LOS ANGELES UNIFIED SCHOOL DISTRICT

Technology Enhanced Learning Environments Guide

One-Computer Classroom

Instructional Technology Pods

Information Resource Center

Individual Computing Devices

Distance Learning Classroom

Instructional Technology Classroom

Prepared for LAUSD by
Center for Educational Leadership and Technology
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PREFACE

The Technology Enhanced Learning Environments Guide is designed to assist Los Angeles Unified School District decision makers, at both the school and district levels, with the effective implementation of learning technologies within classrooms designed for the primary to adult learner. The main purpose of this guide is to assist educators with the selection of realistic and appropriate technology learning environments to address district learning needs and priorities. In an effort to help schools link district/school technology vision and goals with specific technology configurations, CELT has developed six technology enhanced learning environment models.

These configurations are presented in section 2 of the guide which includes diagrams of the six model configurations, general description/overview of potential functions, and instructional links to help decision makers visualize the models and potential uses. These technology enhanced learning environments are intended to be dynamic models that encourage the creation of hybrids and variations to meet the specific needs of the students. The configurations detailed in section 2 include:

- one-computer classroom
- instructional technology cluster
- individual computing devices
- instructional technology classroom
- library/media/information resource center
- distance learning classroom

Section 3 presents strategies for implementing the technology enhanced learning environment configurations at four instructional levels: primary (preK-grade 2), elementary (grades 3-5), middle school (grades 6-8), and high school (grades 9-12). This section also addresses the needs of the adult learner.

Section 4 provides wiring strategies for the technology enhanced learning environments, including room technology outlets (voice/data, voice/data/video, multiple, single, and raceways), individual classroom configurations, non-academic areas, distribution frames, and wiring RFP strategies.
1.0 INTRODUCTION

Curriculum decisions should be the driving force behind the selection and purchase of hardware, software, and network solutions. Pedagogically sound rationale should be the foundation of curriculum decisions to:

- provide equal access to information and resources for all students
- acknowledge developmental needs of the learner population
- incorporate diverse teaching and learning strategies to address unique needs of all learners
- promote relevancy by addressing real-world situations and solutions
- advance higher-order and cooperative learning skills
- develop a desire for lifelong learning and responsible societal membership

Schools that embrace these goals in technology planning will develop a unique, meaningful, and shared vision, and a pathway to achieve desired results. There are many technologies that have the potential to facilitate learning (see Figure 1-1). However, there are many ways of organizing the technologies and many approaches for using the technology at different school levels (primary, elementary, middle, and high school). This document proposes curriculum alignments with technology enhanced learning environments.

![Figure 1-1: Technology-Supported Classroom](image-url)
1.1 Curriculum and Technology Integration

Curriculum and technology integration can best be described as the alignment of content standards, process skills, and technology competencies so that students and teachers learn about technology by teaching and learning with technology. Technology competency milestones, such as students mastering basic word processing skills by grade five or students mastering multimedia development, including voice, video, and data by grade eight, provide the direction for infusing technology tools and resources into appropriate curriculum areas. This introduction of sophisticated technology resources, including, but not limited to, telecommunications, multimedia, virtual reality, distance-learning opportunities, and powerful simulations into daily learning environments, allows teachers and students to focus on content standards and process skills simultaneously. Thus, instructional activities across the disciplines reflect a marriage of content standards, process skills, and technology competencies.

Over time, the successful alignment of curriculum and technology through the use of such models as the integrated unit plan and thematic technology initiative brings about observable changes in teaching and learning environments. Categorized in a Technology and Learning article, authors Odvard Egil Dyrli and Daniel E. Kinnaman propose that the impact of technology integration on the curriculum will occur in three progressive levels:

- **enhancing and enriching** the existing curriculum using technology within the confines of existing school structures and schedules
- **extending** the existing curriculum with technology by providing opportunities beyond the limitations of school structures and schedules without serious disruption
- **transforming** the classroom curriculum through technology in ways that may require new paradigms, changes in organizational structures, and innovative schedules of schooling

Schools and educators will not necessarily progress through these levels unless multiple factors are considered simultaneously. When aligning curriculum and technology resources, correlations must be made with respect to:

- levels of access (degree to which appropriate technology is available)
- curriculum design principles (suggested means by which to support teachers’ efforts)
- technology-based interventions (specific applications and solutions that facilitate development from one stage to the next)
- outcomes (skills, effects, and competencies that may occur as a result of moving through each stage)

Curriculum and technology integration strategies should also address the process of aligning specific learning environments with:

- identified instructional reform efforts (cooperative learning, real-world applications, authentic assessment, NCTM standards)
- developmental needs of the learning population (primary, elementary, middle school, high school, and adult learners)
- staff attitudes and competencies
• specific technology hardware and software solutions

Equally significant is the need to remember that the integration of instructional technologies through the creation of technology enhanced learning environments is not the end target, but rather the means toward addressing school and district priorities in the area of educational reform. Reform efforts in the area of curriculum, addressing instructional content areas and what students are taught, include:

• national curriculum
• core curriculum
• meta curriculum
• world-class standards
• technology integration
• thematic units and interdisciplinary instruction
• assessment tests
• competency certification

Reform efforts in the area of learning, pertaining to the manner in which students learn, include:

• constructivism
• discovery learning
• active learning
• inquiry-based learning
• multiple intelligences
• cooperative learning

Reform efforts in the area of assessment, how we evaluate improvement and growth, include:

• authentic assessment
• portfolio assessment
• performance-based assessment
• outcome-based assessment

Curriculum integration is an evolution, not an event. It is cyclical in nature. The more students and teachers learn about the potential of specific applications and technology resources, the more they will be able to teach and learn with these powerful tools. Likewise, as the number of instructional initiatives increases as a result of teaching and learning with technology, the sophistication level of the users increases, and the need to know more about complex features and advanced applications escalates.

1.2 Serving Multiple Audiences With Multiple Roles

Regardless of age, the role of the 21st century learner includes many hats and multiple experiences. On any given day the learner may assume the role of writer, mathematician,
scientist, musician, artist, researcher, producer, publisher, entrepreneur, and/or inventor. It is the responsibility of school district leadership to provide developmentally appropriate and challenging learning environments to support the work of its student body in the many roles they are likely to assume during their learning experiences. Learning environments with the capacity to address such diversity must be flexible, adaptable, powerful, and sophisticated, yet simple enough for its intended audience to use with ease. The following sections provide examples of the ways in which technology resources support the multiple roles of the 21st century learner.

Mathematician

The world of the mathematician includes mastery of basic computation skills; practice with gathering, manipulating, and interpreting numerical quantities; contexts to write and communicate mathematical ideas; and real world opportunities to apply their skills. Quality applications can provide review, reinforcement, and remediation. Numeric/graphing calculators and Internet data gathering projects offer easy means to collect data for manipulation. Spreadsheets, charts, and graphs present information in multiple formats that enhance both interpretation and analysis. Ideas for curriculum and technology integration in mathematics are listed below.

<table>
<thead>
<tr>
<th>Mathematics</th>
<th>• Use technology to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- think critically and solve problems mathematically</td>
</tr>
<tr>
<td></td>
<td>- chart and graph spreadsheet data using “what if” questions</td>
</tr>
<tr>
<td></td>
<td>- research great mathematicians and write about math concepts</td>
</tr>
<tr>
<td></td>
<td>- review through drill and practice of initial learning and remediation</td>
</tr>
<tr>
<td></td>
<td>- explore spreadsheet functions involving higher math concepts</td>
</tr>
<tr>
<td></td>
<td>- model and simulate mathematical relationships</td>
</tr>
</tbody>
</table>

Scientist

The scientist learns early on to ask questions, theorize answers, develop hypothesis, and conduct experiments in an attempt to support/refute their ideas. The ability to access research data in their field of studies; consult with local, national, and global experts; collect, store, and manipulate findings for analysis; and present findings in a logical and understandable format is greatly enhanced by technology resources. The use of simulations to rehearse experiments or conduct experiments too dangerous for the school environment makes the work of student scientists safe and practical. Ways in which scientists use technology resources are listed in the following chart.

<table>
<thead>
<tr>
<th>Science</th>
<th>• Use technology to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- present multimedia lab experiments</td>
</tr>
<tr>
<td></td>
<td>- conduct simulations with and without probes for analyzing data</td>
</tr>
<tr>
<td></td>
<td>- store information in databases for searching, sorting, and manipulating</td>
</tr>
<tr>
<td></td>
<td>- model dangerous experiments</td>
</tr>
<tr>
<td></td>
<td>- use electronic probes/meters to take measurements</td>
</tr>
<tr>
<td></td>
<td>- graph and chart results</td>
</tr>
<tr>
<td></td>
<td>- research scientific information</td>
</tr>
<tr>
<td></td>
<td>- obtain expert advice and opinions using the Internet</td>
</tr>
<tr>
<td></td>
<td>- think critically and solve problems scientifically</td>
</tr>
</tbody>
</table>
**Explorer/Researcher**

As Internet and World Wide Web access spreads and bandwidth increases, international borders seemingly disappear and our world appears to grow ever smaller. Whether the topic of their investigations includes the study of history, geography, government, or economics, the student researcher of the 21st century must master navigation, selection, evaluation, discrimination, and documentation skills. In addition to online information, many electronic collections are available which include animated graphics, video footage, sound, charts, graphs, and diagrams. The use of simulations allow the researcher to "step back in time" and assume the role of decision makers in a variety of historical events. Uses of technology for research and exploration in the area of social studies are listed below.

<table>
<thead>
<tr>
<th>Social Studies</th>
<th>• Use technology to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- compare and contrast historical events</td>
</tr>
<tr>
<td></td>
<td>- learn database research skills</td>
</tr>
<tr>
<td></td>
<td>- research historical information, including primary sources</td>
</tr>
<tr>
<td></td>
<td>- simulate events in other times and places</td>
</tr>
<tr>
<td></td>
<td>- create multimedia presentations of projects</td>
</tr>
<tr>
<td></td>
<td>- telecommunicate with others interested in similar studies</td>
</tr>
<tr>
<td></td>
<td>- poll large audiences on world events/issues, quickly and easily</td>
</tr>
<tr>
<td></td>
<td>- participate in political decision-making online</td>
</tr>
<tr>
<td></td>
<td>- think critically and solve problems concerning historical, cultural, and geographical perspectives</td>
</tr>
</tbody>
</table>

**Writer/Publisher**

From the creation and publication a child's first story to the production of a high school year book, writing and publishing tools have infiltrated educational learning environments across the nation. Publishing houses in elementary schools are busy laminating stories written and illustrated with easy to use word processing programs. The process is frequently supplemented with portable keyboard devices (AlphaSmart/Dreamwriter style products) and the help of parent volunteers. Middle school students regularly produce and publish weekly or monthly school newsletters. At the high school level, students are engaged in professional quality desktop publishing and graphic design activities for community businesses and organizations. The list below provides just a sample of strategies for curriculum and technology integration for the student writer and publisher.

<table>
<thead>
<tr>
<th>Language Arts, Reading, English</th>
<th>• Use technology to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- think critically and solve problems</td>
</tr>
<tr>
<td></td>
<td>- learn keyboarding skills</td>
</tr>
<tr>
<td></td>
<td>- communicate effectively to articulate and solve problems</td>
</tr>
<tr>
<td></td>
<td>- apply skills to improve study habits</td>
</tr>
<tr>
<td></td>
<td>- identify and practice sounds and sound combinations across words</td>
</tr>
<tr>
<td></td>
<td>- guide the writer through the stages of the writing process</td>
</tr>
<tr>
<td></td>
<td>- serve as a tutorial and practice reading program for spelling practice</td>
</tr>
<tr>
<td></td>
<td>- research information in multiple formats</td>
</tr>
<tr>
<td></td>
<td>- telecommunicate with others interested in writing activities</td>
</tr>
<tr>
<td></td>
<td>- layout, design, and desktop publish</td>
</tr>
<tr>
<td></td>
<td>- create multimedia presentations of projects</td>
</tr>
<tr>
<td></td>
<td>- develop vocabulary and comprehension with interactive story books</td>
</tr>
<tr>
<td></td>
<td>- supplement and complement speech/communication presentations</td>
</tr>
</tbody>
</table>
Creator/Communicator

The study of fine arts, composition of musical arrangements, and creation of artistic works can all be enhanced and supported with learning environments rich in music and art peripheral devices and applications. The primary learner begins with easy to use, yet powerful point and click applications, while middle and high school students frequently have access to nearly commercial quality graphic design and MIDI resources. Some integration examples are listed in the following chart.

<table>
<thead>
<tr>
<th>Art</th>
<th>Use technology to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- design and create works of art</td>
</tr>
<tr>
<td></td>
<td>- create multimedia presentations of projects</td>
</tr>
<tr>
<td></td>
<td>- research information in multiple formats</td>
</tr>
<tr>
<td></td>
<td>- view world-famous works of art</td>
</tr>
<tr>
<td></td>
<td>- visit famous art museums around the world</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Music</th>
<th>Use technology to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- compose music using a MIDI keyboard device/ interface</td>
</tr>
<tr>
<td></td>
<td>- analyze student performance using a video</td>
</tr>
<tr>
<td></td>
<td>- critique a performance</td>
</tr>
<tr>
<td></td>
<td>- hear world-famous performances available on CD-ROM, music CDs, and laserdisc</td>
</tr>
<tr>
<td></td>
<td>- create interactive composition with immediate feedback</td>
</tr>
<tr>
<td></td>
<td>- add musical complement and sound to multimedia presentations</td>
</tr>
</tbody>
</table>

Global Citizen

The concepts of personal wellness and individual participation in a global community begin at the earliest grades and are reinforced throughout the school years. Beginning with a basic knowledge of food groups and nutrition through to a complex understanding of body functions, chemistry, and systems, multiple technologies support health and physical education programs. The ability to communicate (online and teleconferencing) with global friends, pen pals, and audiences via the World Wide Web significantly enhances our understanding of other cultures and nations. Technology integration in these areas is outlined in the following chart.

<table>
<thead>
<tr>
<th>Health Education</th>
<th>Use technology to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- create multimedia presentations</td>
</tr>
<tr>
<td></td>
<td>- conduct nutrition research</td>
</tr>
<tr>
<td></td>
<td>- determine fitness by use of spreadsheet templates</td>
</tr>
<tr>
<td></td>
<td>- identify and study the systems of the body</td>
</tr>
<tr>
<td></td>
<td>- research wellness information</td>
</tr>
<tr>
<td></td>
<td>- simulate body systems and functions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Education</th>
<th>Use technology to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- measure fitness</td>
</tr>
<tr>
<td></td>
<td>- keep records during sporting events</td>
</tr>
<tr>
<td></td>
<td>- analyze athletic performance</td>
</tr>
<tr>
<td></td>
<td>- show trends and relationships over a period of time</td>
</tr>
</tbody>
</table>
### World Languages

- Use technology to:
  - practice language mechanics and dialog
  - create interactive media presentation of other cultures
  - introduce and drill grammatical structures
  - telecommunicate with others around the globe in their native language
  - write in multiple languages
  - convert text from one language to another

### Entrepreneur/Inventor

The popularity of national programs such as OM (Olympics of the Mind) and the USFIRST competitions coupled with school-based Invention Conventions highlight the power and potential of technology resources to create, test, and refine inventions; design, develop, prototype, produce, and market products; or identify, strategize, and solve problems. Within the traditional disciplines, listed in the following chart, are many effective means to integrate technologies into these learning environments.

### Vocational Education/Technology Education

- Use technology to:
  - teach students current job-market skills
  - become familiar with careers and the necessary training required
  - conduct electronic research
  - apply CAD/CAM software for design and development
  - prepare students for college entrance requirements in selected fields
  - telecommunicate with business and industry experts/mentors
  - experiment with robotics and artificial-intelligence agents
  - effectively apply expert system software and artificial intelligence
  - think critically and solve problems

### Business Education

- Use technology to:
  - teach students current job-market skills
  - develop and run model businesses and simulations
  - develop and run actual businesses (online entrepreneurs)
  - engage in real world computer applications
  - prepare graduates for the 21st century workforce
  - prepare for electronic marketing strategies and business practices
  - experience electronic communication in a global economy
  - research business and economic information
  - write and communicate effectively
  - design and improve systems
  - select equipment/tools for specific tasks and troubleshoot equipment
  - think critically and solve problems

### Lifelong Learner

Gifted or challenged, young or old, novice or expert, we are all travelers on a lifelong learning journey. One minute we might be determining our own individual needs, the next assisting another through personal challenges toward the attainment of their goals. We pursue goals for both profit and pleasure, in either case the ways in which we seek information and ideas are similar. The wealth of current and rapidly emerging technology resources provide a means to pave the path for all travelers on this endless journey. The appropriate use of and access to technology resources provides individuals in all stages of life, all occupations, and interest levels with vast information resources, powerful
productivity tools, easy communication channels, easy to use organizers, and exciting methods of expression.

The following is a small sample of extended learning opportunities available for all learners.

<table>
<thead>
<tr>
<th>Extended Studies</th>
<th>Use technology to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- diagnose and prescribe necessary remediation</td>
</tr>
<tr>
<td></td>
<td>- teach/ reinforce basic skills</td>
</tr>
<tr>
<td></td>
<td>- compensate for reading difficulties</td>
</tr>
<tr>
<td></td>
<td>- improve memory and visual perception</td>
</tr>
<tr>
<td></td>
<td>- motivate and challenge all learners</td>
</tr>
<tr>
<td></td>
<td>- embrace assistive/ adaptive devices</td>
</tr>
<tr>
<td></td>
<td>- facilitate electronic mentoring</td>
</tr>
<tr>
<td></td>
<td>- participate in electronic competitions</td>
</tr>
<tr>
<td></td>
<td>- think critically and solve problems</td>
</tr>
<tr>
<td></td>
<td>- create multimedia project presentations</td>
</tr>
<tr>
<td></td>
<td>- model and simulate virtual environments</td>
</tr>
<tr>
<td></td>
<td>- research, explore, and investigate information</td>
</tr>
<tr>
<td></td>
<td>- telecommunicate globally (e-mail, chats, conferencing)</td>
</tr>
<tr>
<td></td>
<td>- design and desktop and/ or web publish</td>
</tr>
<tr>
<td></td>
<td>- communicate using writing tools and devices</td>
</tr>
<tr>
<td></td>
<td>- study advanced topics</td>
</tr>
<tr>
<td></td>
<td>- research a hobby, special interest, or problem area</td>
</tr>
<tr>
<td></td>
<td>- create a family history/ genealogy</td>
</tr>
</tbody>
</table>

In addition to addressing the changing and diverse roles of the learner when selecting instructional technology integration strategies, teachers' attitudes regarding technology and their levels of technology competency must be factored into the selection process. Both students and staff should experience success and positive interaction for long-term goals to be met. Thus, a needs assessment in the areas of teacher attitudes and technology competencies becomes the foundation of an effective professional development plan of action.
2.0 TECHNOLOGY ENHANCED LEARNING ENVIRONMENTS

Technology enhanced learning environments are usually, but not always, designed to incorporate one or more computers. The capacity, location, size, mobility, versatility, peripheral devices, and accompanying software applications all help to define the functional capacity and intent of specific learning environments. Most school environments will implement variations on one of six model configurations: one-computer classroom (1-2 computers), computer clusters (3-6 computers), computer classrooms (15 to 30 computers), individual computing devices (1 to 1 device to child ratio), library/ media/ information resource center technology resources, and distance learning classroom. An orientation to the potential of each model configuration is provided in this section. In an effort to help schools link their technology visions and goals with specific technology configurations, six technology enhanced learning environment configurations are defined:

- one-computer classroom
- instructional technology cluster
- instructional technology classroom
- individual computing devices
- library/ media/ information resource center
- distance learning classroom

These technology enhanced learning environments are intended to be dynamic models that encourage the creation of hybrids and variations to meet the specific needs of the students.
The purpose of the information in Section 2 is to assist educators with the selection of realistic and appropriate technology learning environments to address district needs and priorities. Diagrams of each model/configuration follow the more general description/overview of its functions and their instructional links to help a decision maker visualize the models and their potential uses.

2.1 One-Computer Classroom

In American schools today, the most common configuration within individual classrooms is still the single computer workstation for both teacher and student use or possibly one computer for the teacher and another one for students. Sometimes these computers are housed on a moveable cart so they can be shared or moved to other environments.

In the one-computer classroom the computer generally serves one of three primary roles:

1. teacher presentation/management station (frequently "off-limits" to students)
2. shared presentation/group activity station (projection capacity a must)
3. highly specialized, custom configuration for a specific task and/or audience

Teacher Station

The computer resource in school districts with the greatest potential for implementing change and creating change agents is the "teacher computer". This is the computer assigned to an individual teacher to assist with teaching, learning, and management of daily classroom functions. Whether it is a full-size desktop system or a portable model, the acknowledgment that educators require tools at least equivalent to those used by students is critical to the successful integration of all other technology enriched learning environments.

To manage the emerging diversity of today's classroom the individual teacher configuration should provide confidentiality and portability with video out and large group projection capabilities, internal telecommunication access, and network connectivity. This system should be compact enough to travel with the teacher who provides instruction in a variety of classrooms and into the homes of all educators. Access to the school network allows for flexibility in lesson planning, preparation, resources selection, and reporting purposes.

Educators have found the introduction of new technologies via specially configured systems both successful and economical. Teachers and students learn and work together with computer systems that have all the necessary software and peripherals in place and are frequently included as a component of a new instructional initiative.

The teacher workstation area normally is located toward the front of the room in proximity to the teacher's desk. The exact location needs to be determined on a room-by-room basis. Access to voice, video, and data communications should be available at this location. Thus, two voice/data cables and one video drop cable should be brought to this area.
Presentation/Group Activity Station

This use of the computer has proven successful using one-computer-classroom software applications called "groupware", such as those developed by Tom Snyder Productions. In this environment only one computer is needed to direct and store the work and activities of many groups of students. The ability to project an image of the computer screen to a large group, using either a stand-alone projection device, a scan converter with a large screen television/monitor, or a LCD projection panel and overhead projector is required. Software would include simulations, groupware programs, and presentation creation applications.

The presentation/group activity workstation is normally located in an area of the room where a small group of students can work together without disturbing the remainder of the class, but also where all students can view a projected image for large group interactions. The intent is to allow the class to sometimes engage in a large group activity together using the computer as information source and at other times let a small group of students use the workstation during the class session for a small group presentation/project.

The exact location needs to be determined on a room-by-room basis. Multiple data cables should be available at this location. Two-to-six data cables should be considered for this area. If there are definite plans to utilize video applications at these workstations, consideration to providing a second video drop cable at the outlet may be advantageous. The cost impact of adding these video drops must be compared to their benefits.
Custom Computer Configuration

The computer (desktop or laptop) customized with peripherals and software is assigned to address a specific purpose, activity, and/or task. The use of this computer may range from a highly specialized system equipped with adaptive/assistive devices for a specific physically and/or educationally challenged student, which will travel with the child throughout the school day, to a desktop publishing system complete with scanner, laser printer, clipart, and digitizing equipment that may be used by all teachers and students on a sign-up basis. In most school buildings, mobility is a key component of this design, allowing freedom of movement for the special needs child and access to the special capabilities of these systems for teachers and students, as needed. Optimally, these configurations will be network ready, providing access to printers, modems, and other network features. Software applications and peripherals selected for incorporation in these unique configurations will vary at the different instructional levels and according to the targeted function.

![Diagram of Custom Computer Configurations]

**Figure 2-4: Custom Computer Configurations**

With the customized computer, access and functionality will be limited by availability of equipment and design. However, this particular configuration will serve as the vanguard of specialization. Due to its specificity, this unit will be equipped to perform a single task well. Because of the restrictions upon the hardware, mobility will be a key determinant in successfully incorporating any specific custom computer in an instructional setting. Generally speaking, this is not a multi-functional set-up. As such, it must be moved to the environment where and when the need dictates. With fewer students able to access the hardware at once, this arrangement is best suited to small groups of learners. The potential for creating a well-equipped, single-function workstation is best actualized here.
The basic computer unit serves as the foundation for building various configurations by incorporating specific software and peripheral components, each designed to provide unique functionality. The task of educators is to effectively link this functionality with curriculum and management needs and outcomes. Software selection will define the capacity of the system required in terms of memory, hard drive, and system speed for acceptable performance levels. A sampling of custom workstation models follows.

**Desktop Publishing**

In most every classroom a desktop publishing configuration complete with laser printer, scanner, digitizer, and accompanying software including layout and design programs with clipart can enhance the quality of student generated projects from content specific reports, poetry, newsletters, advertisements, to the school year book. The professional look and feel of resulting collaborative products develop camaraderie among peers, a sense of pride, and feelings of confidence in students.

The **desktop publishing** configuration generally consists of a laser printer or color inkjet printer, scanner, and digital camera with appropriate software including layout and design programs and clipart collections. A monitor large enough to display full-page portrait orientation and side-by-side pages is also a desired feature of this configuration.

**Instructional Multimedia Research**

The **instructional multimedia research** configuration provides a technologically rich arena for identifying, classifying, synthesizing, and analyzing data in a host of content-specific and cross-content topics. Students with access to online telecommunication databases, visual laserdisc archives, and CD-ROM collections master the skills necessary to isolate, restate, and organize information of importance and relevance to their specific topic/ task.

**Instructional Multimedia Presentation/Production**

As we prepare students to share information gathered in an interesting and engaging manner, the **presentation/production** configuration with both audio/ video input and output capacity; a scanner; and CD-ROM, laserdisc, and video support will provide an engaging and interactive stage upon which they may choreograph their presentations. Multimedia/ hypermedia programs at all levels provide for the integration of visuals, sound, text, and animation. The ability to project an image of the computer screen to a large group, using either a stand-alone projection device, a scan converter with a large screen television/ monitor, or a LCD projection panel and overhead projector is an important element of this configuration.

**Individual Telecommunications**

Until the school/ district network is able to provide telecommunication access to all systems on the network, an **individual telecommunication** configuration is an alternative solution to networked telecomputing. This system is not conducive to movement throughout the building as a dedicated telephone line, modem, and printer are required. Frequently, this configuration is located in a central place such as the library/ media center. Access to a network modem will make this configuration obsolete, although it could still function as a back-up solution when needed.
Remediation/Enrichment

The remediation/enrichment configuration is determined not so much by specific peripherals, but rather the instructional software accessible from either system hard drive storage or network software. Depending on time of day, individual student, and software selected the computer may provide either remedial and/or enrichment activities. Software would include drill and practice, tutorials, simulations, content specific programs, research materials, and access to the Internet.

The student workstation area normally is located toward the rear of the room. The intent is to allow a small group of students to use the workstations during the class session. The exact location needs to be determined on a room-by-room basis. Multiple data cables should be available at this location. Two-to-six data cables should be considered for this area. If there are definite plans to utilize video applications at these workstations, consideration to providing a second video drop cable at the outlet may be advantageous. The cost impact of adding these video drops must be compared to their benefits.

Music

With the incorporation of technology into the music curriculum, students can create new works and study existing pieces as never before possible. In combination with special composition software, a MIDI keyboard connected to the computer allows students to create spontaneously while the computer records and remembers the details. As with words and a word processor, students may then review their musical composition, revise, and edit as desired. The student may begin the score today in an upbeat and happy mood and finish the piece tomorrow in a somber or melancholy mood, with the information saved to floppy disk, hard drive, or network storage between intervals. CD-ROM writers allow student compositions to be saved to CD in same medium of popular music stars. Music CD-ROM discs combining music and graphics allow students to study the music of our nation/world and the diverse cultures that comprise our country/world.

Arts

For the student who never felt like an artist, the use of technology in the arts provides a pathway toward creativity through graphic programs that encourage exploration of shapes, colors, patterning, repetition, and recursion. The low cost of color printers adds another dimension to this level of exploration. Specialty software programs allow for cartooning, technical drawing, and combining colors and sounds. Laser video provides the teacher of fine arts with a venue allowing students to explore the characteristics and trends of individual artists or time periods.

Video Production

The video production configuration enables students to record, edit, and create nearly commercial-quality video segments. These might result in student generated commercials, MTV-like music videos, documentaries, and/or short movies. With the addition of video production firmware (additional cards within the cpu) and software to a high-end (significant RAM and hard drive capacity is required) workstation, students are able to input digital video from camcorders, VCRs, DVD and/or laserdisk players and output edited and compiled video onto an external monitor/TV for review, critique, and revision.
Physical Education

Students are instructed that physical education and exercise is good for their health and well-being, but these concepts are often difficult to prove within the classroom. Biofeedback probes and devices connected to a computer allow educators to demonstrate reduced/increased heart rates and stress control, and record subtle changes over time. Real-time data gathered during these activities in the physical education environment can be evaluated in science and math classes, as an interdisciplinary link. Digitized videos of gymnastic moves, football throws, and golf and tennis swings allow students to compare, contrast, and critique their form with that of their peers.

Technology Education

In an effort to keep abreast of changes dictated by the demands of the 21st century, technology education, as the combination of many business educational and vocational educational programs have been renamed, has seen an enormous influx of vocation-specific applications and peripherals. In an effort to replicate the technologies found in today’s business community, many secondary schools incorporate sophisticated office automation and business systems into the curriculum, frequently providing a host of services to the community. The “auto shop” incorporates specialized programs and computer systems for diagnosing and repairing vehicles. Drafting has embraced many facets of computer-aided design (CAD), followed by computer-aided manufacturing (CAM) in woodworking and metals. In the technology-enhanced “machine shop,” students use computer equipment to design and program.

Special Education/Universal Access and Design

In the area of special education great strides have been made in the development of adaptive/assistive devices and software enhancements. Technology has the ability to help compensate for the hearing impaired, visually impaired, mobility impaired, learning disabled, and otherwise educationally challenged child. Special software programs combined with custom input and output devices allow the mute to speak, the blind to print, and the palsied to keyboard to identify just a few. Technology allows for the recognition of speech to execute commands, printers to produce Braille efficiently and effortlessly, enhanced visual images for the visually challenged, audio output for the blind to “hear” the output of a monitor, a wide variety of alternative input devices for the young and otherwise disabled, and electronic communication among the deaf community. This unique population of learners begins to communicate and compete on a level playing field with the integration of universal access and design technologies in our schools. In addition, all students with varying learning styles can benefit from universal access and design features available on workstations located throughout the school facility.

2.2 Instructional Technology Cluster

The instructional technology cluster consists of approximately three to six networked computer systems grouped in same instructional area. These systems may remain in one location for the duration of the school year, a semester, or the duration of a special project. School-wide network connectivity of these systems will provide access to printers, Internet/WWW access (modems), CD-ROM towers, library media center resources, and DVD/laserdisc players. The ability to project an image of the computer screen using either a stand-alone projection device, a scan converter with a large screen television/monitor, or a
LCD projection panel and overhead projector significantly increases the large group impact of the cluster.

The **instructional technology cluster** allows for potentially 30% to 60% of a class to work independently or in small groups on instructional activities. Functionality, the **instructional technology cluster** lends itself to a wider range of small group and cooperative learning experiences. In addition, the facilitator may wish to incorporate presentation capabilities by projecting computer-generated lessons onto a large screen with the use of projection device. Rather than assume that all students will be working simultaneously on a computer-assisted instructional task, this organizational pattern incorporates as its core the computer-as-resource, and computer-as-tool philosophy. The implication is that technology would serve as a supplement to, and vehicle for instructional delivery and/or student production.

**Within the Regular Classroom**

Within the **regular classroom** a technology cluster encourages the use of computers as a learning tool. Specific software programs including drill and practice, tutorial, and simulations would be used to introduce, review, and/or remediate content related information. Extensive use of word processing at all grade levels, data bases from the upper elementary grades through high school, and spreadsheets from middle school through high school would allow for the integration of information from one discipline to another across the school network, from class to class.

**In Specialist Clusters**

**Specialist clusters** located throughout the school for keyboarding, art, music, special education, or other specific purposes may be found within classrooms, in the library/media center, and/or student tutoring/support centers.

As teachers more fully incorporate and integrate technology into all aspects of their teaching style, specialist areas (art, music, physical education, vocational/technology education, special education), they will demand additional technology resources. Teachers who were once satisfied with a single **custom computer configuration**, will require a **specialist cluster** of systems to achieve their instructional goals. Software and peripherals will be unique to the discipline being covered (see the **custom computer configurations** described above).
The **instructional technology cluster** is an ideal complement to some of the **individual computing devices** described next. Classroom sets of these low-cost devices, used in conjunction with a cluster of desktop workstations can mirror the functionality of a full-scale computer classroom/ lab for a fraction of the cost.

### 2.3 Individual Computing Devices

Providing a device per child by purchasing classroom sets of these individual computing devices has proven effective and even affordable. Two different strategies are available, 1) less than fully functional computing devices that complement desktop workstations selling for under $300 and 2) fully featured portable laptop computers that are networkable and Internet ready, some using infrared/ wireless technology to connect to networks and the Internet.

**Low Cost Alternatives**

Some of the most popular alternatives in this category include **productivity devices** such as AlphaSmarts (Intelligent Peripherals), DreamWriters (NTS), and GeoBooks (Brother). The features of each range significantly, but all have a full-size keyboard, memory to store multiple files, a screen to view files, and the ability to share information either via cable or infrared with other like devices, computers, and printers. They are portable, durable, battery-operated, and intended to complement computer and printer resources. Some can be purchased in sets with mobile, recharging carts that include a printer, thus creating a "lab
to go”. With most of these devices selling for less than $300 per unit, the cost of 25 units, 2 computers, and 2 printers can cost less than 30% of the cost of a 25 station computer lab also with 2 printers, yet holds the potential to provide nearly 90% of the functionality.

Likewise, in the areas of mathematics and science, the use of numeric calculators, graphing calculators, and CBLs (computer-based labs) using different probes and meters for real-world data collection, places the student firmly in the role of mathematician, scientist, and explorer of his/her world. Graphing calculators support algebra, trigonometry, and calculus studies, allowing the student to manipulate and understand otherwise abstract and hard to grasp equations and relationships. CBL meters and probes linked to either a graphing calculator or computer, transform the world of analog information into digital data that can be graphed, charted, manipulated, and studied.

Advances in the capacity and functionality of personal digital assistants (PDAs) make them very appealing to the digital generation of secondary learners. These devices can simultaneously serve as a database of names, addresses, numbers, email addresses; link to the Internet and email; pager; personal calendar/scheduler; and digital data collection device by connecting probes and meters similar to those used with the CBLs.

![Figure 2-6: Low Cost Individual Computing Devices](image)

**Fully Featured Laptops**

The dream of a computer for every child has become a reality in a number of K-12 schools across the nation and the impact to date on teaching and learning is favorable. A study by ROCKMAN ET AL. which was published in June of 1997, Report of a Laptop Program Pilot - A Project for Anytime Anywhere Learning by Microsoft Corporation and Notebooks for Schools by Toshiba America Information Systems, presents the most compelling evidence to date of the benefits and potential made possible through the "computer-for-every-child" strategy.

Pilot laptop programs have been sponsored jointly by Microsoft Corporation and Toshiba America in which they seek to facilitate “anytime, anywhere” learning by helping schools acquire laptop computers and Microsoft Office software tools for every student. Some of the benefits described in the Rockman report include on-demand access to technology at school and home, increased motivation by students and parents, active parent participation, and enthusiastic teacher commitment to the laptop initiatives.
The NetSchools concept of total immersion by students and faculty with their StudyPro notebook computers and the infrared-networked environment presents another "computer-for-every-child" strategy. Total cost of ownership data has lead some districts/schools to embrace the NetSchools model instead of purchasing standard laptop computers. Software security strategies, Internet access, and the robust design of the StudyPro are all features identified as highly desirable by educators.

A recent addition to the laptop family of computers is the Apple iBook with its infrared communications via the AirPort station for Internet/network access. Resembling a colorful clamshell more than a traditional laptop, these laptops provide anytime, anywhere learning without the usual reliance on cabled network connectivity for Internet and network links.

As fully-featured and custom-configured laptop computers become smaller and less expensive to purchase, upgrade, secure, and service/maintain, they become a more realistic strategy for integration into K-12 school environments.

![Figure 2-7: Fully Featured Laptops for Student Use](image)

### 2.4 Instructional Technology Classroom

The **instructional technology classroom** provides nearly a one-to-one student-to-computer ratio by locating approximately 15 to 30 networked computers in one instructional area. Specific functions of these classrooms may require access to one or more file servers. School-wide network connectivity of these systems will provide access to printers, Internet/WWW access (modems), CD-ROM towers, library media center resources, and DVD/laserdisc players. The ability to project an image of the computer screen to a large group, using either a stand-alone projection device, a scan converter with a large screen television/monitor, or a LCD projection panel and overhead projector significantly increases the quality of large group instruction. A permanent, ceiling-mounted projection device is generally the preferred projection solution in this environment. The inclusion of an "electronic white board" for efficiently capturing and downloading brainstormed ideas, diagrams, charts, and other board notes is recommended.

Although the size and shape of specific instructional areas may dictate the layout of the instructional technology classroom, four of the most common layout options are:
- multiple corner clusters (see figure 2-8)
- multiple hexagon clusters
- around the perimeter stations (work tables in center)
- rectangular back-to-back stations

NOTES:
"A"
These Corner Units can be used for printers, scanners,

NOTES:
"B"
The arrangement of this Training Lab layout is to provide up to 30 workstation areas that will provide multiple configuration usage arrangements. User Groups can be arranged in three separate cells or combined into one large class. Alternatively, groups can range from 2-8 people in 7 cells.

"C"
Whole class training can be provided from the Teacher Station and using the overhead projection system.

Traditionally referred to as the “computer lab”, this physical layout affords students to work individually or in pairs at a variety of technology-based projects. When students engage in thematic and interdisciplinary units, it is possible to expect that different groups of students may work on several aspects or assignments simultaneously, depending on student need and software availability. Thus the primary function of this particular format becomes one of individual, small-group, or team production area.

Regardless of the floor plan selected for the instructional technology classroom, the function(s) identified will determine hardware, software, peripheral, scheduling, professional development, and staffing needs. This model generally provides for a 1-to-1 or 2-to-1 student to computer ratio. Depending upon student population, number of computers in the classroom, proficiency levels of teaching staff, the instructional technology classroom can address one or a combination of the following:
**Writing Laboratory**

Focused on experiencing the writing process of brainstorming, list generating, writing, critiquing, and revising, the writing lab is directly connected to the language arts curriculum with class time scheduled and managed by the language arts teacher(s). Ideally, written work generated in a writing lab can be accessed from other workstations throughout the school facility.

**Instructional Integration Activities**

Available to classroom teachers for conducting specific technology-related activities requiring a high student-to-computer ratio, this instructional technology classroom model would be available on a sign-up basis. Systems must be in place to ensure that required applications, peripherals, and support services are available to assist classroom teachers with these integration activities.

**CAD/CAM**

Generally found at the secondary level, the computer-aided design/computer-aided manufacturing (CAD/CAM) lab enables students to experience and develop production skills comparable to real-world industry. Students work independently or in pairs with instructors trained on these very specific software applications and accompanying peripheral devices.

**Business Applications Center**

Students experience the world of office automation and the corporate environment in this business application model with state-of-the-art hardware and software applications. Mastery of sophisticated word processing, database, spreadsheet, and presentation applications, along with the interchange of information from one application to the other, is a focus of this environment. The fluent use of email, messaging, scheduling, and conferencing applications is also emphasized.

**Personal Productivity Centers**

Personal productivity centers for teachers and/or students (either separately or in a shared facility) provide computers for completing assignments, grades, correspondence, projects, and/or course work. Network access allows for retrieval of data files from previous classes from networked servers.

**Computer Literacy Classes**

Generally staffed by a full or part-time technology instructor(s), computer literacy classes include introduction to computer vocabulary and terminology, identification of computer parts and peripherals, history of computers, introductory programming concepts, introduction to word processing, data bases, spreadsheets, and graphics programs. Although the current trend is to integrate more and more of this information and skills into the core curriculum, classroom teachers still require support with developing, aligning, and delivering this curriculum content.
Programming Classes

Taught by classroom teacher(s) and/or programming teacher(s), these courses range from introductory programming concepts with a "turtle" based programming language at the elementary level to sophisticated languages such as Visual Basic, C and C++ at the high school level. HTML programming for developing web-based instruction, activities, and products is currently in great demand both within schools and the business community.

Integrated Learning Systems

Specially designed to deliver, manage, and assess selected instructional objectives, an ILS generally requires a one-to-one student-to-computer ratio and staffing to manage the flow of students on the system. Once comprised mainly of proprietary applications, current ILS collections include and integrate many popular software applications into their management systems.

2.5 Library/Media/Information Resource Center

Located centrally within the school, the library/media/information resource center combines the roles of today's library services, audio visual/media departments, and technology center into one library/media/information resource center for teachers and students. Four specific environments are incorporated to the conventional library area:

- technology research station(s)
- student workstations
- technology lending center
- video control room

All computers in this area would be connected to school and district-wide networks as this infrastructure becomes available, providing access to printers, the WWW/Internet, data files created in other classes, and network applications and devices.
This area is defined by its multiple purposes. Given the combined functions of providing access to information, as well as a place to process the information, the library/media/information resource center offers students and teachers an arena for extensive research and production opportunities. While this configuration is the least suited for formal large-group presentations, it serves as a resource-rich facility where independent and small-group learning are encouraged.

**Checkout Desk**

The checkout desk is the area where the media center/library resources are taken out and returned by students and teachers. It is advantageous to have a computerized circulation system with bar code scanning available. If network connectivity is available, students and teachers can access the availability of books and other library resources from their classroom or home. Generally a voice/data outlet is needed.

**Electronic Card Catalog**

The arrangement for electronic card catalog access is important in providing the advanced means to locate information available within the media center/library as well as the external resources that may be available. Identifying the location and the number of workstations that will be available for student usage is necessary so that the cabling paths and quantity of cables can be planned. Generally a high-density data or a voice/data outlet with both used as data is required. Access to a local or networked printer is recommended so patrons can print as needed.
CD-ROM/DVD Multi-media Areas

The availability of CD-ROM and DVD resources as well as multi-media workstations for on-demand student and teacher usage should be available in the media center/library. The number of workstations will depend greatly on available workstation resources. The data and video cabling for these workstations must be planned. It is important to plan both CD-ROM/DVD workstations as well as multi-media workstations so that cabling paths can be identified. Depending on the number of workstations connected, one or more high-density data or voice/data outlet with both used as data is required. A jack for one or more printers should be included in the design of this area.

Student Workstation Areas

The availability of workstations for on-demand student and teacher usage should be available in the library. The number of workstations will depend on available space and local preference. The data cabling for these workstations should be arranged to allow additions should more workstations become available. The main concern becomes location and furniture type. Therefore it is important to plan for the maximum workstation configuration from the start so that cabling paths can be identified since it generally is cheaper to pull cable once, than to do it on two occasions. Based on the number of workstations in the area, one or more high-density data or a voice/data outlet with both used as data is required. A jack for one or more printers should be included in the design of this area.

Library Office

The library office areas also need to plan for integration with the technology network system. The location the computer workstation table(s) or desk(s) is needed to locate the data network outlet(s) effectively and thus define the number of voice/data cables required. It is recommended that at least one voice/data outlet be placed in each library office.

Library Management

The library management and information system will be based on the Machine Readable Cataloging system (US MARC) format and will provide fully integrated components to provide online:

- maintenance of bibliographic data
- circulation data
- cataloging procedures
- public access
- circulation control
- serials control
- acquisitions
- report generation
- system administration
- access to other libraries by using standard protocols
• processing of inter-library loans
• placement of materials on reserve
• multiple CD-ROM / DVD access
• flexible printing/ non-printing routines
• context-sensitive help for ease of use by patrons
• access to student information components

As an interface or connection for instructional resource management, the system can provide options for users to view, schedule, reserve resource materials, and establish private collections of classroom materials remotely.

The system also can provide for retrospective conversion, by internal staff or by sending shelf lists to external conversion agencies.

2.6 Distance Learning Classroom

The distance learning classroom in its most sophisticated form provides for real-time two-way audio/ video/ data transmission from two or more remote locations. A collection of large screen monitors, video cameras, microphones, speakers, and a telephone/ fax allow “students” (teachers or school age children) to actively participate, asking and responding to questions, in a class consisting of participants from potentially across the nation.

The multiple monitors and video cameras capture and display participants and activity at the different remote sites. One video camera is generally dedicated to projecting instructor support materials in the form of either computer generated images, maps, wall charts, close-up hands-on demonstration (dissection), or hand-written notes. Likewise, microphones and speakers capture and transmit “classroom” oral presentations and discussion. The facsimile machine allows the instructor to send quizzes, tests, and assignments to the “class” at the appropriate time. Students may also submit lengthy or confidential questions to the instructor via this media. The console to control the flow of voice, video, and data signals within this environment generally requires a custom design specific to each individual location.

Currently, the electronic signals sent and received are carried via some combination of satellite and/ or microwave transmission and fiber optic and/ or coaxial “cable company” cable. The distance between remote sites may be within buildings in a single town or among schools across the nation. Changing regulations within the telecommunications industry and technological advances involving the transmission of voice, video, and data hold the potential to dramatically decrease the cost and complexity of distance learning configurations. Streaming video broadcasts over fiber and via the Internet are currently being explored for this use.
The distance learning classroom is designed primarily as a means by which to extend learning beyond the perimeters of the school site. Because it features two-way communication, the range of possible opportunities in which to expand curriculum offerings is virtually limitless. Both staff and students can take advantage of on-site offerings that would otherwise be unavailable to them. With the inclusion of cable TV access, another dimension of learning sources are opened for the educational community. By using video networking capabilities, long-distance conferences can be arranged, participation in national forums is possible, and direct access to experts in the field becomes a reality. This form of learning is firmly grounded in communication and mutual networking with others who would otherwise be unavailable as resources.

For the school/district who has access to limited resources due to remote or rural location or the school/district with state-of-the-art resources and is looking for the next technology horizon, the distance learning classroom may be the solution to address needs at both ends of the spectrum. The resources to equip this environment are not inexpensive, yet the potential for schools removed from the mainstream is unbounded. A distance learning classroom centrally located within a school/district can provide instruction for both students and staff in the following areas:

**Student Instruction**

- offer traditionally low enrollment courses
- conduct advanced placement courses as needed (math and science are popular)
- offer courses with national instructor shortages (Japanese, Russian)
allow “students as teacher“ opportunities with broadcasts from school to school

Teacher and staff professional development and training
- secure nationally recognized speakers via satellite for professional development activities
- facilitate district discussions on local/ regional/ global issues
- broadcast town meetings and disseminate important information to the community

Videoconferencing
- minimize the need to travel among schools within the district for meeting
- facilitate curriculum development among staff at different schools or sites
3.0 USING THE LEARNING ENVIRONMENTS

American schools of the 21st century are attempting to restructure in order to more fully address the multiple needs of a widely diverse and ever changing audience. From the youngest of learners, some identified for special services beginning at age three, to our senior citizens can all benefit from technology enriched learning environments within our schools and distributed throughout the community. Section 3 of this guide looks at the development learning needs of preK-12 and adult learners and the manner in which these multiple audiences are likely to use technology enhanced learning environments.

For purposes of this guide, learners are grouped into five audiences from preK to adults:

- primary learner (preK - Grade 2)
- elementary learner (Grades 3-5)
- middle school learner (Grades 6-8)
- high school learner (Grades 9-12)
- adult learner

This section of the Technology Enriched Learning Environments Guide will review the needs of these five audiences and align developmentally appropriate integration strategies with each technology enhanced learning environment configuration. The developmental needs of the elementary, middle school, and high school student differ; thus, the technology environment selected for each group should address these differences.

The goal of successfully implementing a variety of technology learning environments throughout the district should be to:

- attain school, district, and state curriculum standards
- individualize learning to address multiple styles and developmental stages
- provide authentic and meaningful learning experiences
- promote effective problem-solving and decision making
- improve communication, cooperation, and collaboration skills

3.1 Primary Learners (PreK to Grade 2)

For the primary learner, their world must be rich with letters, sounds, words, numbers, patterns, colors, creatures, community, creativity, and cooperation. Unlike early computer applications, there is an abundant selection of programs which "drill" and "thrill" (rather than "drill and kill") while practicing and reinforcing emerging reading and math literacy skills. The graphical user interface (GUI) of both the MAC OS and Windows operating systems, combined with quality sound capacity on all modern computers allows even the youngest of users to explore and experiment independently in electronic environments. Graphical representation of real world experiences begins the process of building bridges from the concrete to the abstract for the early learner. The remainder of this section will review potential uses of the six model configurations to enhance the early learning experience.
The primary learner benefits from environments:

- relying primarily on point and click interaction with icon linked auditory instructions, help options, and feedback
- rich in art and music exploration, with many arenas for creativity
- providing opportunities for the development of their self-concept and understanding of family and community
- presenting and reinforcing emergent reading/writing and math literacy skills
- supportive of group interactions and projects

Table 3-1: Primary Integration Strategies By Learning Environment

<table>
<thead>
<tr>
<th>Learning Environment</th>
<th>Technology Integration Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Computer Classroom</td>
<td>• alternative/ adaptive/ assistive input devices</td>
</tr>
<tr>
<td></td>
<td>• group creative writing experiences</td>
</tr>
<tr>
<td></td>
<td>• graphing and manipulating of group data</td>
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<tr>
<td></td>
<td>• remediation and enrichment activities</td>
</tr>
<tr>
<td></td>
<td>• teacher workstation to model and direct collaborative activities with projection capacity</td>
</tr>
<tr>
<td></td>
<td>• creativity and exploratory technologies rich with graphics and sound</td>
</tr>
<tr>
<td></td>
<td>• CD-ROM interactive story books</td>
</tr>
<tr>
<td>Instructional Technology Cluster</td>
<td>• computer managed instruction</td>
</tr>
<tr>
<td></td>
<td>• group multi-media production</td>
</tr>
<tr>
<td></td>
<td>• remediation and enrichment activities</td>
</tr>
<tr>
<td></td>
<td>• classroom student work-stations for drill and practice</td>
</tr>
<tr>
<td>Individual Computing Devices</td>
<td>• introduction to numeric calculators to embrace and reinforce math concepts</td>
</tr>
<tr>
<td></td>
<td>• beginning keyboarding activities</td>
</tr>
<tr>
<td>Instructional Technology Classroom</td>
<td>• access for individual exploration, technology awareness, and initial exposure to basic computing skills</td>
</tr>
<tr>
<td></td>
<td>• introduction to basic paint program elements</td>
</tr>
<tr>
<td></td>
<td>• Integrated Learning System for skills mastery</td>
</tr>
<tr>
<td>Library/ Media/ Information Resource Center</td>
<td>• storybook selection</td>
</tr>
<tr>
<td></td>
<td>• author studies</td>
</tr>
<tr>
<td></td>
<td>• technology resources awareness</td>
</tr>
<tr>
<td>Distance Learning Classroom</td>
<td>• &quot;meet&quot; online pen pals and/or information experts</td>
</tr>
</tbody>
</table>
3.2 Elementary Learners (Grades 3 to 5)

Now masters of basic reading and math concepts, the elementary learner seeks multiple opportunities to practice and apply these skills. They are ready to explore more complex topics, consider multiple opinions, research new information, and draw conclusions of their own. The occasion to produce/publish for a younger audience presents situations designed to build self-confidence and independence. The remainder of this section will review potential uses of the six model configurations to enrich learning experiences of the elementary child.

The elementary learner benefits from environments:

- rich in art, music, and animation exploration, with many arenas for creativity
- providing opportunities for the development of their self-esteem and cooperative learning skills
- offering experiences and activities for practicing and refining reading, writing, and mathematical computation skills
- contributing to the development of core content areas (e.g., reading, language arts, mathematics, science, and social studies)
- presenting multiple research mediums (databases, encyclopedias, atlases, Internet/ World Wide Web)
### Table 3-2: Elementary Integration Strategies By Learning Environment

<table>
<thead>
<tr>
<th>Learning Environment</th>
<th>Technology Integration Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Computer Classroom</td>
<td>• short creative writing experiences</td>
</tr>
<tr>
<td></td>
<td>• graphing and manipulating of data</td>
</tr>
<tr>
<td></td>
<td>• remediation and enrichment activities</td>
</tr>
<tr>
<td></td>
<td>• teacher workstation to model and direct collaborative activities with projection capacity</td>
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</tr>
<tr>
<td>Instructional Technology Cluster</td>
<td>• keyboarding skills</td>
</tr>
<tr>
<td></td>
<td>• computer managed instruction</td>
</tr>
<tr>
<td></td>
<td>• creative writing activities</td>
</tr>
<tr>
<td></td>
<td>• remediation and enrichment activities</td>
</tr>
<tr>
<td></td>
<td>• interactive, multiple-ending story development</td>
</tr>
<tr>
<td>Individual Computing Devices</td>
<td>• regular use of numeric calculators</td>
</tr>
<tr>
<td></td>
<td>• introduction to graphing calculators</td>
</tr>
<tr>
<td></td>
<td>• mastery of keyboarding skills</td>
</tr>
<tr>
<td></td>
<td>• writing activities</td>
</tr>
<tr>
<td>Instructional Technology Classroom</td>
<td>• lab access for initial exposure to new productivity applications and tools</td>
</tr>
<tr>
<td></td>
<td>• introduction to graphic design elements</td>
</tr>
<tr>
<td></td>
<td>• basic computer literacy skills development</td>
</tr>
<tr>
<td></td>
<td>• Integrated Learning System for skills mastery</td>
</tr>
<tr>
<td>Library/ Media/ Information Resource Center</td>
<td>• data gathering and research</td>
</tr>
<tr>
<td></td>
<td>• author studies</td>
</tr>
<tr>
<td></td>
<td>• technology resources awareness</td>
</tr>
<tr>
<td>Distance Learning Classroom</td>
<td>• school news broadcasts</td>
</tr>
</tbody>
</table>
3.3 Middle School Learners (Grades 6 to 8)

Many middle school students across our nation have already sailed past the technology skills level of educators within our schools. With regard to telecommunications skills, they send e-mail with ease, chat regularly on topics of interest, and know how to use search engines and strategies to readily find information on the World Wide Web. Many have created and maintain web pages for family and friends. Unfortunately this is a critical time when the disparity between the "haves" and "have nots" becomes most evident. Students with access to computer technology beyond the school day are able to create reports using word processors and desktop publishing, while students without access continue to submit handwritten papers. Multimedia presentations, web sites, and video production projects are also within reach of the middle school child with access to the Internet, camcorders, digital cameras, and video production equipment. Emerging higher-order thinking skills need to be honed and challenged for all learners within the school environment. Strategies to level the playing field will be introduced within the review of the model configurations appropriate for the middle school student.

The middle school learner benefits from environments:

- nurturing emerging higher-order thinking skills
- with arenas to work cooperatively with peers
- providing opportunities to develop self-confidence
- enabling the development and maturation of communication skills

Table 3-3: Middle School Integration Strategies By Learning Environment

<table>
<thead>
<tr>
<th>Learning Environment</th>
<th>Technology Integration Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Computer Classroom</td>
<td>• collaborative multi-media presentations</td>
</tr>
<tr>
<td></td>
<td>• class/ school newsletters</td>
</tr>
<tr>
<td></td>
<td>• micro-computer based lab explorations</td>
</tr>
<tr>
<td></td>
<td>• groupware activities and simulations</td>
</tr>
<tr>
<td></td>
<td>• telecommunications projects</td>
</tr>
<tr>
<td>Instructional Technology</td>
<td>• daily journals</td>
</tr>
<tr>
<td>Cluster</td>
<td>• problem-solving technology applications</td>
</tr>
<tr>
<td></td>
<td>• creative and expository writing activities</td>
</tr>
<tr>
<td></td>
<td>• research, data collection and manipulation</td>
</tr>
</tbody>
</table>
### Learning Environment | Technology Integration Strategies
---|---
Individual Computing Devices | • regular use of graphing calculators in algebra  
• data gathering for research and writing activities  
• electronic note-taking in school and during fieldtrips  
• use of CBL (computer-based lab) probes and meters connected to graphing calculators and computers for scientific data collection and manipulation  
• communicate via email

### Instructional Technology Classroom |  
• on-going curriculum integration activities  
• cross-content research and writing assignments  
• "technology as a tool" activities (wp, db, ss, dr)

### Library/ Media/ Information Resource Center |  
• electronic and on-line research in content areas  
• identify, synthesize, and organize information  
• independent study, skills drills, homework

### Distance Learning Classroom |  
• world languages studies  
• broadcasts of projects and plays to other facilities

### 3.4 High School Learners (Grades 9 to 12)

The world of work is a reality in one fashion or another for most high school students either through part-time jobs, volunteer activities, or internships. Some have already identified career paths, others seek to further their education through degree or certification programs, while some decide to leave the school environment prior to receiving their diploma. All high school students will require the competitive edge allowing them to compete in an increasingly sophisticated, global economy and workplace. Secondary school environments strive to meet the needs of all these audiences: prepare students with workplace competencies which allow them to immediately enter the job market and succeed, provide pathways to positive higher education experiences, and engage the disinterested with meaningful experiences and opportunities advancing toward the attainment of their diploma. All secondary learning environments must promote skills fostering high levels of learning, engaging higher-order thinking, and encouraging collaboration, teamwork, and sense of citizenship. The infusion of a diverse array of technology resources throughout secondary school facilities provides the potential to meet the disparate needs of this audience. This section provides an overview of technology resources for the secondary school student.

The high school learner benefits from environments:

- formalizing higher-order thinking and problem-solving skills  
- involving or mirroring real-world experiences  
- developing a sense of community membership
- identifying future vocational and academic pursuits

**Table 3-4: High School Integration Strategies By Learning Environment**

<table>
<thead>
<tr>
<th>Learning Environment</th>
<th>Technology Integration Strategies</th>
</tr>
</thead>
</table>
| One-Computer Classroom              | • collaborative multi-media presentations  
                                 | • desktop publishing community services  
                                 | • original research and publications  
                                 | • real-world task specific technology applications                                                |
| Instructional Technology Cluster    | • school yearbook  
                                 | • integration of data collected across disciplines  
                                 | • school/community newsletters and bulletins  
                                 | • collaborative projects addressing global issue                                                      |
| Individual Computing Devices        | • sophisticated use of graphing calculators in advanced mathematics courses  
                                 | • data gathering for writing, research and presentation projects  
                                 | • electronic note-taking in school and at remote/off-site locations  
                                 | • use of personal digital assistants for information, time, and school activities management  
                                 | • use of CBL (computer-based lab) probes and meters connected to graphing calculators and computers for scientific data collection and manipulation  
                                 | • communicate via email                                                                           |
| Instructional Technology Classroom  | • CAD/CAM design and development lab  
                                 | • simulated office automation distributed network  
                                 | • programming and advanced placement instruction                                                   |
| Library/Media/Information Resource Center | • data collection and transfer via telecommunications  
                                 | • student as mentor/technician/assistant program  
                                 | • in-depth electronic and on-line research                                                          |
| Distance Learning Classroom         | • low enrollment courses  
                                 | • advanced placement courses  
                                 | • courses with national instructor shortages  
                                 | • community broadcasts                                                                           |
3.5 Adult Learners (Beyond Grade 12)

The 21st century job market, including educational institutions, requires that all adult learners become masters of adaptation and change. No longer is one skill likely to last an employable lifetime. As stated by President Clinton, "... what you earn depends on what you can learn. Not only what you know today, but what you are capable of learning tomorrow." Public school facilities have an opportunity to garner on-going support from the greater school community while meeting an important retraining need for adult citizens. Providing access to technology learning environments and coursework during primarily non-school hours holds huge potential as a "win-win" situation for preK-12 students and the community alike. The following provides examples of school-community partnerships formed around the notion of adult education where technology is both the "objection of instruction" and the "means to deliver instruction".

The Adult learner benefits from environments:

- acknowledging and utilizing existing knowledge and expertise
- offering opportunities for networking and collaboration
- providing meaningful learning experiences in word processing, database, spreadsheet, presentation, web-development, and email applications
- identifying new vocations and career options
- linked to the Internet and the World Wide Web
- flexibly addressing time and location requirements

Table 3-5: Adult Integration Strategies By Learning Environment

<table>
<thead>
<tr>
<th>Learning Environment</th>
<th>Technology Integration Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Computer Classroom</td>
<td>• access to Internet/ WWW from home via modem</td>
</tr>
<tr>
<td></td>
<td>• desktop publishing resume/ marketing materials</td>
</tr>
<tr>
<td></td>
<td>• original research and publications</td>
</tr>
<tr>
<td>Instructional Technology Cluster</td>
<td>• networking with community members</td>
</tr>
<tr>
<td></td>
<td>• school/ community projects</td>
</tr>
<tr>
<td></td>
<td>• real-world task specific technology applications</td>
</tr>
<tr>
<td>Instructional Technology Classroom</td>
<td>• CAD/ CAM design and development lab</td>
</tr>
<tr>
<td></td>
<td>• simulated office automation distributed network</td>
</tr>
<tr>
<td></td>
<td>• programming/ network management instruction</td>
</tr>
<tr>
<td></td>
<td>• word process, database, spreadsheet basics</td>
</tr>
<tr>
<td>Learning Environment</td>
<td>Technology Integration Strategies</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Individual Computing Devices         | • sophisticated use of graphing calculators in advanced mathematics courses  
|                                      | • data gathering for writing, research and presentation projects        
|                                      | • electronic notetaking at meetings, seminars, and/or courses/classes  
|                                      | • use of personal digital assistants for information, time, and schedule management  
|                                      | • address communication needs via email                                  |
| Library/ Media/ Information Resource Center | • data collection and transfer via telecommunications                  
|                                      | • mentor/ technician/ assistant program                                 
|                                      | • in-depth electronic and on-line research                              |
| Distance Learning Classroom           | • adult education courses                                              
|                                      | • world languages courses                                               
|                                      | • remote staff development opportunities                                |
4.0 WIRING STRATEGY FOR TECHNOLOGY ENHANCED LEARNING ENVIRONMENTS

In addition to the manner in which technology resources are configured, the capacity of each with respect to a few key variables will also significantly affect their functionality within the learning environment. These key variables include network access, e-mail and World Wide Web access, projection capacity, and cable/distance learning capacity. Planning for appropriate wiring strategies throughout district facilities will significantly enhance the functionality of the technology enhanced learning environments discussed previously.

4.1 Room Outlet Types

The configurations selected for specific rooms within a school will determine the types of technology outlets best suited for the environment. Outlet strategies are needed to address the needs of the following situations:

- teacher presentation outlet
- teacher outlet
- small offices and conference rooms
- student outlets
- single outlets (phone only, video only)
- lab raceway

The following sections discuss strategies for addressing each of these situations.

Teacher Presentation Outlet (TP/VP)

Teachers should have an outlet near their desk for voice, data, and video. In addition it should have the capability for displaying the computer screen, video player output, and programs from the RF video network onto a 31” or 32” video monitor (See Figure 4-1).
Figure 4-1: Typical Teacher Presentation Outlet (TP/VP)

Note that this configuration uses two outlets. The TP plate is located conveniently near the teacher’s desk. The VP plate is located near the TV monitor, which will typically be placed on a tall cabinet or permanently connected to the wall or ceiling.
For new construction and for facilities with drywalls, the wiring should be placed within the walls and each TP or VP plate terminated on a single gang box. For existing buildings, the wiring from the ceiling or hallway can be protected in a raceway (for example, Wiremold 700) which flares out to a single gang box containing the outlet.

**Teacher Outlet (T)**

For smaller teaching environments, such as in special education classrooms, teachers should have an outlet near their desk for voice, data, and video, as shown in Figure 4-1. This provides almost the same capability as the TP/VP plate, but is less convenient because cables must be run directly between the computer and the video monitor. This outlet is best used where video is seldom used or where video monitors are not permanently installed.
Small Offices and Conference Rooms (M)

Figure 4-4 shows the simplest outlets for offices and conference rooms. One of the RJ-45 jacks can be used for voice and the other for data. They can be both be used for data or voice by connecting the patch cords on the patch panels in the wiring closet to either the data or voice services.

Figure 4-4: Administrative Voice/Data Outlet (M)

For new construction and for facilities with drywalls, the wiring should be placed within the walls, terminated on a single gang box. For existing buildings, the wiring from the ceiling or hallway can be protected in a raceway (for example, Wiremold 700) which flares out to a single gang box containing the outlet.

Student Outlets (Sn)

Where high densities of workstations are involved, such as in labs or clusters of workstations in a classroom, higher density outlets such as those shown in Figure 4-5 should be used.

S4 Outlet
Figure 4-5: Student 4 and 6 Workstation Outlets (S4 and S6)

For new construction and for facilities with drywalls, the wiring should be placed within the walls, terminated on a single gang box. For existing buildings, the wiring from the ceiling or hallway can be protected in a raceway (for example, Wiremold 700) that flares out to a single gang box containing the outlet.

Single Outlets - Phone (P) and Video (V)

Sometimes only a single outlet is required, such as for voice or data (see Figure 4-6) or video only (Figure 4-7).
For new construction and for facilities with drywalls, the wiring should be placed within the walls, terminated on a single gang box. For existing buildings, the wiring from the ceiling or hallway can be protected in a raceway (for example, Wiremold 700) that flares out to a single gang box containing the outlet.

**Lab Raceway (Wn)**

For computer labs, particularly where the walls are made of cinder block or masonry, raceway such as Wiremold 2000 can be employed to cost effectively provide data lines to a large number of workstations (see Figure 4-8).

If power is also required, raceways with a metal central divider (such as Wiremold 4000) should be used, with power running in one channel and data circuits in the other (see Figure 4-9).
4.2 **Alignment with Technology Enhanced Learning Environments**

The following table aligns five of the six technology enhanced learning environments with typical outlet options. Most individual computing devices run on regular or rechargable batteries, requiring no special outlet strategies.

<table>
<thead>
<tr>
<th>Learning Environment</th>
<th>Wiring Strategy (Most to Least Desirable within Environment)</th>
</tr>
</thead>
</table>
| Individual Computer                   | • Use voice/ data/ video outlet at front of room  
                                       | • Use voice/ data outlet at front of room                                                                                   |
| Instructional Technology Cluster      | • Use 4 or 6 data outlet at back of room  
                                       | • Use single outlet in back of room, with 4-8 port network hub  
                                       | • Use 4-8 port network hub on teacher’s data outlet                                                                       |
| Instructional Technology Classroom    | • teacher’s outlet (see individual computer)  
                                       | • multiple 4-6 port outlets around the room or raceway with outlets 3’ apart (with power if necessary)                      |
| Information Resource Center           | • any combination of voice/ data, voice/ video/ data, high density data, or raceway outlets that are appropriate.            |
| Distance Learning Complex             | • any combination of voice/ data, voice/ video/ data, high density data, or raceway outlets that are appropriate but will probably need an ample supply of video connections |
4.3 Nonacademic Areas

All school facilities contain a number of spaces which are not used for direct student instruction. For the purposes of this guide, these areas are identified as “nonacademic areas”. When planning wiring strategies and outlet selection for administrative offices, teacher workrooms, auditorium/stage areas, gymnasium/sports areas, and cafeteria/lobby areas refer to the proposed guidelines for nonacademic areas in sections 4.3.1 to 4.3.5.

Administrative Offices

The administrative office areas need to plan for integration onto the technology network system. The planned location of a desk or workstation table is needed to locate the data network outlet effectively and thus define the number of voice/data cables required. It is recommended that at least two voice/data cables run to each administrative outlet location.

In certain administrative offices such as the principal’s or superintendent’s, the inclusion of video drop cables might be considered.

Teacher Workroom

Teacher workrooms represent areas where teachers can access the technology network for class preparation or administrative information input or access until workstations can be placed in the classrooms. These areas should be planned to allow the teacher ample space in a private environment. Therefore the identification of an area where the workstations can be located is important. The exact location and quantity of workstations will vary depending on the room configuration. Allowance for a workstation area of approximately 36’ wide and 30’ deep is recommended.

Auditorium/Stage Areas

The auditorium/stage area represents a whole school presentation area. The ability to present information to a large group is particularly important. For this reason technology tools such as video projection systems and large screen displays are required. The fixed mounting of these devices normally is recommended because of the setup time required. If these devices are planned and the locations are identified, both data and video cabling can be arranged. Usually it is recommended that multiple video cable drops be located throughout the auditorium to provide videotaping or live broadcast of events that occur in the auditorium.

Gymnasium/Sports Areas

The arrangement for video drop cabling in the gymnasium and other sports-related areas is recommended to support the ability to videotape or provide live broadcasting of events held in these areas. Planning for multiple video drops provides greater options for camera angle coverage.

Cafeteria/Lobby Areas

The cafeteria and lobby areas represent general student body congregation areas. These areas are well suited for the display of school notices and other school activity information. If these areas are cabled for data and video drops, electronic bulletin boards are possible.
The display of pertinent video programming and news events can be provided in these areas.

4.4 Distribution Frames

Within each facility distribution frame areas will need to be identified. Depending on the size of the school and sophistication of the network, the number of distribution frames may vary. Use the guidelines below for locating the main distribution frame area and the video head-end area.

Main Distribution Frame Area

The wiring distribution area identified as the main distribution frame (MDF) area should be the room or closet that provides the most central cabling distribution point for the building or campus. This location requires a secure environment with adequate electrical power from which the data cables can begin their run through the building to their room outlet locations. This area needs to provide adequate room for the installation of one or more 19" equipment racks, wire management trays, cross-field punchdown blocks, and other cabling hardware. This area should be identified by trained professionals who can determine the cable run lengths and compare various MDF sites to determine the best fit. This is important because an improperly located MDF can result in the extra cost imposed by an additional distribution frame, called an intermediate distribution frame (IDF). Some buildings will require multiple data cabling distribution areas, but the number of these areas should be kept minimal to reduce costs.

Video Head-End Area

The video head-end area is the room where the video distribution amplifier and other signal processing equipment will be located. Normally it is recommended that this area be in proximity to the media center/library. This facilitates control over resources transmitted on the video system from the same area that normally manages these types of programming resources, videotapes, laserdiscs, TV channel distributions, etc.

This area will require ample space for a 19" equipment rack (enclosed), adequate electrical power supply, and ample ventilation to prevent room overheating.

4.5 Wiring Standards

All facilities should adopt a voice and data wiring system based on the Electronics Industry Association/Telecommunications Industry Association (EIA/TIA) 568A standard for structured building wiring. This standard covers small, medium and large buildings as well as "campus" environments where several buildings are on the same property.

New wiring should use four pair (eight wires) of enhanced Category 5 unshielded twisted pair (UTP) wires for each circuit to a modular jack in each wall plate. Enhanced Category 5 UTP supports analog phones, fax, Integrated Services Digital Network (ISDN) phones, two pair RS232D data lines, LocalTalk, Ethernet (10BaseT), Token Ring (4/16 mbps), Ethernet (100BaseTX), FDDI over copper (100 mbps), Asynchronous Transfer Mode (ATM) and gigabit Ethernet (1,000 mbps). The network backbone incorporates fiber optic cable that supports speeds up to 1,000 mbps. The copper/fiber network wiring will support voice, data, and interactive video.
For distribution of a large number of simultaneous one-way video programs, the district should standardize on cable TV industry standards.

Table 4-2 summarizes minimum wiring recommendations for voice, data, and video communications.
Table 4-2: Minimum Building Wiring Recommendations Summary

<table>
<thead>
<tr>
<th>Infrastructure Area</th>
<th>Component</th>
<th>Data</th>
<th>Voice</th>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Area</td>
<td>Connector</td>
<td>RJ-45</td>
<td>RJ-45</td>
<td>BNC Connector</td>
</tr>
<tr>
<td></td>
<td>Pinning</td>
<td>EIA/ TIA 568-B</td>
<td>EIA/ TIA 568-B</td>
<td>N/ A</td>
</tr>
<tr>
<td></td>
<td>Face Plate</td>
<td>Three (3) Composite</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distribution</td>
<td>One per Work Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mounting</td>
<td>Permanent/ Wall Mount</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>Cable</td>
<td>Level 5 UTP</td>
<td>Level 5 UTP</td>
<td>RG-6</td>
</tr>
<tr>
<td></td>
<td>Conductor</td>
<td>4-Pair (8 Conductor)</td>
<td>4-Pair (8 Conductor)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Install</td>
<td>Conduit/ Cable Tray/ Hidden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution Frame</td>
<td>Patching Connector</td>
<td>RJ-45</td>
<td>RJ-45</td>
<td>N-Type</td>
</tr>
<tr>
<td></td>
<td>Punch Down</td>
<td>110 Type</td>
<td>110 Type</td>
<td>N/ A</td>
</tr>
<tr>
<td></td>
<td>Mounting</td>
<td>Wall/ Cabinet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backbone</td>
<td>Cable Type</td>
<td>50 µm Multimode (500 MHz*km) (single mode if over 550 m) Fiber Optic</td>
<td>Level 3 UTP</td>
<td>RG-11</td>
</tr>
<tr>
<td></td>
<td>Conductor</td>
<td>24 Strand</td>
<td>100 Pair</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Connector</td>
<td>SC-Duplex Type</td>
<td>Amp 50 pin</td>
<td>N-Type</td>
</tr>
<tr>
<td></td>
<td>Mounting</td>
<td>Conduit/ Cable Tray</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campus Backbone</td>
<td>Cable Type</td>
<td>50 µm Multimode (500 MHz*km) (single mode if over 550 m) Fiber Optic</td>
<td>Level 3 UTP</td>
<td>RG-11</td>
</tr>
<tr>
<td></td>
<td>Conductor</td>
<td>24 Strand Multimode (or 12 Single-mode)</td>
<td>100 Pair</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Connector</td>
<td>SC-Duplex Type</td>
<td>Amp 50 pin</td>
<td>N-Type</td>
</tr>
<tr>
<td></td>
<td>Mounting</td>
<td>Conduit/ Overhead Pole/ Direct Burial</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>