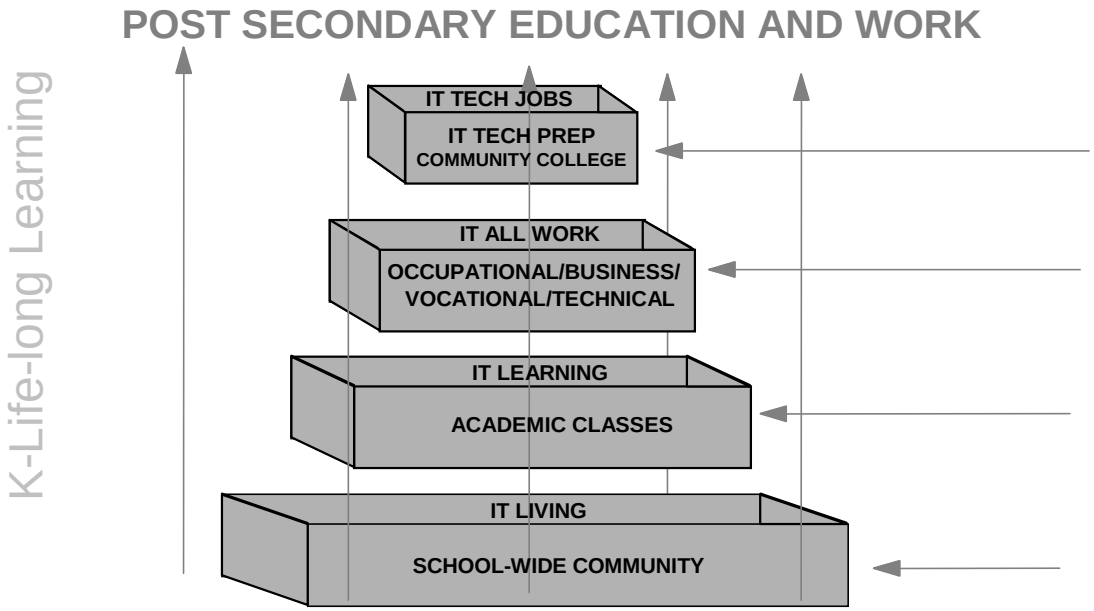
The IT World, however, is fast-paced and continually changing. To succeed in life and work, people constantly develop new ways of learning and working to keep current with the technologies and expectations for performance. How many of us have learned how to use our cable TV/VCR remote control buttons, fill out lottery ticket forms so they can be run through the scanner, or use our ATM cards? How many of us have learned to use the new computer program at work—once, twice, perhaps three times in the past year? In the IT world, it is assumed that everyone is a user of IT and therefore has some foundation of IT skill and knowledge.

A Disconnected System: The Fragmented Career Pathway

Currently in the K-Lifelong learning system, the pathway to IT careers is fragmented as illustrated in the chart below. Although there are places in our communities for people to develop IT skills for living, learning and working, these IT initiatives operate independently of one another. Although unlikely, it is possible that an individual might move through the educational system in a community without access to technology and without developing IT skills. One student might develop IT skills for living in the community, learn word-processing at a Community Technology Center, and develop IT skills for learning in his or her academic classes. Another student might develop IT skills for living and learning, develop IT skills for all work in high school occupational or vocational programs, and go on to work in the IT industry after post secondary training in an IT specific program.

The way our system is currently constructed, each of these levels operates separately and independently of one another. No previous learning is expected or presumed. For example, the best high school and technical college IT training programs begin at ground zero, presuming little or no IT training prior to the learner's entry into that program. Academic teachers in schools see little relationship between the skills students are developing in academic classrooms and the IT skills valued by employers and needed for all work. By operating independently, IT initiatives at each of these levels duplicate efforts to develop IT programs and to identify successful IT learning strategies. This has resulted in an IT education-to-employment system that is disjointed, fragmented, repetitive and wasteful. This system cannot get students on the "fast track" into the IT workforce. In order to incorporate IT skills for learning and working into the education and training system, we need to reduce duplication, see the connections and synergy among these levels, and create new learning systems that build on previous life experiences with technology.

Fragmented Career Pathway

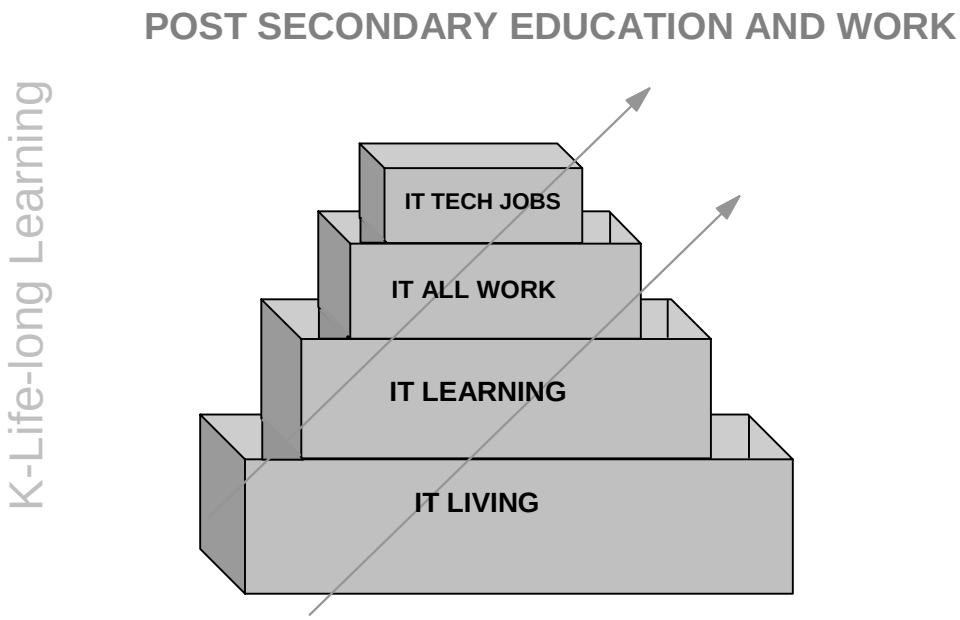


The Nested System

Education and training for information technology skills should not be thought of as necessary only for people planning to work in the IT industry. Technology has changed the way we live, learn and work. We all need to be able to use technology at school, in the workplace, and increasingly at home. The Nested System indicates the additive nature of learning about Technology. An individual's level of learning will depend upon the individual's life needs. Developing IT skills and knowledge can begin at, and be part of, all levels of education. However, no matter where you start, because of the changing nature of technology and its impact on our lives and work, the learning process needs to continue beyond the traditional boundaries of education and become part of life-long learning and personal development.

The Nested System, shown below, illustrates the connections among the IT skills and knowledge found in daily living, in learning, in all work across our wide range of industries, and in technical jobs (see examples on page 6). This model provides a foundation and organizing structure to analyze IT skills used in these life situations to develop education and training programs that build on previous learning as well as prepare learners for future learning in IT. As an organizer, this model does not change the skills needed for IT living as a literate IT consumer, or the IT skills necessary for learning or working. It clearly illustrates the connections among these levels needed to redesign IT pathways to provide all students with the core IT skills needed for success in life and work in our technology rich environments. Through the Nested System approach, there will be increased opportunity and expanded options for all students to access high skill, high wage, high tech careers.

The Nested System—IT Pathway Pipeline Model



Making Connections

An effective IT pathway pipeline model demands a rethinking of technology learning in schools. The model's implementation does not require a new, stand-alone information technology curriculum. Instead, it requires the use of existing threads of IT skill and knowledge to connect the boxes in the currently fragmented IT career pathway, the use of IT tools for learning and authentic assessment, and an integration of IT learning into existing K-20 curriculum. For example, spreadsheets can be used in economics classes to track stock prices and ratios, word processing at the K-2 level can be used for story composition and rewrites, software simulation can be used in physics classes to illustrate what happens during a nuclear explosion, a live video connection to a museum curator can answer the tough questions that students develop when analyzing the relationship between art and culture, and the Internet can be used to facilitate interactions with colleagues around the world in different time zones. (See Web sites such as Marco Polo, www.marcopolo.com, for examples of how IT can be integrated into curricula).

At appropriate developmental levels some learners will be ready to focus on developing IT skills to enhance employment and prepare for entry into specific IT careers. At that point, high quality, skill standards-based IT career cluster initiatives or other workforce development programs can help in their school-to-career transition.

The Important Role of Industry

In order for the Pathway Pipeline model to be effective, employers must actively participate in the educational process. It is critical that students have direct contact with the IT industry and related groups within the community in order to see how their developing skills can be applied, to be encouraged and inspired by role models, to network and prepare for careers in IT, and to explore their own careers, interests and values. The following chart details a sampling of the ways that IT employers and community groups can get involved in education at the different grade levels.

Employer Involvement in Skill Development

Grade 4 *(IT Literacy)*	**Grade 8** *(IT Fluency)*	**Grade 10** *(IT for All Work)*	**Grade 12** *(IT Employability)*	**Grades 13-14** *(Higher Skilled IT employability)*
▪ Guest speakers (through all grades) ▪ Virtual field trips ▪ Virtual interviews with scientists and business leaders ▪ Class demonstrations of electronic tools ▪ Service learning, volunteer work or community projects	▪ Workplace field trips ▪ Shadow opportunities ▪ Classroom mentors ▪ Jointly developed/carried out projects between businesses and schools ▪ Continued involvement in community projects/service learning ▪ Day at College (Community College and 4-Year College) ▪ Junior Achievement	▪ Field trips to high tech companies ▪ Mentoring by IT professionals ▪ Shadowships ▪ Intensive work-based learning experiences ▪ Initial internship/ apprenticeship experiences (e.g.,Youth Tech Entrepreneurs) ▪ School-based businesses	▪ Internships ▪ Apprenticeships ▪ Part-time jobs ▪ Employer sponsored competitions ▪ Continued intensive work-based learning experiences	▪ Coop Jobs ▪ Continued intensive work-based learning experiences ▪ Web-based businesses ▪ Personal small business ▪ Students as IT consultants to small businesses ▪ Related part-time employment

Pathway Pipeline Model—Benchmarks

The chart on the following pages reflects the rising tide of information technology fluency in this country. It uses an advanced organizer based on categories of skills and knowledge needed by people in IT careers. The standards contained within the chart represent skills and knowledge found in several sets of national and state IT skill and technology standards. This model proposes a continuum of interactive IT learning that begins with basic *IT skills for learning* and ends with core *IT employability*.

This chart can be used in several ways:

- if you are a consumer or user of IT, the chart can help you follow your progress through the various levels of IT proficiency as you move from a user of IT for living and learning to a professional user of IT to an IT technical worker.
- if you are a developer of IT training programs or other out-of-school programs, the chart can help you identify and sequence program and course content.
- if you are an educator, the chart can help you plan the development of programs and curriculum.

The following key words or terms also can be used to describe the levels of IT proficiency:

1. uses
2. applies, designs/develops at basic level
3. designs/develops at intermediate level
4. evaluates, enhances, and extrapolates

Benchmarked to excellent examples of strong technology standards currently used in schools across the nation, this chart also identifies and sequences anticipated learner outcomes for grades 4, 8, 10 and 12. These align the model's structure with grade levels used to structure learning standards in most states. This structure invites options for specialization at the secondary levels and articulates with post secondary technical training, as well as with science, mathematics and technology curriculum in 4-year colleges. The sequencing of skills in this model can also be used with adult learners.

The standards that are reflected in the chart include:

- the NorthWest Center for Emerging Technologies (NWCET) Information Technology Skill Standards[1] (http://www.nwcet.org)
- the Ohio Information Technology Competency Profile[2] (http://itworks-ohio.org/ITCOMP.htm)
- the International Society for Technology Education's (ISTE) "Profiles for Technology Literate Standards[3] (http://cnets.iste.org)
- the Patrick Lyndon Pilot School's Technology Learning Standards (http://lyndon.boston.k12.ma.us/)[4]
- the North Carolina State Standards for K-12 Computer/Technology Skills[5] (http://www.dpi.state.nc.us/ Curriculum/)
- the National Research Council, Committee on Information Technology Literacy "Components of Fluency with Information Technology"[6] and
- the American Library Association's "Nine Information Literacy Standards for Student Learning"[7] (http://www.ala.org/aasl/ip_nine.html)

NWCET has developed skill standards for eight career areas: Database Development and Administration, Digital Media, Enterprise Systems Analysis and Integration, Network Design and Administration, Programming/Software Engineering, Technical Support, Technical Writing, and Web Development and Administration. ISTE has developed technology foundation standards, divided into six broad categories, for all students.

The Ohio Information Technology Competency Profile includes IT competencies centered upon core academic subjects and built around four occupational clusters: Information Services and Support, Network Systems, Programming and Software Development, and Interactive Media. North Carolina has developed a detailed curriculum matrix for computer technology skills linked to grades K-12. The National Research Council has developed "Components of Fluency with Information Technology" which include 10 Intellectual Capabilities, 10 Information Technology Concepts, and 10 Information Technology Skills. Finally, the American Library Association has published nine information literacy standards for student learning.

The Pathway Pipeline Model Benchmarks Chart

IT Skill and Knowledge	**IT Literacy – Grade 4** *Career awareness and IT skills for learning*	**IT Fluency – Grade 8** *Career exploration and transition from IT skills for learning to IT skills for working*	**IT for All Work – Grade 10** *Core IT employability for all work*	**IT Employability – Grade 12** *Initial specialized technical job skills for the IT industry*
Technology and Society	▪ Understands and uses computers as a tool for living and learning ▪ Respects the work of others (copyright, acceptable use, responsible use) ▪ Understands impact of technology on individuals and communities	▪ Understands, explains and provides examples of how computers are used as tools for working	▪ Understands, explains and provides examples of how computers are used to carry out business ▪ Understands past and current trends in computer technology	▪ Understands and explains how IT impacts society and the operation and management of business
Information Literacy	▪ Appreciates that information can be useful to life and pursues information close to own interests	▪ Accesses information efficiently and effectively ▪ Evaluates information critically and uses information accurately and creatively	▪ Strives for excellence in information seeking and generation ▪ Applies basic principles of visual communication to transferring data into graphics form	▪ Generates and pursues information and practices ethical behavior in regard to information and information technologies
PC Principles and Operation	▪ Determines when technology is useful and selects appropriate technology tools and resources ▪ Installs and uses programs (disc, CD, download) and uses new simple learning programs ▪ Uses a computer independently	▪ Uses PC and MAC computers independently ▪ Can teach others to operate computers (turn on, use mouse, call up programs, save, and locate files)	▪ Performs basic personal computer operations	▪ Understands issues affecting system purchase and upgrade decisions
World Wide Web	▪ Locates information from Web sites ▪ Uses search engines ▪ Demonstrates responsible behavior while on-line	▪ Locates and organizes information from Internet resources ▪ Differentiates between more useful and less useful information	▪ Uses Internet as a research and business tool in a highly effective manner	▪ Understands and demonstrates use of Internet for e-commerce
Word Processing to Desktop Publishing	▪ Uses word processing for documents, letters and reports (edit, format, spell check)	▪ Creates complex word processed letters, memos and reports which include tables and footnotes/endnotes in teams	▪ Creates complex desktop published documents and reports using multiple applications in teams (Photoshop, PageMaker, Excel, Access)	▪ Selects, integrates and uses appropriate technologies to create complex professional publications (e.g., yearbook, brochure, multifold flyers)

IT Skill and Knowledge	**IT Literacy – Grade 4** *Career awareness and IT skills for learning*	**IT Fluency – Grade 8** *Career exploration and transition from IT skills for learning to IT skills for working*	**IT for All Work – Grade 10** *Core IT employability for all work*	**IT Employability – Grade 12** *Initial specialized technical job skills for the IT industry*
Graphics and Image Processing to Multimedia Publishing	▪ Creates simple graphics using drawing and painting software programs ▪ Uses scanner and digital camera and images from the Web ▪ Creates thematic slide shows	▪ Creates composite imagery integrating photos, drawings and text using drawing or painting software programs ▪ Creates a hypermedia presentation	▪ Creates original audio, video and animation elements ▪ Incorporates and edits sound and images from various sources of input ▪ Creates interactive multimedia presentations	▪ Selects, integrates and uses appropriate media for complex interactive multimedia presentations such as: ▪ Web presentation with music, video, & animation ▪ CD-ROM ▪ Video game
Keyboarding	▪ Familiar with keyboard functions ▪ Keyboards with minimal frustration	▪ Keyboards to 20 words per minute	▪ Keyboards to 35 words per minute including numbers and symbols	▪ Proficient in keyboarding skill (accuracy and speed)
E-mail	▪ Corresponds with an e-mail partner	▪ Requests and sends information globally (with attachments) concerning research topics ▪ Uses a listserv	▪ Understands e-mail system components and organization ▪ Uses appropriate e-mail writing style and protocols for various purposes (personal/business)	▪ Moderates listserv ▪ Manages e-mail address books and listservs ▪ Uses e-mail effectively and appropriately
Software and Systems Integration	▪ Recognizes that files/software/ hardware have different formats (file types, extensions, operating systems) ▪ Selects and uses software appropriate to task (e.g., KidPix, Word)	▪ Integrates various pieces of software (word processing, images from Illustrator, photos from PhotoShop) into one product/project	▪ Works with and integrates items into project work from multiple operating systems	▪ Coordinates communication between different operating environments (e.g., facilitating data exchange and communication between Unix and Windows NT networks)
Database Software: Use to Management	▪ Searches and sorts prepared databases ▪ Defines parts of a database ▪ Develops simple databases and enters information	▪ Uses database to manage personal information (music collections, phone numbers) ▪ Creates, modifies and prints database reports ▪ Applies search and sort strategies ▪ Accesses local, national, regional databases (e.g., DOL, occupational information) for project work	▪ Applies database to actual situations and real world (business) problems (college, scholarships) ▪ Uses, modifies, designs and creates relational databases, including queries, forms and reports	▪ Critically analyzes and evaluates databases and their complex interaction ▪ Accesses and applies/uses large scale databases for project work (e.g., GIS, census, corporate reports)

IT Skill and Knowledge	IT Literacy – Grade 4 *Career awareness and IT skills for learning*	IT Fluency – Grade 8 *Career exploration and transition from IT skills for learning to IT skills for working*	IT for All Work – Grade 10 *Core IT employability for all work*	IT Employability – Grade 12 *Initial specialized technical job skills for the IT industry*
Spreadsheet	▪ Creates graphs and charts ▪ Defines spreadsheet terms ▪ Enters data into prepared spreadsheet ▪ Performs simple mathematical calculations and notices changes	▪ Uses spreadsheets for managing finances, addresses, purchases	▪ Applies spreadsheet principles to real-life situations and business problems	▪ Designs, creates, modifies and troubleshoots spreadsheets ▪ Uses databases functions to perform "What If Analysis" or decision models
Operating Systems	▪ Uses both CD-ROMs and 3.5" disks ▪ Obtains and transfers information from each ▪ Maintains files	▪ Maintains files and folders in more than one platform ▪ Uses multiple operating systems (MacIntosh, Windows, Unix, DOS)	▪ Installs software programs and performs basic configuration operations ▪ Understands compatibility issues	▪ Troubleshoots basic configuration problems ▪ Customizes operating system environments
Programming	▪ Follows a simple structured program (e.g., Lego LOGO, Basic)	▪ Creates simple structured programs (e.g., Lego Mindstorms, HTML)	▪ Creates simple object oriented programs using already developed source code (e.g., Java Script, Macros)	▪ Creates programs developing own source code (e.g., Web applications, free/shareware)
Hardware Installation and Configuration	▪ Demonstrates knowledge of individual parts that make up a stand-alone PC computer system and the relationship between components	▪ Installs and configures hardware in a PC computer system (e.g., printers)	▪ Troubleshoots minor problems and can articulate problems to technicians	▪ Demonstrates basic knowledge of PC hardware troubleshooting and maintenance
Network Technologies	▪ Can manage one's own electronic portfolio in a networked environment	▪ Understands overall design and components of a LAN and WAN system	▪ Performs basic set up and configuration of network hardware and software	▪ Monitors overall network operations ▪ Troubleshoots basic problems ▪ Implements administrative functions
Self-Management, Teamwork and Communication Skills (Soft Skills)	▪ Works in teams ▪ Values diversity Develops basic skills in literacy and numeracy ▪ Listens actively and communicates own ideas	▪ Solves problems ▪ Makes decisions ▪ Integrates learning ▪ Writes clearly and concisely ▪ Calculates accurately ▪ Navigates systems ▪ Adapts to changing environments ▪ Demonstrates integrity, honesty and ethical behavior	▪ Speaks effectively and persuasively ▪ Analyzes, interprets information, and draws conclusions ▪ Manages resources ▪ Generates ideas ▪ Coaches others ▪ Monitors and corrects systems	▪ Leads teams ▪ Negotiates effectively ▪ Continuously improves quality of work ▪ Teaches others ▪ Generates designs ▪ Creates and manages projects

Conclusion

This pathway pipeline model will meet the needs of both the IT industry and education systems because it:

- Expands the pool of talented potential IT workers to all students and provides all learners with the basic skills and knowledge needed to access the high skill, high wage jobs associated with IT.
- Structures the development of IT skills and knowledge along a single continuum of learning that begins in schools and continues in the workplace.
- Uses IT skill standards as the primary components of the skeletal structure so that clear connections are made between the IT skills for learning developed in academic classes and the skills needed to be successful in technology rich work environments.
- Provides support and enrichment of academic learning by integrating technology tools and resources.
- Provides support for students to become power users of technology and opportunities to explore IT careers.
- Allows students to develop core IT skills needed for all work as a benchmark for high school graduation.
- Provides options for specialization and vendor specific credentialling at the secondary and post secondary levels.
- Articulates the K-12 pathway with grades 13-20 IT technical and professional career training.
- Links Learning and IT Working through the most current skills and knowledge drawn from front line workers in the IT industry.

Notes

[1] NorthWest Center for Emerging Technologies, Regional Advanced Technology Education Consortium, Bellevue Community College. 1998. "Building a Foundation for Tomorrow: Skill Standards for Information Technology," Bellevue, Washington.

[2] Ohio Department of Education, Ohio Board of Regents, and Tech Prep Curriculum Services at the Ohio State University. 1999.

[3] International Society for Technology in Education—NETS Project. 1998. "National Educational Technology Standards for Students," ISTE, Eugene, Oregon.

[4] Patrick Lyndon Pilot School, 1999. "Technology Learning Standards," Boston, Massachusetts.

[5] North Carolina Department of Public Instruction, 1999. "K-12 Computer/Technology Skills," Raleigh, North Carolina.

[6] National Research Council. 1999. "Being Fluent with Information Technology," National Academy Press, Washington, D.C.

[7] American Library Association and Association for Educational Communications and Technology. 1998. "Information Literacy Standards for Student Learning," in Information Power: Building Partnerships for Learning.